Uniper Technologies

Uniper Technologies Limited, Technology Centre, Ratcliffe-on-Soar, Nottinghamshire, NG11 0EE T+44 (0) 115 936 2900 www.uniper.energy

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EMERGE CENTRE
SUPPORTING INFORMATION
prepared for
DR A READ, REDEVELOPMENT MANAGER, RATCLIFFE-ON-SOAR
by
S Henson & R M C Brandwood

SUMMARY

This document and its appendices contain the supporting information for the application for an Environmental Permit for the EMERGE Centre, which should be read in conjunction with the formal application forms.

Prepared by	**Approved for publication**

Master copy signed by S Henson & S J Griffiths (07/08/2020)

S Henson **Environmental Compliance**	**S J Griffiths** **Technical Head** **Environmental Sciences & Climate Change**

Telephone +44 (0) 115 936 2900 (please ask for Proposal Management)
E-mail utgcustomeradmin@uniper.energy

CLIENT DISTRIBUTION LIST

EF	Dr A Read	Redevelopment Manager, Ratcliffe-on-Soar

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ABBREVIATIONS

ACC	Air Cooled Condenser
APCR	Air Pollution Control Residues
BAT-AEEL	BAT Associated Energy Efficiency Level
BAT-AEL	BAT Associated Emission Levels
APC	Air Pollution Control
APCR	Air Pollution Control Residues
BAT	Best Available Technique
BREF	BAT Reference Document
BS EN	British Adoption Of A European (EN) Standard
CCTV	Closed-Circuit Television
CEMS	Continuous Emissions Monitoring System
CEN	European Committee For Standardization
CFD	Computational Fluid Dynamics,
CHP	Combined Heat And Power
CO	Carbon Monoxide
COSHH	Control Of Substances Hazardous To Health
CV	Calorific Value
C&D	Construction and Demolition
C&I	Commercial and Industrial
DAHS	Data Acquisition And Handling System
DCS	Distributed Control System
EA	Environment Agency
ELV	Emission Limit Value
EMDC	East Midlands Development Corporation
EMERGE	East Midlands Energy Re-Generation
EMS	Environmental Management System
EP	Environmental Permit
EPC	Engineering Procurement Construction
EPR	Environmental Permitting (England And Wales) Regulations
ERF	Energy Recovery Facility
ESP	Electrostatic Precipitator
EU	European Union
EWC	European Waste Catalogue
FGC	Flue Gas Cleaning
FGR	Flue Gas Recirculation
FGT	Flue Gas Treatment
FIFO	First In, First Out
GBP	Pound Sterling
GWP	Global Warming Potential
HCl	Hydrogen Chloride
HF	Hydrogen Fluoride
HGV	Heavy Good Vehicle
HSE	Health And Safety Executive
IBA	Incinerator Bottom Ash
ID	Induced Draft

IED	Industrial Emissions Directive
ISO	International Organization For Standardization
LACW	Local Authority Collected Wastes
LOI	Loss On Ignition
LPG	Liquid Propane Gas
MCERTS	[Environment Agency] Monitoring Certification Scheme
MIG	Metal Inert Gas
MJ	Megajoules
MSW	Municipal Standard Waste
MW	Megawatts
NCV	Net Calorific Value
NH_3	Ammonia
NOx	Nitrogen Oxides
OEM	Original Equipment Manufacturer
OTNOC	Other Than Normal Operating Conditions
PAC	Powdered Activated Carbon
PCB	Polychlorinated Biphenyl
PCDD/F	Polychlorinated Dibenzo-P-Dioxins / Furans
PM	Particulate Matter
POCP	Photochemical Ozone Creation Potential
QSCZ	Qualifying Secondary Combustion Zone
RDF	Refuse-Derived Fuel
RO	Reverse Osmosis
SCP	Site Closure Plan
SCR	Selective Catalytic Reduction
SHE	Safety, Health And Environment
SNCR	Selective Non-Catalytic Reduction
SO_2	Sulphur Dioxide
TIG	Tungsten Inert Gas
TOC	Total Organic Carbon
TVOC	Total Volatile Organic Carbon
UK	United Kingdom
UV	Ultraviolet Light
VOC	Volatile Organic Carbon
WAC	Waste Acceptance Criteria
WHO-TEQ	World Health Organisation Toxic Equivalent Quotient
WI BREF	BAT Reference Document For Waste Incineration

1 INTRODUCTION

Uniper UK Limited is proposing to develop an Energy Recovery Facility (ERF, herein 'the Installation') at the Ratcliffe-on-Soar Power Station site (herein 'the Power Station site') – known as East Midlands Energy Re-Generation (EMERGE) Centre.

The Installation is a multifuel Energy Recovery Facility ('ERF'), recovering energy from waste material. It is anticipated to accept non-hazardous residual (i.e. non-recyclable) commercial and industrial (C&I) wastes and local authority collected wastes (LACW), including in the form of refused derived fuel (RDF).

This document and its appendices contain the supporting information for the application for an Environmental Permit (EP) for the Installation. They should be read in conjunction with the formal application forms.

In Section 1 an overview of the operational processes of the Installation are provided. In Section 2, further information in response to specific questions in the application forms is provided.

1.1 The Applicant

Uniper is a leading international energy company with around 11,500 employees and activities in more than 40 countries. In the UK, Uniper operates a flexible generation portfolio of seven power stations, and a fast-cycle gas storage facility. A broad range of commercial activities are offered through the Engineering Services division, while the Uniper Engineering Academy delivers high-quality technical training and government-accredited apprenticeship programmes for the utility, manufacturing and heavy industry sectors. Uniper owns and operates the Ratcliffe-on-Soar Power Station.

1.2 The Site

The Power Station site covers an overall area of circa 273 hectares (ha). This includes circa 167 ha lying to the north of the A453 Remembrance Way and circa 106 ha to the south of the A453. The main built elements of the Power Station and its related infrastructure are located in the northern part of the site ('the Northern Site'). The Installation is proposed to be located at the central northern end of the Northern Site, on an open area covering circa 4 ha.

The Installation site has never previously been fully 'developed', but has been utilised as a laydown area and car park for contractors working on the wider Power Station site. As a consequence of this activity, it is surfaced with a mixture of tarmac and compacted stone hardstanding.

The following drawings are included within Appendix A of the Permit Application:

- Site Location Plan (Appendix A.1);
- The Environmental Permitting Boundary (Appendix A.2)
- Indicative Site Layout (Appendix A.3)
- Emission Points to air (Air Discharge 1 & Air Discharge 2) and water (Water discharge 1) (Appendix A.4)

A Site Condition Report is included as Appendix B of the Permit Application. The Site Condition Report provides a summary of the existing data on the ground conditions within the Installation boundary, at the time of submission of this EP application.

1.2.1 Site Context

The current coal-fired Power Station, located adjacent to the installation boundary for the EMERGE site, was constructed in the 1960s and commenced commercial operations in late 1967. It has an export capacity of approximately 2,000 megawatt electrical (MWe) and is fitted with Flue Gas Desulphurisation and Selective Catalytic Reduction. At present, the Power Station operates under a ‘Capacity Market’ contract, and it is operated to meet commercial trading requirements in addition to being available to National Grid to support reliable operation of the power network. In accordance with the UK Government’s coal phase-out strategy, it is planned to cease operations before October 2025.

In the context of over 50 years of coal-fired energy production drawing to a close, the emerging East Midlands Development Corporation (EMDC) has identified the current coal fired Power Station site as one of three strategically important locations for future economic growth in the East Midlands, the other two being around the proposed High Speed 2 (HS2) station at Toton and the existing East Midlands Airport.

The vision for the site of the current coal fired Power Station after it ceases operating is to create an employment site based around modern industrial and manufacturing uses, underpinned by a sustainable energy theme. Whilst this vision is in its early stages, the Installation is viewed as the catalyst, being the first new build on the redeveloped Power Station site, by virtue of generating lower carbon and partially renewable energy for the future industry and manufacturing uses.

1.3 The Activities

The Installation will consist of a single Schedule 1 Installation activity as defined in the Environmental Permitting Regulations[1] (EPR) and several directly associated activities.

The relevant Schedule 1 Activities and Directly Associated Activities are outlined in Table 1 and Table 2 respectively.

[1] The Environmental Permitting (England and Wales) Regulations 2016

Table 1: Schedule 1 Activities

Schedule 1 Activity	Description	Limits of specified activity
Section 5.1 Part A(1) (b)	**Line 1** – The incineration of non-hazardous waste in a waste incineration plant or waste co-incineration plant with a capacity exceeding 3 tonnes per hour. Emission Point Air Discharge 1 (See Appendix A.4 of the Permit Application).	From receipt of waste to emission of exhaust gas and disposal of waste arising.
Section 5.1 Part A(1) (b)	**Line 2** – The incineration of non-hazardous waste in a waste incineration plant or waste co-incineration plant with a capacity exceeding 3 tonnes per hour. Emission Point Air Discharge 2 (See Appendix A.4 of the Permit Application).	From receipt of waste to emission of exhaust gas and disposal of waste arising.

Table 2: Directly Associated Activities

Directly Associated Activity	Description	Limits of specified activity
Electricity generation for export to National grid	Generation of electrical power using a steam turbine from energy recovered from the flue gases.	
Emergency back-up generator	Medium Combustion Plant <20 MWth diesel powered generator to provide electrical power to the plant in the event of an interruption in the supply.	The generator shall not be tested for more than 50 hours a year; and the total operational hours shall not exceed 500 hours per year, as a rolling average over a period of three years.
Surface water management	Management of surface water drainage. Emission Point Water Discharge 1 (See Appendix A.4 of the Permit Application).	Handling and storage of surface water until discharge into the Ratcliffe Power Station site drainage system at the Installation boundary.

1.4 The Installation

The nominal operating capacity of the Installation will be approximately 30 tonnes per line per hour of waste, with a nominal calorific value of 10.0 MJ/kg. The Installation would have a gross electricity generating capacity of 49.9 megawatts (MW_e) and the anticipated waste throughput would be around 472,100 tonnes per annum (tpa) (for a 10.0 MJ/kg calorific value (CV)) with a maximum of 524,550 tpa (for a 9.0 MJ/kg CV) based on a forecast plant availability of 90 %. After subtracting the power used to run the Installation itself (about 6.5 MW_e), it would have the ability to export about 43.4 MW_e of electricity to the local electricity grid, a significant proportion of which would be classed as renewable. This is sufficient to meet the average annual domestic electricity needs of about 90,000 homes.

The Installation would be a conventional twin line combustion plant, based on grate technology. It is proposed to operate as a merchant Installation (at the point of development) and is anticipated to accept non-hazardous residual commercial and industrial (C&I) wastes and local authority collected wastes (LACW), including in the form of refused derived fuel (RDF). It would also have the potential to treat the combustible fraction of construction and demolition (C&D) waste and is also intended to be capable of accepting certain waste biomass fuels.

Whilst the Installation would have a grid connection, it could also supply power to individual customers via a private wire system. Finally, it would, in the event that viable opportunities for the supply of heat do not exist from the outset, also be combined heat and power (CHP) ready and capable of providing heat in the form of steam (or possibly hot water) for use by local heat users. The short to medium term objective is that the Installation could serve a site heat network, and potentially also (via heat exchangers) a cooling network.

The energy efficiency of the Installation is discussed further within Section 2.7 and a CHP Assessment is included as Appendix F of the Permit Application.

The Installation would be located within a main building, up to 49.5 m high at its highest point (over the boiler), that would include:

- A Reception / Tipping Hall, with points of access and egress set at ground level;
- A below ground Bunker;
- A Boiler Hall;
- A Turbine Hall, with two turbines for resilience;
- A Flue Gas Treatment (FGT) Installation;
- An Incinerator Bottom Ash (IBA) bay; and

The Air Cooled Condenser (ACC) is proposed to be located to the west of the main building and north of the Turbine Hall. It would form a separate standalone structure in order to enable sufficient air flow through the units.

The twin side by side stacks would protrude through the FGT Installation roof and extend to a height of circa 110 m. Each stack would be circa 1.85 m in diameter, braced together near the top and include an external continuous emissions monitoring system (CEMS) platform.

The Installation would also include the following ancillary / infrastructure:

- Vehicle weighbridges and weighbridge office;
- Substation (within its own enclosure);
- Fire water tank and associated pump house;
- Tanks / silos (containing fuel oil and FGT reagent);
- Internal circulation roadways and manoeuvring areas;
- Employee and visitor parking for cars, motorbikes and cycles;
- Fencing and gating;
- Service connections;
- Surface water drainage;
- Lighting and CCTV; and
- New areas of hard and soft landscaping.

An indicative ERF process diagram is included as Figure 1.

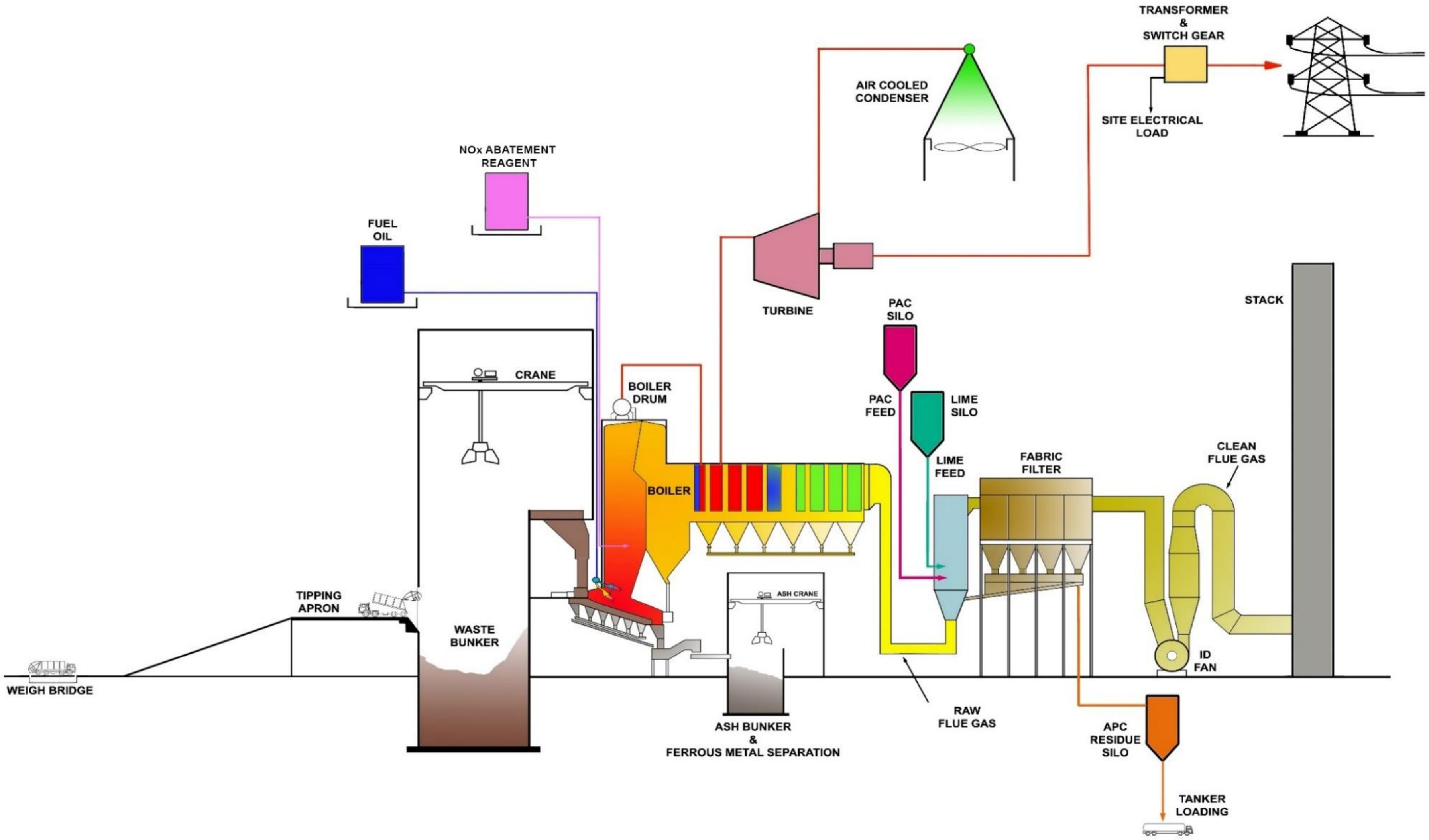

Figure 1: Indicative ERF Process Diagram[2]

[2] Courtesy of AXIS PED Limited

1.4.1 Waste Reception and Handling

Incoming waste would be delivered to the Installation by HGVs. Incoming vehicles would use the Power Station's existing HGV access via the grade separated junction off the A453 on to Barton Lane. Once within the Power Station site, vehicles would use the existing tarmac internal access roads to reach the incoming weighbridges located to the south of the gatehouse. At the weighbridges, details of the vehicle and weight would be checked and recorded. Loads would also be inspected on a random periodical basis to confirm the nature of the incoming material. There is queuing capacity for up to 8 HGVs at the weighbridge (including a vehicle on each weighbridge).

