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ENERGY AND CLIMATE CHANGE
ENVIRONMENT AND SUSTAINABILITY
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MINING AND MINERAL PROCESSING
MINERAL ESTATES
WASTE RESOURCE MANAGEMENT

ENDLESS ENERGY LIMITED

ENDLESS ENERGY FACILITY

ASSESSMENT OF BEST AVAILABLE TECHNIQUES

SEPTEMBER 2018

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TABLES

1 INTRODUCTION

1.1.1 Endless Energy intend to operate a 148,800 tonnes per annum Clean Energy Facility, 3km East of Keighley Town Centre, at grid reference SE080 415. This is a listed activity under Schedule 1, Section 5.1 Part A (1) b of the Environmental Permitting (England and Wales) Regulations 2016. The plant must therefore be operated in accordance with the BREF note on incineration and the Environment Agency's "How to Comply with Your Environmental Permit; Additional Guidance for the Incineration of Waste" which describe what is currently considered as BAT for the energy from waste sector.

1.1.2 It is a requirement of the Industrial Emissions Directive that listed activities are operated using the "best available techniques" (BAT) for preventing pollution in order to ensure a high level of protection of the environment as a whole.

1.1.3 This report sets out the reasons for the choice of moving grate technology and for the selected abatement technologies, showing why these are the best available technique in this instance.

1.1.4 The report also describes the indicative BAT standards set out in the Environment Agency's Guidance EPR 5.01 and explains how the site will meet these standards.

2 BEST AVAILABLE TECHNIQUES FOR THE COMBUSTION OF RESIDUAL COMMERCIAL AND INDUSTRIAL WASTES

2.1.1 There are a number of potential technologies for the combustion of residual commercial and industrial wastes. Table 2:1 below, details the potential technologies and considers their suitability to deliver the Best Available Technique in this case.

Table 2:1 Comparison of Potential Technologies

Technology	Comments
Fixed Bed Incinerator	This is a proven technology but has limited potential to accommodate variations in the incoming waste, waste would need to be of similar CV and evenly spread to maximise efficiency and ensure complete combustion.
Rotary Kiln Incinerator	This provides good burn out and can accommodate a range of fuels. However, the system uses more excess air than other technologies and so may have reduced efficiency.
Fluidised Bed Incinerator	This is an expensive technology but provides good results for large projects with a uniform fuel. The system needs fuel to meet a uniform small particle size and therefore is unsuited to mixed waste.
Gasification or Pyrolysis	These technologies can achieve low emissions but there is limited experience in the UK and operational reliability and long term maintenance costs are uncertain.
Moving Grate	This is a robust and proven technology in the UK. The moving grate allows agitation of the waste, improving aeration and therefore combustion. The speed of the grate can be adjusted to accommodate different waste types. This system therefore has the capacity to handle fuel with a wide range of varying size, CV and moisture content. This makes it well suited to treating mixed waste. The system has better energy efficiency than the rotary kiln.

2.1.2 From the commentary above it can be seen that moving grate technology will deliver a robust and proven system for a waste stream that may have variable composition and calorific value. Furthermore, the speed of the moving grate can be adjusted to vary the quantity of waste on the grate, ensuring complete burn out of all the material. The system is designed so that there is no requirement for the grate to be cooled with water and the system is hardwearing requiring little maintenance.

2.1.3 The moving grate moves the waste through different phases of combustion, ensuring that complete oxidation is achieved and that emissions are minimised. In the first part of the process wastes are gasified, ignited and combusted on the surface of the grate. This is followed by a second stage of combustion, where further oxidation occurs and complete burn-out of the wastes is achieved. Both primary and secondary airflow are utilised with air being introduced in a controlled manner. Additional air is introduced in the boiler as a means of ensuring that the off-gases remain at a temperature of over 850°C for more than 2 seconds and that species such as carbon monoxide are oxidised, reducing emissions.

2.1.4 The technology is able to manage heterogeneous waste and can handle a range of particle sizes and variable CV. The firing diagram (presented as Appendix A to the "Operating Techniques") shows that the plant can handle a throughput of 19.6 tonnes an hour and a CV range of 8-14 MJ/Kg, although normal operation will usually be well within these limits.

2.1.5 The technology has therefore been selected as the Best Available Technique in this circumstance as it is a proven and robust technology which includes a number of mechanisms to ensure complete combustion and lower emissions.

3 BEST AVAILABLE TECHNIQUES FOR THE ABATEMENT OF POINT SOURCE EMISSIONS TO AIR

3.1.1 The major emissions to air from combustion processes may include nitrogen oxides, acid species such as sulphur dioxide and particulates. In addition, there is a need to control emissions of carbon monoxide, metals, dioxins and furans and other volatile organic compounds (VOCs). Abatement systems have been put on place to treat these gases and ensure that emissions from the plant are acceptable.

3.1.2 The proposed abatement technique for each pollutant has been chosen to ensure that it represents the Best Available Technique in this instance for controlling pollution and providing a high level of environmental protection.

3.2 Nitrogen Oxides

3.2.1 Nitrogen oxides (NO_X) can act to irritate the respiratory system and can worsen the symptoms of asthma. They may also react with volatile organic compounds in the presence of sunlight to form ozone. This, similarly, can have a negative impact on respiratory function. It is therefore important that levels of nitrogen oxides in emissions are controlled.

3.2.2 Table 3:1 below, sets out the different technologies that might be used for control of NO_X with a comment on their applicability in this case.

