Technical Appendix: Final Motivation for the Additional Postponement of Compliance Timeframes in terms of Regulation 11 of the Section 21 NEM:AQA Minimum Emissions Standards

Report Prepared by

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Foreword

This technical appendix presents technical information regarding Sasol's investigations into solutions for compliance with existing plant standards and new plant standards as prescribed in the Minimum Emissions Standards (MES), specified in Part 3 of GN 893.

Each chapter represents technical information pertaining to a particular listed activity, and is structured as follows:

- Applicable MES for the given process or listed activity is provided.
- A short description of the production process involved is presented (as included in the main report, but with more detail, as pertinent).
- A discussion on the various technology options investigated to achieve compliance with the applicable MES and the constraints involved in implementing them.
- Proposed alternative emission limits informed by all these inputs.

This technical work on technology options for compliance with the MES informed the chapter on "Reasons for applying for postponement" in the accompanying Sasol Synfuels motivation report, and also informed the alternative emissions limits requested.

Although this additional postponement application relates to the 2015 existing plant standards, for completeness' sake, this appendix also outlines the challenges faced in meeting new plant standards.

A note on the assessment of feasibility of compliance with the prescribed MES

In this technical appendix, statements are incorporated regarding the feasibility of identified technologies as emissions abatement solutions. Assessments of these technologies were triggered in some instances by Sasol's internal policies regarding continuous improvement, and in others, by the requirement to comply with the MES. The assessment of feasibility is a holistic assessment of the implications of compliance from multiple perspectives, including but not limited to:

- The viability of a technology to achieve the desired emission reduction outcome.
- The integration viability of technologies within the unique Sasol CTL environment.
- The upstream and downstream impacts of implementing a technology.
- Operability of the technology.
- Implementation considerations including process safety risks, construction risks, production risks and integrated planned maintenance scheduling implications.
- Financial implications, including upfront capital expenditure and lifecycle operating costs.
- Environmental cross-media impacts.
- Ambient air quality benefits arising.

These assessments inform decision-making regarding the holistic 'feasibility' of a compliance technology.

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Glossary

Definitions of terms as per GN 893, that have relevance to this application:

Existing Plant - any plant or process that was legally authorized to operate before 1 April 2010 or any plant where an application for authorisation in terms of the National Environmental Management Act 1998 (Act No.107 of 1998), was made before 1 April 2010.

Fugitive emissions - emissions to the air from a facility, other than those emitted from a point source.

New Plant - any plant or process where the application for authorisation in terms of the National Environmental Management Act 1998 (Act No.107 of 1998), was made on or after 1 April 2010.

Point source - a single identifiable source and fixed location of atmospheric emission, and includes smoke stacks.

Point of compliance – means any point within the off gas line, where a sample can be taken, from the last vessel closest to the point source of an individual listed activity to the open-end of the point source or in the case of a combination of listed activities sharing a common point source, any point from the last vessel closest to the point source up to the point within the point source prior to the combination/interference from another Listed Activity.

Definitions of terms as per the NEM:AQA that have relevance to this application:

Priority area - means an area declared as such in terms of Section 18.

Priority area air quality management plan - means a plan referred to in Section 19.

Additional terms provided for the purpose of clarity in this application:

Additional postponement applications – Sasol submitted draft applications for exemption in terms of Section 59 of NEM:AQA from certain MES, along with draft applications for postponement from certain MES. These exemptions were motivated on the basis that the applicable standards were infeasible based on, amongst others, technology, brownfields, environmental and economic constraints. Since the conclusion of the stakeholder engagement process, Sasol has been directed to rather seek postponement from the compliance timeframes in the MES to address its challenges. Consequently the exemption application will instead be submitted as a postponement application, in addition to its existing postponement applications which have already been submitted to the National Air Quality Officer. Natref now therefore makes application for postponement in respect of those applications which were previously submitted, advertised and made available for public comment, as exemption applications. These are referred to herein as *additional postponement applications*.

Alternative emissions limits – the standard proposed by Sasol based on what is considered reasonable and achievable as a consequence of the assessments conducted and which Sasol proposes as an alternative standard with which it must comply. The alternative emissions limits are specified as *ceiling emissions limits*, as defined in this Glossary. In all instances, these alternative emission limits seek either to maintain emission levels under normal operating conditions as per current plant operations, or to reduce current emission levels, but to some standard which is not identical to the promulgated minimum emissions standards. Specifically, these alternative emissions limits do not propose an increase in current average baseline emissions.

Atmospheric Impact Report – in terms of the Minimum Emission Standards an application for postponement must be accompanied by an Atmospheric Impact Report as per Section 30 of NEM:AQA. Regulations Prescribing the Format of the Atmospheric Impact Report (AIR) were published in Government Notice 747 of 2013).

Ambient standard - The maximum tolerable concentration of any outdoor air pollutant as set out in the National Ambient Air Quality Standards in terms of Section 9(1) of the NEM:AQA.

Ceiling emissions limit – Synonymous with "maximum emission concentrations". The administrative basis of the Minimum Emissions Standards is to require compliance with the prescribed emission limits specified for existing plant standards and new plant standards under all operational conditions, except shut down, start up and upset conditions, based on daily average concentrations as defined in Part 2 of the MES. Whereas average emission values reflect the arithmetic mean value of emissions measurements for a given process under all operational conditions over a 3 year period, the ceiling emission would be the highest daily average emission concentration obtained. Hence, ceiling emission values would be higher than average emission values, and the difference between ceiling and average values being dependent on the range of emission levels seen under different operational conditions. Since the Minimum Emissions Standards specify emissions limits as ceiling emissions limits or maximum emission concentrations, Sasol Synfuels has aligned its alternative emissions limits with this format, to indicate what the 100^{th} percentile emissions measurement value would be under any operational condition (excluding shut down, start up and upset conditions). It is reiterated that Sasol Synfuels does not seek to increase emission levels relative to its current emissions baseline through its additional postponement applications and proposed alternative emissions limits (specified as ceiling emission limits), but rather proposes these limits to conform to the administrative basis of the Minimum Emissions Standards.

Criteria pollutants – Section 9 of NEM:AQA provides a mandate for the Minister to identify a national list of pollutants in the ambient environment which present a threat to human health, well-being or the environment, which are referred to in the National Framework for Air Quality Management as "criteria pollutants". In terms of Section 9, the Minister must establish national standards for ambient air quality in respect of these criteria pollutants. Presently, eight criteria pollutants have been identified, including sulphur dioxide (SO_2), nitrogen dioxide (NO_2), ozone (O_3), carbon monoxide (CO), lead (Pb), particulate matter (PM_{10}), particulate matter ($PM_{2.5}$), benzene (C_6H_6). In this document, any pollutant not specified in the National Ambient Air Quality Standards ("NAAQS") is called a "non-criteria pollutant".

Existing plant standards - The emission standards which existing plants are required to meet. Emission parameters are set for various substances which may be emitted, including, for example, particulate matter, nitrogen oxides and sulphur dioxide.

Listed activity - In terms of Section 21 of NEM:AQA, the Minister of Water and Environmental Affairs has listed activities that require an atmospheric emissions licence. Listed Activities must comply with prescribed emission standards. The standards are predominantly based on 'point sources', which are single identifiable sources of emissions, with fixed location, including industrial emission stacks.

Maximum emission concentrations – Synonymous with "ceiling emissions limits". Refer to glossary definition for ceiling emissions limits.

Minimum emissions standards – prescribed maximum emission limits and the manner in which they must be measured, for specified pollutants. These standards are published in Part 3 of GN 893.

Minister – the Minister of Environmental Affairs.

New plant standards - The emission standards which existing plants are required to meet, by April 2020, and which new plants have to meet with immediate effect. Emission parameters are set for various substances which may be emitted, including, for example, particulate matter, nitrogen oxides and sulphur dioxide.

Postponement – a postponement of compliance timeframes for existing plant standards and new plant standards and their associated special arrangements, in terms of Regulations 11 and 12 of GN 893. In the context of Sasol's applications, these postponements are referred to as *initial postponements* and *additional postponements*, as defined in this Glossary.

GN 893 – Government Notice No. 893, 22 November 2013, published in terms of Section 21 of the National Environmental Management: Air Quality Act (Act No 39 of 2004) and entitled '*List of Activities which Result in Atmospheric Emissions which have or may have a Significant Detrimental Effect on the Environment, Including Health and Social Conditions, Economic Conditions, Ecological Conditions or Cultural Heritage'*. GN 893 repeals the prior publication in terms of Section 21, namely Government Notice No. 248, 31 March 2010. GN 893 deal with aspects including: the identification of activities which result in atmospheric emissions; establishing minimum emissions standards for listed activities; prescribing compliance timeframes by which minimum emissions standards must be achieved; detailing the requirements for applications for postponement of stipulated compliance timeframes.

Sasol Synfuels – the entity now known as Sasol Chemical Industries (Pty) Limited operating through its Secunda Synfuels Operations, formerly known as Sasol Synfuels (Pty) Limited. To avoid unnecessary confusion, the name "Sasol Synfuels" has been retained in this report.

Special arrangements –specific compliance requirements associated with a listed activity's prescribed emissions limits in Part 3 of GN 893. These include, among others, reference conditions applicable to the listed activity prescribed emission limits, abatement technology prescriptions and transitional arrangements.

List of Abbreviations

AEL – Atmospheric Emissions License

AIR - Atmospheric Impact Report

CO – Carbon Monoxide

CTL – Coal-to-liquid

ESP – Electrostatic Precipitator

FGD – Flue Gas Desulphurisation

FT – Fischer-Tropsch

GHG – Green House Gas

GO – General Overhaul

HOW – High Organic Waste

HPA – Highveld Priority Area

HCl – Hydrogen Chloride

H_2S – Hydrogen Sulphide

MES - Minimum Emission Standards

NAAQS - National Ambient Air Quality Standards

NEMA - National Environmental Management Act (Act No. 107 of 1998)

NEM:AQA - National Environmental Management: Air Quality Act (Act No. 39 of 2004)

NH_3 - Ammonia

NO_2 – Nitrogen Dioxide

NOx – Oxides of Nitrogen

PM – Particulate Matter

$PM_{2.5}$ - Particulate Matter with radius of less than 2.5 μm

PM_{10} - Particulate Matter with radius of less than 10 μm

SCR - Selective Catalytic Reduction

SNCR – Selective Non-Catalytic Reduction

SO_2 - Sulphur Dioxide

t/h – tons per hour

TOC – Total Organic Compounds

VOC – Volatile Organic Compound; equivalent to TVOC (Total Volatile Organic Compounds)

WSA – Wet Sulphuric Acid

1 Steam Plant: Postponement request for PM, SO_2, NOx

1.1 Applicable standards

Minimum Emission Standards (MES) Category 1.1 prescribes emission limits applicable to solid fuel combustion installations.

