Comments on the Provisional Atmospheric Emission License (PAEL) Issued to Thabametsi Power Company (Pty) Ltd.[1]

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Executive Summary

- The Provisional Atmospheric Emission License (PAEL) for the Thabametsi power plant allows the plant to use old sub-critical (circulating fluidized bed) CFB technology that is much less efficient and more polluting than other super-critical boiler technologies, including super-critical CFB technology.
- The PAEL does not adequately assess air pollution impacts from the Thabametsi plant. It provides no support for its assertions concerning the effectiveness of proposed air pollution control technologies; underestimates NOx emissions; and fails to require continuous emissions monitoring or sufficient reporting.
- The PAEL was based on flawed Atmospheric Impact Reports (AIRs) which, among other things, 1) omit providing or discussing crucial data and modelling information, without which a proper assessment of the AIR's assumptions and results is not possible; 2) fail to model important sources of air pollution associated with the Thabametsi power station, including emissions from the coal mining activities supplying the mine, transport and storage of coal, and ash handling, storage and disposal; and 3) inadequately assess the cumulative impacts, including the full range of emissions from the Medupi and Matimba plants and surrounding mines and haul roads; 4) ultimately underestimate the air pollution impacts of the power station.
- There is simply no justification for permitting such a power plant in an already polluted Priority Area where the National Ambient Air Quality Standards (NAAQS) are not being met.

I. Introduction

As an engineer with over 30 years' experience in power plant design, operation and maintenance, my comments are based on my review of the Provisional Atmospheric Emission License (PAEL) issued to Thabametsi Power Company (Pty) Ltd issued by the Department of Environmental Affairs (now Department of Environment Forestry and Fisheries) (hereafter "Department") as well as the letter explaining this issuance by the Department.[2] I refer to my three previous reports based, first, on information in Thabametsi's environmental impact assessment reports and then related to the initial and revised Atmospheric Impact Reports (AIRs) on the Thabametsi power plant. My reports were issued March 23, 2018 (**Attachment A6A**); May 21, 2018 (**Attachment A6B**); and September 3, 2018 (**Attachment A6C**).

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[1] PROVISIONAL ATMOSPHERIC EMISSION LICENCE AS CONTEMPLATED IN SECTION 43 OF THE NATIONAL ENVIRONMENTAL MANAGEMENT: AIR QUALITY ACT, 2004, (ACT NO. 39 OF 2004), Issued 14 February 2019.

[2] Letter from Dr. Thulie Khumalo, Department of Environmental Affairs, Republic of South Africa to Ms. Nicole Loser, Center for Environmental Rights (CER), dated October 7, 2019.

I have seen no responses by the Department or Thabametsi to address and correct the various technical issues raised in my previous reports. Each of the issues raised remain unresolved, and are especially pertinent to the PAEL, which permits what was previously contemplated as Phase 1 of the full Thabametsi project – i.e., one-half of the full 1200MW project.

II. Brief Description of the Project

The proposed Thabametsi power plant will be located in the Waterberg Bojanala Priority Area, which is in violation of South Africa's NAAQS for a number of pollutants. There are no residential, commercial and industrial areas within a 5 km radius from the center of the proposed operation except for the Grootegeluk Coal Mine to the southeast. The proposed Thabametsi Coal Mine will be developed adjacent to the project site. The closest residential areas from the center of the proposed operations are all to the east-southeast, and include Marapong, 13.5 km away, Onverwacht, 20 km away, and Lephalale, 25 km away. Eskom's Matimba Power Station is located 14 km to the east southeast, and the Medupi Power Station is located 13 km to the southeast. The proposed project will consist of the following as shown in Section 5.3 of the PAEL: identical Boiler Units 1, 2, 3, and 4; an ash dump; a coal yard; and a lime stockpile. However, significant additional air pollution sources such as the adjoining Thabametsi coal mine and haul roads are not included or considered in the PAEL's analysis.

III. Comments

A. The PAEL relies on an Atmospheric Impact Report for the power plant that is severely deficient and underestimates the potential pollution impacts from the power station

As I explained in my reports dated September 3, 2018, and May 21, 2018, the AIR supporting Thabametsi power station's application is deficient and underestimates the potential pollution from the power station.