Table 3:1: Secondary Control of NO_X

Technology	Comments
SNCR with ammonia	Ammonia is introduced to the gas flow and reacts with NO_X to form harmless nitrogen and water. This is effective and can reduce NO_X levels by up to 70%. However ammonia is a dangerous chemical to handle with the potential for release of toxic and flammable ammonia gas. Safety systems must be put in place to control the receipt, storage and use of the ammonia.
SNCR with urea	This operates in the same way as described above but employs a lower risk reactant. Urea will not dissociate, evolving ammonia gas, until it meets the high temperature gas within the flue. This makes it safer to store and handle.
SCR	This technology also uses a reaction with ammonia to convert NO_X to N_2 and H_2O. However a catalyst is employed to improve the rate of reaction allowing the reaction to proceed at lower temperatures. Although SCR can achieve even lower levels of NO_X than SNCR it has higher construction and operating costs. It has been found for a plant using the same moving grate technology that the cost of installing and operating SCR would incur additional costs of £1,049,000 a year, compared with a base case of SNCR[1]
Flue gas recirculation	Flue gas recirculation enhances the primary control of NO_X. By recirculating a portion of the flue gas it is possible to control oxygen levels in the combustion chamber, reducing the formation of NO_X. At a similar plant it was found that the reduction in NO_X using SNCR and FGR was only marginally better than use of SNCR alone. In most other respects there was very little difference in performance between the use of SNCR or SNCR with FGR. The SNCR alone was predicted to consume slightly more reagent whilst in combination with FGR slightly more electricity was used.[1] It is concluded that the additional cost of installing FGR would have minimal environmental benefit. Although FGR is not employed internal gas recirculation (IGR) provides good mixing of the gases within the furnace, reducing emissions of NO_X.

3.2.3 Use of SNCR will allow the plant to comply with the emission limits imposed by Annex VI of the Industrial Emissions Directive and lower limits if necessary. Low levels have been demonstrated at facilities in the Netherlands (see Air Quality Report). Air quality modelling has also demonstrated that it will not impact local air quality, with worst case process contributions of 2.69 µg/m^3 for long term emissions and 28µg/m3 for long term emissions, that is, just 6.74% and 14% of the statutory air quality standards respectively. Whilst even lower emissions might be achieved by employment of SCR it must be questioned whether the additional costs would be justified.

3.2.4 It has therefore been concluded that SNCR represents BAT for the control of NOX at this site.

3.2.5 NO_X will be minimised by the controlled injection of either ammonia or urea in order to achieve the best emission profile in the exhaust gas stream. Urea reacts with the

[1] ERM, July 2012, application for the Leeds Recycling and Energy Recovery Facility, made on behalf of Veolia

nitrogen oxides that may be present, forming nitrogen (N_2) and water (H_2O). This allows emissions of nitrogen oxides to be reduced to a very low level, preventing the associated health effects.

3.2.6 Ammonia may be formed as a result of partial reaction. As a result, ammonia will be monitored continuously at the stack to ensure that ammonia "slip" is in accordance with the IED requirement, (ammonia slip is ammonia passing through the system without fully reacting with NO_X) Since the reactions rely on high temperature the injection point will be carefully positioned to ensure sufficient temperature and residence time. Monitoring of the emissions and temperature will feed back to the SCADA system allowing the injection rate to be adjusted to provide the most effective treatment.

3.2.7 This method of control is recognised within the European BREF note as potential BAT for the control of NO_X. It has also been selected as the best available technique in this instance as it is a proven technology that can be closely monitored in order to control pollutants.

3.3 Carbon Monoxide

3.3.1 Carbon monoxide is a common by-product of incomplete combustion. It is known to be toxic, binding to haemoglobin in the blood and preventing the uptake of oxygen. It is therefore important that it is controlled.

3.3.2 The main control to minimise emissions of carbon monoxide is to control the combustion process to ensure that complete combustion occurs. In this instance the control is provided by:

- the two-stage combustion process;
- the addition of primary and secondary air to ensure the availability of excess oxygen;
- the internal gas recirculation (IGR) which enhances the turbulence and mixing in the furnace; and
- the presence of burners which can be used, if required, to keep the temperature above 850^{o}C for a flue gas residence time of 2 seconds as required by the IED.

3.3.3 These measures combine to ensure that any carbon containing compounds are fully oxidised to carbon dioxide. The combustion process is monitored to ensure that the correct conditions are achieved and carbon monoxide is oxidised.

3.3.4 Good control of the combustion process is the recognised Best Available Technique for control of carbon dioxide.

3.4 Acid Gases

3.4.1 Sulphur dioxide and other acid species, such as hydrogen chloride, form acids which can act as a respiratory irritant. They can also lead to acid deposition which causes damage to vegetation. It is therefore important that these species are controlled.

3.4.2 For most combustion processes the primary controls will typically involve the selection of low sulphur fuels. It is clearly difficult to control the sulphur content of incoming waste and so for waste incineration primary controls are limited. A low sulphur auxiliary fuel will be utilised for start-up and to keep the incinerator at temperature where required.

3.4.3 Acid gases are generally controlled by using an alkaline substance to neutralise them, commonly sodium bicarbonate or lime. Systems may be wet or dry, introducing the alkaline reactant as either a powder or in solution.

3.4.4 Table 3:2 below, sets out advantages and disadvantages of the different possible solutions for the control of acid gases at the site.