Once checked and recorded, the vehicles would travel around the main building in a clockwise direction before reaching the entrance doorway on the western elevation of the Waste Reception Hall. Once within the hall, vehicles would be directed to a vacant tipping bay and discharge the load into the Bunker. On completion of tipping operations, vehicles would leave the Waste Reception Hall through a doorway in the eastern elevation. Vehicles would then continue in a clockwise direction along the internal access road (which runs immediately adjacent to the main building and passes underneath the Administration Offices) before reaching the exit weighbridge. Records would again be taken before the vehicle travels back along the Power Station site's internal access road and exits onto the public highway network.

The Waste Reception Hall would include six tipping bays to allow multiple vehicles to discharge at the same time. The entry and exit doors would be equipped with fast acting vertical folding roller doors, which would be kept closed except for vehicle access and egress.

The Bunker would be constructed from concrete and completely housed within the main building. It would provide storage capacity for 5 days (without stacking).

Above the Bunker would be overhead traveling cranes equipped with petal grabs. These would be used to mix, stack and load the waste into the feed chutes of the furnaces. The cranes would be operated automatically during normal operations.

The Installation is proposed as a twin line plant. As such, waste would be loaded into the feed chutes of the two furnaces by the petal grabs. Following loading into the feed shuts, the waste would be transferred onto each grate by a hydraulically powered feeding unit. The backward flow of combustion gases or the premature ignition of waste would be prevented by keeping the chute full of residual waste and by keeping the furnace under negative pressure. A level detector would monitor the amount of waste in each chute and an alarm sounded if the waste falls below the safe minimum level. The feed rate into the furnaces would be controlled by a combustion control system.

Further details of the incoming waste management procedures can be found in Section 2.2.

1.4.2 Raw Materials Handling and Storage

Apart from treating waste, the Installation would use various raw materials during processing. Primarily, these would include dry or semi-dry lime, ammonium hydroxide / urea, powdered activated carbon (PAC) and low sulphur fuel oil.

Further detail pertaining to the quantities of materials to be stored on site, corresponding containment systems and reagent selection criteria can be found in Section 2.1.

In addition, various other materials would be used for the operation and maintenance of the Installation, including:

- Hydraulic oils and silicone-based oils;
- Inert gases for electrical switchgear;
- Gas emptying and filling equipment;
- Refrigerant gases for air conditioning plant;
- Glycol / anti-freeze for cooling;
- Oxyacetylene, Tungsten Inert Gas (TIG) and Metal Inert Gas (MIG) welding gases; and
- CO_2 / fire-fighting foam agents.

In order to minimise the risks of contamination to process and surface water, all liquid chemicals stored on site would be kept in bunded controlled areas.

In addition to the raw materials described above, the Installation would require materials necessary to maintain the boiler water demineralisation plant; these may include hydrochloric acid (35 % solution); caustic soda (30 % solution); and various other boiler water dosing chemicals.

1.4.3 Combustion Process

The Installation would use a moving grate system that moves the residual waste from the feed inlet to the residual discharge. This mixes the residual waste along the surface of the grate to ensure that all material is exposed to the combustion process. Auxiliary burners (which typically operate for up to 16 hours during a start-up event) would run on low sulphur fuel oil. Once operational, there should be no more than two cold start-ups per year and per line outside planned maintenance activities.

Primary air for combustion is fed to the underside of the grate. Secondary air is also admitted above the grate to create turbulence and ensure complete combustion with minimum levels of oxides of nitrogen (NO_x). The volume of both primary and secondary air is regulated by a combustion control system.

The combustion control system regulates combustion conditions (and thereby minimises the levels of pollutants and particulates in the flue gas before flue gas treatment) and controls the heat input to the boiler. The furnaces are also fitted with auxiliary burners, fuelled by diesel / low sulphur fuel oil, which would automatically maintain the temperature above 850 °C, on the very rare occasions, that temperatures start to fall below this. Combustion chambers, casings and ducts, and ancillary equipment are maintained under slight negative pressure to prevent the release of gases.

During operation, the temperature in the combustion chambers would be continuously monitored and recorded to demonstrate compliance with the requirements of the Industrial Emissions Directive (IED), Waste Incineration Best Available Techniques Reference (WI BREF) conclusions and the Environmental Permit. The combustion control system would be an automated system, including the monitoring of combustion and temperature conditions of the grates, modification of the residual waste feed rates, and the control of primary and secondary air. Further details of the combustion monitoring systems can be found in Sections 2.5.3 to 2.5.5.

1.4.4 Energy Recovery

The energy generation process is founded upon hot gases from the furnace passing to a boiler which converts the energy from the gases into steam. The boiler would consist of evaporative tubes, superheaters and an economiser. As the Installation comprises a twin line system, there would be two boilers working in parallel, albeit independently of one another.

Superheated steam would be piped from the boilers to the steam turbines that would power a generator to generate electricity. It is envisaged that turbine inlet steam conditions will be around 430 °C and 60 bar representative of modern energy from waste plant, which provides an acceptable balance between plant efficiency and availability, noting that the precise conditions will be finalised during engineering design. The electricity generated would route via the switch gear within the Turbine Hall and then onto the on-site substation. The Installation could also supply power directly to end users via a ‘private wire’ arrangement.

The superheated steam from the boiler would cool as it passes through the turbine, reducing in pressure and temperature. The low-pressure steam exiting the turbines would be piped to the ACC where the steam would be circulated around a network of pipes that would run above a series of fans. The air from the fans would pass over the pipes cooling and condensing the steam into condensate under a vacuum. The condensate would then be recirculated for use in the boiler system. The use of an ACC system means that there would be no visible plume generated from the cooling process.

Based upon known residual waste compositional analysis (and as accepted in Government policy such as the Renewable Heat Incentive) circa 50 % of residual waste is deemed to comprise biodegradable (biogenic) waste, by energy content. Hence, circa 50 % of the energy generated at the Installation would be classed as renewable energy. A more detailed discussion of the biogenic energy content based on the anticipated fuel mix can be found in the Greenhouse Gas Assessment included as Appendix D4 of the Permit Application.

The energy generation process is founded upon hot gases from the combustion chamber passing to a boiler which converts the energy from the gases into steam. The Installation includes a steam turbine that would have a generation capacity capable of exporting approximately 43.41 MW of electricity to the local electricity distribution network (of which 21.7 MW would be classed as renewable assuming a biogenic energy content in waste of 50 %).

The Installation would also have the capability to export heat to local heat users. To facilitate this, the turbine would be equipped with steam extraction points to allow steam to be supplied directly to consumers, or to be condensed in heat exchangers in order to provide hot water. An air-cooled condenser, located next to the main building, would then be used to condense the residual steam from the steam turbine to water that would then be reused in the boiler.

Further details of the energy efficiency of the Installation can be found in Section 2.7.

1.4.5 Flue Gas Abatement

Gases generated during the combustion process would be cleaned before being released into the atmosphere to the standards required to protect human health and the environment. The Installation would be served by a flue gas treatment system and associated reagent storage silos.

Flue gas treatment (FGT) reagents and APCR would be stored in silos located within the main building. Vehicles would access the silos via a door on the eastern elevation of the main building (between the Turbine Hall and Ammonia Store) in order to deliver FGT reagents and export APCR. FGT reagents and residues would be transferred by sealed pumps into and out of the storage silos. Vehicles would then exit via a door on the western elevation of the main building (to the south of the Administration Offices).

A BAT assessment of the abatement techniques can be found in Section 2.6 of this report and Appendix E of the Permit Application, with BAT justification for reagent selection included in Section 2.1.3.

1.4.5.1 NO_x Reduction

NO_x levels would be managed through careful control of combustion air and selective non-catalytic reduction. This involves the injection of aqueous ammonia / urea solution into the combustion chamber of the boiler. The aqueous ammonia / urea reacts with both nitrogen oxide (NO) and nitrogen dioxide (NO_2) to form nitrogen and water.

1.4.5.2 Reagent Dosing

Acid gases produced during the combustion process would be removed by reacting the gas with dry or semi-dry lime as a reagent. Neutralisation of the acid gases takes place as they react with the reagent. The residual material would be recovered at the outlet of the flue gas scrubbing system.

Activated carbon would also be injected into the flue gas duct to minimise the flue gas emissions of dioxins, mercury and other heavy metals.

1.4.5.3 Fabric Filtering

After reacting with the FGT reagents, the gases would be drawn through a fabric bag filter to remove particulates, including any reagent particles. The fabric filter would be divided into separate compartments with numerous filter bags, allowing for maintenance as described below. The treated flue gas passes through an induced draught (ID) fan into the stacks for release to the atmosphere.

Regular bag filter cleaning would be performed on-line by pulsing compressed air through the filter bags. The residues are known as APCR and would be collected in fully enclosed hoppers beneath the filters.

Bag failure, albeit an infrequent occurrence, would be identified by a sudden drop in pressure in the system and a small increase in particulate concentration at detection meters installed immediately downstream of the bag filter. The compartment containing the failed bag would be isolated and then replaced. The Installation would be capable of operating at full capacity with one compartment off-line whilst maintenance was being undertaken. Spare bags would be held on site and installed immediately after a failure occurred.

1.4.5.4 Stack

Following cleaning, the combustion gases would be released into the atmosphere via the stacks. Emissions from the stacks would be monitored continuously by an automatic computerised system and reported in accordance with the Environment Agency’s requirements for the operation of the Installation. The proposed stacks would be 110 m high and would contain emission to air points Air Discharge 1 & Air Discharge 2, which are shown in Appendix A.4 of the Permit Application. The Installation will also include a diesel powered generator to provide electrical power to the plant in the event of an interruption in the supply (See Table 2). This will also have its own stack (forming Air Discharge 3) but as the generator location will be confirmed during detailed design, this is not currently show in Appendix A.4 of the Permit Application.

1.4.6 Residue Recovery and Disposal

Two types of solid by-products would be produced from the operation of the Installation, Incinerator Bottom Ash (IBA) and Air Pollution Control residues (APCR), each of which would have separate handling and disposal arrangements as described below.

Residue recovery and disposal is further discussed in Section 2.8.

1.4.6.1 Incinerator Bottom Ash (IBA)

IBA – which may also include the ash collected from the boiler surfaces – is the inert burnt-out residue from the combustion process. Typical operation is expected to generate 116,609 tpa of bottom ash, but with up to 129,564 tpa produced, depending on the CV of the incoming waste. Bottom ash typically comprises a mixture of metals, glass, brick, rubble, sand and grit as well as ash from combusted material.

IBA would all be managed in the main building. It would be quenched as it leaves the combustion chamber to both cool the ash and also reduce potential for emissions of ash (dust) into the air. Any water not vaporised in the quenching process would be collected and recycled for continued use in the quenching process. The IBA would be deposited into a bunker where it would be stored prior to being loaded into HGVs within the bottom ash tunnel (located on the eastern side of the main building). HGVs would export the IBA to a re-processor where metals would be extracted, with the remaining material typically processed for use as a recycled aggregate.

1.4.6.2 Air Pollution Control Residues (APCR)

After reacting with the FGT reagents, the gases would be drawn through a fabric bag filter to remove particulates, including any reagent particles. Regular bag filter cleaning would be performed on-line by pulsing compressed air through the filter bags. The residues are known as APCR and would be collected in fully enclosed hoppers beneath the filters. APCR comprise fine particles of ash and residue from the flue gas treatment process, which are collected in the bag filters.

It is estimated that the operations would generate between 16,500 tpa and 26,500 tpa of APCR, depending on the CV of the incoming waste and the final abatement techniques selected. APCR would be stored in silos within the main building. The APCR silos would have capacity for 5 days of storage, although at normal operating conditions less than half of this capacity would generally be used prior to export off-site.

Due to the alkaline nature of the APCR, they are classified as hazardous waste (in much the same way as cement). The APCR would be transported off-site to a Permitted Hazardous Waste disposal site. Alternatively, the residues may be taken to an appropriate treatment site where, for example, they could be reused in the stabilisation of acid wastes or used in cement manufacture.

1.4.7 Emissions Monitoring and Stack

The proposed stack height for the Installation is 110 m. The cleaned gas is monitored for pollutants using a Continuous Emission Monitoring System (CEMS) and discharged to atmosphere through two flues enclosed within a common windshield.

The CEMS Installation will be compliant with the UK Monitoring Certification Scheme (MCERTS) and therefore the requirements in the UK of BS EN 14181. It will comprise two monitoring systems (one in service and one redundant) per plant line.

The following species emitted to air will be monitored continuously:

- Dust
- Nitrogen Oxides (NO_x)
- Sulphur Dioxide (SO_2)
- VOCs (as total organic carbon, TOC)
- Hydrogen Chloride (HCl)
- Carbon Monoxide (CO)
- Ammonia (NH_3)
- Flow

Periodic sampling will be undertaken of the following species:

- Hydrogen Fluoride (HF)
- Mercury (Hg)
- Group III metals (Antimony (Sb), Arsenic (As), Lead (Pb), Chromium (Cr), Cobalt (Co), Copper (Cu), Manganese (Mn), Nickel (Ni), Vanadium (V))
- Cadmium (Cd) + Thallium (Tl)
- Dioxins and Furans
- Dioxins and Dioxin-like PCBs

The frequency of these measurements will be four times per year in the first year of operation giving way to twice per year thereafter. This is with the exception of mercury and dioxins and furans. For these species there is a risk based approach to monitoring that could lead to the subsequent retrofit of continuous mercury monitoring for reporting or/and a continuous long-term sampling system for dioxins and furans.