Table 1: Category 1: Combustion Installations, Subcategory 1.1: Solid Fuel Combustion Installations

Description:	Solid fuels combustion installations used primarily for steam raising or electricity generation.		
Application:	All installations with design capacity equal to or greater than 50 MW heat input per unit, based on the lower calorific value of the fuel used.		
Substance or mixture of substances		**Plant status**	**mg/Nm^3 under normal conditions of 10% 0_2, 273 Kelvin and 101.3 kPa.**
Common name	**Chemical symbol**		
Particulate matter	N/A	New	50
		Existing	100
Sulphur dioxide	SO_2	New	500
		Existing	3,500
Oxides of nitrogen	NO_x expressed as NO_2	New	750
		Existing	1,100

Notwithstanding that the additional postponement is made in terms of 2015 existing plant standards, for completeness' sake, this chapter outlines the challenges faced in meeting the new plant standards for PM, SO_2 and NOx.

1.2 Description of the plant

Steam is a critical industrial process requirement across the Sasol Synfuels operation. Process steam must be available at the right quality (correct temperature and pressure) and quantity (volume of steam demanded) at all times and at all processes where steam is required. To meet these exacting steam requirements a large fleet of small boilers was built rather than a small fleet of large boilers. The fleet of boilers allows both planned and unplanned disruptions to steam generation to be managed without compromising the supply of steam to users across the complex.

The Sasol Synfuels East and West operations have a fleet of 17 pulverised coal fired boilers, each with a maximum production capacity of 540 tons per hour (t/h) of 40 bar superheated steam. The superheated steam is fed into common steam headers from where it is routed to the various users. The layout of the entire facility is based on minimising the distance over which the steam has to be moved with the largest steam users placed closest to the steam plants, to minimise the loss of heat from the system. In addition to process demands, steam is supplied to generate 'critical power' which is needed in the event of a loss of power from the national grid. That critical power allows for safe plant shutdown without damage to the plant. Excess steam is used to generate additional electricity, which offsets some of the facility's electricity demand from the national grid.

All boiler work, including maintenance and upgrades is driven by a strictly applied general overhaul (GO) schedule, to assure that process steam is not interrupted. Not only is the GO schedule coordinated internally within the Secunda complex, but also with other fuel refineries to avoid inland fuel shortages, and the national electricity supplier to avoid possible regional power shortages. The GO schedule is also aligned with other statutory inspections prescribed for pressure vessels. The net effect of the GO schedule is to ensure that boilers are shut down individually in a routine, sequential manner. A single cycle of boiler shutdowns through the entire fleet of 17 boilers takes several years.

In addition the steam plants are integrated with the Rectisol and sulphur recovery plants. Two tall stacks (301 m on the East factory and 250 m on the West factory) serve to co-disperse emissions from the steam plant and the sulphur recovery plant. The high boiler outlet temperatures from the steam plants provide essential buoyancy to the much cooler off-gas stream from the sulphur recovery plant, significantly improving atmospheric dispersion of these emissions. That requirement for high boiler emission temperatures constrains boiler operations, such as constraining further improvements in boiler efficiencies through further heat recovery. Atmospheric emissions from the boilers include the greenhouse gas carbon dioxide (CO_2), as well as SO_2, NOx and PM.

1.3 Technology options for compliance: PM

The current boiler fleet has installed PM abatement technology, in the form of electrostatic precipitators (ESPs) combined with flue gas conditioning through ammonia dosing, to enhance particulate matter capture. The current collection efficiency of ESPs is in excess of 99%. Although the ESPs were originally designed for PM emission rates of 200mg/m^3, through ammonia dosing to improve particle agglomeration, Sasol Synfuels has been able to currently achieve an average emission concentration of below 100 mg/m^3 (the existing plant standard), at additional operating costs.

Annual maintenance is performed on the ESPs to maintain this average emission level. While the 2015 existing plant standard is currently achieved (on average), maintenance alone will not guarantee 100 mg/Nm^3 as a sustainable ceiling limit going forward. The ESPs are close to the end of their operational life, and meeting a ceiling limit of 100 mg/Nm^3 is a much more onerous requirement than achieving an average limit of 100 mg/Nm^3.

Sasol Synfuels investigated the following options for compliance with PM emission limits for existing and new plant standards:

a) **Replacement of ESP internals with bag filters or the installation of new baghouses**: Synfuels boilers operate with flue gases at higher temperatures than typical boiler fleets (~220°C), as a result of integration with the sulphur recovery and Rectisol plants. Standard bags are unable to withstand these temperatures, thus specialised bag material would be required. The specialised bags have high maintenance requirements (bag replacements every +/- 4 years) and baghouses furthermore have high energy requirements to compensate for the large pressure drop over the system. Due to these negative operational impacts, bag filters are not considered a sustainable abatement technology for the Synfuels operation.

b) **SO_3 (sulphur trioxide) injection** was also explored as a means to enhance the performance of current ESPs by reducing electrical resistivity and improving surface conductivity of the PM in order to increase collection efficiency to above 99%. This was found not to be a feasible option as temperatures at the inlet of the Sasol Synfuels ESPs are too high, at 220°C, to implement this technique effectively. The reactions that reduce PM only occur optimally at 120 – 130°C and are not present at the high temperature at which these ESPs operate. Investigations were conducted into lowering flue gas temperatures to improve the efficacy of SO_3 injection. This option was discarded since lowering flue gas temperatures has negative impacts on stack temperature and emission dispersion, which would actually worsen the steam plant's ambient impacts and thereby negate any benefits of SO_3 injection.

c) **Increasing the size of the ESPs**, through addition of more ESP fields or increasing the length of the fields was investigated. Increasing the length of the fields was found to be ineffectual since the current ESPs are already optimised from a height perspective for PM collection, and therefore increases in height would not improve PM collection any further. Adding more fields to the ESPs was found not to be viable due to the negative impact on boiler outages during installation, combined with significant plot space constraints.

d) **Renewal of current ESP fields** is a technically feasible option, since this would not have negative integration impacts on current operations, and does not require any further plot space. Furthermore, the technology is well understood by Sasol Synfuels and compatible with the existing boiler fleet. The boiler fleet operates with a high linear velocity inside the ESP. ESP vendors have confirmed that while the existing plant standard (as a ceiling limit) can sustainably be achieved under these conditions through ESP field renewal, they cannot provide performance guarantees on the lowest ceiling emission concentration achievable, due to technology limitations on the ESP technology. Best information available for the steam plant is that, while renewal of ESP fields may achieve PM emission concentrations under the existing plant standard, they will not achieve the new plant standard.

Table 2: Summary of technology feasibility assessment associated with installation of PM abatement technologies at the Sasol Synfuels steam plant

TECHNICAL OPTION	OUTCOME OF TECHNOLOGY FEASIBILITY ASSESSMENT	SUMMARY OF REASONS FOR FEASIBILITY ASSESSMENT OUTCOME
Replacement with bag filters	Not feasible	Higher auxiliary power requirement, resulting in reduced boiler fleet steam output by the equivalent of 100MW of power generation. Less steam output for same amount of coal used and environmental impacts. Negative operational impacts due to Increased risk of unplanned boiler outages as a result of bag damage at high temperatures, and its negative effect on steam plant output. High maintenance costs for frequent replacements of bag made form expensive temperature-resistant material.
Sulphur trioxide injection	Not feasible	Negative impacts on emission dispersion at reduced boiler flue gas temperatures, resulting in increased ambient impacts. Incompatible with boiler fleet operating temperatures.
Increasing the length of ESP fields	Not effective	No improvement in PM collection efficiency resulting from implementation.
Adding more fields to ESPs	Not feasible	Plot space constraints.
Renewal of electrostatic precipitator fields	Feasible (estimated cost in excess of R850 million for the fleet)	No significant negative impacts. From a construction perspective can only be done during extended boiler outages cycle (150 days per boiler).

1.4 Technology options for compliance: SO_2

The steam plant currently meets the existing plant standard for SO_2. SO_2 emissions result from the combustion of sulphur present in the coal feedstock. As such, emissions are directly related to the sulphur content of coal, which in South Africa is fairly low, typically in the 0.7-0.9% range. An international technology scan was conducted, and a variety of flue gas desulphurisation (FGD) technologies were investigated for the purpose of bringing SO_2 emissions into compliance with the 2020 new plant standard of 500 mg/Nm^3. The following options for compliance with SO_2 emission limits for new plant standards were investigated:

- Wet FGD;
- Dry FGD (spray dry technology);
- Semi-dry FGD;
- Direct sorbent injection (DSI) with lime; and
- De-stoning of the coal feedstock to the steam plant

The various FGD technologies were evaluated at conceptual development level to establish the optimal solution for Sasol Synfuels that had the least negative impact in all the areas. The conceptual phase of the project identified semi-dry technology as the technology most likely to be suitable for SO_2 reduction for a number of reasons, key among them being a more compact space footprint compared with other FGD options, given significant space constraints on the site, and the lower water consumption of the process.

Even though the semi-dry technology was identified as the potentially most suited FGD solution, extensive engineering work on this technology identified significant feasibility concerns relating to negative environmental cross-media impacts and technical challenges for its implementation at the Sasol Synfuels steam plant.