Table 3:2: Control of Acid Gases			
Technology	**Advantages**	**Disadvantages**	**Compatibility with other Systems**
Wet system with sodium hydroxide	High removal rates Low solid waste production	Effluent treatment required Hazardous reagent	The Endless Energy Facility uses very little water. A wet system will necessitate treatment facilities for a large quantity of effluent and discharge of large quantities of water. This system cannot be used with activated carbon but would require a separate system.
Dry system with lime	Good removal rates Low leaching potential of solid residues High Energy Recovery	May generate larger quantities of solid waste Hazardous reagent	Can easily be combined with use of pulverised activated carbon (PAC). PAC may be introduced through a separate injection nozzle or can be introduced in a mixture with the lime.
Dry system with sodium bicarbonate	Good removal rates Non-hazardous material and therefore easier to handle	More leachable residues produced Most effective at higher temperatures, efficacy reduces considerably below 180^{O}C.	Filter bags generally can withstand a maximum temperature up to 250^{O}C.

3.4.5 In this instance lime delivers BAT for the control of sulphur dioxide and HCl and other acid species. Cost benefit is not presented here as the main reason behind selection of this technology, rather than any of the other options, is compatibility with the other flue gas treatments to be utilised.

3.4.6 Treatment with lime is effective at a lower temperature than can be achieved using sodium bicarbonate. This will allow the reaction temperature in the air pollution control system to be lowered, allowing a higher rate of energy recovery in the boilers. This, along with the reduced costs of the reagent, make use of lime preferable over sodium bicarbonate.

3.4.7 In addition, the use of lime allows the use of pulverised activated carbon, which can be introduced into the gas stream with or alongside the lime. Activated carbon will remove metals and VOCs from the flue gas. This system would be incompatible with wet acid gas removal, which would necessitate drying of the air stream before it could be treated in a separate carbon filter. Such a system would increase capital costs considerably and also increase costs and energy use during operation because additional energy would be required for drying.

3.5 VOCs, Metals and Dioxins and Furans

3.5.1 These species have a range of adverse effects and may be toxic or carcinogenic. Good control of these emissions is therefore essential.

3.5.2 The first line of defence against emissions of VOCs, including dioxins and furans is good control of the combustion process. Where sufficient air is provided VOCs will oxidise. Dioxins and furans may be generated by de-novo synthesis at temperatures between 200 and 450˚C. For this reason, it is important that high temperatures are maintained in the combustion chamber, destroying VOCs and that the exhaust gases are then cooled quickly so that these temperatures are avoided. The system is designed to achieve this temperature profile and minimise emissions of VOCs.

3.5.3 Pulverised activated carbon will be injected into the gas stream alongside the lime. Residual VOCs and any volatile metals will adsorb to the surface of the carbon. This system is considered to be BAT for control of metals and VOCs, providing control of metals and residual VOCs. Dioxins and furans are commonly associated with particulates and therefore will also be contained by the bag filters. Emissions to air will be very low.

3.6 Particulates

3.6.1 Particulates may impact on health, particularly the fine PM_{10} and $PM_{2.5}$ which can penetrate into the lung. They may also cause a nuisance where they settle on windows, cars or other surfaces. For these reasons they must be properly controlled.

3.6.2 Table 3:3, below, provides a commentary on the different technologies that may be utilised for control of particulates.

Table 3:3: Control of Particulates

Technology	Comments
Wet scrubber	A wet scrubber will use water to wash particulates out of the air stream and is typically used at Material Recycling Facilities or similar facilities. This will be more effective with a cooler air stream as water will evaporate at the temperatures within the flue. Not suitable in isolation for EfW.
Electrostatic precipitator	These are less effective than other methods though they can be used as part of a combined approach. The Environment Agency's guidance "How to Comply, Additional Guidance for the Incineration of Waste" states that they, "are not BAT on their own".
Ceramic filter	Generally more compatible to smaller plants as they are unsuitable to cope with very high gas flows. The Environment Agency's guidance "How to Comply, Additional Guidance for the Incineration of Waste" notes that they are more prone to blinding than bag filters.
Bag filter	These are a proven effective technology and the Environment Agency guidance indicates that they will be BAT in many circumstances.

3.6.3 In this instance, following the other gas treatments, the exhaust gas will pass through a bank of filter bags. These bags will trap the particulates along with the residual lime and activated carbon. The bags will periodically be cleared by air pulse cleaning and the flue gas treatment residues will be collected in a sealed container. Bag filters are compatible with the other flue gas cleaning technology to be used on site and are considered to be BAT for this process.

4 GENERATION

4.1.1 The Environment Agency's guidance highlights that greater efficiency in electricity generation may be achieved by use of a gas turbine. This has been considered however use of steam has been selected as allowing greater control and more flexibility. Steam is likely to allow a greater overall energy efficiency through facilitating heat- off take and it allows the flexibility to use power for heat or electricity as appropriate.

5 COOLING

5.1.1 Cooling will be achieved using air cooled condensers. Use of air cooled condensers will reduce water usage and there will be no requirement for cooling towers or discharge to water course. Air cooled condensers are therefore considered to be BAT for this installation.

6 COMPLIANCE WITH CHAPTER IV OF THE IED

6.1 Article 46

6.1.1 Article 46 requires that emissions are vented via a stack with a height calculated to ensure protection of human health. It sets absolute limits on the emissions that may be discharged from the stack. In addition, Article 46 requires that discharges to the aquatic environment from gas cleaning systems are minimised and controlled within set limits and that any contaminated water is contained.