Further details pertaining to the monitoring of emissions to air can be found in Section 2.5.1.

1.4.8 Site Drainage

Further details pertaining to site drainage can be found in Section 2.3.

1.4.8.1 Surface Water Drainage

The Installation would give rise to surface water run-off from on-site roads, vehicle parking areas, roofs of buildings and other hardstanding; some of the roof water would be diverted to a rainwater harvesting tank located in the main building for use within the Installation. The remaining surface water run-off will pass through oil interceptors and silt traps prior to discharge into the Ratcliffe Power Station surface water drainage system. This discharge point is shown as Water Discharge 1 in Appendix A.4 of the Permit Application and would be subject to continuous pH measurement and daily visual inspection for the presence of oil.

1.4.8.2 Foul Water Drainage

Foul water generated by the Installation would be collected on the site via a series of pipes which would connect to a septic tank. The contents of the tank would be emptied on a regular basis by a tanker and taken offsite to a suitable sewage treatment facility.

1.4.8.3 Water Supply

Whilst the steam cycle energy generation process is a closed loop system (i.e. boiler water is converted into steam and then condensed back to water for reuse), the Installation would be a net user of water.

Water would be sourced from the existing town main and from the rainwater harvesting tank. The precise point of connection and supply requirements would be established at the detailed design stage.

1.4.8.4 Electrical Connection

The Installation is an electrical generating development and would meet its own operational electricity needs. On the rare occasions when the Installation would need to import power, it would do so through the electrical connection described below. The Installation would export and import electrical power through the 11/132 kV transformer which is proposed to be constructed to the south of the main building.

1.4.9 Additional Operations

The Installation will require a water supply of approximately 104,000 m^3/year. The water demand will be to maintain the water level in the boiler system (steam cycle), which is to be sourced from the existing town main. Additional water to top up the ash quench system will be sourced from a rainwater harvesting tank, to be located in the main building.

Water to be used in the boiler will undergo treatment within a Reverse Osmosis (RO) water treatment plant. Water treatment chemicals will be stored within a bunded area within the on-site water treatment plant.

Water for fire-fighting will be stored in dedicated firewater storage facilities with a duty electric pump and standby diesel pump.

A diesel generator (Air Discharge 3 – See Section 1.4.5.4) will provide power to safely shutdown the Installation, which will provide sufficient power to run or shut the plant down in the event of the loss of a grid connection.

Other supporting infrastructure would include an electricity connection compound, combined heat and power (CHP) building, roads, car parking and a gatehouse / weighbridge complex.

2 OTHER INFORMATION

2.1 Raw Materials

2.1.1 Quantity and Use of Raw Materials

The main raw materials (> 5 tonnes) which will be stored at the Installation are presented in Table 3, with indicative values for their annual tonnages and on-site storage capacities.

Table 3: Raw Material Storage, Consumption and Environmental Impacts

Material	Process	On-site storage capacity (m^3)	Annual throughput (tpa)	Comments on the Potential Environmental Impact
Dry / Semi-dry Lime ($Ca(OH)_2$)	Flue gas treatment - acid gas scrubbing	376	8,557 (dry) or 7,606 (semi-dry)	Removed as a constituent of the APCR by the bag filter and disposed of as hazardous waste at a suitable licensed waste treatment facility. Refer to **Section 2.8.2**.
Activated carbon	Flue gas treatment - dioxins / heavy metals	45	472	
Aqueous ammonia (NH_4OH) / Urea	Flue gas treatment - NO_x reduction	38	2,013 (aqueous ammonia) or 888 (Urea)	Any unreacted ammonia (a chemical intermediate) would be released to atmosphere at low concentrations. Dosing will be controlled as to minimise slip. Refer to **Section 2.2.3**.
Diesel / low sulphur fuel oil	System firing	175	472	Stored within a tank in a bunded, hardstanding area with contained drainage. Refer to **Section 2.4.5**.
Hydrochloric acid (35 % solution); caustic soda (30 % solution); and various chemicals.	Boiler water dosing	N/A	< 100	Stored within a tank in a bunded, hardstanding area with contained drainage. Refer to **Section 2.4.5**.

In addition, various other materials would be used in small amounts (< 5 tpa) for the operation and maintenance of the Installation including:

- Hydraulic oils and silicone-based oils;
- Inert gases for electrical switchgear;
- Gas emptying and filling equipment;
- Refrigerant gases for air conditioning plant;
- Glycol / anti-freeze for cooling;
- Oxyacetylene, TIG, MIG welding gases; and
- CO_2 / fire-fighting foam agents.

In order to minimise the risks of contamination to process and surface water, all liquid chemicals stored on site would be kept in bunded controlled areas. All chemicals will be handled in accordance with COSHH Regulations and full product data sheets will be readily available on site.

Material usages will be periodically reviewed in light of product development, with a view to identifying those with a lower environmental impact where appropriate. Any significant change of material will be assessed against a risk assessment criteria to ensure it does not negatively affect the operation of the site.

2.1.2 Fuel and Chemical Storage

In order to minimise the risks of contamination to process and surface water, all liquid chemicals stored on site would be kept in bunded controlled areas. The use of hardstanding and contained (i.e. isolated) drainage will also be implemented to ensure containment of any spillages and mitigate any impact to soils or groundwater. Secondary containment facilities will have capacity to contain whichever is the greater of 110 % of the tank capacity or 25 % of the total volume of materials being stored, in case of failure of the storage systems.

The details of the on-site fuel and chemical storage facilities are presented within the Site Condition Report, included as Appendix B of the Permit Application. An overview of fuel/chemical storage procedures is also provided in Section 2.4.5 of this report.

Boiler water treatment chemicals will be used to control water hardness, pH and scaling and will be delivered in sealed containers and stored in a bunded area within the water treatment room.

Welding gasses (oxygen and acetylene) will be kept within a secure compound area.

2.1.3 Reagent Selection

This section provides a rationale for the reagent selection for pollution control measures to be implemented by the Installation. A summary of the BAT Assessment (Appendix E of the Permit Application) is provided with Section 2.6 of this document.

2.1.3.1 Acid Gas Abatement

Table 4: Acid Gas Abatement BAT Summary

Parameter	Units	Dry Lime	Dry Sodium Bicarbonate	Semi-dry Lime
Mass of reagent	tonne/y	8,557	14,030	7,606[3]
Mass of residues	tonne/y	10,487	14,886	9,767
Cost of reagent	GBP/y	1,608,649	3,086,559	1,459,117
Cost of residue disposal	GBP/y	1,310,862	1,860,734	1,220,927
Cost per tonne acid gas abated	GBP/t	1,564	2,019	1,609

An assessment of acid gas abatement options indicates that all three options have similar environmental performance. However, on the basis of cost and global warming potential, a dry or semi-dry process using lime reagent is regarded at BAT for the Installation.

2.1.3.2 Nitrogen Oxides Abatement

Two related technologies are available: selective non-catalytic reduction (SNCR) and selective catalytic reduction (SCR). In both technologies, ammonia (NH_3) is injected into the flue gas to convert NO_x into nitrogen and water; the difference is that SCR uses a catalyst to enhance this reaction. In SNCR and SCR ammonia can be added as a solution (aqueous ammonia, usually about 25 % NH_3 in water) or as urea ($CO(NH_2)_2$), which breaks down into NH_3 in the flue gas.

Table 5: NO_x Abatement BAT Summary

Parameter	Units	SNCR ammonia	SNCR urea	FGR + SNCR ammonia	SCR ammonia
Mass of reagent	tonne/y	2,013	888	1,400	1,348
Cost of reagent	GBP/y	372,332	353,390	259,014	249,301
Cost per tonne acid gas abated	GBP/t	944	913	1,705	5,848

An assessment of NO_x abatement options indicates that selective non-catalytic reduction (SNCR) using either aqueous ammonia or urea is BAT. This system can deliver the required NO_x emission performance at lowest cost and with the smallest impact on global warming potential.

[3] Mass of reagent only (excluding water)

2.1.3.3 Mercury, Heavy Metals, CO and Organics Abatement

For control of carbon monoxide and organic compound emissions, maintaining good primary combustion and designing the boiler with a suitable time-temperature profile is BAT for this Installation.

To provide additional abatement of organic compounds, powdered activated carbon (PAC) injection is BAT. PAC injection is also BAT for the control of mercury and other heavy metal emissions. PAC residues would be collected together with fly ash and acid gas abatement residues in the bag filters.

2.1.4 Auxiliary Fuel Selection

As per Article 50 (3) of the Industrial Emissions Directive (refer to Section **Error! Reference source not found.**), the fuels eligible to be used for auxiliary firing are:

- liquefied gas (LPG);
- fuel oil; and
- natural gas.

Auxiliary burners typically operate for up to 16 hours during a start-up event. Once operational, there should be no more than two cold start-ups per year and per line outside planned maintenance activities. The auxiliary burners would automatically maintain the temperature above 850 °C, on the very rare occasions, if ever, that temperatures start to fall below this.

The storage of LPG will require specialist pressure vessels and presents an explosion risk. The proximity of the A453 carriageway precludes the use of LPG due to explosion risk.

When firing using natural gas, large volumes of gas are required. This would have to be supplied from a high-pressure gas main in close proximity to the Installation. There is not a high-pressure gas main within the Installation Boundary or near to the site. Therefore, natural gas is not a suitable auxiliary fuel.

A fuel oil tank can be easily installed at the site. Storage of low sulphur fuel oil does not present the same safety risks as LPG. The combustion of fuel oil will lead to emissions of sulphur dioxide, but these emissions will be minimised as far as reasonably practicable through the use of low sulphur fuel oil.

Considering the availability and safety of the available fuels, low sulphur fuel oil is considered BAT for the Installation.

2.2 Incoming Waste Management

2.2.1 Waste to be Processed

The Installation is anticipated to accept non-hazardous residual C&I wastes and LACW, including in the form RDF. It would also have the potential to treat the combustible fraction of C&D waste and is also intended to be capable of accepting certain waste biomass fuels.

An indicative list of European Waste Catalogue (EWC) Codes that the Installation plans to accept are listed in **Error! Reference source not found.**. This is not expected to be the exhaustive list and will continue to be expanded as discussions with suppliers and local authorities continue to develop.

Table 6: Proposed Waste Codes to be Accepted by the Installation

EWC code	Description
02	**WASTE FROM AGRICULTURE, HORTICULTURE, AQUACULTURE, FORESTRY, HUNTING AND FISHING, FOOD PREPARATION AND PROCESSING**
02 01	**waste from agriculture, horticulture, aquaculture, forestry, hunting and fishing**
02 01 03	plant-tissue waste
02 06	**waste from baking and confectionery industry**
02 06 01	materials unsuitable for consumption or processing
03	**WASTES FROM WOOD PROCESSING AND THE PRODUCTION OF PANELS, FURNITURE, PULP, PAPER AND CARDBOARD**
03 01	**wastes from wood processing and the production of panels and furniture**
03 01 01	waste bark and cork
03 01 05	sawdust, shavings, cuttings, wood, particle board and veneer other than those mentioned in 03 01 04
03 03	**wastes from pulp, paper and cardboard production and processing**
03 03 01	waste bark and wood
03 03 07	mechanically separated rejects from pulping of waste paper and cardboard
04	**WASTES FROM THE LEATHER< FUR AND TEXTILE INDUSTRIES**
04 02	**wastes from the textile industry**
04 02 10	organic matter from natural products (for example grease, wax)
04 02 21	wastes from unprocessed textile fibres
04 02 22	wastes from processed textile fibres
15	**WASTE PACKAGING; ABSORBENTS, WIPING CLOTHS, FILTER MATERIALS AND PROTECTIVE CLOTHING NOT OTHERWISE SPECIFIED**
15 01	**packaging (including separately collected municipal packaging waste)**
15 01 01	paper and cardboard packaging
15 01 02	plastic packaging
15 01 03	wooden packaging
15 01 05	composite packaging
15 01 06	mixed packaging
15 01 07	glass packaging
15 01 09	textile packaging
16	**WASTES NOT OTHERWISE SPECIFIED IN THE LIST**
16 03	off specification batches and unused products
16 03 04	inorganic wastes other than those mentioned in 16 03 03
16 03 06	organic wastes other than those mentioned in 16 03 05

EWC code	Description
17	**CONSTRUCTION AND DEMOLITION WASTES (INCLUDING EXCAVATED SOIL FROM CONTAMINATED SITES)**
17 02	**wood, glass and plastic**
17 02 01	wood
17 02 03	plastic
18	**WASTES FROM HUMAN OR ANIMAL HEALTH CARE AND/OR RELATED RESEARCH (except kitchen and restaurant wastes not arising from immediate health care)**
18 01	**wastes from natal care, diagnosis, treatment or prevention of disease in humans**
18 01 04	wastes whose collection and disposal is not subject to special requirements in order to prevent infection (for example dressings, plaster casts, linen, disposable clothing, diapers)
18 02	**wastes from research, diagnosis, treatment or prevention of disease involving animals**
18 02 03	wastes whose collection and disposal is not subject to special requirements in order to prevent infection
19	**WASTES FROM WASTE MANAGEMENT FACILITIES, OFF-SITE WASTE WATER TREATMENT PLANTS AND THE PREPARATION OF WATER INTENDED FOR HUMAN CONSUMPTION AND WATER FOR INDUSTRIAL USE**
19 02	**wastes from physio-chemical treatments of waste (including dechromatation, decyanidation, neutralisation)**
19 02 03	premixed wastes composed only of non-hazardous wastes
19 05	**wastes from aerobic treatment of solid wastes**
19 05 01	non-composted fraction of municipal and similar wastes
19 05 02	non-composted fraction of animal and vegetable waste
19 05 03	off specification compost
19 06	**wastes from anaerobic treatment of waste**
19 06 04	digestate from anaerobic treatment of municipal waste
19 06 06	digestate from anaerobic treatment of animal and vegetable waste
19 12	**wastes from the mechanical treatment of waste (for example sorting, crushing, compacting, pelletising) not otherwise specified**
19 12 01	paper and cardboard
19 12 04	plastic and rubber
19 12 07	wood other than that mentioned in 19 12 06
19 12 08	textiles
19 12 10	combustible waste (refuse derived fuel)
19 12 12	other wastes (including mixtures of materials) from mechanical treatment of wastes other than those mentioned in 19 12 11
20	**MUNICIPAL WASTES (HOUSEHOLD WASTE AND SIMILAR COMMERCIAL, INDUSTRIAL AND INSTITUTIONAL WASTES) INCLUDING SEPARATELY COLLECTED FRACTIONS**
20 01	**separately collected fractions (except 15 01)**
20 01 01	paper and cardboard

EWC code	Description
20 01 08	biodegradable kitchen and canteen waste
20 01 10	clothes
20 01 11	textiles
20 01 38	wood other than that mentioned in 20 01 37
20 01 39	plastics
20 02	**garden and park wastes (including cemetery waste)**
20 02 01	biodegradable waste
20 03	**other municipal wastes**
20 03 01	mixed municipal waste
20 03 02	waste from markets
20 03 03	street cleaning residues
20 03 04	septic tank sludge
20 03 07	bulky waste

Whilst unloading incoming waste, visual inspections will be undertaken by the tipping hall operator to determine if any of the waste is deemed ‘unacceptable’. This will include large bulky items, incombustible and potentially hazardous materials. Any waste found to be unacceptable will be removed from the bunker and stored in a designated quarantine for further inspection. Should this waste be found to be unacceptable then arrangements will be made for transfer of the waste to a suitably licensed waste management facility.