The AIR, among other things, 1) omits or fails to discuss crucial data and modelling information, without which a proper assessment of the AIR's assumptions and results is not possible; 2) fails to model important sources of air pollution associated with the Thabametsi power station, including emissions from the coal mining activities supplying the mine, transport and storage of coal, and ash handling, storage and disposal; and 3) inadequately assesses the cumulative impacts, including the full range of emissions from the Medupi and Matimba plants and surrounding mines and haul roads; 4) ultimately underestimates the air pollution impacts of the power station.

I address these issues in detail in my previous reports.

B. The PAEL Underestimates and Inadequately Controls for Air Pollution Impacts

Section 5.1 of the PAEL states that:

> "[C]oal will be transported to the proposed Thabametsi Power Plant by means of closed conveyors or by train. Limestone will be transported to the proposed Thabametsi Power Plant by trucks. The proposed Thabametsi Power Plant will consist of four Circulating Fluidized Bed (CFB) boiler units, each with a power rating of 157.5 MWe. Emissions from two boiler units will be routed to a separate stack. The boiler units will operate continuously, i.e. 24 hours a day. Each boiler will consume coal at a maximum rate of 179 tons/hour. Each boiler unit will be fitted with a fabric filter, which has a cleaning efficiency of 99.9% and an availability of 100%.
> …
> Coal combustion takes place in this suspended condition at a temperature of 760°C to 927°C to prevent the formation of nitrogen oxide (NOx).
> …
> Sulphur-absorbing chemical such as limestone or dolomite are typically mixed with the coal in the fluidisation phase. These absorb up to 95% of the SO2.
> …
> NOx is produced from thermal fixation of atmospheric nitrogen in the combustion flame and from oxidation of nitrogen bound in the coal. The quantity of NOx produced is directly proportional to the temperature of the flame." (emphasis added).

There are numerous issues and misstatements in the discussion above.

i. The PAEL Fails to Accurately Account and Control for all PM Emissions Associated with the Project

Particulate matter (PM) emissions of various sizes (i.e., PM_{10} and $PM_{2.5}$) will occur due to the transportation of coal (i.e., by conveyors or by train) and limestone (by truck) to the Thabametsi power plant. The quantification of these emissions and their impacts based on the actual designs and operational aspects of transportation have not been properly addressed in the supporting documents such as the AIR. It is highly unlikely that completely covered conveyors will be used to transport coal due to safety and flammability reasons.

ii. The Effectiveness of Proposed Controls Are Unsupported

There is no support provided in any of the project documents that the fabric filters, which will be used to control fly ash, will achieve and maintain the stated cleaning efficiency of 99.9% for PM_{10} and $PM_{2.5}$. While fabric filters can achieve this level of performance, considerable preventive and on-going maintenance is required to attain and maintain it, including: pro-active replacement of bags (i.e., before they develop leaks); incorporation of leak detection technology to assist in pin-pointing leaking bags, should they occur; continuous compartment pressure drop measurements;

continuous flow measurements, etc. None of the project documents discuss any design aspects of the fabric filters. Thus, assuming that they will meet the 99.9% cleaning efficiency is not supportable.

It is also not clear what is meant by "availability of 100%" in connection with the fabric filters. Typically, hundreds or thousands of individual filters are housed in boxes for each boiler. It is common for many of these filter bags to leak over time, and they have to be replaced. There is nothing in the PAEL that points to a maintenance program for the fabric filters to ensure that anything approaching 100% availability (i.e., no leaking filter bags) is even feasible or possible. Thus, simply stating that there will be 100% availability is meaningless and misleading without a comprehensive plan to maintain and replace leaking bags.

Section 5.1 of the PAEL states that "up to" 95% of the SO_2 will be absorbed in the CFB boilers. Yet there is no technical or engineering support provided for this assumed SO_2 reduction. SO_2 removal in a CFB depends on many factors including the level, type and form of sulfur in the coal, the reactivity of the limestone that will be used, the size distribution of the coal and limestone that will be used, and the residence times of the coal and limestone particles in the CFB. Depending on these factors, actual SO_2 removal rates can be far lower, down to 50% or similar. Yet, none of the project documents discuss any of these design aspects. Therefore, simply assuming that 95% of the SO_2 will be removed at all times and under all conditions is not supportable.