Negative environmental cross-media impacts of compliance with the SO_2 new plant standard for boilers include:

- Currently ~220°C. This high stack temperature improves the buoyancy of the plume and ensures dispersion of the plume. The installation of FGD technology would reduce the plume temperature to below 135°C. As a result of the temperature reduction in the stack, the buoyancy of the plume would be negatively affected and pollutants such as H_2S that exit the stack with the boiler off gas would not be as effectively dispersed, causing an increased ambient impact. Reduction of the off gas temperature has the additional risk of condensation in the stack which could affect the structural integrity of the stack.
- To overcome the negative dispersion impacts of the pressure drop of the FGD equipment (and its negative impacts on plume buoyancy described above), significant additional power input equivalent to ~100 MW of power would be required for booster fans. This large reduction in net energy output from the boiler fleet represents much lower energy efficiency of the steam plant, .and correspondingly higher carbon intensity and lower water efficiency of steam production.
- Lime or limestone is required as the sorbent for the desulphurisation reaction. Sasol would require up to 180,000 tons per year of lime, and limited suppliers exist with the ability to supply Sasol with high quality lime or limestone suited to the technology choice. Within the Sasol Synfuels factory site, the increase in lime transport logistics from a large centralised lime storage facility to smaller day silos at the steam plant where the lime would be consumed proved to be a significant obstacle due to site space constraints.
- Additional dry waste production results from the use of large volumes of lime in the process, which would require significant additional waste handling infrastructure. Additional waste would be produced in the ratio of ~2 tons of waste for every ton of lime consumed. This new stream of ~350,000 tons per year would require a waste management solution.
- An increase in raw water consumption for the Secunda complex in the order of 4,000 Megalitres per year. While theoretically this water could be made available to Sasol Synfuels, in terms of the Department of Water Affairs' water efficiency objectives and the "water allocation reform" initiative, this additional volume of water intake would be contrary to other environmental policy objectives.

- From a cradle to grave perspective, the greenhouse gas footprint from mining and transporting of limestone, operating a lime calcining unit, emissions from the calcining process, and operating the desulphurisation unit (with its additional electricity demand) amounts to an additional 535,000 tons of CO_2 per year.

Implementation of the semi-dry FGD technology is a high capital-cost and operating-cost intensive technology, also associated with high levels of technical and operational risk given the constrained space within which the plant would have to be built and installed, where the steam plant is integrated into the petrochemical production process. Major risks of constructing and operating the semi-dry technology on the Sasol Synfuels boilers which render the technology infeasible were identified, including:

- Current ducts to the stack for the steam plant and the sulphur recovery plant pose space constraints for the implementation of FGD. These would have to be completely rebuilt and moved to make sufficient space available. This rebuilding and movement would pose a significant risk to plant availability and operations arising from the major construction activities that would be required in a constrained area, adjacent an active pipe rack and ducting that would remain in operation throughout the lengthy construction period.
- Once ducts were moved, installing the FGD units in such close proximity to this active pipe rack containing steam and various petrochemicals increases risk to the Sasol Synfuels process plant and major safety concerns, since the petrochemical components that flow through the pipes are hazardous and explosive. The constrained construction space where rigging with cranes would be required for the FGD construction is a safety concern for Sasol. It poses both a risk to personnel and operation of the facility in a safe manner during construction.
- Globally, there is no reference plant where this technology has been implemented under the same extent of space constraints while the balance of the plant needs to continue being operational for production purposes. This lack of reference creates significant uncertainties for production stability at Sasol Synfuels during the lengthy construction process.

Sasol has also investigated the removal of sulphur upstream of the boilers in order to reduce SO_2 emissions. This process is called de-stoning. It involves removing a portion of the ash with some pyritic sulphur (in the form of iron sulphide). The investigation concluded that the technology was infeasible due to the following negative impacts:

- De-stoning requires additional raw water to wash the coal. After coal washing, this would become waste water, requiring treatment.
- An upper limit of 30% of the sulphur in coal could theoretically be removed, at high capital cost. De-stoning would therefore reduce emissions to no less than an *average* of ~1,200 mg/Nm^3, meaning that this costly process does not go a significant way to improving emissions or meeting new plant standards specified as *ceiling* limits.
- Destoning results in increased mine consumption and reduced mine life as a portion of the coal mined is discarded in the destoning process.
- Increased waste footprint due to a portion of the high ash coal being discarded. An additional high ash coal discard stream of ~440,000 tons per year is generated.

Table 3: Summary of technology feasibility assessment associated with installation of SO_2 abatement technologies at the Sasol Synfuels steam plant

TECHNICAL OPTION	OUTCOME OF TECHNOLOGY FEASIBILITY ASSESSMENT	SUMMARY OF REASONS FOR FEASIBILITY ASSESSMENT OUTCOME
Wet FGD	Not feasible	Space constraints Negative logistics implications outside of Secunda, and within the factory complex Reduced plume buoyancy resulting in increased ambient impacts of other emissions emitted via common stacks, if energy losses are not compensated for High capital and operating costs Significant environmental cross-media impacts, including increased water demand, waste footprint, CO_2 emissions
Semi-dry or dry FGD	Not feasible	Space constraints Negative logistics implications outside of Secunda, and within the factory complex Reduced plume buoyancy resulting in increased ambient impacts of other emissions emitted via common stacks, if energy losses are not compensated for Constructability issues and associated safety and production stability risks High capital and operating costs Environmental cross-media impacts, including increased water demand, waste footprint, CO_2 emissions
Direct sorbent injection	Not feasible	Significant negative impact on ash transport and storage system and current ESP system, since these are already operating at their performance limits and cannot accommodate the further negative impacts of direct sorbet injection. The ash system and chosen ESP technology would need substantial upgrades as a result Resultant increase in PM emissions from direct sorbent injection
De-stoning	Not feasible	Increased water demand Reduction of coal mine lifetime, necessitating opening of new mines Increased waste footprint, resulting in disposal of additional tailings

1.5 Technology options for compliance: NO_x

The Sasol Synfuels steam plant's current emissions operate marginally above the existing plant standard ceiling limit of 1,100 mg/Nm^3. Sasol undertook a pre-feasibility study on available technologies to reduce NO_x emissions from the Sasol Synfuels boilers. The options considered were the installation of: Low NOx burners (LNB), LNB with over fire air (OFA) or flue gas recirculation, Selective non catalytic reduction (SNCR) and Selective catalytic reduction (SCR). The approach to reducing NOx is generally staged, where technologies are implemented in this order depending on the promulgated emission reduction required. Technology costs increase as more stringent controls are implemented. It is expected that compliance with new plant standards under most normal operating conditions could theoretically be achieved by installing Low NOx burners (LNBs), although this would likely be the upper limit of abatement potential for LNB technology alone.

a) **Low NO_x burners** are a widely used, proven technology to reduce the emissions of boiler NOx, and are the most cost-effective way to reduce these emissions. However, LNBs would decrease boiler efficiencies, requiring an additional ~140,000 tons per year of coal feed to achieve the same steam output to meet the plant's constant steam demand levels. Consequently, while NOx concentrations in the flue gas would be reduced, the total NOx load on the ambient environment is not reduced in the same ratio, since more coal is burned to achieve the same steam output. This impact would be true for all related emissions (SO_2 and PM), with a negative impact on boiler efficiency and greenhouse gas emissions (increase of ~190,000 tons of CO_2 per year).

b) If LNBs alone would not realise the required emission reductions, then **Over Fire Air (OFA)** or selective non-catalytic reduction (SNCR) would be required in addition to LNBs to abate further. OFA is a further air staging method that inhibits the formation of NOx by introducing a portion of the combustion air in “ports” above the last burner level. This is a technically risky option, requiring significant structural modification of the boilers and boiler tube arrangements as well as the installation of additional booster fans, which would require additional energy input. As a result of technology risks, OFA is deemed an infeasible technology option.

c) **Selective non-catalytic reduction (SNCR)** involves the injection of ammonia into the area just above the boiler combustion chamber. The reaction only occurs in a limited temperature window of between 900 and 1,100°C. Below this temperature, ammonia does not react and ammonia slip will occur, causing ammonia emissions to atmosphere. Above this temperature window, sticky ammonium bisulphate forms which can cause fouling of the air heaters. The technology is implemented less than conventional LNB and OFA technology. The reason for this is due to relatively low NOx reduction achievable (typically 20-30%) as well as operational risk to the boiler if it is not operated and controlled carefully. The technology alone will not be able to achieve the required reduction to NOx new plant standards from the current Sasol Synfuels baseline. The Sasol Synfuels boilers operate at temperatures in the range of 1200-1300^{0}C which is above the temperature window for the effective operation of SNCR. If the SNCR system is not carefully designed, optimised and operated with adequate control in the Sasol Synfuels boilers, there would be a significant risk of fouling in the air heaters. The fouling of the air heaters would lead to more frequent down time on the boilers, reduction in boiler efficiency and corrosion of equipment. In light of the significant negative operating risks, and associated low relative NOx reduction achievable by this technology, it is deemed not feasible for NOx reduction in the Sasol Synfuels boiler fleet.

d) A further alternative, **Selective Catalytic Reduction (SCR)**, is not seen as a feasible option for NOx reduction due to the constrained space available to install these bulky systems on the Sasol Synfuels boilers. It is furthermore a high capital cost option. SCR has similar large space requirements as the semi-dry FGD system for SO_2 abatement. SCR would have to be implemented between the existing air heater and the ESP of each boiler, for which there is not enough space available on the plant. This would furthermore require very extended boiler outages of approximately 8 months per boiler for installation, owing to the fact that the system is installed in the very constrained space between the air heater and ESP, with high costs associated with lost steam and power production during this period. Safety risks are associated with construction in this very constrained space while working in a fully operating production area.

Table 4: Summary of technology feasibility assessment associated with installation of NO_x abatement technologies at the Sasol Synfuels steam plant

TECHNICAL OPTION	OUTCOME OF TECHNOLOGY FEASIBILITY ASSESSMENT	SUMMARY OF REASONS FOR FEASIBILITY ASSESSMENT OUTCOME
Low NOx burners (LNBs)	Not feasible	Reduction in boiler efficiency, requiring compensation with additional coal consumption Increased greenhouse gas emissions Technology may not achieve the new plant standards
Overfire Air (OFA)	Not feasible	Major structural modifications to boilers and boiler tube arrangement required Risk of increased boiler downtime leading to costly steam and power production losses
Selective non-catalytic reduction (SNCR)	Not feasible	Limited NOx reduction achievable (20 – 30%) Very careful control of operating parameters within a narrow range is required, due to the environmental risk of ammonia slip and the significant operational risk of fouling of air heaters Reduction of boiler efficiency and availability Increased greenhouse gas emissions due to lower efficiencies
Selective catalytic Reduction (SCR)	Not feasible	Space constraints Extended boiler outages leading to costly steam and power production losses High capital and operating cost technology Safety risks associated with construction in very constrained space

1.6 Postponement request

Sasol Synfuels applies for a five-year postponement from the MES for its steam plant, as indicated in Table 1. In place of the MES, Sasol Synfuels proposes the following maximum emission concentrations as alternative emissions limits to be incorporated in its Atmospheric Emissions Licence, as set out in Table 5.