6.1.2 The technology to be utilised has been used elsewhere and missions from the plant have been shown to be within the standards set in Annex VI of the IED. It was determined that the maximum acceptable stack height for planning consent would be 60m. Emissions have therefore been modelled based on a stack height of 60m and this was shown to be acceptable.

6.1.3 Exhaust gases will be treated using dry systems and there will be no water discharge from cleaning of exhaust gases.

6.1.4 The plant will be designed to prevent the accidental release of polluting substances into soil, surface water or groundwater. The site will be provided with appropriate surfacing, bunding and sealed drainage throughout.

6.2 Article 47

6.2.1 Article 47 requires that in the event of a breakdown the plant must reduce or close down operations as soon as practicable until normal operation can be reinstated.

6.2.2 The plant will be monitored continuously and will be adjusted automatically to maintain effective operation. Should a breakdown occur which has the potential to impact on emissions or to cause pollution, a controlled shut down will take place and plant will operate at a reduced level or be shut down until remedial action has been taken and normal operation can be restored.

6.3 Article 48

6.3.1 Article 48 sets out the requirements for monitoring emissions from the site.

6.3.2 Monitoring will be carried out in compliance with the requirements article 48 and Annex VI of the IED. Details are provided in the Monitoring Report.

6.4 Article 50

6.4.1 Article 50 sets a number of operating conditions that must be met in order to minimise pollution. Amongst other requirement this includes a limit on the organic material in the ash and set residence times and temperatures to ensure complete combustion is achieved.

6.4.2 The moving grate will be adjustable so that the speed with which waste is transferred across the grate can be varied to ensure complete burn out. The combustion process will occur in two phases with a primary and secondary injection of air to maintain the temperature and ensure complete oxidation. As a result the ash will have a total organic carbon content (TOC) of less than 3% of the dry weight of the material. Ash will be subject to sampling and analysis to confirm its composition.

6.4.3 Waste will be treated at temperatures well in excess of 850°C with a residence time for the flue gas of at least 2 seconds.

6.4.4 A full CFD model will be completed prior to operation of the facility in order to confirm that the IED combustion conditions are fully met.

6.4.5 Auxiliary burners will be used at start-up and shut down and in the event that the temperature of the combustion gas in the furnace falls below 850^{O}C at the 2 second residence time monitoring point. This will ensure that the correct combustion conditions are maintained whenever waste is treated.

6.4.6 Waste feed to the plant will be automatically prevented:

- at start-up until a temperature of at least 850°C is achieved; or
- if a temperature falls below 850°C at the 2s flue gas residence time monitoring point.

6.4.7 Comprehensive flue gas cleaning will be in place and air dispersion modelling has demonstrated that the plant will not give rise to significant ground level air pollution and comply with Air Quality Objectives.

6.4.8 Heat will be used on for pre-heating combustion air and boiler water. Endless Energy are exploring options for off-take of heat and will develop and maintain a heat and power plan throughout the operational life of the facility showing that heat will be recovered as far as is practicable. The facility will be CHP enabled.

6.4.9 A Technically Competent Manager will be appointed to manage the day to day operation of the site and ensure that procedures are followed correctly.

6.5 Article 52

6.5.1 Article 52 requires that precautions must be taken to ensure protection of the environment during delivery of waste to the site and proper recording of the type and quantity of waste delivered to the site.

6.5.2 Waste pre-acceptance and acceptance procedures will be in place to ensure that all waste delivered to site is in compliance with permit conditions and is suitable for treatment. Details of these are provided in the “Operating Techniques” document that accompanies this application.

6.6 Article 53

6.6.1 Article 53 requires that the residues from the process are minimised in terms of quantity and harmfulness and that dusty residues are properly controlled.

6.6.2 Air Pollution Control residues (APCR) will be minimised by careful monitoring and control of the flue gas cleaning system to optimise its operation and minimise use of raw materials. Bottom Ash will be subject to sampling and analysis to confirm their composition and in particular to quantify leachable heavy metals or other leachable materials. Bottom Ash will be sent on for recycling wherever possible, where this is not practical they will be sent to an appropriately permitted landfill. Remaining wastes will be disposed of at authorised sites in compliance with the requirements of the Duty of Care for wastes.

6.6.3 APCR will be stored in a purpose designed silo with enclosed filling and emptying points. Dust filters will be provided at any breathing vents to prevent emissions during filling and emptying. Bottom ash will be subject to cooling using a water quench and therefore should not become dusty. Bottom ash will be stored inside a building.

7 COMPLIANCE WITH INDICATIVE BAT FOR INCINERATORS

7.1 General

7.1.1 The following tables set out how the installation will comply with the criteria defined in the Environment Agency's guidance note "How to Comply With Your Environmental Permit, Additional Guidance for the Incineration of Waste" (EPR 5.01), which sets out the standards that the Environment Agency view as indicative BAT for waste incineration.

7.1.2 Each table provides brief details of how the plant will comply with the standards set out in the guidance, referring to other documents within the permit application where appropriate.

7.2 Accidents

7.2.1 Table 7:1 sets out compliance with indicative BAT for Accidents.

Table 7:1: Compliance with Indicative BAT Criteria for Accidents	
Indicative BAT Standard	**Compliance with indicative BAT Requirements**
An accident management plan should be in place also covering procedures for abnormal emissions,	An Accident and Amenity Risk Assessment has been prepared setting out the measures in place to minimise environmental incidents or abnormal operating conditions and to minimise pollution should such incidents occur. The Amenity and Accident Risk Assessment is included with the permit application.