The Environmental Management System (EMS) will include procedures to control the inspection, storage and onward disposal of unacceptable waste. Certain wastes will require specific action for safe storage and handling. The EMS will also contain procedures for controlling the blending of waste types to avoid mixing of incompatible wastes.

2.2.2 Waste Handling

Prior to the commencement of operations by the Installation, pre-acceptance and acceptance procedures will be developed which comply with Environment Agency Guidance on the Incineration of Waste[4]:

- A high standard of housekeeping would be maintained in all areas, and suitable equipment will be provided and maintained to clean up spilled materials;
- Vehicles would be loaded and unloaded in designated areas provided with impermeable hardstanding and a drainage system equipped with pollution control measures, refer to Section 2.3.2;
- Uncontained or potentially odorous waste will be stored inside buildings with suitable odour control, refer to Section 2.4.3 and Appendix I of the Permit Application for details of the odour control measures and abatement systems;
- A fire-fighting procedure will be developed for the Installation, refer to Appendix G of the Permit Application.
- The design and handling procedures employed by the Installation will ensure the minimisation of litter dispersal;
- All incoming waste will be unloaded in covered vehicles or containers and unloaded into enclosed reception bunkers or sorting areas; and

[4] Environment Agency, How to comply with your environmental permit. Additional guidance for: The Incineration of Waste (EPR 5.01)

- Delivery and reception of waste will be controlled by a management system that will identify all risks associated with the reception of waste and shall comply with all legislative requirements, including statutory documentation. Regular inspections would be undertaken to ensure that 'unacceptable' waste is identified and segregated. Further details of the procedures to be implemented can be found in Section 2.2.2.1.

2.2.2.1 Waste Pre-Acceptance, Acceptance and Auditing

Waste supply contracts are to be agreed with waste producers and suppliers, which will include details of the types and quantities of waste to be transferred to the Installation.

In line with Environment Agency Guidance (EPR5.01) the Installation will operate systems to ensure that waste to be received by the facility contains information pertaining to:

- its physical and chemical composition;
- any other information necessary to assess its suitability for incineration;
- its hazard characteristics;
- substances with which it cannot be mixed, and
- handling precautions.

Furthermore, this information will be confirmed by periodic auditing of the waste quantities, description and its physical characteristics by:

- checking that the quantity is as declared by the consignor (via the weighbridge);
- visual inspections of the composition of the waste;
- documentation checks; and
- confirmatory sampling where appropriate.

These procedures will be documented and provided to the Environment Agency prior to the commencement of operations by the Installation and issuing of the Environmental Permit. This will include details of waste pre-acceptance, acceptance and auditing procedures, as outlined above.

2.2.3 Waste Minimisation

Residues and wastes will be minimised from the Installation through the use of several specific techniques. Measures such as maintaining feedstock homogeneity and furnace operating conditions ensure that process inputs are stable (reducing material consumption to control output). However, there will inevitably be some variation in inputs, and therefore having a robust, well-tuned abatement plant ensures that where reagents are required to be used, their consumption is optimised and overall use minimised. Finally, the use of proven waste management techniques minimises the overall volume of waste produced.

2.2.3.1 Feedstock Homogeneity

The composition of waste received by the Installation will inevitably vary over time, and by source. This means that the plant and its control system will constantly be seeking to optimise operation with changing feed. The ability to mix fuel in the hoppers will be available, and therefore the crane operator can optimise the fuel feed to the furnace fuel supply lines. This in turn helps stabilise plant operation, reducing variability in performance.

2.2.3.2 Dioxin and Furan Reformation

The production of dioxins and furans, and hence the production of materials containing them, can be minimised through good plant design and operation. These are discussed in sector guidance and the WI BREF document.

Aspects of plant design to reduce reformation of dioxins and furans are described below.

Flue gas cooling, i.e. maximising the rate of cooling of flue gas through the temperature range where dioxin and furan synthesis can occur, is important. This minimises so called de-novo formation of these species and represents BAT.

Whilst flue gas temperatures may be above the synthesis window for dioxins and furans, heat transfer surfaces may be significantly cooler due to the steam or water temperature within tubes. This can cause local formation near the surface of tube banks, for example, and should be minimised through careful design of heat transfer surfaces. In order to optimise energy recovery from the flue gas, it is inevitable that the flue has will be cooled through the temperature range where formation of dioxins and furans could occur. The period of time in this range will be minimised by design of the heat transfer surfaces and associated flue gas path ducting.

Gas path design to optimise velocity is important, with the goal of simultaneously avoiding stagnant or low velocity areas in the flue gas path, and maintaining gas flow at high velocities to minimise residence time in relatively cool areas (especially in temperatures zones where dioxin and furan synthesis is possible). Computational Fluid Dynamics (CFD) will be used as a part of the plant design process to ensure these potentially competing objectives of heat recovery whilst minimising residence time in the flue gas temperature envelop of concern are mutually optimised.

From a plant operation perspective, a well-tuned sorbent injection system will be operated, and cleaning of the gas path both on-load and during maintenance periods will ensure that troublesome deposits cannot build up in service.

2.2.3.3 Furnace Conditions

Whilst fuel homogeneity will be managed as far as possible, furnace optimisation will also be necessary. This ensures the complete burnout of the material on the grate, and also minimises some flue gas components that would then require reagents to control (that may manifest in Air Pollution Control Residue (APCR) streams). Burnout in the furnace is achieved by optimising fuel flow and combustion air supply, thus ensuring that the Total Organic Carbon (TOC, 3 %) or Loss on Ignition (LOI, 5 %) of the Incinerator Bottom Ash (IBA) meet the requirements of BAT.

2.2.3.4 Flue Gas Treatment Control – NO_x and CO

For combustion control, and to ensure complete burnout of the material on the grate, there will be a negligible concentration of CO in the flue gas. This complete burnout comes at the expense of NO_x, which whilst controlled by the combustion system, cannot be controlled to the low concentrations required by the WI BAT Conclusions. To achieve these levels, a Selective Non-Catalytic Reduction (SNCR) system will be required. This will inject a nitrogen bearing reagent such as urea solution or ammonia solution into the flue gas. Key to the efficient utilisation of this reagent, and consistently achieving the required NO_x concentration at the stack, is matching injection to the optimum temperature zone in the gas path, typically in the 850–1050 °C range, and ensuring sufficient residence time and complete mixing of reagent.

Complete mixing will be ensured by minimising the amount of heat transfer surface, or other elements, in the flue gas path in the optimum temperature window, as well as ensuring the number of injection nozzles and injection pressure ensures a complete coverage of the gas path cross section at the injection point.

CFD is an important tool in plant design to ensure this, as is providing some flexibility to move injection points with changing fuel or plant performance.

Injection rates will be controlled by a feedforward signal, such as flue gas flow or steam flow, and trimmed based on measured NO_x at the plant outlet.

Operationally SNCR performance is optimum where combustion conditions are stable, in particular oxygen, CO and temperature distribution in the flue gas.

2.2.3.5 Flue Gas Treatment Control – Acid Gasses and Trace Species

A well designed and operated flue gas cleaning train will ensure that emissions to air of these species are maintained below the BAT levels, whilst optimising the consumption of sorbents by the plant.

A reagent such as lime will be used for control of acid gas species (most notably SO_2 and HCl, but also HF); this process will be controlled based on feed forward signals of flue gas flow or steam flow as well as inlet gas concentration. Feedback control will be offered by monitoring of acid gas species at the flue gas cleaning plant outlet. This control scheme ensures that there is a stable loading of reagent in the flue gas and a stable coherent filter cake developed on the filter media surface.

Activated carbon will be used for trace species control (metals and metalloids); this process will be controlled based on feed forward signals of flue gas flow or steam flow. This will ensure a stable loading of carbon sorbent in the flue gas. It is proposed that mercury process monitoring will be included, and this will allow operators to be alerted of any sub-optimal operation, though the nature of these systems is such that feedback control is not recommended. The accumulation of activated carbon in the dust cake on the surface of the fabric filter media provides some buffering of emissions in the event of a temporary interruption to reagent injection.

Calibration of injection control schemes, including flue gas monitoring, will form part of the normal preventative maintenance programme for the plant.

Both reagents, for acid gas and trace species control, will be stored separately and conveyed to the plant injection points such that independent control of each is possible. Pre-mixed sorbent blends will not be used.

2.2.3.6 Waste Management

Inevitably, there will be waste materials produced by the process, albeit minimised as far as possible. Most notably these include the IBA and APCR streams. In line with BAT, as presented in the new BAT Conclusions, these streams will be segregated from one another, and stored separately to allow waste treatment and material recovery. Both will be separately processed off-site.

These provisions are discussed further in Section 2.8.

2.2.4 Waste Charging

The Installation will meet BAT as indicated in the new BAT Conclusions for Waste Incineration, as well as the requirements of the IED and the indicative requirements of the Environment Agency, for the charging of waste to the furnace. These include:

In the event that charging of waste should be interrupted (tripping automatically or otherwise), the control system will automatically ignite the auxiliary burners to ensure that flue gas temperatures are maintained to ensure complete burnout. The flue gas cleaning plant will also remain in service in this event.

If the flue gas temperature measured at the agreed location drops below 850 °C, this would mean that the conditions of the “two second rule” may not be met. An interlock between this temperature and fuel feeding will be provided in the control scheme such that in this eventuality the charging of waste will be stopped (or during start-up cannot be initiated).

Auxiliary burners will also ignite in the event that flue gas temperature is identified as dropping below the levels required to comply with the “two second rule”. Combustion conditions will be continuously monitored and the control system act to optimise them, ensuring complete burnout and continued compliance with the emission limit values set in the Environmental Permit at the flue.

Waste charging systems will also be interlocked with measured emissions at the stack, meaning that waste charging will be inhibited if stack emissions are greater than any of the emission limit values set in the Environmental Permit.

Whilst waste is charged into the feed chutes by the grab, the onward charging of fuel to the grate is via feed units. These feed chutes will be maintained with a full charge of waste as this, coupled with the furnace being at negative pressure, will ensure there is no back flow of combustion gases into the waste supply system. This in turn reduces the risk of premature combustion of waste prior to admission to the grate. Fuel chute level will be continuously monitored and an alarm raised in the control room should this fall below a predetermined, safe level.

Combustion air will be admitted to the furnace via nozzles on the vessel walls; their design and layout controls flame shape and the overall flow of air and combustion flue gas through the process.

2.3 Water Use and Drainage

2.3.1 Water Supply

2.3.1.1 Process Water

There will not be any process emissions to water or sewer from the Installation under normal operation.

Liquid effluents will be produced from processes such as boiler blow down and from back-washing / regeneration of the water demineralisation plant. This water is collected within the dirty water tank situated below the air cooled condensers. This water is re-used in the ash hopper to quench the hot IBA discharge before it enters the ash loading area. There is a continual requirement for water at this stage of the process and it is normal that this will need to be topped up with clean water. This water will then either evaporate into the flue gas or be retained as moisture in the ash, which is subsequently transported offsite for treatment.

As the IBA quenching requirements will exceed the volume of process water, there will be no process water emissions from the site under normal operation.

2.3.1.2 Potable Water

Towns mains water will be used for potable water supply to the Installation and for the associated offices and mess facilities.

2.3.2 Site Drainage

2.3.2.1 Surface Water Drainage

The Installation would give rise to surface water run-off from on-site roads, vehicle parking areas, roofs of buildings and other hardstanding; some of the roof water would be diverted to a rainwater harvesting tank located in the main building for use within the Installation. The remaining surface water run-off will pass through oil interceptors and silt traps prior to discharge into the Ratcliffe Power Station surface water drainage system.

This discharge point is shown as Waster Discharge 1 in Appendix A.4 of the Permit Application and would be subject to continuous pH measurement and daily visual inspection for the presence of oil.

The indicative drainage layout is presented as Appendix A.6, within Appendix A of the Permit Application.

2.3.2.2 Foul Water Drainage

Foul water generated by the Installation would be collected on the site via a series of pipes which would connect to a septic tank. The contents of the tank would be emptied on a regular basis by a tanker and taken offsite to a suitable sewage treatment facility.

The indicative drainage layout is presented as Appendix A.6, within Appendix A of the Permit Application.

2.4 Emissions

2.4.1 Emissions to Air

The Installation will have two main sources of point source emissions to air, emission points Air Discharge 1 and Air Discharge 2, relating to Line 1 and Line 2 respectively.

The proposed ELVs for the Installation are presented in Table 7.

The BAT Reference Document on Waste Incineration[5] has recently been published. The emission limits being applied for are in accordance with the requirements of the BAT associated emission levels (AELs) for a ‘new’ Installation as well as with the emission limit values (ELVs) set out for waste incineration plant in the IED.

[5] BAT Conclusions for Waste Incineration (EU 2019/2010)

Table 7: Proposed Emission Limit Values (ELVs)

Parameter	Units	Half Hour Average	10 Minute Average	Daily Average	Periodic Limit
Dust	mg/Nm^3	30		5	-
VOCs as Total Organic Carbon (TOC)	mg/Nm^3	20		10	-
Hydrogen chloride	mg/Nm^3	60		6	-
Carbon monoxide	mg/Nm^3	100	150	50	-
Sulphur dioxide	mg/Nm^3	200		30	-
Oxides of nitrogen (NO and NO_2 expressed as NO_2)	mg/Nm^3	400		120	-
Ammonia	mg/Nm^3			10	-
Hydrogen fluoride	mg/Nm^3				1
Cadmium & thallium and their compounds (total)	mg/Nm^3				0.02
Mercury and its compounds	mg/Nm^3				0.02
Sb, As, Pb, Cr, Co, Cu, Mn, Ni and V and their compounds (total)	mg/Nm^3				0.3
Dioxins & furans	Ng I-TEQ/ Nm^3				0.04
Dioxin like PCBs	Ng WHO-TEQ/ Nm^3				0.06

In addition a third air discharge point will be associated with the diesel powered generator providing electrical power to the plant in the event of an interruption in the supply. This generator will not be tested for more than 50 hours a year and the total operational hours will not exceed 500 hours per year, as a rolling average over a period of three years. As such this generator will not be subject to emission limit values under the Medium Combustion Plant Directive or the England and Wales Specified Generator Regulations. The precise location of the diesel generator and hence the associated stack will be determined at the detailed design stage. Given the small size of the generator (<20MWth) and the limited annual operating hours, no significant effects on air quality are anticipated.