Table 5: Alternative emission limit request for Sasol Synfuels steam plant

Emission component	MES for existing plants	MES for new plants	Alternative Emission Limit Requested (*ceiling limit*)[a]	Averaging period for compliance monitoring
	All values specified at 10% O_2 273 K and 101.3 kPa, mg/Nm^3			
SO_2	3,500	500	2 000	Daily average
NO_x	1,100	750	1 400	Daily average
Particulates	100	50	From now until 31 March 2024: 130 From 1 April 2024: 100	Daily average

[a] Since the MES prescribes ceiling limits, the alternative emissions limits requested are aligned to the maximum emission levels expected under all normal operating conditions. The alternative emissions limits proposed are based on a daily averaging period for compliance monitoring.

* As confirmed in the foreword to this appendix, this application relates to postponement of the 2015 existing plant standard only. However, for completeness' sake, these are the limits which Sasol could meet in the longer term, based on current available information.

2 Sulphur recovery: Postponement request for H_2S

2.1 Applicable standards

Table 6: Category 3: Carbonization and Coal Gasification, Subcategory 3.6: Synthetic Gas Production and Clean-up

Description:	The production and clean-up of a gaseous stream derived from coal gasification and includes gasification, separation and clean-up of a raw gas stream through a process that involves sulphur removal and Rectisol as well as the stripping of a liquid tar stream derived from the gasification process.		
Application:	All installations		
Substance or mixture of substances		**Plant status**	**mg/Nm^3 under normal conditions of 273 Kelvin and 101.3 kPa.**
Common name	**Chemical symbol**		
Hydrogen Sulphide	H_2S	New	3,500
		Existing	4,200
Total Volatile Organic Compounds	N/A	New	130
		Existing	250
Sulphur dioxide	SO_2	New	500
		Existing	3,500

This additional postponement application pertains to the H_2S existing plant standard. Notwithstanding that the additional postponement is made in terms of 2015 existing plant standards, for completeness' sake, this chapter outlines the challenges faced in meeting the H_2S new plant standard.

2.2 Description of the plant

The first major processing step in the Sasol Synfuels coal-to-liquid manufacturing process involves the gasification of coal into a synthetic gas 'syngas' which is primarily composed of carbon monoxide (CO) and hydrogen (H_2), which is used for the manufacture of hydrocarbon products including synthetic fuels and chemicals in patented Sasol processes. The product exiting from gasification is a raw gas which must be cleaned up prior to downstream processing. This clean up step involves the removal of impurities from the raw gas, including carbon dioxide (CO_2) and hydrogen sulphide (H_2S). A methanol wash step is used to remove CO_2 and H_2S from the raw gas, and these gases are routed to a sulphur plant for recovery of elemental sulphur. The sulphur recovery process employed by Sasol is a variant of the Stretford process, and produces sulphur product of a purity of up to 99.9%. After the recovery process, the liquid sulphur product is filtered and granulated and sold to third party industries, for use in mining processes and the production of sulphuric acid.

On the Sasol Synfuels West factory, H_2S-containing streams from the Synthetic gas product and clean-up processes are processed by the sulphur plant. As a result of the sulphur recovery process on the Western factory, 75% of the sulphur in the off gases which would otherwise be emitted to atmosphere are recovered in solid form.

The East factory was identical in design to the West factory, until 2010, when a Wet Sulphuric Acid (WSA) plant costing R1 billion (in 2010 nominal value) was commissioned. The plant was built to meet a commitment of a 2 ton per hour reduction in H_2S emissions, which was incorporated into the Highveld Priority Area Air Quality Management Plan. Certain H_2S-containing streams were diverted from the East factory's sulphur recovery plant towards this new facility, which recovers sulphur from the diverted gases and produces a large volume of sulphuric acid of 98.5% purity, for sale to the market. Discussed below, this plant has ongoing operability and stability issues, and experiences significant downtime. When the WSA plant is operational, H_2S emissions are reduced on average by

85% on the Eastern factory. When the plant is not operational, H_2S emissions from the East factory match those of the West factory.

The East and West factories each have a main stack, which disperses the emissions from two integrated Listed Activities (the steam plant under Category 1.1, and Rectisol and Sulphur Recovery under Category 3.6). Steam plant flue gases enter at the bottom of the stack at point B in Figure 1, and off gases from the Rectisol and Sulphur Recovery processes enter just above this point, at point A.

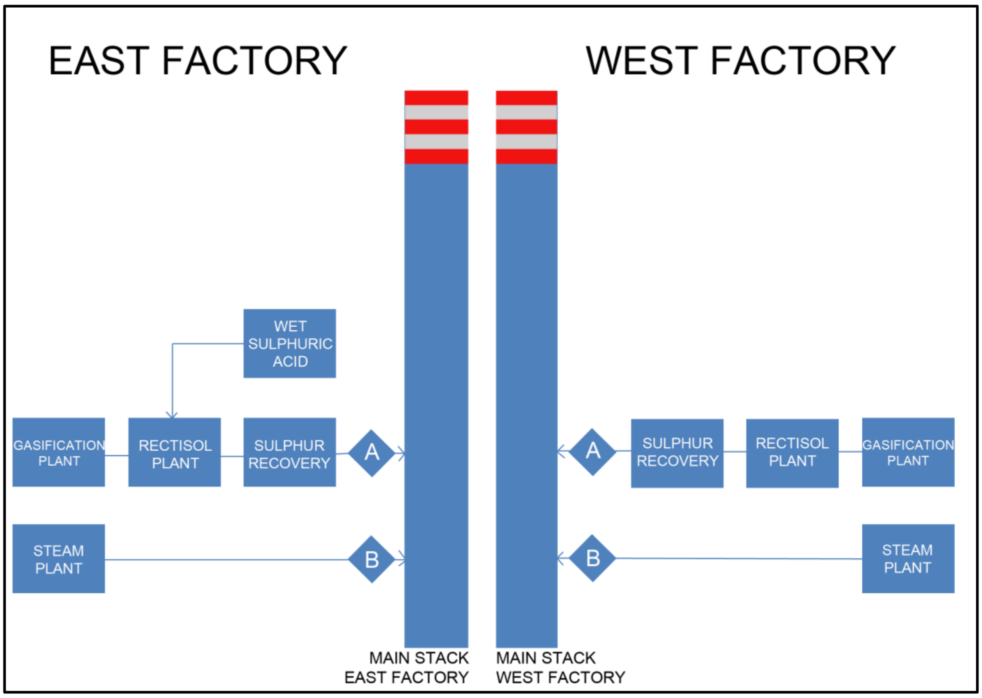

Figure 1: Integration of steam plant and Gasification off gas clean-up processes at main stacks for flue gas dispersion

The MES defines the point of compliance as “any point within the off gas line, where a sample can be taken, from the last vessel closest to the point source of an individual listed activity to the open-end of the point source or in the case of a combination of listed activities sharing a common point source, any point from the last vessel closest to the point source up to the point within the point source prior to the combination / interference from another listed activity”. In the diagram, the points of compliance equate to points A and B, which are points before the activities enter the common main stack and mix and dilute each other. Compliance with H_2S standards in terms of the promulgated MES therefore refers to concentration measurements at point A.

The integration of the two processes is critical from a safety and environmental perspective: hot boiler off gases from the steam plant constitute 90% of the volumetric flow from the main stacks. These hot off gases create buoyancy for the plume, and aid in the effective dispersion of not only the boiler off gases, but also the much cooler off gas stream from synthetic gas production and clean-up activities, which comprise the remaining 10% of volumetric flow through the main stacks. Should the temperature of the boiler off gases be lowered for any reason, this would result in significantly reduced plume buoyancy, worsening the dispersion of stack emissions and raising emission concentrations at ambient level close to the facility.

2.3 Evolution of the Minimum Emissions Standards for H_2S from 2010

The 2010 MES previously classified the sulphur recovery process under Listed Activity Category 3.1, in which was included a special arrangement for H_2S, to limit emissions to a maximum concentration of 1,000 mg/Nm^3 by 2015. The Department of Environmental Affairs (DEA) shortly thereafter commenced a process to amend the MES, and indicated that they would create a new Listed Activity category appropriate for the Sasol Synfuels Sulphur Recovery plant. To this end, Sasol raised its concerns with the DEA and proposed amended limits for existing plant standards and new plant standards in line with what it believed at the time to be reasonable and achievable emission reductions, which could be made compatible with the factory's technology at some future date.

The limits Sasol proposed, which were also shared in the DEA's stakeholder technical workshops on the draft amendments, were as follows:

- 8,400 mg/Nm^3 for existing plant standards, at the time deemed to be achievable with operational modifications and small capital expenditure. This limit was proposed as a rolling 30-day average.
- 4,200 mg/Nm^3 for new plant standards, at the time deemed to be achievable with a subsequent investment in a WSA plant on the West factory, to mirror the plant on the East factory (which had been installed the previous year). This limit was proposed as a rolling 30-day average, with two pre-conditions attached, namely: that a market could be found for additional large volumes of sulphuric acid product, since this would represent a large increase in national production, and could have competition law repercussions, or necessitate management as a large acidic waste stream; and that technology challenges experienced on the WSA East plant had been resolved, such that a WSA West plant could be constructed and successfully integrated into the process, as a fully compatible addition to the core coal-to-liquid fuels manufacturing facility.

This proposal formed the basis of Sasol Synfuels' roadmap for sustainable H_2S emissions improvement at the time. The DEA has since promulgated amendments to the standards, which are more stringent than Sasol's recommended existing and new plant standards, as shown in the MES excerpt for Category 3.6.

Furthermore, In light of technical work which has been conducted in the two ensuing years since Sasol's proposal for amended H_2S emission standards, Sasol Synfuels can no longer realise its initial intent. It therefore proposes a different alternative emission limit, based on more recent information.