7.3 Energy Efficiency

7.3.1 Table 7:2 shown below, sets out compliance with indicative BAT for Energy Efficiency.

Table 7:2: Compliance with Indicative BAT Criteria for Energy Efficiency	
Indicative BAT Standard	**Compliance with indicative BAT Requirements**
The following techniques may reduce energy consumption or increase energy recovery: • Use of heat generated for electricity generation on site or off site, • Use of higher efficiency generation technology e.g. gas turbine or engine, • Use of steam from boilers, • Use of waste heat for CHP or district heating, • Use of waste heat for preheating combustion air, boiler feed or plume reheat, • Effective furnace insulation, • use of flue gas recirculation • Effective maintenance of heat exchangers • Prevention of uncontrolled air ingress. • use of ion exchange instead of high pressure membrane filtration for boiler water treatment	Electricity will be generated and exported to the National Grid, consideration is being given to use of heat and possible heat off-takers are being investigated. Heat will be utilised where practicable. Consideration has been given to use of a gas turbine but a steam turbine has been selected as giving greater opportunity for off-take of heat. Heat will be utilised and pre-heating of air and water where required. The furnace, boilers and associated plant have high standards of insulation, allowing energy use to be as efficient as possible. Heat exchangers will be properly maintained with regular cleaning of the boiler tubes to maintain their effectiveness. On-line cleaning is achieved by soot blowers and water sprays within the system. The design of the feed hopper leads to a column of waste in the feed chute, effectively sealing the system. Waste is fed into the plant using a ram. This prevents ingress of air via the waste feed point. Demineralisation of boiler water will be by ion exchange reducing the electrical and the water consumption. A deaerator and oxygen scavenger will be used to reduce the oxygen content within the boiler water. Further details regarding energy generation and use are provided in "Keighley Clean Energy Facility, Application for an Environmental Permit, Energy Report", which accompanies the application.
Where electricity only is generated, 5-9MW of electricity should be recoverable per 100,000 tonnes of annual waste throughput depending on waste composition.	The plant will have a rating of 11.35MW for an input of 148,800 tonnes. Proportionately this falls within the required energy efficiency level, being equivalent to a 7.6MW rating at 100,000tpa.

7.4 Use of Raw Materials and Water

7.4.1 Table 7:3 sets out compliance with indicative BAT for use of raw materials and water. Further details regarding the use of raw materials is provided in the Raw Materials report which forms part of this application.

Table 7:3: Compliance with Indicative BAT Criteria for Raw Material and water Use	
Indicative BAT Standard	**Compliance with indicative BAT Requirements**
Water use should be minimised with reuse being utilised where appropriate. Water use should be monitored.	Water use is minimised on site. Air cooled condensers negate the need to use large quantities of water in cooling. Flue gas treatment utilises a dry system with on water use. Following initial filing of the bottom ash quench system water will be recirculated. Quench water will be replenished using wash down water or boiler blowdown so that use of mains water is minimised. Reuse of water will also minimise emissions of contaminated water from the site. Small quantities of water will be required for boiler water make up. Water used for cleaning will be minimised with vacuuming, mopping and sweeping being utilised as far as possible as an alternative to washing down. All use of mains water will be metered and recorded. This information will be used to set targets for improved efficiencies where appropriate.
Use of gas treatment chemicals should be optimised. Where appropriate alkaline reagents should be recycled.	Use of reagents and plant emissions will be monitored. Monitoring results will be processed by the SCADA system allowing automatic adjustment of the dosing rate in order to optimise use of reagents. Some of the APC residues from flue gas treatment are recirculated to minimise the use of lime.
Air Pollution Control Residues should be kept separately from bottom ash.	APCR will be transferred via an enclosed system into a silo. Bottom ash will be stored separately on a dedicated platform.

7.5 Avoidance Recovery and Disposal of Wastes

7.5.1 Table 7:4 describes how the plant meets the requirements set out in section 1.4 of EPR/5.01 for avoidance, recovery and disposal of wastes. Further details are provided in the Waste Minimisation Report, which accompanies this application.

Table 7:4: Compliance with Indicative BAT Criteria for Waste Avoidance, Recovery and Disposal	
Indicative BAT Standard	**Compliance with indicative BAT Requirements**
Bottom ash should be handled to minimise emissions of dust	Bottom ash will be subject to a water quench which will minimise the risk of it becoming dry and dusty. Bottom ash will be stored and loaded inside a building and transported in covered lorries to control fugitive emissions.
Bottom ash should be allowed to drain, with quench water being recycled.	Bottom ash will be allowed to stand on the platform whilst water drains to a collection point pending reuse. Ash taken off site will be less than 20% water.
Adequate cleaning facilities should be provided to allow cleaning of any ash spillage.	Cleaning facilities will be available on site so that any spillage of ash can be cleared immediately.
Ash should be recycled where possible.	Bottom ash is conveyed past an overband magnet to recover ferrous metal pending recycling. A dedicated storage area will be provided for ferrous metal. The remaining bottom ash will be recycled. APCR have less scope for recycling however the options will be kept under review and APCR will be recycled if practical.
Fly ash and/or APCR should be stored and transported in a manner that prevents fugitive emissions of dust.	APCR are conveyed via an enclosed system and stored in a sealed silo. Systems are in place to prevent overfilling of silos and tankers. Dust filters are fitted to silos to prevent breathing losses.
A BAT decision should be taken regarding whether Boiler residues may be combined with fly ash or bottom ash	Boiler Ash will be mixed with bottom ash. Experience at other sites indicated that this is the most appropriate option.
The best environmental option should be used for disposal.	Ash will be assessed in line with the ESA protocol to determine whether it is hazardous or non-hazardous. Materials will be disposed of at an appropriately permitted landfill where there are no recycling options. Bottom ash will be recycled.
The operator shall regularly audit the waste disposal/recovery routes to ensure their waste is being properly dealt with.	Endless Energy Limited will audit the disposal/recovery routes selected to ensure that waste is handled in accordance with all legislative requirements.