The statements pertaining to NOx from the CFB boilers are also contradictory and misleading. The PAEL states that NOx formation will be prevented altogether, but a few paragraphs later it states that NOx will be produced due to "thermal fixation of atmospheric nitrogen" and from the nitrogen bound in coal. The latter is correct – i.e., even in these CFB boilers, NOx will be produced by both thermal oxidation of nitrogen in the air used as the oxidant for coal as well as from the nitrogen present in coal.[3] The PAEL is wrong when it states that NOx is directly proportional to the temperature of the flame, implying a linear relationship between flame temperature and the quantity of NOx formed. In fact, thermal NOx formation typically increases exponentially (i.e., much faster than linearly) with increasing temperature.[4]

iii. CFB Boilers are an Outdated Control Technology

CFB boilers are not new technology as claimed in the PAEL and in the reasons justifying the issuance of the PAEL. I quote from the latter:

> "1.2. Pollution Prevention Measures: Best Practicable Environmental Option The applicant proposes to utilize a modern technology in form of Circulating Fluidized Bed (CBD) boiler

[3] *See, e.g.*, Energy Solutions Center, *How NOx is formed*, (accessed October 21, 2019), http://cleanboiler.org/workshop/how-is-nox-formed/.

[4] Id.

units….The technology is said to have the ability to achieve lower emission of pollutants…"

The first CFB boilers were used in the United States well over 40 years ago. Thus, they are quite old technology. However, what is new is that there are now super-critical forms of these CFB boilers, which are much more thermally efficient (i.e., they can generate more electricity using less coal, thus producing fewer pollutants for the same quantity of electricity generated) than the sub-critical CFB units proposed at Thabametsi. I quote from literature from China on this subject:

> "The first 600 MWe supercritical CFB boiler and its auxiliaries were successfully developed and demonstrated in Baima Power Plant, Shenhua Group as well as the simulator, control technology, installation technology, commissioning technology, system integration and operation technology. Compared with the 460 MWe supercritical CFB in Poland, developed in the same period and the only other supercritical one of commercial running in the word beside Baima, the 600 MWe one in Baima has a better performance. Besides, supercritical CFB boilers of 350 MWe have been developed and widely commercialized in China."[5] (emphasis added).

With regard to the 460 MW supercritical boiler in Poland referenced above, which has been in operation since 2009 (i.e., over 10 years now), I note its superior environmental performance as stated below:

> "The Łagisza power plant in Będzin, Poland, is home to the world's first 460-MW supercritical circulating fluidized bed boiler (CFB), which remains the largest of its kind outside China. Since beginning commercial operation in June 2009….Sulfur dioxide emissions are controlled by feeding limestone into the boiler…NOx emissions are effectively controlled by staged combustion as well as the addition of ammonia as part of a selective non-catalytic reduction process…An ESP system is used to control PM emissions. Consequently, in 2015 the emissions were as follows: 17,000.2 kg PM (<30 mg/Nm3); 454,962.3 kg SOx (<200 mg/Nm3); 521,274.3 kg NOx (<200 mg/Nm3); and 721,367 tCO2."[6] (emphasis added).

I contrast the underlined PM, SO_2, and NOx performance of the Lagisza CFB boiler with that allowed under the PAEL (Section 7.2, excerpted below for the first boiler – the rest are identical) for each of the four Thabametsi CFB boilers: i.e., 50 mg/Nm^3 for PM; 500 mg/Nm^3 for SO_2; and 750 mg/Nm^3 for NOx. These PAEL levels are over 1.5 times the performance achieved in Poland

[5] Lyu, J., Yang, H., Ling, W. et al. Front. Energy (2019) 13: 114. https://doi.org/10.1007/s11708-017-0512-4, Development of a supercritical and an ultra-supercritical circulating fluidized bed boiler.
[6] Malgorzata Wiatros-Motyka, IEA Clean Coal Center. See https://www.worldcoal.org/%C5%82agisza-power-plant-world%E2%80%99s-first-supercritical-cfb

in 2015 for PM; over 2.5 times for SO_2; and over 3.5 times for NOx. While we obviously do not have actual emissions from Thabametsi at this time, the emissions levels permitted by the PAEL (to which actual emissions could approach without proper operation of the air pollution controls proposed at Thabametsi) are substantially higher than the reported emissions from the Lagisza power plant.

7.2. Point source – maximum emission rates (under normal working conditions)

Point Source Code	Activity	Pollutant Name	Maximum Release Rate			Duration of Emissions
			(mg/Nm³)	Date to be Achieved By	Average Period	
EU001	SA0101	PM	50	Upon commencement	24 Hours	Continuous
	SA0101	SO_2	500	Upon Commencement	24 Hours	Continuous
	SA0101	NO_x	750	Upon commencement	24 Hours	Continuous

There is simply no justification to approve what is demonstrably old and outdated technology as is being done in the PAEL.