Two key underlying assumptions, on which Sasol's previous proposal was predicated, have changed:

- At the time, the Sasol position was that the Secunda facility was to continue operations to its planned end of life in 2035 (when available coal from Sasol's mines in the vicinity would run out). After that, Sasol made a strategic decision to extend the lifetime of the Secunda assets to 2050, which includes a significant capital re-investment to lengthen the lifetime of current assets, and replace certain critical components on the plant. Accordingly, Sasol Mining (Pty) Ltd was tasked with developing a detailed mine plan to secure the necessary coal reserves to enable operations to extend by 15 years. Sasol Mining has since reviewed and optimised its coal assets to maximise and stretch their lifetime and maximise yield from their existing coal resources, in order to address the plan with which it was tasked. This involved an adjustment of coal sulphur content projections, which, while on average will remain at the current range of 0.7-0.9%, may show a greater range of variability, with instantaneous concentrations of up to 1.1%. Since H_2S emissions are a function of the sulphur content of the coal, daily average emissions under these scenarios could be higher than what was previously predicted as a maximum;
- At the time, Sasol was embarking on an extensive engineering programme to bring operational stability to the new WSA plant on the East factory, which had been built just prior to the promulgation of the 2010 MES. When the WSA plant is operational, it diverts certain H_2S-containing streams away from the Sulphur Recovery factory and into a sulphuric acid manufacturing process with higher recovery efficiency. Thereby, H_2S emissions from the East factory are lowered. Unfortunately, technical problems have beset this plant since it was commissioned, because of a combination of problems leading to acid corrosion. Efforts to improve performance were identified. Given present knowledge and operational experience of

the new WSA plant, Sasol is not in a position to commit to implementation of further improvements of a similar magnitude on the Western factory, since significant technology integration concerns remain.

2.4 Technology options for compliance

An H_2S emission reduction roadmap was compiled to explore technology options to reduce H_2S emissions in line with the 2010 MES, with conclusions that hold for the amended 2013 MES. Four technologies were evaluated as potential abatement solutions:

a) **De-stoning of gasification feed coal:** Beneficiation of coal to the gasification process would reduce the amount of pyrite (iron sulphide) in the coal to the gasifiers, and therefore the mass of sulphur compounds in the raw gas. Investigations into de-stoning confirmed that reductions in coal pyrite content would be insufficient to meet the new plant standard, and would therefore necessitate an additional implementation of abatement technology at both the East and West factories. Furthermore, de-stoning as a technology option on the East factory would erode revenue streams from the Wet Sulphuric Acid (WSA) plant commissioned in 2010, since it would reduce the concentration of H_2S in the feed gas to WSA below the plant's design basis, causing further operational challenges beyond those experienced currently by this plant. Other negative technology and environmental considerations identified include:

- The tailings consisting of coal containing pyritic sulphur arising from the de-stoning process would need to be landfilled, increasing waste production and creating the risk of spontaneous combustion as well as risk of leaching.
- If the technology were implemented, a portion of the coal mined would have to be discarded. This would reduce the lifetime of the Secunda mines and coal would have to be sourced from elsewhere and transported to the Secunda facility to supplement production.

On the basis of these negative operations impacts, de-stoning was not considered a feasible option for efficient H_2S abatement, since it is incompatible with the current assets.

b) **Amine-Claus:** An amine solvent is used to selectively remove H_2S from the feed stream. The enriched H_2S stream is then sent to a Claus unit for sulphur recovery. Although there are a number of commercial references world-wide for amine applications, there are no references with a feed stream similar to that of the Sasol Rectisol process's off-gas streams. Sasol Rectisol off-gas is unique and distinct from commercial references in that it has low H_2S concentrations, is of a very large volume and contains different contaminants to the amine selective process. In light of this, the technology is deemed incompatible with the core Sasol coal-to-liquid conversion technology, and introduces unacceptable production stability risks. While this technology option was identified to be potentially more feasible than de-stoning or Selective Rectisol, technology compatibility remains an unacceptable risk. This option furthermore would have the most extensive implementation timeline due to the scale of piloting requirements, and would have high associated capital costs.

c) **Selective Rectisol-Claus:** This option would require diversion of the entire feed stream from the two existing Rectisol plants to two new Selective Rectisol units. A Selective Rectisol unit differs from the standard Rectisol unit at Sasol Synfuels in that the H_2S is selectively removed from the feed stream and then fed to a Claus unit. Complete replacement of a core current technology with a different technology introduces unacceptable production risks for Sasol Synfuels. Furthermore, it would require a standalone unit to enable conversion of the existing Rectisol trains due to extended implementation requirements. Significant additional electricity requirements would arise for use of this technology. For these reasons, Selective Rectisol was identified as not being a feasible option for H_2S reduction.

d) **Addition of a WSA plant on the West factory:** The WSA technology, in which off-gas is converted to sulphuric acid, has recently been installed on the Sasol Synfuels East plant as part of Sasol's HPA commitments. This has reduced H_2S emissions from the East Sulphur Recovery factory during periods when the WSA plant is operational. Even if the WSA was successfully implemented and replicated on the West factory, this technology will not achieve the amended existing or new plant standards promulgated by the DEA in 2013, just as it also cannot achieve Sasol's 2011 proposal on amended MES limits, for the reasons explained above.

Table 7: Summary of technology feasibility assessment associated with installation of H_2S abatement technologies at the Sasol Synfuels sulphur recovery plant

TECHNICAL OPTION	OUTCOME OF TECHNOLOGY FEASIBILITY ASSESSMENT	SUMMARY OF REASONS FOR FEASIBILITY ASSESSMENT OUTCOME
Destoning of gasification feed coal	Not feasible	Will not meet existing or new plant standards A very large magnetite supply would be necessary for the coal beneficiation Water intensive process Additional stream for disposal arises, namely coal containing pyritic sulphur, which increases risk of leaching High capital costs
Amine-Claus	Not feasible	Unacceptably high risks on operational stability Very high capital cost option
Selective Rectisol-Claus	Not feasible	Complete replacement of current core Rectisol technology well before end of life High additional energy requirements Very high capital cost option
Further wet sulphuric acid plant on West factory	Not currently considered feasible	Low plant availability on WSA East. Focussed efforts to improve availability ongoing and starting to show positive results. Further WSA plant will not feasibly meet existing or new plant standards Market for sulphuric acid produced

2.5 Postponement request

Sasol Synfuels is applying for a five-year postponement from the MES for its sulphur recovery plant, as indicated in Table 6. In place of the MES, Sasol Synfuels proposes the following maximum emission concentrations as alternative emissions limits to be incorporated in its Atmospheric Emissions Licence, for compliance by each separate stack, as set out in Table 8. In light of these developments, Sasol has proposed an alternative emissions limit which reflects current realities, given the information available presently. The requested alternative emissions limit is 12,500 mg/Nm^3, which reflects the ceiling emission level that may be reached under certain normal operating conditions on the West plant, and on the East plant (if the WSA plant is not operational). It should be noted that if the Sulphur Recovery plant on the East factory is operating, while the WSA plant is down, this is still classified as a normal operating condition and would have to comply with the MES ceiling limits during such periods.

Table 8: Alternative emissions limit request for Sasol Synfuels sulphur recovery plant

Emission component	**MES for existing plants**	**MES for new plants**	**Alternative Emissions Limit Requested (ceiling limit)[a]**	**Averaging period for compliance monitoring**
	All values specified at 273 K and 101.3 kPa, mg/Nm^3			
H_2S	4 200	3 500	12 500	Daily average

[a] Since the MES prescribes ceiling limits, the alternative emissions limits requested are aligned to the maximum emission levels expected under all normal operating conditions. The alternative emissions limits proposed are based on a daily averaging period for compliance monitoring.

As confirmed in the foreword to this appendix, this application relates to postponement of the 2015 existing plant standard only. However, for completeness' sake, this is the limit which Sasol could meet in the longer term, based on current available information.

3 Rectisol Plant: Postponement request for VOCs

3.1 Applicable standards

Table 9: Category 3: Carbonization and Coal Gasification, Subcategory 3.6: Synthetic Gas Production and Clean-up

<table>
<tr><td>Description:</td><td colspan="3">The production and clean-up of a gaseous stream derived from coal gasification and includes gasification, separation and clean-up of a raw gas stream through a process that involves sulphur removal and Rectisol as well as the stripping of a liquid tar stream derived from the gasification process.</td></tr>
<tr><td>Application:</td><td colspan="3">All installations</td></tr>
<tr><td colspan="2">Substance or mixture of substances</td><td rowspan="2">Plant status</td><td rowspan="2">mg/Nm^3 under normal conditions of 10% 0_2, 273 Kelvin and 101.3 kPa.</td></tr>
<tr><td>Common name</td><td>Chemical symbol</td></tr>
<tr><td rowspan="2">Hydrogen Sulphide</td><td rowspan="2">H_2S</td><td>New</td><td>3,500</td></tr>
<tr><td>Existing</td><td>4,200</td></tr>
<tr><td rowspan="2">Total Volatile Organic Compounds</td><td rowspan="2">N/A</td><td>New</td><td>130</td></tr>
<tr><td>Existing</td><td>250</td></tr>
<tr><td rowspan="2">Sulphur dioxide</td><td rowspan="2">SO_2</td><td>New</td><td>500</td></tr>
<tr><td>Existing</td><td>3,500</td></tr>
</table>

This additional postponement application pertains to the existing plant standard for VOC. Notwithstanding that the additional postponement is made in terms of 2015 existing plant standards, for completeness' sake, this chapter outlines the challenges faced in meeting the VOC new plant standard.

3.2 Description of the plant

The gasification process produces a gas stream (called "raw gas") containing, amongst others, trace quantities of volatile organic compounds (VOCs). The raw gas is processed downstream in the Rectisol plant, as illustrated in Figure 1. The Rectisol plant purifies the incoming raw gas separating primarily carbon dioxide, hydrogen sulphide (H_2S) and trace amounts of VOCs. At Rectisol, the raw gas is first cooled and then sent to an absorption column. In the absorption column, first the VOCs are absorbed using methanol and then, in the upper sections, the majority of carbon dioxide and almost all H_2S is removed, since these impurities inhibit the effectiveness of downstream process catalysts. From here, the cleaned gas ("pure gas" or "syngas") is sent to the next process unit in the catalytic coal-to-liquid conversion process, where it undergoes Fischer-Tropsch chemical reactions to form hydrocarbon chains, as precursors to chemical and fuel products.

The Rectisol process is therefore essential to ensure the purity of gas fed to the Fischer-Tropsch synthesis unit.

From the Rectisol plant's absorption column, the methanol stream containing the impurities (carbon dioxide, H_2S and trace amounts of VOCs) proceeds to the methanol regeneration section where the methanol is flashed at near-atmospheric pressure and impurities released into an "off-gas" stream. The off-gas stream (primarily carbon dioxide, with a smaller portion of H_2S and also containing trace quantities of VOCs) is routed to the main stack via the Sulphur Recovery plant, where most of the H_2S is first removed. This is illustrated in Figure 1.