7.6 Incoming waste and Raw Material Management

7.6.1 Table 7:5 below, sets out how the site meets indicative BAT for management of incoming waste and raw materials.

7.6.2 All raw materials will be stored in appropriate containers with secondary containment for liquids. All storage will be within the sealed drainage system for the site, preventing fugitive emissions to surface water. Full details are provided in the Raw Materials Report which accompanies this application.

Table 7:5:Compliance with Indicative BAT Criteria for Incoming Waste and Raw Material Management	
Indicative BAT Standard	**Compliance with indicative BAT Requirements**
Waste should be pre-treated to reduce variations in feed composition to control emissions	A crane within the waste bunker will mix wastes to ensure homogeneity. The furnace has been designed to be able to treat waste with a range of composition and particle size. Waste of varying composition can be successfully treated whilst the plant remains within emission limits. See detail in section 2, above.
A high standard of housekeeping should be maintained	High standards of housekeeping will be applied throughout the site with first in first out treatment of waste and all areas kept and tidy.
Loading and unloading should take place in designated areas with proper hardstanding and adequate drainage	Unloading of waste will take place in the waste reception hall. Loading of outgoing materials will take place in designated areas adjacent to the storage areas. All waste storage takes place on impermeable pavement within the sealed drainage system and, with the exception of APCR, which are stored in a sealed silo, all waste will be stored inside the building.
Odorous waste should be stored inside buildings with adequate odour control	Waste will be unloaded and stored inside the building. The roller shutter doors will be kept closed, other than for access/egress by delivery vehicles. Negative pressure within the building will be maintained by using air from the reception hall as combustion air in the process.
Fuel and treatment chemicals should be stored in tanks or silos unless supplied in drums. If the is a risk of fugitive emissions they should be fitted with abatement	All fuels and chemicals will be stored in appropriate tanks, silos or drums. All liquids will be provided with secondary containment, i.e. a double skinned tank or a bund. Smaller containers will be stored on a drip tray. Silos ae located over impermeable pavement within the sealed drainage system. The lime and PAC silos will be provided with dust filters to prevent breathing losses.
Provide roofing and drainage segregation to minimise contamination of groundwater	Water from the process will be kept separate to drainage from roofs and clean areas of the site. If not used on site rainwater will discharge via a SUD system. Process water will be reused as far as possible with the remainder being discharged to foul sewer.
Specific requirements must be followed in respect of checking statutory documentation	Transfer notes will be available for all waste streams and acceptance checks will include ensuring that waste is in accordance with the environmental permit and the description on the transfer note. The waste carrier's registration of each company delivery waste to the site will also be confirmed.
Litter should be avoided	Waste carriers will be required to use covered or enclosed vehicles. Waste will be unloaded in the waste reception hall. The site will be inspected daily and any litter will be collected.
Techniques should be used to increase the homogeneity of the waste and ensure that the waste which would prevent the incinerator from operating is excluded	Wastes will be inspected during unloading and any unsuitable wastes (including bulky items) will be removed and reloaded onto the delivery vehicle or placed in the quarantine area pending treatment at another authorised facility. Grabs will be used to mix waste in the bunker.
Odour should be minimised	Waste will be treated on a first in first out basis. Wastes within the bunker will be mixed 60% of the time by the crane (the other 40% of the time will involve loading the feed hopper), meaning that waste will not be left at the bottom of the bunker for excessive lengths of time. Air from the waste reception hall will be utilised as combustion air, keeping the reception hall under negative pressure and treating odorous compounds via high temperature. The doors will be kept closed other than for access and egress. During plant shut down no waste will be received. The bunker will be managed so that it can be emptied and cleaned during incinerator shutdown.

7.7 Waste Charging

7.7.1 Waste charging will be carried out in accordance with Table 7:6 below in order to comply with indicative BAT as set out in EPR 5.01.

Table 7:6: Compliance with Indicative BAT Criteria for Waste Charging	
Indicative BAT Standard	**Compliance with indicative BAT Requirements**
Automatic systems should be in place to ensure compliance with IED article 50	During start-up, waste charging is automatically prevented if the temperature in the furnace is below 850˚C.
Charging should be as air tight as possible	Charging will be such that a column of waste is provided in the charging chute, forming an air tight seal.
Charging rates should be within the design capacity	A firing diagram is provided as an appendix to the "Operating Techniques" document. Loading rates will be within the parameters set in the firing diagram.
The feed chute hopper should include a low level alarm and isolation doors should be double doors and/or have a cooling system to prevent ignition of waste in the chute	A low level alarm will be installed on the waste feed chute in order to ensure that sufficient waste is present to maintain the air tight seal. The feed chute will be water cooled in order to prevent any hot spots. During start-up an isolation flap will be closed to seal the furnace.

7.8 Furnace Requirements and Validation of Combustion Conditions

7.8.1 Table 7:7 below shows how the facility will comply with IED requirements for the furnace conditions and the requirements for indicative BAT set out in EPR5.01. It also shows how these conditions will be validated to demonstrate compliance with IED and minimise emissions from the combustion chamber.