In addition, I note that the Thabametsi boilers will not be required to install selective non-catalytic reduction (SNCR) for NOx, as is used for the Lagisza boiler in Poland. SNCR could reduce NOx by a further 25-50% from current levels.

C. Emissions from the Thabametsi Plant Will Contribute to Existing Violations of the NAAQS

The Thabametsi power plant will be located in the Waterberg Bojanala Priority Area, which does not meet many of the NAAQS. I have reviewed recent monitoring data from Lephalale, roughly 25 km from the proposed project site where there is substantial residential population. Results are summarized below:

Lephalale NAAQS Exceedances (January 2017 – May 2019)

Month	*Year*	*Pollutant*	*# Exceedances*
November	2017	PM10-24hr	1
April	2017	O3-8hr	1
September	2017	O3-8hr	17
October	2017	O3-8hr	5
March	2018	SO2-10min	1
March	2018	SO2-1hr	1
May	2018	SO2-1hr	1
August	2018	O3-8hr	8
September	2018	O3-8hr	54
February	2019	SO2-10min	8
February	2019	SO2-1hr	3

First, it is clear that even under current conditions, without the Thabametsi plant's emissions, NAAQS levels of PM_{10}, SO_2, and ozone (formed in the atmosphere from volatile organic compounds and NOx) are already being exceeded as shown in the table above. This does not include the recent coal-feed problems being experienced at Medupi, which is allegedly being supplied with coal by trucks (generating enormous fugitive dust and PM_{10} impacts in the process), because the coal conveyor supplying Medupi is broken.[7] Thus, any additional levels of increased pollutant mass into the atmosphere in the area will only further exacerbate the ambient air pollution problems in the region. I should also note that the expected benefits of scrubber installation at the Medupi units (which are supposed to begin coming online starting in 2021[8]) is uncertain because there is no certainty as to the scrubber installation/operation schedule at that plant.

Thus, there is no justification for approving another highly polluting coal plant like Thabametsi when emissions from existing sources in the Waterberg Bojanala Priority Area have already resulted in multiple exceedances of the NAAQS.

C. Monitoring Requirements in the PAEL are Inadequate

Requirements for monitoring of the actual pollutant emissions from the CFB boilers are grossly inadequate. Section 7.4 of the PAEL shows the following (for the first boiler, the others being identical).

7.4. Point source – emission monitoring and reporting requirements

Point Source Code	Activity	Polluted	Emission Sampling / Monitoring Method	Sampling Frequency	Sampling Duration	Parameters to be Measured	Parameters to be Reported	Reporting Frequency
EU001	SA0101	PM	As per NEM:AQA Schedule A (31 October 2018)	daily	As per selected method	PM	PM	Quarterly
	SA0101	SO_2	As per NEM:AQA Schedule A (31 October 2018)	daily	As per selected methed	SO_2	SO_2	Quarterly
	SA0101	NO_x	As per NEM:AQA Schedule A (31 October 2018)	daily	As per selected methed	NO_x	NO_x	Quarterly

Continuous Emissions Monitors (CEMs) should be required for each of the three pollutants and for exhaust flow. CEMs are used extensively in coal-fired power plants throughout the world, including in South Africa (at least for SO_2 and NOx). Yet, there is no mention of CEMs in Condition 7.4 above. The "daily" sampling frequency makes no sense because emissions from the plant can and will vary considerably on much shorter time-scales – making daily snap-shot measurements meaningless. CEMs typically measure emissions on a minute-by-minute basis and report hourly average concentration or hourly mass emissions.

IV. Conclusion

There is no justification for allowing the significant additional emissions from the Thabametsi power plant into an already-polluted airshed. Contrary to its statements, the PAEL would allow old, inefficient and polluting CFB technology, without proper NOx controls, with dubious support for the SO_2 and PM controls' expected performance, and without continuous emissions monitoring and reporting of hourly average concentrations or mass emissions. This is unreasonable and

[7] See, https://www.dailymaverick.co.za/article/2019-10-23-medupi-magic-fails-eskom-and-south-africa/
[8] http://m.engineeringnews.co.za/article/medupi-to-comply-with-emissions-standards-2016-05-13

dangerous in an already-polluted Priority Area where the NAAQS are not being met, and where there are already major sources of air pollution in the vicinity of the power station.