3.3 Technology options for compliance

Technology options identified for abatement of VOC emissions emanating from the Rectisol process include:

a) **End-of-pipe abatement:** The off gas stream from the raw gas clean-up process has a large volumetric flow rate (predominantly containing carbon dioxide, and a small percentage of H_2S) with a very low concentration of trace VOC components at near atmospheric pressures. The following technologies were considered to address trace VOCs:

- **Absorption**: Generally, absorption technologies operate most effectively at high pressure, since this reduces investment costs associated with equipment. High gas volumes at low, near-atmospheric pressure are contrary to this principle, and hence make this option infeasible. To increase the pressure, the off-gas stream would have to be compressed at the cost of very high energy consumption.
- **Adsorption**: Adsorption, like absorption, is favoured by increased pressure, and hence for the same reasons is considered infeasible.
- **Incineration**: The gas consists of primarily carbon dioxide (in excess of 95 percent, on a volume basis) with traces of VOCs and some H_2S. To incinerate this off-gas, a large amount of energy would have to be added. This would increase energy import from Eskom and render the Sasol Synfuels complex less energy efficient. The environmental benefits of reducing these trace VOCs would therefore come at the environmental cost of increased carbon dioxide emissions (greenhouse gases) generated by the extra energy required.

The installation of end-of-pipe abatement equipment is therefore not considered by Sasol Synfuels to be a feasible solution.

b) **Wash tray replacements:** One of the potential solutions involves a replacement of pre-wash trays in the Rectisol plant’s absorption column in order to improve the absorption of VOCs. This project is currently in implementation phase and is planned to be completed in September 2016. Based on a sampling campaign performed in October 2013 for the first replacements, no difference was observed in the VOC content in off-gas streams between Rectisol phases with modified and unmodified trays, meaning that this solution does not remove trace VOCs, as had been initially thought.

c) **Installation of a wet sulphuric acid (WSA) plant on West factory:** As discussed in the previous chapter, the installation of a further WSA plant was investigated to reduce H_2S emissions from the Sulphur Recovery process. When in operation, WSA takes part of the off-gas stream and incinerates it to convert the hydrogen sulphide to sulphur oxides. In the process, VOCs contained in that stream are also oxidised to carbon dioxide. Since the part of off-gas stream fed to WSA contains a slightly higher concentration of VOCs than the remaining off-gas, the concentration of VOCs in off-gas routed to the atmosphere (via the main stacks) is reduced. Indications are that VOC emissions on the East factory are lower when the WSA plant is operational and equivalent on the West factory when the WSA plant is offline. Unfortunately, technical problems have beset this plant since it was commissioned, because of a combination of problems leading to acid corrosion. Efforts to improve performance were identified. Given present knowledge and operational experience of the new WSA plant, Sasol is not in a position to commit to implementation of further improvements of a similar magnitude on the Western factory, since significant technology integration concerns remain.

Table 10: Summary of technology feasibility assessment associated with installation of VOC abatement technologies at the Sasol Synfuels Rectisol plant

TECHNICAL OPTION	OUTCOME OF TECHNOLOGY FEASIBILITY ASSESSMENT	SUMMARY OF REASONS FOR FEASIBILITY ASSESSMENT OUTCOME
End of pipe solution	Not feasible	High energy requirements High capital costs
Drip tray replacements	Feasible	Negligible removal of VOCs from off-gas stream
Further wet sulphuric acid plant on West factory	No longer considered feasible	As per explanation in previous chapter of this report Continued technology challenges Will not meet existing or new plant standards

3.4 Postponement request

Sasol Synfuels applies for a five-year postponement from the MES for its Rectisol plant, as indicated in Table 9. In place of the MES, Sasol Synfuels proposes the following maximum emission limits as alternative emissions limits to be incorporated in its Atmospheric Emissions Licence, as set out in Table 11.

Table 11: Alternative emissions limit request for Sasol Synfuels Rectisol plant

Emission component	MES for existing plants	MES for new plants	Alternative Emissions Limit Requested (*ceiling limit*) [a]	Averaging period for compliance monitoring
	All values specified at 273 K and 101.3 kPa, mg/Nm^3			
VOCs – East factory	250	130	300	Daily average
VOCs – West factory	250	130	300	Daily average

[a] Since the MES prescribes ceiling limits, the alternative emissions limits requested are aligned to the maximum emission levels expected under all normal operating conditions. The alternative emissions limits proposed are based on a daily averaging period for compliance monitoring.

As confirmed in the foreword to this appendix, this application relates to postponement of the 2015 existing plant standard only. However, for completeness' sake, these are the limits which Sasol could meet in the longer term, based on current available information.

4 Wet Sulphuric Acid plant: Challenges in meeting new plant standards for SO_2 and SO_3 and acid mist as SO_3

4.1 Applicable standards

Table 12: Category 7.2: Production of Acids

Description:	The production, bulk handling and or use in manufacturing of hydrofluoric, hydrochloric, nitric and sulphuric acid (including oleum) in concentration exceeding 10%. Processes in which oxides of sulphur are emitted through the production of acid sulphites of alkalis or alkaline earths or through the production of liquid sulphur or sulphurous acid. Secondary production of hydrochloric acid through regeneration.		
Application:	All installations producing, handling and or using more than 100 tons per annum of any of the listed compounds (Excluding metallurgical processes related activities regulated under category 4).		
Substance or mixture of substances		**Plant status**	**mg/Nm^3 under normal conditions of 273 Kelvin and 101.3 kPa.**
Common name	**Chemical symbol**		
Total fluoride measured as Hydrogen Fluoride (from processes in which HF is evolved)	F as HF	New	5
		Existing	30
Hydrogen chloride (from primary production of hydrochloric acid)	HCl	New	15
		Existing	25
Hydrogen chloride (from secondary production of hydrochloric acid)	HCl	New	30
		Existing	100
Sulphur dioxide	SO_2	New	350
		Existing	2,800
Sulphuric acid mist and sulphur trioxide expressed as SO_3 (from processes in which SO_3 is evolved).	SO_3	New	25
		Existing	100
Oxides of nitrogen expressed as NO_2	NO_x	New	350
		Existing	2,000

Notwithstanding that no additional postponement is made in terms of 2015 existing plant standards, for completeness' sake, this chapter outlines the challenges faced in meeting the new plant standards for SO_2 and SO_3 and acid mist as SO_3.

4.2 Description of the plant

The wet sulphuric acid plant (WSA) was commissioned in 2010 to reduce H_2S emissions from the Sasol Secunda complex by conversion of H_2S to sulphuric acid product, as described earlier. The WSA plant is located on the eastern Sasol Synfuels factory, as is illustrated in Figure 1. The plant was designed to achieve a 99% conversion efficiency of H_2S into product.

The plant's design includes a number of emission abatement controls:

- A wet scrubber was installed to control SO_2 and acid mist emissions.
- To further reduce acid mist emissions, a wet electrostatic precipitator (ESP) was included in the design by Sasol.
- To control NO_x the plant was designed with Selective Catalytic Reduction.

As described previously, extensive engineering work was conducted subsequent to the plant's commissioning to attempt to stabilise and optimise the plant's operations, which would also be beneficial for reducing SO_2, SO_3 and NO_x emissions further.

The plant was designed and constructed prior to the promulgation of the Regulations on 31 March 2010, and commissioned very soon thereafter. In the absence of promulgated MES, the plant was designed to include the best available abatement equipment with design limits specified by the technology supplier.

The WSA plant is currently compliant with new plant standards for NO_x, HF and HCl, but does not meet new plant standards for SO_2 and acid mist as SO_3.

4.3 Technology options for compliance: SO_3 and acid mist

The original vendor design of the plant included the installation of a wet scrubber. To further reduce acid mist emissions, a wet ESP was added to the design by Sasol. The operation of the wet ESP was optimised in 2011 to ensure minimal emissions and ensure compliance with design specifications. It is Sasol's view that Best Available Technology for emissions control is already installed on this plant, in accordance with design specifications provided by the technology supplier.

Given challenges in operability of the WSA plant, during the optimisation studies, various actions were identified to reduce acid mist emissions as well.

- **Wet ESP electrode replacement:** the wet ESP is fitted with electrodes that assist in creating an electric field that attracts the acid mist droplets. During optimisation it was found that the wet ESP electrodes were failing. If the electrodes fail, the effective field in the wet ESP reduces and the wet ESP is not as efficient as designed, leading to elevated emissions. Sasol Synfuels is in the process of replacing the wet ESP electrodes with new electrodes to ensure that the unit is functioning optimally. The transformer that supplies the unit was also optimised to ensure that the electricity supply to the wet ESP is adequate. Emissions improved as a result, but not to the level required by the new plant standards.
- **Automated control of wet ESP:** During the optimisation study it was also observed that the acid mist emissions were variable. In order to operate the wet ESP at optimal emission reduction levels, automated control of the system will be required. Automated control of the wet ESP was not available at the time of construction; hence currently the wet ESP is manually controlled. Since the start-up of the unit, control technology that may be applicable to this process has been developed. The control system is new technology and will have to be optimised and the operators trained to ensure optimal functioning of the control system. Emissions are likely to improve as a result, but may not reach the level required by the new plant standards.

Table 13: Summary of technology feasibility assessment associated with SO_3 and acid mist reduction options at the Sasol Synfuels WSA plant

TECHNICAL OPTION	OUTCOME OF TECHNOLOGY FEASIBILITY ASSESSMENT	SUMMARY OF REASONS FOR FEASIBILITY ASSESSMENT OUTCOME
Wet ESP electrode replacement	Feasible, but may not attain compliance with new plant standards	Small modifications to existing plant were feasible, without significant negative downstream or upstream impacts
Automated control of wet ESP	Feasible, but may not attain compliance with new plant standards	Small modifications to existing plant are feasible, without significant negative downstream or upstream impacts

4.4 Technology options for compliance: SO_2

The WSA plant was designed for a SO_2 –to-product conversion efficiency of 99% (90% efficiency for each of two catalyst beds). After optimisation efforts, the plant operates in excess of 99% conversion efficiency, leaving less than 1% of SO_2 emitted to atmosphere. SO_2 emissions are significantly below the existing plant standard of 2 800 mg/Nm^3.

Increasing efficiency further would require installation of either an additional catalyst bed or a bleed line back to the inlet, which will show marginal efficiency gains of 0.9% while reducing the capacity of the plant, at significant cost.