Table 7:7: Compliance with Indicative BAT Criteria for Furnace Conditions and Validation of Those Conditions	
Indicative BAT Standard	**Compliance with indicative BAT Requirements**
Gases from the combustion process should be maintained at 850^{O}C for at least 2 seconds	A CFD model will be provided to demonstrate that the furnace is able to comply with this important requirement. According to the CFD results, a measurement and monitoring system will be developed and be put in place within the SCADA system. The furnace flue gas temperature after 2s residence time will be monitored and where this temperature falls below 850°C, the burner will start automatically.
Incinerators must be provided with auxiliary burners	Auxiliary burners are provided to ensure that the conditions above are met. Gas oil will be utilised as the auxiliary fuel.
Ash should be minimised and the bottom ash should have a TOC content of less than 3%	Combustion is carefully controlled to ensure that complete combustion occurs and the TOC content of the ash will be less than 3%.

Table 7:7: Compliance with Indicative BAT Criteria for Furnace Conditions and Validation of Those Conditions	
Indicative BAT Standard	**Compliance with indicative BAT Requirements**
	Continuous monitoring of flue gas is undertaken and provides a feedback to automatically optimise the dosing of lime, PAC and Ammonia (urea maybe used according to the required NO_X emission level). Part of the APCR are recirculated, further reducing residues.
Installations should not give rise to significant ground level air pollution	Air quality modelling has been completed and demonstrates that ground level pollution will be well within the statutory limits. (See Air Quality Report).
Primary air should be controlled to minimise NO_X	The temperature inside the furnace is monitored continuously and primary air is regulated to ensure optimal conditions. The system is properly maintained to retain air tight conditions.
Air and fuels should be properly distributed to minimise hot spots	The moving grate allows an even distribution of waste which is mixed within the chamber by the action of the grate, ensuring even combustion.
Temperature and residence time should be validated at the operational stage using a time of flight method and use of suction pyrometers to confirm that 95% of 1 minute mean temperatures measured over an hour at the lowest temperature location exceed the minimum temperature requirement (acoustic pyrometers or shielded thermocouples only be used if calibrated against suction pyrometers)	Validation tests will be carried out to demonstrate that the residence time of at least 2 seconds above 850^{O}C is met after the last injection of air. Thermocouples calibrated with a suction probe will be used to measure the temperature within the furnace.
Testing should be carried out over normal operation and under "most unfavourable" conditions to prove the requirements are met	Temperature and residence time will be recorded over normal operation and during at least one test scenario where the plant is operating at the edges of the operating envelope shown on the firing diagram.
Oxygen level should be reported on a wet basis and should be sufficient to allow adequate combustion (likely to be around 6%)	Oxygen levels will be monitored on a wet basis. The system allows for the introduction of primary and secondary air and it is therefore possible to carefully control oxygen levels within the combustion chamber to guarantee complete burn out.
Optimum control of the combustion process must be maintained	The temperature and oxygen levels within the furnace are monitored. In addition, an infrared camera is located within the furnace giving a view of the full width of the grate. This allows the surface temperature across the grate to be monitored and allows the identification of cool or hot spots. The operator is able to adjust the operation of the feed rams and the movement of the grate to even out the quantity of waste on the grate. Both primary and secondary air injection and operation of the auxiliary burners are also controlled to maintain optimal conditions within the furnace and minimise emissions.
Rapid monitoring needs to be combined with a secondary air supply arrangement that can also respond rapidly to prevent high CO events	The secondary injectors will be monitored and maintained to ensure effective operation.

7.9 Dump Stacks and By-passes

7.9.1 Table 7:8 sets out compliance with indicative BAT for dump stacks and by-passes.

Table 7:8: Compliance with Indicative BAT Criteria for Dump Stacks and By-Passes	
Indicative BAT Standard	**Compliance with indicative BAT Requirements**
Dump stacks should only operate for safety reasons and frequencies greater than once a year are unlikely to be acceptable. Any operation of a dump stack or by-pass will be considered abnormal operation	There are no dump stacks or by-passes that will operate during normal operation of the plant. Such measures will only be used in an emergency situation to ensure safety.
Electric heating is available for new bag filters to avoid the need for a by-pass on start-up	The bag filters will be pre-coated with lime and will be pre heated using an electric heater so that they are fully operational on start-up and no by-pass is required.
Failure of the flue gas cleaning plant should not normally led to operation of a dump stack	The air pollution control system is robust and failures should be rare. In the event of a failure in the system with the potential to cause unacceptable emissions the plant will undergo a controlled shut-down. There will be no uncontrolled releases to air.

7.10 Cooling Systems

7.10.1 EPR 5.01 sets out indicative BAT for water cooled systems, describing the requirements for cooling water intakes and cooling towers etc. These are not relevant in this case as air cooled condensers will be used following the turbine.

7.11 Boiler Design

7.11.1 The design of the boiler meets the requirements of indicative BAT as shown in Table 7:9 below.

Table 7:9:: Compliance with Indicative BAT Criteria for Boiler Design	
Indicative BAT Standard	**Compliance with indicative BAT Requirements**
De novo synthesis of dioxins and furans should be minimised by maintaining the efficiency of the boiler, allowing rapid cooling of the flue gas through the critical range (450°C to 200˚C)	The boiler has been designed to ensure that there are no pockets of stagnant of slow moving air where the dioxin forming temperatures may persist. The boiler will be subject to regular cleaning to maintain the efficiency of the tubes and minimise the build-up of any materials that may act as catalysts to dioxin formation. Online cleaning will be completed by soot blower and water sprays. The configuration of the boiler optimises the flow of gas to recover heat efficiently whilst minimising dioxin formation. The gas temperature at the exit from the boiler to the flue gas abatement system will be approximately 140^{O}C.