2.4.2 Fugitive Emissions to Air

The refilling of fuel and chemical tanks / silos at the Installation has the potential to introduce fugitive emissions to air.

The lime and activated carbon silos will be filled by bulk tanker, offloaded pneumatically with displaced air vented through a reverse pulse jet filter. The silos will be fitted with high-level controls and alarms. All silos will be fitted with bag filter protection to prevent release of dust during refilling, which will be cleaned at regular intervals and inspected for damage / leaks.

The APCR silo will be unloaded by a chute system, which will back-vent into the tanker to prevent the release of dust from the silo during unloading.

Dust emissions are unlikely to occur as all process operations are undertaken within enclosed buildings. During prolonged periods of dry weather, site roads would be damped down / washed if the potential for fugitive dust impacts resulting from traffic movements are identified by the site management.

2.4.3 Odour Emissions

Whilst unloading incoming waste, visual inspections will be undertaken by the tipping hall operator to determine if any of the waste is deemed ‘unacceptable’. This will include large bulky items, incombustible and potentially hazardous materials. Any waste found to be unacceptable will be removed from the bunker and stored in a designated quarantine area for further inspection. Should this waste be found to be unacceptable then arrangements will be made for transfer of the waste to a suitably licensed waste management facility.

All deliveries of residual waste, which could give rise to odour, would be within enclosed delivery vehicles in order to minimise the potential for fugitive emissions. To further reduce odour, all waste handling and management activities will be undertaken within enclosed spaces, in order to minimise emissions of odour.

The waste bunker will be continuously held under negative pressure by an induced draught (ID) fan, which will draw in air from the area and feed it into the combustion chamber beneath the grate. To maintain negative pressure in the waste bunker area, primary combustion air will be drawn from the area and fed into the combustion chamber beneath the grate. As the installation consists of two independent incineration lines, closure of one line will still allow the tipping hall to be maintained under negative pressure due to operation of the other line.

In order to avoid the proliferation of anaerobic conditions within the bunker, which increases the potential for odorous emissions, frequent mixing and rotation of the waste would be undertaken. The handling operators would be trained to operate a FIFO (first in, first out) system, so that residual waste is not routinely kept in the bunker for longer than two to three days. In addition, periodic emptying and cleaning of the bunker would be carried out, to further minimise the potential for odorous emissions.

Where appropriate, prior to periods of planned maintenance, waste stored within the waste bunker will be ‘run-down’ so that it does not contain significant quantities of old and potentially odorous material. Should a period of extended unplanned shutdown occur, arrangements will be made to stop or divert incoming waste to the Installation.

A dedicated Odour Management Plan (OMP) for the Installation is presented as Appendix I of the Permit Application. The OMP sets out:

- A conceptual odour model for the Installation;
- procedural controls to minimise odour;
- a process for the investigation of odour complaints; and
- a contingency action plan to investigate and rectify any incidents.

2.4.3.1 Odour Abatement System

During periods of shutdown, all doors to the waste bunker area will remain closed. This will help to contain any odour within the waste bunker area and ensure that the abatement system is effective in preventing the release of odour.

A deodorising system will be employed during periods of shutdown, to manage emissions of odour from the Installation. Odour treatment chemicals (details of which will be provided during detailed design) will be mixed with water and delivered via nozzles as a mist, within the waste reception hall. The odour treatment chemicals are designed to react with the odorous components to remove them or convert them to less odorous compounds that have a lower hedonic score and are therefore less offensive.

Should odour be detected during periods of shutdown when the odour abatement system is operational, then the system will be inspected and maintenance performed, if required.

A BAT case for the chosen odour abatement technology is presented within Section 2.6.8.

2.4.4 Emissions to Water and Sewers

Under ‘normal operations’, there will not be any process emissions to water or sewer from the Installation. Liquid effluents will be produced from processes such as boiler blow down and from back-washing / regeneration of the water demineralisation plant. This water is collected within the dirty water tank situated below the air cooled condensers. This water is re-used in the ash hopper to quench the hot IBA discharge before it enters the ash loading area. There is a continual requirement for water at this stage of the process and it is normal that this will need to be topped up with clean water. This water will then either evaporate into the flue gas or be retained as moisture in the ash, which is subsequently transported offsite for treatment. As the IBA quenching requirements will exceed the volume of process water, there will be no process water emissions from the site under normal operation.

Foul water generated by the Installation would be collected on the site via a series of pipes which would connect to a septic tank. The contents of the tank would be emptied on a regular basis by a tanker and taken offsite to a suitable sewage treatment facility.

The Installation would give rise to surface water run-off from on-site roads, vehicle parking areas, roofs of buildings and other hardstanding; some of the roof water would be diverted to a rainwater harvesting tank located in the main building for use within the Installation. The remaining surface water run-off will be pass through oil interceptors and silt traps prior to discharge into the Ratcliffe Power Station surface water drainage system. This discharge point is shown as Water Discharge 1 in Appendix A-4 of the Permit Application and would be subject to continuous pH measurement and daily visual inspection for the presence of oil.

A description of the surface water drainage system is provided in Section 2.3.2 and the indicative drainage layout is presented as Appendix A.6, within Appendix A of the Permit Application.

2.4.5 Contaminated Water

In order to minimise the risks of contamination to process and surface water, all liquid chemicals stored on site would be kept in bunded areas. The use of hardstanding and contained drainage will also be implemented to ensure containment of any spillages and mitigate any impact to soils or groundwater. Secondary containment facilities will have capacity to contain whichever is the greater of 110 % of the tank capacity or 25 % of the total volume of materials being stored, in case of failure of the storage systems. The details of the proposed containment systems can be found in the Site Condition Report, which is included as Appendix B of the Permit Application.

In order to further prevent potentially contaminative emissions to surface water, the discharge point shown as Waste Discharge 1 in Appendix A-4 of the Permit Application would be subject to continuous pH measurement and daily visual inspection for the presence of oil.

Tanker off-loading of chemicals will take place within areas where the drainage is contained with the appropriate capacity to contain any potential spill during delivery. This will include measures such as areas of hardstanding with falls to a gully and/or sump.

Spill kits, including relevant absorbent materials, will be made available near to fuel and chemical stores throughout the Installation, in order to mitigate the impact of potential spillages. Any recorded pollution incident would be reported to the site management, who would be responsible for notification of the relevant authorities (Environment Agency / Health and Safety Executive).

Furthermore, prior to construction, an emergency response system would be set up to deal with incidents of construction spillages. Appropriate measures would be required to intercept, prevent and reduce any contamination through the agreed emergency response procedures. Following any significant event, testing and management of groundwater during Site development will prevent migration and contamination.

2.4.6 Noise Emissions

A dedicated noise assessment for the Installation is presented as Appendix C of the Permit Application.

2.5 Monitoring Methods

The Installation will undergo continuous / periodic measurements of all pollutants, as outlined in Section 1.4.7. The measurements will be performed in accordance with CEN or equivalent standards (e.g. ISO, national, or international standards), to ensure consistent and comparable measurements. All measurement systems, as well as periodic measurements, will be certified to MCERTS standards or carried out by sufficiently accredited organisations.

The Installation will also be equipped with a Data Acquisition and Handling System (DAHS). The DAHS will enable various parameters to be directly measured in order to verify process efficiency.

2.5.1 Monitoring of Emissions to Air

In line with the requirements of the Industrial Emissions Directive and of the conclusions on Best Available Techniques for Waste Incineration plant the monitoring of emissions to air at the flue will be a combination of continuous measurements and periodic sampling.

The following species emitted to air will be monitored continuously:

- Dust
- Nitrogen Oxides (NO_x)
- Sulphur Dioxide (SO_2)
- VOCs (as total organic carbon, TOC)
- Hydrogen Chloride (HCl)
- Carbon Monoxide (CO)
- Ammonia (NH_3)

- Flow

Furthermore, to allow correction to reporting conditions a number of peripheral measurements will be made:

- Temperature
- Pressure
- Oxygen content
- Moisture content (where sampling is not dry)

Data will be collated, processed and reported to demonstrate compliance with the Emission Limit Values contained in the Environmental Permit, in line with the requirements of the IED and UK guidance on data acquisition and handling standards (BS EN 17255-1:2019). The CEMS Installation will be compliant with the UK Monitoring Certification Scheme (MCERTS) and therefore the requirements in the UK of BS EN 14181. It will comprise two monitoring systems (one in service and one redundant) per plant line. Installing equipment approved under these schemes, along with maintaining and calibrating it in line with the equipment suppliers and appropriate standards, will ensure the high degree of reliability required to comply with the requirements IED.

Periodic sampling will be undertaken of the following species:

- Hydrogen Fluoride (HF)
- Mercury (Hg)
- Group III metals (Antimony (Sb), Arsenic (As), Lead (Pb), Chromium (Cr), Cobalt (Co), Copper (Cu), Manganese (Mn), Nickel (Ni), Vanadium (V))
- Cadmium (Cd) + Thallium (Tl)
- Dioxins and Furans
- Dioxins and Dioxin-like PCBs

The frequency of these measurements will be four times per year in the first year of operation giving way to twice per year thereafter. This is with the exception of mercury and dioxins and furans. For these species there is a risk based approach to monitoring that could lead to the subsequent retrofit of continuous mercury monitoring for reporting or/and a continuous long-term sampling system for dioxins and furans.

For mercury, continuous monitoring is not required where sufficient stability in emissions can be demonstrated. This is shown by gathering six consecutive results, gathered at the rate of two results per month, below the threshold level, which is currently under discussion with the regulatory authorities, but anticipated to be 10 $\mu g/Nm^3$ (at reporting conditions of 11 % O_2, dry vol). Where this cannot be demonstrated, mercury abatement equipment can be optimised and further testing completed. If six values below this threshold are gathered then periodic monitoring can be maintained and continuous monitoring is not required. If any of the results are above the threshold then continuous monitoring is required.

If emissions of dioxins and furans below the sampling period averages in the BREF cannot be demonstrated with six sets of periodic monitoring gathered at a rate of two tests per month until six results are obtained then continuous samplers will be required. If the results are not below the limit value (demonstrating sufficient stability) then the plant can be optimised and six further results gathered. If these results are all below the limit then periodic sampling can be maintained, if not then continuous/long-term sampling will be required to be installed.

The plant design will allow subsequent retrofit of continuous monitoring systems should they be required. Mercury will be continuously monitored for process control and performance (though not reporting).

The provisions for monitoring flue gas temperature, to demonstrate compliance with the "two second rule" are discussed in Section 2.5.4.

During start-up and shutdown, Emission Limit Values do not apply, and whilst data will be gathered via the CEMS, this will not be included in the averaging data required to be reported for compliance demonstration. Overall, data will be captured, processed and reported in such a manner as to allow the Installation to demonstrate to the Environment Agency compliance with the conditions of the Environmental Permit.

2.5.2 Monitoring of Emissions to Water and Sewers

The Installation would give rise to surface water run-off from on-site roads, vehicle parking areas, roofs of buildings and other hardstanding; some of the roof water would be diverted to a rainwater harvesting tank located in the main building for use within the Installation. The remaining surface water run-off will be passed through oil interceptors and silt traps prior to discharge into the Ratcliffe Power Station surface water drainage system. This discharge point is shown as Water Discharge 1 in Appendix A.4 of the Permit Application and would be subject to continuous pH measurement and daily visual inspection for the presence of oil.

2.5.3 Process Monitoring

The Installation will be controlled from a new, dedicated, central control room via a modern distributed control system (DCS) supplied as part of the overall development. This DCS will optimise the performance of the plant, within predetermined limits, to ensure safe operation, based on measured data from the process to achieve the best balance between energy output and continued compliance with emission limits whilst ensuring complete burnout of the material fed to the grate. Data continually monitored by the process will include:

- Waste and combustion air flows
- Auxiliary burner fuel flow
- Reagent, water and air flows to the SNCR and flue gas cleaning plant
- Boiler outlet flue gas temperature and oxygen content
- Flue gas composition at the inlet to the flue gas cleaning plant
- Stack flue gas composition
- Boiler feedwater flow and steam drum level
- Air cooled condenser inlet and outlet pressure
- Generated and sent out electrical power

The instrumentation used to perform these functions will be selected based on experience in order to ensure robust and reliable performance, and fast enough response to allow efficient control of the overall process.

In addition to the process monitoring above, it is a requirement of the IED that the Installation will be designed to ensure that combustion gases experience a temperature of 850 °C or more for at least two seconds subsequent to the last point of combustion air addition. This is known as the "two second rule". If the process monitoring scheme identifies lower temperatures than this in the relevant locations in the flue gas (see Section 2.5.4) then waste charging will be tripped and auxiliary burners ignited until temperature is restored or the unit is taken off-load.

2.5.4 Validation of Combusting Conditions

As is a requirement of the IED, the Installation will be designed to ensure that combustion gases experience a temperature of 850 °C or more for at least two seconds subsequent to the last point of combustion air addition. This is known as the “two second rule”. During the design stage Computational Fluid Dynamic (CFD) modelling will be completed to confirm that this requirement is met across the likely operating range and fuel diet of the plant.

This CFD modelling will also be used to defined the most appropriate location to site flue gas temperature measurement such that this condition can be confirmed continuously in operation. Where the exact location cannot be used, for example if there will be boiler structural members interfering with access, then an alternative location will be used and corrections developed to allow the measured temperature at that location to be correlated with that at the preferred location. This calculation, and the associated validating CFD work, will be made available for inspection by the Environment Agency following design of the boiler. This will be as outlined in the recent Environment Agency document “Guidance for Furnace Design Submissions for Waste Incineration Plant”.

The results of the CFD will be confirmed during commissioning and a validation report provided to the Environment Agency containing the following information;

- The results of the validation tests
- Provide a summary for each load case tested confirming:
  - the volume of the Qualifying Secondary Combustion Zone (QSCZ)
  - the residence time in the QSCZ
  - volumetric furnace flow through the QSCZ (Am^3/s)
  - the CV of the fuel during the test
  - oxygen concentrations during the test
- Justification of any data excluded from the report (e.g. fouling).
- Identification of any additional correction factors applied not identified during the methodology report.
- Calculated measurement uncertainties.
- Raw temperature data for each test
- The report should reference the results of the validation tests in relation to the predictions from the CFD model, including the IED mean and IED peak residence times.
- Discussion of how validated residence times and temperatures at the CV of waste used during the validation tests may be influenced by the range of CVs expected to be seen by the Installation.
- Assess how the validation tests, at specified operating conditions, relate to validating other conditions within the operating envelope.
- Discussion of how boiler fouling is predicted to impact on residence times determined through validation.
- Conclusion on whether the requirements of Article 50(2) have been met by the Installation.

2.5.5 Monitoring Oxygen Levels

It is widely understood that the oxygen concentration at the boiler exit must be monitored and controlled such that sufficient excess air is available, thus ensuring complete burnout of combustible gases. Based on this measured value, the supply of combustion air will be regulated.

2.6 Technology Selection (BAT)

This section details the assessment of Best Available Techniques (BAT) applicable at the Installation in relation to plant design, emissions control and energy efficiency. The assessment is made in accordance with Environment Agency guidance, including EPR 5.01 applicable to the incineration of waste.