Table 14: Summary of technology feasibility assessment associated with SO_2 reduction options at the Sasol Synfuels WSA plant

TECHNICAL OPTION	OUTCOME OF TECHNOLOGY FEASIBILITY ASSESSMENT	SUMMARY OF REASONS FOR FEASIBILITY ASSESSMENT OUTCOME
Additional catalyst bed	Feasible but unjustifiable marginal improvement	Marginal efficiency gains at high cost Reduced plant production capacity Marginal reduction in SO_2 emissions
Bleed line back to the inlet	Feasible but unjustifiable marginal improvement	Marginal efficiency gains at high cost Reduced plant production capacity Marginal reduction in SO_2 emissions

4.5 Proposed alternative emission limit

As confirmed in the foreword to this appendix, this application relates to postponement of the 2015 existing plant standard only. However, for completeness' sake, these are the limits which Sasol could meet in the longer term, based on current available information.

Table 15: Alternative emission limit request for Sasol Synfuels WSA plant

Emission component	MES for existing plants	MES for new plants	Alternative Emission Limit (*ceiling limit*) [a]	Averaging period for compliance monitoring
	All values specified at 273 K and 101.3 kPa, mg/Nm^3			
SO_3 and acid mist as SO_3	100	25	100	Daily average
SO_2	2,800	350	800	Daily average

[a] Since the MES prescribes ceiling limits, the alternative emissions limits are aligned to the maximum emission levels expected under all normal operating conditions. The alternative emissions limits proposed are based on a daily averaging period for compliance monitoring.

The alternative emissions limits that are seen as feasible based on presently available technologies have been indicated above based on a daily averaging period for compliance monitoring.

5 HOW incinerators

5.1 Applicable standards

Table 16: Category 8.1: Thermal Treatment of Hazardous and General Waste

Description:	Facilities where general and hazardous waste are treated by the application of heat.		
Application:	All installations treating 10 Kg per day of waste.		
Substance or mixture of substances		**Plant status**	**mg/Nm^3 under normal conditions of 10% 0_2, 273 Kelvin and 101.3 kPa.**
Common name	**Chemical symbol**		
Particulate matter	N/A	New	10
		Existing	20
Carbon Monoxide	CO	New	50
		Existing	75
Sulphur dioxide	SO_2	New	50
		Existing	50
Oxides of nitrogen	NO_x expressed as NO_2	New	200
		Existing	200
Hydrogen chloride	HCl	New	10
		Existing	10
Hydrogen fluoride	HF	New	1
		Existing	1
Sum of Lead, arsenic, antimony, chromium, cobalt, copper, manganese, nickel, vanadium	Pb+ As+ Sb+ Cr+ Co+ Cu+ Mn+ Ni V	New	0.5
		Existing	0.5
Mercury	Hg	New	0.05
		Existing	0.05
Cadmium Thallium	Cd Tl	New	0.05
		Existing	0.05
Total Organic Compounds	N/A	New	10
		Existing	10
Ammonia	NH_3	New	10
		Existing	10
		Ng I-TEQ.Nm^3 under normal conditions of 10% 02, 273 Kelvin and 101.3 kPa.	
Total Organic Compounds	N/A	New	0.1
		Existing	0.1

(a) The following special arrangements shall apply:

(vi) Exit gas temperatures must be maintained below 200 °C

Note: only special arrangement (vi) is listed in this excerpt for brevity, since the other 20 arrangements are not the subject of this postponement application.

This additional postponement application pertains to the existing plant standards. Notwithstanding that the additional postponement is made in terms of 2015 existing plant standards, for completeness' sake, this chapter outlines the challenges faced in meeting the new plant standards.

5.2 Description of the plant

The purpose of the two High Organic Waste (HOW) incinerators is to treat Nitrogen-rich effluent streams from the Sasol Synfuels Phenosolvan and Sasol Solvents facilities. HOW from the Sasol Synfuels Phenosolvan plant (Ammonia recovery) and HOW from the Sasol Solvents plant (Carbonyl recovery) is treated at the water recovery plant area, where the HOW is combusted in the presence of fuel gas and air, for safe disposal of this waste stream.

The HOW incinerators currently comply with existing plant standards and new plant standards for SO_2, CO, HCl, TOCs and dioxins and furans, but emission levels are above the MES for PM, NOx, Metals, Mercury (Hg), Cadmium plus Thallium (Cd + Tl), Hydrogen fluoride (HF) and ammonia (NH_3).

The HOW incinerators are designed to operate at high temperatures to ensure complete combustion of their feed streams. As a result of high combustion temperatures, flue gas temperatures exceed 200°C. This does not meet the requirement prescribed under special arrangement (a)(vi).

5.3 Technology options for compliance: MES

The HOW incinerators currently employ steam flow, pressure control and a trip system to manage PM emission impacts. Nitrogen blankets on tanks mitigate ammonia emissions.

Sasol Synfuels' approach to further emission reductions from its incinerators is informed by the waste hierarchy, which places preference on solutions to avoid and reduce waste over disposing of it (to landfill, or to atmosphere, via incineration), since this averts negative environmental impacts. The alternative options evaluated in terms of the waste management hierarchy include the following, which would concurrently address the emission components not achieving the MES:

- Operational improvements.
- Installation of abatement technology on existing equipment.
- Installation of a new incinerator.
- Reduction of the waste streams being incinerated at source.
- Alternative, beneficial use of the incinerated streams.

It should be noted that landfilling of HOW as an alternative to incineration was not considered as an option, since this will be prohibited by the recently promulgated Standards for Disposal of Waste to Landfill published in terms of the National Environmental Management: Waste Act (Act No. 59 of 2008).

A description of each solution investigated is described in the Sections to follow.

5.3.1 Operational improvements

These incinerators, though decades old, are maintained to operate at optimal performance for their design intent. As such, investigations did not identify any material potential for emissions reductions via operational improvements.

5.3.2 Installation of abatement technology on existing equipment

A pre-feasibility study was conducted to determine the best abatement route on the existing incinerators. Only commercially proven technologies were considered in the study; however these have not been proven on the unique waste streams arising from the Sasol process, and hence piloting would be required to demonstrate performance capabilities under all normal operating conditions. Retrofits to this existing equipment in a brownfields area creates risks of disrupting upstream production, since the plant cannot operate without HOW incinerator capacity online, as there is no other outlet available for the high calorific value streams it receives and thermally treats.

Installing abatement equipment to comply with the MES for all components would have a high capital cost.

These reasons combined rendered this option operationally infeasible for Sasol Synfuels.

5.3.3 Installation of new incinerator

Replacing the HOW incinerators was investigated. Due to the prohibitively high capital cost, and early retirement of still functional equipment that incinerator replacement would necessitate, the replacement of the existing equipment with new equipment is not seen as a feasible solution.

This high cost rendered this option financially infeasible for Sasol Synfuels.

5.3.4 Reduction of streams at source and beneficial utilisation

The feed to the incinerator is made up of a stream from operating division Sasol Solvents (10-15% by volume) and a Sasol Synfuels stream from the Phenosolvan plant (85-90% by volume). A study is currently underway to investigate the potential for diversion of either of these streams away from the incinerators, by identifying alternative beneficial uses.

The feasibility of this solution is currently unknown, but it is known that solutions to reduce volumes of feed streams to incinerators would not practically reduce emission concentrations, but would rather reduce the tons (pollution load) of emissions to atmosphere. Since the MES are specified on a concentration basis, reduction in tons of emissions from incinerators, while beneficial for ambient air quality, would not deliver compliance with MES. Concentrations are not always a useful indicator of ambient impacts of a listed activity. Thus, postponements from the concentration-based MES would still be required, aligned with current ceiling emissions concentrations.

Table 17: Summary of technology feasibility assessment associated with emission reduction options at HOW incinerators

TECHNICAL OPTION	OUTCOME OF TECHNOLOGY FEASIBILITY ASSESSMENT	SUMMARY OF REASONS FOR FEASIBILITY ASSESSMENT OUTCOME
Operational improvements	Feasible	Very small improvements in emission concentrations possible due to technology constraints
Installation of abatement technology on existing plant	Infeasible	Negative impacts on upstream operations during technology installation Negative environmental cross-impacts associated with compliance High cost option
Installation of new incinerator	Infeasible	Shutting down existing equipment before end of useful life is financially unsustainable High cost option
Reduction of feed streams at source	Feasibility being determined – but it is known that this will not change emissions concentrations	No negative externalities identified Aligned with waste hierarchy priorities May be more cost-effective than other solutions

5.4 Technology options for compliance: flue gas exit temperature

Special arrangement 8(a)(vi) under Category 8.1 of the MES requires flue gas exit temperatures for incinerators to be maintained below 200°C. The HOW incinerators were designed to have stack exit temperatures above 200°C to ensure complete combustion of the feed material and thereby reduce emissions of other atmospheric pollutants, which are also regulated by emission standards under Category 8.1 of the MES.

The requirement for incinerator flue gas exit temperatures to be lower than 200°C is typically employed to reduce the risk of *de novo* dioxin and furan formation by ensuring that exit temperatures are below the temperature window where dioxins or furans can be formed.

The formation of dioxins and furans requires two preconditions; in addition to the optimal temperature window, the precursor chemical components for their formation, chlorinated compounds, must also be present in the stack gas. Without chlorinated compounds present, it would not be possible for dioxins and furans to form, regardless of the temperature conditions within the stack.

The feed to the HOW incinerator consists of two streams that do not contain chlorinated compounds. Unlike general waste with numerous and varying feed sources that may contain chlorinated compounds, a finite set of feed streams to the HOW incinerator originate within the factory, and are more homogenous with regards to feed composition. It is therefore unlikely that dioxins and furans could be formed. Dioxin and furan measurements have indicated that emissions from the incinerators are well below the MES, supporting this statement.

Reducing the exit gas temperature to comply with the special arrangement would require the installation of a low temperature quench, as the current operating temperature is not significantly above 200°C, making the alternative solution of waste heat recovery infeasible. The low temperature quench would reduce plume buoyancy and have an unintended negative impact on the dispersion potential of the plume (thereby increasing ambient impacts of emissions rather than reducing them), without any measurable benefit on dioxin and furan formation, since precursors are not present in the feed stream.

A postponement of the requirement is therefore requested, in favour of operating at current flue gas exit temperatures. Measurement of dioxins and furans will continue to ensure that these emissions are maintained at their current very low levels.

5.5 Postponement request

Sasol Synfuels is applying for a five-year postponement from the MES for its HOW incinerators, as indicated in Table 16. In place of the MES, Sasol Synfuels proposes the following maximum emission concentrations as alternative emissions limits to be incorporated in its Atmospheric Emissions Licence, as set out in Table 18.