Table 7:9:: Compliance with Indicative BAT Criteria for Boiler Design	
Indicative BAT Standard	**Compliance with indicative BAT Requirements**
Releases to water from boilers should be minimised to minimise the impact of boiler treatment chemicals. Boiler blow down and cleaning water should be treated to an acceptable standard prior to discharge or disposal to a permitted facility	Boiler blow down will be directed to the bottom ash quench system. If excess water is generated this will be treated, allowing solids settlement and pH correction before discharge to foul sewer. This is not expected to be necessary more than once or twice a year. Discharge to the foul sewer will be in accordance with the terms of the trade effluent consent for the site. There are no emissions to surface water.

7.12 Emissions to Air and Surface Water

7.12.1 The BAT must be employed to control emissions to air and ensure that all emissions are in compliance with Annex VI of the Industrial Emissions Directive and will not cause ground levels of pollution that may breach the statutory or recommended air quality standards.

7.12.2 Selection of BAT for control of particulates, carbon monoxide, acid gases, nitrogen oxides (NO_X), metals, VOCs and dioxins and furans is set out in section 3 above.

7.12.3 There are no emissions to surface water from the site. Air cooled condensers will operate to condense steam following use in the turbines.

7.12.4 Quench water is recirculated. Boiler blowdown or washdown water will be directed to the central waste water tank for use in the quench, replacing any evaporative losses. Water will only be discharge to foul sewer in the event of excess water being present in the waste water tank as described in Table 7:9.

7.13 Odour

7.13.1 Table 7:10 shows how odour will be controlled on site in order to comply in full with the requirements of section 3.3 of EPR 5.01, which sets out indicative BAT for odour control.

Table 7:10: Compliance with Indicative BAT Criteria for Odour Control	
Indicative BAT Standard	**Compliance with indicative BAT Requirements**
Odour should be controlled by enclosing odorous waste on its way to the furnace and confining waste to designated areas	Waste is unloaded inside the waste reception hall and will be stored pending treatment in the waste bunker. This bunker is fully within the building which is kept under negative pressure by use of air from the reception hall as combustion air for the furnace. Fast acting roller shutter doors will be kept closed at all times other than when a vehicle is entering or exiting the building in order to contain any odour or litter and minimise access to the waste by vermin.
Putrescible waste should be treated within a reasonable time scale	Waste is treated on a first in first out basis. Wastes within the bunker will be mixed by the crane throughout the day. Any waste will be treated within 8 days following arrival at the site.
The site should be designed to facilitate cleaning and should be cleaned on a regular basis	The site will be designed with concrete surfaces that are easy to wash down. The site will be kept tidy and swept on a regular basis to avoid any build-up of residues around the site. The bunker will be periodically emptied and cleaned.
Ash and waste should be transported in covered vehicles	All carriers will be required to use enclosed or covered vehicles to minimise dust, odour and litter escaping.
Good dispersion from the stack is required	The efflux velocity of the stack will be 23.2 metres per second at maximum.
Drawing air from odorous areas at a rate to contain odour. Odorous air should as far as possible be fed into the combustion process	The extraction system will be designed to ensure the building is kept under negative pressure. Odorous air will be fed into the combustion process.

7.14 Monitoring and Reporting of Emissions

7.14.1 Table 7:11 below sets out how the installation will be operated in order to comply with the requirement of section 3.5 of EPR 5.01, monitoring and reporting of emissions.

Table 7:11: Compliance with Indicative BAT Criteria for Monitoring and Reporting	
Indicative BAT Standard	**Compliance with indicative BAT Requirements**
The plant must comply with the monitoring requirements set out in chapter IV and Annex VI of the IED	Monitoring will be carried out in full compliance with the IED, as described in section 6, above. Full details are provided in the monitoring report accompanying this application.
The following PAHs should be monitored and the results reported in the same frequency as for dioxins and dioxin like PCBs: • Anthanthrene • Benzo(a)anthracene • Benzo(b)fluoranthene • Benzo(k)fluoranthene • Benzo(p)naph(2,1-d)thiophene • Benzo(c)phenanthrene	Monitoring of these PAHs will be carried out quarterly for the first year and then at least once every six months.

Table 7:11: Compliance with Indicative BAT Criteria for Monitoring and Reporting	
Indicative BAT Standard	**Compliance with indicative BAT Requirements**
• Benzo(ghi)perylene • Benzo(a)pyrene • Cholanthrene • Chrysene • Cyclopenta(c,d)pyrene • Dibenzo(ah)anthracene • Fluroranthene • Indo(1,2,3-cd)pyrene and • Naphthalene.	

8 CONCLUSION

8.1.1 In view of the evidence presented above the proposed technology and management techniques that will be employed at the installation are considered to be BAT. The technology selected will provide a high level of protection for the environment and is considered the best available in the context of the facility. The technology provider is supplying an integrated solution with the incinerator, boiler, turbines and pollution abatement equipment designed to work together effectively.

8.1.2 The plant will be operated in accordance with a written management system with and the environmental management system will be accredited to ISO14001. A planned preventative maintenance programme will be in place to ensure that all plant, equipment and pollution prevention infrastructure operates effectively. Staff will receive training to ensure that they are competent in their role and can manage the plant under both normal and abnormal operating conditions.

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