The full BAT Assessment is included as Appendix E of the Permit Application.

2.6.1 Boiler Technology

A range of boiler designs have been considered for the Installation. Four different technologies are summarised below.

Moving Grate	
Description	Waste is delivered onto a grate and is slowly transported through the furnace. Hot primary air is delivered underneath the grate to dry the waste and initiate combustion. Secondary air is added above the grate to complete combustion. Ash residue falls off the end of the grate into a reception pit.
Advantages	• Proven at this scale and already widely adopted across Europe. • Wide fuel flexibility, allowing mixed quality wastes to be delivered directly without pretreatment. • Low maintenance, high proven availability. • Ash residue mainly removed as low risk incinerator bottom ash (IBA). • Several EPC contractors available, so costs are controlled/competitive
Disadvantages	• Some other plant designs can potentially delivery higher efficiency.

Rotary Kiln	
Description	Waste is fed into the top of a slowly rotating, inclined kiln. Combustion air is also delivered at the top of the kiln and flue gases and ash exit the kiln at the bottom.
Advantages	• Very good fuel flexibility, allowing mixed quality wastes to be delivered directly without pretreatment. • Higher combustion temperatures produce a glassy slag solid residue, which can be beneficial when processing hazardous wastes.
Disadvantages	• Only proven at small scale. Multiple units would be required to deliver the required waste consumption at the Installation. • Efficiency is lower than other options. • Higher combustion temperatures and excess air give higher NO_x levels • Reliability issues, particularly related to seal air ingress.

Fluidised Bed	
Description	Waste is combined with inert bed material (e.g. sand) and ash, all of which is fluidised on an upward flow of air. In Circulating Fluidised Bed combustion, solids are carried out of the furnace, before being separated from the flue gas and returned to the furnace.
Advantages	• Excellent combustion efficiency and heat transfer from fuel to boiler. • Ability to utilise high moisture and/or high ash fuels. • Lower combustion temperatures deliver lower NO_x levels.
Disadvantages	• Requires small fuel particle size, therefore requires pre-treatment. • Higher Capex and Opex than other options.

Gasification	
Description	Waste is gasified in a low oxygen environment to produce a synthesis gas (syngas). The syngas is then cooled and cleaned before being combusted in a steam-raising boiler or gas engine.
Advantages	• Gasification can potentially deliver higher unit efficiency than the other technologies. However, initial plants have failed to demonstrate this as yet. • Incineration bottom ash by-product is potentially more saleable.
Disadvantages	• Requires tight fuel quality control, therefore requires pretreatment and blending if mixed quality wastes are used. • Technology has shown poor reliability and is regarded as high risk. • Syngas clean-up can be difficult and expensive.

Review of the main technology options shows that Rotary Kilns are not suitable for the size of the Installation. Gasification is also considered to be unsuitable due to the much higher level of technical risk and poor performance of existing Installations.

Therefore, a quantitative comparison is made between using a grate or using a fluidised bed. The conclusions of this comparison are summarised in Table 8.

Table 8: BAT Assessment for Boiler Technologies

Parameter	Units	Grate	Fluidised Bed
Global Warming Potential	tonne CO_2/y	67,775	76,926
Abated NO_x emission	tonne/y	323	323
Aqueous Ammonia	tonne/y	2,013	1,575
IBA	tonne/y	118,221	14,423
APCR, including fly ash	tonne/y	19,508	107,546

A detailed breakdown for costs for both options is not readily available at this stage. However, it is envisaged that capital costs for the fluidised bed option will be slightly higher than for the grate, due to the need for fuel preparation prior to use and due to a more complex boiler. In particular, fluidised beds make use of high quantities of expensive refractory.

Plant maintenance costs are also expected to be higher for the fluidised bed. Again, replacement of refractory in the boiler is expensive and fluidised beds often experience problems with bed ash removal.

Costs for reagents are likely to be comparable, as lower ammonia demand is partially offset against costs for bed material. Major differences are expected for waste streams, however, because the high quantity of APCR generated in the fluidised bed will significantly increase disposal costs relative to the grate.

Overall, the assessment of boiler technology concludes that grate combustion is BAT for the Installation. This technology can deliver the required performance at lowest cost and is likely to have higher availability.

2.6.2 Nitrogen Oxides Abatement

While there are several combinations of technology and reagent that could be considered, the most likely four options for assessment are presented below. In all four cases, it is assumed that primary NO_x control via air-staging is adopted.

SNCR using aqueous ammonia	
Description	Aqueous ammonia is injected via an array of nozzles into flue gas at the furnace exit. Ammonia dosing is controlled to reduce NO_x emissions down to permitted levels.
Advantages	• SNCR is a proven technology and is widely adopted. • Relatively simple technology and proven high reliability. • Low cost in comparison to SCR.
Disadvantages	• Lower NO_x removal efficiency than SCR. • Higher excess of reagent required compared to SCR. • More hazardous reagent than urea.

SNCR using urea	
Description	Urea is injected via an array of nozzles into flue gas at the furnace exit. Urea dosing is controlled to reduce NO_x emissions down to permitted levels.
Advantages	As above, plus • Urea is easy to handle and less hazardous than ammonia.
Disadvantages	As above, plus • Urea can be more expensive than ammonia. • Additional CO_2 release from urea. • Higher N_2O production.

Flue Gas Recirculation + SNCR using aqueous ammonia	
Description	Primary NO_x emissions are reduced by about 20 % using FGR. Aqueous ammonia is then injected via an array of nozzles into flue gas at the furnace exit. Ammonia dosing is controlled to reduce NO_x emissions down to permitted levels. Lower primary NO_x emissions result in lower ammonia demand than without FGR.
Advantages	• Reduced demand for ammonia (lower reagent cost).
Disadvantages	• Significantly higher Capex due to more complex boiler design. • Additional auxiliary power demand for FGR fans (partially offset by reduced reagent dosing). • Risk of corrosion in FGR ducts, if wet corrosive species condense from flue gas. There may also be an erosion risk from any carryover particulate in the FGR.

SCR using aqueous ammonia	
Description	Aqueous ammonia is injected via a grid into flue gas, upstream of a catalyst reactor. The higher reaction efficiency enables NO_x to be abated to lower levels.
Advantages	• Higher NO_x removal efficiency and lower NO_x emissions are achievable. • Lower level of unreacted ammonia (ammonia slip) emission.
Disadvantages	• Very high Capex. • Catalyst degrades over time, requiring replacement.

All of the above options are technically feasible and could satisfy BAT requirements. A detailed assessment of each option is provided in the following sections. The conclusions of this comparison are summarised in Table 9.

Table 9: BAT Assessment for NO_x Abatement Technologies

Parameter	Units	SNCR ammonia	SNCR urea	FGR + SNCR ammonia	SCR ammonia
Boiler NO_x	tonne/y	942	942	753	942
NO_x removed	tonne/y	619	619	431	753
Photochemical Ozone Creation Potential (POCP)	t_{C2H4}-eq	-8,002	-8,002	-8,002	-4,668
Global Warming Potential	tonne CO_2-eq/y	8,293	20,972	8,706	10,181
Mass of Reagent	tonne/y	2,013	888	1,400	1,348
Annualised Cost	GBP/y	584,228	565,286	734,125	4,405,967
Cost per tonne NO_x abated	GBP/t	944	913	1,705	5,848

In summary:

- The global warming potential impact is smallest when using SNCR with aqueous ammonia. GWP is slightly higher if installing flue gas recirculation. Using urea as reagent leads to a high GWP due to the increased emission of N_2O. GWP is also significantly higher for the SCR option; in this case, the electrical output of the Installation would reduce by about 3.7 MWe, or 8 %.
- The analysis shows approximately equivalent total costs for SNCR using aqueous ammonia or urea. Installing flue gas recirculation roughly doubles the cost of abatement; even though primary NO_x levels are reduced and less reagent is required, these savings do not compensate for the higher capital costs, auxiliary power demand and maintenance costs for the system. The SCR option has, by far, the highest cost per tonne abated.

An assessment of NO_x abatement options indicates that selective non-catalytic reduction (SNCR) using either aqueous ammonia or urea is BAT. This system can deliver the required NO_x emission performance at lowest cost and with the smallest impact on global warming potential.

2.6.3 Acid Gas Abatement

In order to meet the required emission limits, an acid gas abatement system is required. Four different solutions are summarised below.

Wet scrubber using sodium hydroxide	
Description	An absorption tower (scrubber) is installed at the back end of the flue gas path, in which an alkaline solution of sodium hydroxide (NaOH) is sprayed. Flue gases pass through the scrubber where the acid gas react with NaOH to form salts and water.
Advantages	• Very high acid gas abatement efficiencies are possible, due to the excellent mixing of flue gas and abatement liquor. • Lower volumes of solid residue are produced, compared to other options.
Disadvantages	• High demand for water. • Large volumes of effluent are produced. This requires treatment in a wastewater treatment plant. • A visible plume is generated. • Flue gas reheating is likely to be required to aid plume dispersion. This has a detrimental impact on efficiency. • Much higher capital costs, and higher operating costs than other options. • NaOH is very hazardous reagent. • This system is less compatible with Powdered Activated Carbon (PAC) injection (discussed later).

Dry sorbent injection using lime	
Description	A solid alkaline powder, in this case slaked lime ($Ca(OH)_2$), is injected into the flue gas. The lime is collected on a bag filter, forming a filter cake through which the flue gas passes. The filter cake is periodically removed and collected. Acid gases react with the lime, forming salts and water.
Advantages	• Good abatement efficiency can be obtained, although an excess of reagent has to be used. • Proven technology and is widely adopted. • No effluent is produced. • No visible plume is created. • Lower capital and operating costs than other options. • Highly compatible with PAC injection.
Disadvantages	• A hazardous solid residue is produced. • Lime is a hazardous reagent.

Dry sorbent injection using sodium bicarbonate	
Description	Exactly the same process as described above, except that sodium bicarbonate ($NaHCO_3$) is used as reagent.
Advantages	As above, and • Sodium bicarbonate is less hazardous than lime. • The level of excess reagent required is lower than lime.
Disadvantages	As above, and • The optimum reaction temperature is higher than for lime and is at the upper end of the acceptable range for bag filters. • The solid residue is more leachable, and potentially more hazardous, than for lime. • Sodium bicarbonate is more expensive than lime.

Semi-dry sorbent injection using lime	
Description	This process is similar to dry sorbent injection, except the reagent is injected as a slurry into the flue gases. Acid gases react more readily with the alkaline reagent in an aqueous phase, thus reducing the level of excess reagent required. The water injected then evaporates in the flue gas leaving the solid residue, which is collected in a bag filter.
Advantages	• Higher abatement efficiency is achievable compared to dry sorbent injection, or for the same level of abatement less reagent is required. • No effluent is produced. • No visible plume is created. • Highly compatible with PAC injection.
Disadvantages	• A hazardous solid residue is produced. • Lime is a hazardous reagent. • Water evaporation in the flue gas extracts heat and so requires a higher flue gas temperature prior to sorbent injection. This has a detrimental impact on efficiency.

From the initial assessment, the wet scrubber option has several significant disadvantages and this option is therefore not considered BAT for this Installation. The other three options potentially could represent BAT and are summarised within Table 10.

Table 10: BAT Assessment for Acid Gases Abatement

Parameter	**Units**	**Dry Lime**	**Dry Sodium Bicarbonate**	**Semi-dry Lime**
SO_2 removed	tonne/y	1,265	1,265	1,265
HCl removed	tonne/y	3,213	3,213	3,213
POCP (SO_2 emissions)	t_{C2H4}-eq	387	387	387
Water required	tonne/y	0	0	30,424
Global Warming Potential	tonne CO_2-eq/y	574	6,366	2,433
APCR	tonne/y	10,487	14,886	9,767
Annualised Cost	GBP/y	7,030,225	9,078,294	7,234,142
Cost per tonne acid gas abated	GBP/t	1,564	2,019	1,609

In summary:

- CO_2 emissions are lowest when using lime in a dry sorbent injection process. Net CO_2 emissions are significantly higher if using sodium bicarbonate as reagent. It should be noted, however, that CO_2 will be produced in the off-site manufacture of lime and these lifecycle emissions are not included in this analysis.
- Overall costs for the dry and semi-dry systems using lime are similar.

An assessment of acid gas abatement options indicates that all three options have similar environmental performance. However, on the basis of cost and global warming potential, a dry or semi-dry process using lime reagent is regarded at BAT for this Installation.

2.6.4 Particulate Matter Abatement

Three technologies are considered for removal of particulate matter from the flue gases at the Installation.

Bag filters	
Description	A series of bag filters (or fabric filters) resembling socks are held in an assembly downstream of the boiler and acid gas sorbent injection. Flue gases pass through the filters and solids are held on the outside, where they form a cake (which aids further particulates collection and acid gas abatement). The cake is periodically removed by pulsing high pressure air into the filter bags (where filters are of a pulse jet type).
Advantages	• High particulate matter collection efficiency. • Proven technology and is widely adopted. • Works in combination with acid gas and heavy metal abatement processes. • Easy maintenance. Sections can be isolated and filter bags replaced during operation.
Disadvantages	• Higher pressure drop than electrostatic precipitators, resulting in slightly higher auxiliary power demand.

Electrostatic Precipitators	
Description	An electrostatic precipitator (ESP) assembly consists of a series of charged wires and collection plates. As particles pass the wires, charge is transferred and they are attracted to the collection plates which run parallel to the flue gas. Collected particulate matter is intermittently knocked into collection hoppers beneath the ESP.
Advantages	• No major pressure drop, resulting in reduced auxiliary power demand.
Disadvantages	• Collection efficiency is lower than for bag filters and is very dependent on ash composition. • Not suited to collection of acid gas abatement residue or activated carbon.

Wet scrubber	
Description	Wet scrubbers, as detailed in acid gas abatement, also provide high particulate matter abatement.
Advantages	• Can be combined with acid gas abatement.
Disadvantages	• Large volumes of effluent are produced. This requires treatment in a wastewater treatment plant. • Produces a visible plume. • Flue gas reheating is likely to be required to aid plume dispersion. This has a detrimental impact on efficiency. • Much higher capital costs, and higher operating costs than other options. • Less compatible with Powdered Activated Carbon (PAC) injection (discussed later).

Environment Agency guideline states that electrostatic precipitators and wet scrubbers in isolation do not represent BAT. Electrostatic precipitators are unable to deliver the required abatement performance and the significant disadvantages of wet scrubbers have already been discussed when considering acid gas abatement.

The assessment concludes that bag filters are BAT for particulate matter abatement at the Installation. This technology is able to deliver the required abatement performance and benefits from the synergy with acid gas and heavy metal abatement techniques.

2.6.5 Mercury, Heavy Metals, CO and Organics Abatement

For control of carbon monoxide and organic compound emissions, maintaining good primary combustion and designing the boiler with a suitable time-temperature profile is BAT for this Installation. To provide additional abatement of organic compounds, powdered activated carbon (PAC) injection is BAT.