The incinerators will comply with the new plant standards set for carbon monoxide, SO_2, hydrogen chloride, ammonia, and dioxins and furans.

Table 18: Alternative emissions limits request for Sasol Synfuels HOW incinerators

Emission component	MES for existing plants	MES for new plants	Alternative Emission Limit Requested (*ceiling limit*) [a]	Averaging period for compliance monitoring
	All values specified at 10% O_2, 273 K and 101.3 kPa, mg/Nm^3			
PM	25	10	1,398	Daily average
NO_x	200	200	2,449	Daily average
HF	1	1	7	Daily average
Pb+As+Sb+Cr+ Co+Cu+Mn+Ni+V	0.5	0.5	21	Daily average
Hg	0.05	0.05	0.27	Daily average
Cd+Tl	0.05	0.05	0.12	Daily average
TOC	10	10	50	Daily average

[a] Since the MES prescribes ceiling limits, the alternative emissions limits requested are aligned to the maximum emission levels expected under all normal operating conditions. The alternative emissions limits proposed are based on a daily averaging period for compliance monitoring.

* As confirmed in the foreword to this appendix, this application relates to postponement of the 2015 existing plant standard only. However, for completeness' sake, these are the limits which Sasol could meet in the longer term, based on current available information.

Furthermore, Sasol Synfuels applies for postponement from special arrangement 8(a)(vi) for its HOW incinerators, and requests that it be permitted to continue operating at current flue gas exit temperatures.

6 Biosludge incinerators

6.1 Applicable standards

Table 19: Category 8.1: Thermal Treatment of Hazardous and General Waste

Description:	Facilities where general and hazardous waste are treated by the application of heat.		
Application:	All installations treating 10 kg per day of waste.		
Substance or mixture of substances		**Plant status**	**mg/Nm^3 under normal conditions of 10% 02 , 273 Kelvin and 101.3 kPa.**
Common name	**Chemical symbol**		
Particulate matter	N/A	New	10
		Existing	20
Carbon Monoxide	CO	New	50
		Existing	75
Sulphur dioxide	SO_2	New	50
		Existing	50
Oxides of nitrogen	NO_x expressed as NO_2	New	200
		Existing	200
Hydrogen chloride	HCl	New	10
		Existing	10
Hydrogen fluoride	HF	New	1
		Existing	1
Sum of Lead, arsenic, antimony, chromium, cobalt, copper, manganese, nickel, vanadium	Pb+ As+ Sb+ Cr+ Co+ Cu+ Mn+ Ni V	New	0.5
		Existing	0.5
Mercury	Hg	New	0.05
		Existing	0.05
Cadmium Thallium	Cd Tl	New	0.05
		Existing	0.05
Total Organic Compounds	N/A	New	10
		Existing	10
Ammonia	NH_3	New	10
		Existing	10
		Ng I-TEQ.Nm^3 under normal conditions of 10% 02 , 273 Kelvin and 101.3 kPa.	
Total Organic Compounds	N/A	New	0.1
		Existing	0.1

Note: no special arrangements that form part of this Category 8.1 are listed in this excerpt, since none are the subject of this postponement application.

This additional postponement application pertains to the existing plant standards. Notwithstanding that the additional postponement is made in terms of 2015 existing plant standards, for completeness' sake, this chapter outlines the challenges faced in meeting the new plant standards.

6.2 Description of the plant

Process effluent streams including Reaction Water and Stripped Gas Liquor, along with plant runoff and storm water streams, are treated in an aerobic activated sludge wastewater treatment process which generates excess activated sludge (biosludge) requiring disposal. This excess activated biosludge, together with a smaller stream of neighbouring Secunda's domestic sewage sludge which Sasol treats on behalf of the municipality, is thickened. This de-watered sludge has a solid concentration of ~12%, which is the upper limit of what can be achieved through mechanical de-watering. The centrifuged sludge is then pumped to four Lurgi multiple-hearth incinerators for incineration.

6.3 Technology options for compliance

Currently, emissions from the biosludge incinerators are mitigated by Venturi scrubber towers, which reduce concentrations of PM, metals, NH_3, HF and HCl.

Sasol Synfuels' approach to further emission reductions from its incinerators is informed by the waste hierarchy, which places preference on solutions to avoid and reduce waste over disposing of it (to landfill, or to atmosphere, via incineration), since this averts negative environmental impacts. The alternative options evaluated in terms of the waste management hierarchy include the following, which would concurrently address the emission components not achieving the MES:

- Operational improvements.
- Installation of abatement technology on existing equipment.
- Installation of a new incinerator.
- Reduction of the waste streams being incinerated at source.
- Landfilling.
- Alternative, beneficial use of the incinerated streams.

This approach was applied to the HOW and biosludge incinerators to identify the most sustainable solution.

6.3.1 Operational improvements

Investigations were conducted by Sasol Synfuels into opportunities for operational improvements for emission reductions, and the small improvement opportunities identified have already been implemented. These have marginally reduced emissions through optimisation of the operation of the biosludge incinerators. Operational improvements are constrained by the limits of performance of the installed technology.

6.3.2 Installation of abatement technology on existing equipment

Pre-feasibility studies on abatement of biosludge incinerator emissions to comply with the MES have been conducted. These studies concluded that at least four large projects would need to be implemented at each of the four biosludge incinerators to render compliance: a new centre shaft gearbox; new centrifuges; post combustion chambers; and flue gas cleaning systems. Further studies would be required to confirm resultant emission performance relative to the MES.

The high costs of abating emissions were identified by technology vendors to be in line with the costs of installing new incinerators. Furthermore, retrofits to existing equipment in a brownfields area creates risks of disrupting upstream production, since the plant cannot operate without biosludge incinerator capacity online, for management of this continuous stream. These reasons combined rendered this option unsustainable for Synfuels.

6.3.3 Installation of new incinerator

The implementation of an incinerator replacement that delivers full compliance was investigated, including a mechanical dewatering section, a fluidised bed incinerator section and a flue gas treatment section. The capital cost of an incinerator replacement is expected to be high. Due to the prohibitively high capital cost, and early retirement of still functional equipment that incinerator replacement would necessitate, the replacement of the existing equipment with new equipment is not seen as a feasible solution.

6.3.4 Landfilling

Sasol has investigated opportunities to stabilise the total centrifuged biosludge stream using ash, which would enable the waste to be landfilled for a maximum of 15 years after the recent promulgation of the Standards for Disposal of Waste to Landfill under the National Environmental Management: Waste Act.

This option will require a large capital outlay to buy land, build a suitable landfill site and install two large thermal dryer plants, for a limited timeframe before the waste-to-landfill prohibition would be implemented. For these reasons, this option was identified as infeasible.

6.3.5 Reduction of streams at source

A number of projects are being investigated and implemented upstream of the biosludge incinerators in the water and waste treatment process (for example, the recent introduction of anaerobic treatment capacity), which have the potential to reduce the volume of streams to the aerobic basins, and subsequently to the biosludge incinerators. The beneficial impact of these projects will only be quantifiable once these interventions are completed. These reductions would not change the emissions concentrations from the biosludge incinerators, but would rather reduce pollutant loads.

6.3.6 Beneficial utilisation

Pilot investigations into blending and composting initiatives are underway, informed by the waste hierarchy. Developing these options further will require additional time and resource allocation which extends beyond the 2015 compliance timeframe stipulated for existing plant standards - an Environmental Impact Assessment is underway to confirm that composting options can be scaled up.

Reduction in volumes fed to the incinerators would result in a corresponding reduction in total pollution load of emissions dispersed into the atmosphere, but this would not alter the emission concentrations from the incinerators, which is how the MES are prescribed.

Table 20: Summary of technology feasibility assessment associated with emission reduction options at biosludge incinerators

TECHNICAL OPTION	OUTCOME OF TECHNOLOGY FEASIBILITY ASSESSMENT	SUMMARY OF REASONS FOR FEASIBILITY ASSESSMENT OUTCOME
Operational improvements	Feasible	Very small improvements in emission concentrations possible due to technology constraints
Installation of abatement technology on existing plant	Infeasible	Negative impacts on upstream operations during technology installation Negative environmental cross-impacts associated with compliance High cost option
Installation of new incinerator	Infeasible	Shutting down existing equipment before end of useful life is financially unsustainable High cost option
Landfilling	Infeasible	High cost option which would only be permitted for 15 years in terms of the Waste Act
Reduction of feed streams at source	Feasible, but will not change emission concentrations	Projects being implemented which will result in small downstream improvements at the biosludge incinerators
Beneficial utilisation	Potentially feasible, but will not change emission concentrations	Pilot study underway, but will not be able to manage most of the biosludge volumes While emission volumes will decrease, emission concentrations will not change, hence this option does not deliver compliance with the MES

6.4 Postponement request

Sasol Synfuels is applying for a five-year postponement from the MES for its biosludge incinerators, as indicated in Table 19. In place of the MES, Sasol Synfuels proposes the following maximum emissions limit as alternative emissions limits to be incorporated in its Atmospheric Emissions Licence, as set out in Table 21.

The incinerators will comply with new plant standards prescribed for Cadmium + Thallium and dioxins and furans.

Table 21: Alternative emissions limit request for Synfuels biosludge incinerators

Emission component	MES for existing plants	MES for new plants	Alternative Emission Limit Requested (*ceiling limit*) [a]	Averaging period for compliance monitoring
	All values specified at 10% O_2, 273 K and 101.3 kPa, mg/Nm^3			
PM	25	10	890	Daily average
CO	75	50	5,000	Daily average
SO_2	50	50	150	Daily average
NO_x expressed as NO_2	200	200	640	Daily average
HCl	10	10	20	Daily average
HF	1	1	28	Daily average
Pb+As+Sb+Cr+ Co+Cu+Mn+Ni+V	0.5	0.5	2.4	Daily average
Hg	0.05	0.05	0.85	Daily average
Cd+Tl	0.05	0.05	Compliant	Daily average
TOC	10	10	50	Daily average
NH_3	10	10	47	Daily average

[a] Since the MES prescribes ceiling limits, the alternative emissions limits requested are aligned to the maximum emission levels expected under all normal operating conditions. The alternative emissions limits proposed are based on a daily averaging period for compliance monitoring.

As confirmed in the foreword to this appendix, this application relates to postponement of the 2015 existing plant standard only. However, for completeness' sake, these are the limits which Sasol could meet in the longer term, based on current available information.