Powdered activated carbon (PAC) injection is also BAT for the control of mercury and other heavy metal emissions. PAC residues would be collected together with fly ash and acid gas abatement residues in the bag filters. Indicative quantities of all residues are shown in Table 11.

Table 11: BAT Assessment for Mercury, Heavy Metals, CO and Organics Abatement

		Dry Lime	Dry Sodium Bicarbonate	Semi-dry Lime
Acid Gas Abatement Residues	tonne/y	10,487	14,886	9,767
Fly ash	tonne/y	6,288	6,288	6,288
PAC	tonne/y	472	472	472
Total APCR	tonne/y	17,247	21,646	16,528

2.6.6 Condenser Cooling

Three options are considered for condenser cooling at the Installation:

Direct water-cooled condenser	
Description	In a water-cooled condenser, steam exiting the turbine is condensed onto the outside of tubes containing the cooling water. With direct water cooling, the cooling water is extracted from a local water course (e.g. river) and warmed cooling water is returned to the water course.
Advantages	• Direct cooling can deliver lower condenser vacuums, resulting in higher turbine efficiency and more electricity output. • Ambient air temperature has no impact on efficiency (although water temperature will impact efficiency, this is generally less variable).
Disadvantages	• Requires suitable water course close to Installation. • Environmental impacts of dumping heat into the water course. • Water treatment required on large volumes of cooling water (e.g. for legionella risk).

Indirect water-cooled condenser	
Description	With indirect water cooling, warmed cooling water from the condenser is circulated to a cooling tower where it is sprayed into an up-flow of air to release its heat, before being recycled to the condenser. Make-up water is required to compensate for evaporation losses.
Advantages	• No extraction or release to water course. (Make-up water can be sourced from towns water). • Less noisy than air-cooled condensers.
Disadvantages	• Cooling tower is large structure affecting visual impact of Installation. • Visible plumes are produced. • Cooling efficiency is affected by ambient air temperature. • Water treatment required.

	• Higher cost than other options. • Can require large site footprint.

Air-cooled condenser (ACC)	
Description	In an air-cooled condenser, steam exiting the turbine is contained within tubes in the condenser, with cooling air flowing past the tubes to provide cooling. Air flow is driven by fans located under the condenser.
Advantages	• No water extraction required (from water course or towns main, unless sprays are included for periods of high ambient temperature operation). • No water treatment required. • No visible plume produced. • Proven technology that is widely deployed.
Disadvantages	• Efficiency is affected by ambient air temperature. • Noise.

For the Installation the option of direct water-cooled condensers is rejected because it is not envisaged that there will be water extraction from, or release into, the local river. Releasing significant amounts of heat directly into the river could potentially have adverse environmental impacts, so this is not considered BAT. Indirect water-cooled condensers are also rejected as an option because of the significant visual impact of both the cooling tower and plume.

Therefore, best available technique is considered to be air-cooled condensers (ACC). This technology is widely adopted in similar Installations. One disadvantage of ACC, higher noise, can be mitigated by locating the condensers away from any sensitive receptors and by maximising shielding.

2.6.7 Energy Efficiency and Heat Recovery

The factors considered in relation to heat recovery and energy efficiency are:

Boiler Heat Recovery	
Description	The principal method of recovering heat energy released from the combustion of fuel is to use a heat recovery boiler. The boiler uses a combination of membrane tube walls, superheater tube banks and an economiser located in the flue gas path to extract heat from the combustion flue gases. Additional heat extraction from the flue gases is achieved by using a gas-gas heat exchanger to pre-heat incoming combustion air. Air-heater flue gas outlet temperature is designed to remain above the acid dew point temperature to prevent corrosion of downstream ducts and equipment.
Advantages	• Proven and widely adopted.
Disadvantages	• Corrosion can occur if flue gas temperatures are reduced below the acid dew point.

Steam Temperature and Pressure	
Description	Thermodynamics determine that the transfer of heat in steam to mechanical energy in the steam turbine is dependent on the temperature and pressure differential between inlet and outlet conditions. Increasing turbine inlet steam temperature and pressure increases turbine efficiency, while reducing condenser temperature and pressure (vacuum) also increases efficiency.
Advantages	• Higher unit efficiency and electricity output.
Disadvantages	• Increasing steam inlet temperatures increases corrosion risks for steam tubes and other components, which can lead to increased maintenance demands and reduced unit availability. • Increasing steam inlet temperatures can require more expensive components and may not be cost-effective. • Lowest condenser vacuums are obtained by extracting from water courses.

Feedwater Heating	
Description	Turbine cycle efficiency improvements can be obtained by extracting some steam from the low pressure turbine inlet and using it to preheat feedwater from the condenser prior to passing back into the boiler.
Advantages	• Potentially increased efficiency.
Disadvantages	• More complex boiler design.

Auxiliary Power	
Description	Auxiliary power (works power) is electricity consumed by the power plant. When selecting plant equipment, such as boiler type, flue gas cleaning systems and condenser type, the power demand for these systems should be reduced as far as possible.
Advantages	• Reduced auxiliary power demand increases unit efficiency and electricity output.
Disadvantages	• No disadvantages

Flue Gas Condensation	
Description	Combustion installations are usually designed for flue gases to be released at temperatures above the acid dew point temperature. However, these gases contain significant amounts of energy, as sensible heat and as latent heat in water vapour. Flue gas condensers are heat exchangers which can extract this energy by transferring it to a water circuit.
Advantages	• Significantly higher boiler efficiencies can be obtained.
Disadvantages	• Extracted heat is of low grade (low temperature), so utilisation options are limited. • Additional cost of heat exchanger. • Flue gas exiting the plant is at low temperature. This will create a visible plume and it likely to adversely impact emissions dispersion.

Combined Heat and Power	
Description	Combined heat and power plants have higher efficiency because both heat and electricity are useful outputs. For industrial CHP applications it is common for relatively high grade (high temperature and/or pressure) to be required, which entails extracting steam from the cycle and reducing electricity generation. For district heating applications, lower temperature heat can be utilised which enables almost full electricity output to be maintained.
Advantages	• Higher unit efficiency.

	• Displaces power and heat generation from other sources (e.g. giving CO_2 savings). • Provides additional revenue stream for Installation.
Disadvantages	• Requires heat demand close to Installation. • Capital costs for heat pipelines can be very high. • Can reduce maximum electrical output.

At this point, the project has not been developed to the point of having chosen an EPC contractor for the Installation or finalised the plant design. However, in order to maximise heat recovery and plant efficiency, a heat recovery boiler, incorporating membrane tube walls, superheaters and an economiser, will be used. Combustion air and feed water preheating will be adopted. It is envisaged that turbine inlet steam conditions will be around 430 °C and 60 bar representative of modern energy from waste plant, which provides an acceptable balance between plant efficiency and availability. The precise conditions will be finalised during engineering design.

Options are currently being explored for making the Installation a Combined Heat and Power Installation. Further details are provided in the CHP Assessment, which is included as Appendix F of the Permit Application.

2.6.8 Odour Abatement System

The EA guidance on odour[6] identifies the following 'end of pipe' treatments for the abatement of odour:

1. Adsorption using activated carbon, zeolite, alumina (disposable or with regeneration);
2. Dry chemical scrubbing – solid phase impregnated with chemical agents such as pH modifiers, chlorine dioxide or permanganate;
3. Biological treatment – trickling biofilters, soil bed biofilters, non-soil biofilters – (peat, heather, wood bark, compost), bioscrubbers;
4. Absorption (scrubbing) – spray and packed towers, plate absorbers (single pass or recirculating);
5. Thermal treatment – existing boiler plant, thermal or catalytic oxidation;
6. Other techniques:
    a. Odour treatment chemicals
    b. Condensation
    c. Plasma technology (ozone)
    d. Catalytic iron filters
    e. UV

The odour control measures (presented within Section 2.4.3), outline procedural controls on the emissions of odour from the Installation. As such, it is not considered that odour arising from the Installation will represent a significant issue. The capital cost of abatement techniques 1–5 is considered to be unjustified in the context of the Installation, taking into account the predicted infrequency and low severity of the residual odour generated by the Installation. Hence, the commercial availability and relatively low capital cost of odour treatment chemicals renders them a suitable odour abatement technique.

It is understood that odour treatment chemicals have been accepted by the EA as representing BAT for the abatement of odour at other ERF Installations and represent a proven odour abatement technology.

[6] Environment Agency Guidance Note H4: Odour

Odour treatment chemicals are designed to '*react with the odorous components to remove them or convert them to less odorous compounds that have a lower hedonic score and are therefore less offensive'*. The guidance notes that odour treatment chemicals can be effective within an enclosed environment (such as a waste reception hall) where effective mixing can take place. It is also noted that in some cases '*simple water misting, surfactants or buffers may be as effective as more complex agents'*. The odour treatment chemicals will be mixed with water and delivered via nozzles as a mist, within the waste reception hall.

2.7 Energy Efficiency

The energy generation process is founded upon hot gases from the furnace passing to a boiler which converts the energy from the gases into steam. The boiler would consist of evaporative tubes, superheaters and an economiser. As the Installation comprises a twin line system, there would be two boilers working in parallel, albeit independently of one another. Superheated steam would be piped from the boilers to the steam turbines that would power a generator to generate electricity.

The Installation could also supply heat and /or power directly to end users via a 'private wire' arrangement. The Installation would also have the capability to export heat to local heat users. To facilitate this, the turbine would be equipped with steam extraction points to allow steam to be supplied directly to consumers, or to be condensed in heat exchangers in order to provide hot water. An air-cooled condenser, located next to the main building, would then be used to condense the residual steam from the steam turbine to water that would then be reused in the boiler.

The electricity generated would route via the switch gear within the Turbine Hall and then onto the on-site substation, for export electricity to the National Grid via a power transformer that steps up the voltage to the level required. In case of failure of the plant, the interruption to on site electricity supply will be avoided by being able to import power from the network and, for use in an emergency. A diesel generator will provide power to safely shutdown the Installation in the event of the loss of a grid connection.

An R1 assessment has been undertaken and the Installation will generate electricity at 30 % gross efficiency. This is consistent with the BAT Associated Energy Efficiency Levels stated in the new WI BAT Conclusions. The estimated R1 value in operation will be 0.76.

2.7.1 Energy Requirements

The Installation will have a gross electrical output of 49.9 MWe, (design when operating in fully condensing mode), with a parasitic load of 6.5 MWe with the balance exported to the National Grid. Therefore, the Installation will export approximately 43.4 MWe in fully condensing mode.

The plant will have a nominal design capacity of approximately 30 tonnes of fuel per line per hour, based on a net calorific value of 10 MJ/kg. Assuming an operational availability of 7,884 hours per annum, the nominal design capacity of the plant is approximately 472,100 tonnes per annum of waste. Therefore, the Installation will annually generate approximately 393,412 MWh and export 342,245 MWh of electricity.

Table 12 compares these figures with the benchmark data for MSW incineration plants, given in the EA Sector Guidance Note EPR5.01 and in the BREF for Waste Incineration (WI BREF).

Table 12: Installation Energy Benchmark Comparison

Parameter	Unit	The Installation	Benchmark
Gross power generation, nominal design	MWh/t waste	0.83	0.415–0.644
Net power generation, nominal design	MWh/t waste	0.72	0.279–0.458
Internal power consumption, nominal design	MWh/t waste	0.11	0.15
Power generation (assumed gross) for 100,000 tpa of waste	MWe	10.57	5–9
Gross electrical efficiency	%	30	25–35

The parasitic load of the plant, 6.5 MWe, will be consumed by a range of plant items. There are numerous consumers across the plant, including:

- Combustion air (forced draft) fans;
- Flue gas (induced draft) fans;
- Fuel conveyors and feeders;
- Grate drives;
- Main boiler feed pumps;
- Air cooled condenser fans;
- Flue gas treatment plant reagent dosing pumps and screws;
- Instrument and process air compressors;
- Control systems; and
- Office and administration buildings.

Several of these consumers will continue to require power even during the rare periods that the Installation is not operating, most notably the office and administration buildings, but also some of the plant items such as instrument air compressors and the control systems.

2.7.1.1 Operating and Maintenance (O&M) Procedures

An O&M manual will be developed for the Installation. These O&M procedures will incorporate the following elements:

- Good maintenance techniques and regimes across the whole plant;
- Good housekeeping across the whole plant, recognising the benefits not only to efficiency, but also health, safety and environment this brings;
- Plant Condition Monitoring will be carried out, either continuously, or on a regular basis depending on the plant item and the ease of monitoring. The aim of this is to ensure, for example, that motors and drives are operating efficiently, hot component insulation and cladding are not damaged (minimising heat losses) and that there are no significant leaks from valves, ports or seals;
- Air in-leakage to the gas path, so called “tramp air”, will also be minimised to control the duty placed on the flue gas fans, and therefore their energy consumption; and

- Plant operations staff will be trained in energy awareness and encouraged to be proactive in identification of opportunities for improvements in energy efficiency and other aspects of plant performance.

2.7.2 Additional Energy Efficiency Measures

In order to maximise heat recovery and plant efficiency, a heat recovery boiler, incorporating membrane tube walls, superheaters and an economiser, will be used. Combustion air and feed water preheating will be adopted using low grade heat from the cycle. It is envisaged that turbine inlet steam conditions will be around 400 °C and 40 bar. These are standard parameters for similar Installations, which provide an acceptable balance between plant efficiency and availability. Economiser design will be optimised to balance the competing demands of energy efficiency and operation of the flue gas treatment plant.

These measures ensure that the plant meets the intent of the Industrial Emissions Directive and Waste Incineration BAT Conclusions with respect to plant design and how this should be a balance between the efficiency of the Installation and robustness for the waste basket envisaged.

In operation, the intent will be as far as possible to maintain stable operating conditions, maximising efficiency and where necessary this will be maintained with auxiliary fuel firing. The boiler heat transfer surfaces will also be cleaned on a regular basis, determined during commissioning and optimised in early operation, to ensure the efficient recovery of heat from the flue gas into the steam cycle for supply to the steam turbine.

An energy efficiency plan will also form part of the EMS, ensuring that the operation of the plant is continuously improved. This will mean that, as potential opportunities for efficiency gains are identified, they become formalised in the operating and management practices and procedures for the Installation. In the event that the opportunity for retrofit of new equipment is identified, where these may bring energy efficiency improvements, these will be rigorously assessed to determine the benefit deriving versus cost of Installation.

A CHP Assessment has been carried out for the Installation which is presented as Appendix F of the Permit Application.

2.8 Residue Recovery and Disposal

Prior to the transfer of any residues off-site, where appropriate, the residues will undergo a robust sampling and testing process in accordance with the requirements of WM3 Guidance[7], to determine if the waste is to be classified as hazardous.

Any materials which are to be transferred to landfill from the Installation would undergo Waste Acceptance Criteria (WAC) testing, to ensure that they meet the WAC leachability limits for the designation of the landfill to which they are being transferred.

In accordance with the requirements of Article 4 (Waste Hierarchy) of the Waste Framework Directive, which sets out the priorities for the prevention and management of waste, Uniper will periodically review the options for the recovery and recycling of all residues generated by the Installation.

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[7] WM3: Waste Classification – Guidance on the classification and assessment of waste

2.8.1 Incinerator Bottom Ash (IBA)

Incinerator Bottom Ash (IBA) – which may also include the ash collected from the boiler surfaces – is the inert burnt-out residue from the combustion process. Based on expected operations around 116,609 tpa (and up to 129,564 tpa) of bottom ash would be produced, depending on the CV of the incoming waste. Bottom ash typically comprises a mixture of metals, glass, brick, rubble, sand, and grit as well as ash from combusted material.

IBA would all be managed in the main building. It would be quenched as it leaves the combustion chamber to both cool the ash and also reduce potential for emissions of ash (dust) into the air. Any water not vaporised in the quenching process would be collected and recycled for continued use in the quenching process. The bottom ash would be deposited into a bunker where it would be stored prior to being loaded into HGVs within the bottom ash tunnel (located on the eastern side of the main building). HGVs would export the IBA to a re-processor where metals would be extracted, with the remaining material typically processed for use as a recycled aggregate.

2.8.2 Air Pollution Control Residues (APCR)

Air Pollution Control residues (APCR) comprise fine particles of ash and residue from the flue gas treatment process, which are collected in the bag filters. It is estimated that the operations would generate between 16,500 tpa and up to 26,500 tpa of APCR, depending on the CV of the incoming waste and the final abatement techniques selected. APCR would be stored in silos within the main building. The APCR silos would have capacity for 5 days of storage, although at normal operating conditions less than half of this capacity would generally be used prior to export off-site.

Due to the alkaline nature of the APCR, they are classified as hazardous waste in accordance with WM3 Guidance[8] (in much the same way as cement). The APCR would be transported off-site to a Permitted Hazardous Waste disposal facility. Alternatively, the residues may be taken to an appropriate treatment facility where, for example, they could be reused in the stabilisation of acid wastes or used in cement manufacture.

2.9 Management Systems

2.9.1 Operations and Maintenance

Uniper UK has a long-established environmental management system (EMS) which is accredited to ISO 14001:2015. Uniper's operational sites within the UK are accredited under a shared certificate and meet the requirements of the standard by working to central management instructions as well as site specific / local management instructions. The central management instructions ensure that there is consistency in the implementation of the environmental management system across all Uniper UK sites.

The shared systems require sites to follow the high level management instructions but also to have in place local management instructions that are particular to their plant, equipment and operation. This ensures that the right actions are taken at the right time by the right people.

The EMS objectives and scope includes the following requirements:

[8] WM3: Waste Classification – Guidance on the classification and assessment of waste

- Identifying potential environmental impacts from the activities of the operation and the associated compliance obligations;
- Documenting and implementing standard procedures to mitigate and control these impacts and manage compliance obligations;
- Determining a procedural hierarchy that considers the interaction of the relevant processes;
- Ensuring adequate responsibility, authority and resources to management necessary to support the EMS;
- Establishing performance indicators to measure the effectiveness of the procedures;
- Monitoring, measuring and analysing the procedures and environmental performance for effectiveness;
- Implementing actions as required based on the results of auditing to ensure continual improvements of the processes; and
- Management of change.

These are reflected at a site level through the site level management instructions.

The Installation will be included within the company's current ISO 14001 Environmental Management System. The plant will be designed with an EMS in mind, and a fully integrated EMS will be implemented into all aspects of plant operation.

Suitable assignment of roles and responsibilities for the maintenance and implementation of the EMS and related articles and procedures will be defined at a later date. Information will be updated and provided as it is developed.

The site will operate a complete and effective operational and maintenance system using SAP, which will be employed on all aspects of the process whose failure could impact upon the environment.

There will be documented procedures for the monitoring of emissions and other environmental impacts in line with legislative requirements such as the Environmental Permitting Regulations (EPR). These procedures will be labelled and made available to all employees via the company's document control system which is accessed via a file sharing service. Documented procedures will control operations that may have an adverse impact upon the environment.

There will be a defined procedure for identifying, reviewing and prioritising items of plant for which a preventative maintenance regime is appropriate. This procedure will be contained within work control procedures and companywide SAP maintenance software. Uniper operates a preventative maintenance programme which covers all plant, for which failures could lead to an impact on the environment, including regular inspection of major 'non-productive' items such as tanks, pipework, retaining walls, bunds, ducts and filters. The preventative maintenance system will include auditing of performance against requirements arising from the maintenance programme, and the results of these audits will be assigned a reporting responsibility.

Uniper operates Asset Risk Management systems which provide a systematic process for the evaluation and management of engineering, safety, and environmental risks and performance improvement opportunities. It provides a credible, reliable and consistent risk profile for the whole asset portfolio, and is designed to allow plant staff to manage high priority engineering risks by defining and evaluating their treatment measures and also to simply evaluate potential opportunities using a proprietary software tool called PT-Risk.

The management system will be subjected to an audit from an independent certified auditing company. Currently Uniper already use an independent certified auditing company for all ISO 14001 accredited sites.

2.9.2 Competence and Training

Uniper operates an in-house training and competency process that covers all aspects of operational, engineering, safety and environmental management. Competency Assurance and Development is a systematic process that enables the organisation to demonstrate overall capability through the management of individual competencies. This system is in place across the whole of Uniper and forms part of employees' development programme. This process covers the following items:

- Awareness of the regulatory implications of the EPR permit upon the proposed Installation;
- Awareness of all potential environmental effects from operation under normal and abnormal circumstances; and
- Prevention of accidental emissions and action to be taken when accidental emissions occur.

The skills and competencies necessary for key posts within the proposed ERF plant will be defined as part of the system outlined above. Key posts will be assigned for environmental management and documented skills and competencies will include contractors and those positions involving purchasing equipment and materials.

The potential environmental risks posed by the work of contractors is to be assessed within the work control management systems at the Installation, and instructions will be provided to contractors about protecting the environment whilst working on site as part of a specific site induction process which will be compulsory to all on site contractors.

2.9.3 Accidents / Incidents / Non-conformance

The site EMS system will have set procedures to deal with environmental incidents and emergency preparedness and response.

A full accident management plan will be developed in line with the recommended criteria outlined in the Environment Agency sector guidance note and Uniper requirements. Incidents and accidents are recorded and actioned on the company's centralised database and are reviewed by the site and other teams to identify opportunities for leaning across the organisation.

There is a formal incident investigation process based upon the actual and potential severity of the incident and this forms part of Uniper's integrated management system.

2.9.4 Organisation

It is not possible to supply a management organogram at the time of the application. However, it is likely the Installation will follow the normal structure that Uniper employ elsewhere as outlined below.

Sufficient numbers of staff, in various grades, will be required to manage, operate and maintain the plant on a continuous basis, seven days per week throughout the year. The plant will be managed, operated and maintained by experienced managers, boiler operators and maintenance staff.

The key environmental management responsibilities will be allocated as described below.

- The Plant Manager will have overall responsibility for management of the site and compliance with the operating permit. The Plant manager will have extensive experience relevant to his responsibilities.
- The Production Manager will have day-to-day responsibility for the operation of the plant, to ensure that the plant is operated in accordance with the EP and that the environmental impact of the plant's operations is minimised. In this context, he or she will be responsible for designing and implementing operating procedures which incorporate environmental aspects.
- The Engineering Manager will be responsible for the management of maintenance activities, for maintenance planning and for ensuring that the plant continues to operate in accordance with its design.
- The SHE/Environment Team leader will be responsible for producing reports that need to be submitted to the Environment Agency, liaising with the Uniper Central Environment Team and ensuring the sites management instructions meet the requirements of the EP.

2.10 Closure

The Installation has a design life of circa 30 years. When the Installation has reached the end of its operational life, it may be redeveloped for extended use or demolished as part of a redevelopment scheme and the site cleared and left in a 'satisfactory state' [9].

To achieve this, Uniper would provide the Environment Agency with a detailed Site Closure Plan (SCP) for approval, prior to the commencement of commissioning.

2.10.1 Site Closure Plan

The SCP outlines the process by which the operations will be ceased on site and plant decommissioning achieved. This will include details pertaining to:

- Removal and disposal of raw materials and products
  - Safe removal of all reagents, hazardous materials and residues
- Dismantling of process equipment, including:
  - Dismantling of pipework
  - Storage vessel cleaning and dismantling
- Disposal / recovery of ancillary materials
  - Where possible, the recovery of construction materials (such as ferrous metals)
- Confirmatory analysis of ground conditions (see Section 2.10.1.2)
- Surrender of the EP

The SCP would minimise the emissions to air (chemicals, odour and dust), emission of noise, and pollution occurring to underlying soils and groundwater.

[9] As defined in Paragraph 14(1) of Part 1 of Schedule 5 to the EPR 2010

2.10.1.1 Material Disposal and Recovery

The SCP would include a bill of quantities (BoQ) outlining the quantity of materials present at the site, such as:

- Steelwork;
- Plastics;
- Cables;
- Concrete and Civils Materials;
- Fuel, Chemicals and Oils;
- Consumables;
- Water and Effluents;
- Recoverable ferrous metals; and
- Residues (IBA and APCr).

For each of the items identified in the BoQ, a bespoke disposal or recovery route will be defined, based upon the quantity, physical / chemical characteristics and available disposal methods.

2.10.1.2 Site Condition Reporting

Throughout the operational lifetime of the Installation, records will be maintained to demonstrate that land and groundwater have been sufficiently protected. These records will contain information such as: inspection records of site infrastructure; records of pollution incidents; records of any ground investigations undertaken; and testing / monitoring records of soil, gas and/or water. This information is retained within the operational sections (4–7) of the Site Condition Report[10] (SCR) template.

The site closure plan would include confirmatory analysis of the ground conditions at the site. This would take the form of a robust and targeted sampling regime of soils and groundwater at the site, in order to evaluate the chemical composition against the site baseline. Consideration would be given to likely areas of contamination, as well as any monitoring or sampling undertaken during the operational lifetime of the Installation. This information will be recorded in the surrender sections (8–10) of the SCR template and presented to the EA for approval, prior to EP surrender.

Further information on the Site Condition is presented within Appendix B of the Permit Application.

2.11 Specific Legislative Requirements

2.11.1 Industrial Emissions Directive (2010/75/EU)

The Installation will be designed to comply with the Waste Incineration requirements of the Industrial Emissions Directive (2010/75/EU, IED). These requirements are laid out in Chapter IV of the IED, ‘Special Provisions for Waste Incineration Plants and Waste Co-incineration Plants’, specifically the requirements outlined in Articles 22, 44, 46-50, 52, 53 and 55.

[10] Environment Agency, Guidance for applicants H5. Site condition report – guidance and templates. LIT 8001 Version 3.0 April 2013

The relevant IED articles and evidence on how the Installation intends to comply with these requirements is presented as **Error! Reference source not found.**. This table includes references to the relevant sections of the EP application, or relevant explanatory text, pertaining to the requirements of each article on the 'Operator'.

Table 13: Specific Requirements of the Industrial Emissions Directive

Article	Requirements	Supporting Evidence
22 (2)	Where the activity involves the use, production or release of relevant hazardous substances and having regard to the possibility of soil and groundwater contamination at the site of the Installation, the operator shall prepare and submit to the competent authority a baseline report before starting operation of an Installation or before a permit for an Installation is updated for the first time after 7 January 2013. The baseline report shall contain the information necessary to determine the state of soil and groundwater contamination so as to make a quantified comparison with the state upon definitive cessation of activities provided for under paragraph 3. The baseline report shall contain at least the following information: (a) information on the present use and, where available, on past uses of the site; (b) where available, existing information on soil and groundwater measurements that reflect the state at the time the report is drawn up or, alternatively, new soil and groundwater measurements having regard to the possibility of soil and groundwater contamination by those hazardous substances to be used, produced or released by the Installation concerned. Where information produced pursuant to other national or Union law fulfils the requirements of this paragraph that information may be included in, or attached to, the submitted baseline report.	**Appendix B** – Site Condition Report
44	An application for a permit for a waste incineration plant or waste co-incineration plant shall include a description of the measures which are envisaged to guarantee that the following requirements are met: (a) the plant is designed, equipped and will be maintained and operated in such a manner that the requirements of this Chapter are met taking into account the categories of waste to be incinerated or co-incinerated;	**Section 2.2** – Incoming Waste Management
	(b) the heat generated during the incineration and co-incineration process is recovered as far as practicable through the generation of heat, steam or power;	**Section 2.7** – Energy Efficiency
	(c) the residues will be minimised in their amount and harmfulness and recycled where appropriate;	**Section 2.8** – Residue Recovery and Disposal
	(d) the disposal of the residues which cannot be prevented, reduced or recycled will be carried out in conformity with national and Union law.	**Section 2.8** – Residue Recovery and Disposal
46 (1)	Waste gases from waste incineration plants and waste co-incineration plants shall be discharged in a controlled way by	**Appendix D1** – Air Quality Assessment

Article	Requirements	Supporting Evidence
	means of a stack the height of which is calculated in such a way as to safeguard human health and the environment.	
46 (2)	Emissions into air from waste incineration plants and waste co-incineration plants shall not exceed the emission limit values set out in parts 3 and 4 of Annex VI or determined in accordance with Part 4 of that Annex.	**Section 2.4.1** – Emissions to Air
46 (5)	Waste incineration plant sites and waste co-incineration plant sites, including associated storage areas for waste, shall be designed and operated in such a way as to prevent the unauthorised and accidental release of any polluting substances into soil, surface water and groundwater. Storage capacity shall be provided for contaminated rainwater run-off from the waste incineration plant site or waste co-incineration plant site or for contaminated water arising from spillage or fire-fighting operations. The storage capacity shall be adequate to ensure that such waters can be tested and treated before discharge where necessary.	**Appendix B** – Site Condition Report and **Appendix H** – Environmental Risk Assessment
46 (6)	Without prejudice to Article 50(4)(c), the waste incineration plant or waste co-incineration plant or individual furnaces being part of a waste incineration plant or waste co-incineration plant shall under no circumstances continue to incinerate waste for a period of more than 4 hours uninterrupted where emission limit values are exceeded. The cumulative duration of operation in such conditions over 1 year shall not exceed 60 hours. The time limit set out in the second subparagraph shall apply to those furnaces which are linked to one single waste gas cleaning device.	**Appendix D1** – Air Quality Assessment
47	In the case of a breakdown, the operator shall reduce or close down operations as soon as practicable until normal operations can be restored.	**Section 2.2.4** – Waste Charging
48 (2)	The Installation and functioning of the automated measuring systems shall be subject to control and to annual surveillance tests as set out in point 1 of Part 6 of Annex VI.	**Section 2.5.1** – Monitoring of Emissions to Air
48 (4)	All monitoring results shall be recorded, processed and presented in such a way as to enable the competent authority to verify compliance with the operating conditions and emission limit values which are included in the permit.	**Section 2.5.1** – Monitoring of Emissions to Air
49	The emission limit values for air and water shall be regarded as being complied with if the conditions described in Part 8 of Annex VI are fulfilled.	Under normal operation, there will be no emissions of process effluent from the Installation discharged to sewer, and the only effluent discharge to sewer will be domestic effluents.
50 (1)	Waste incineration plants shall be operated in such a way as to achieve a level of incineration such that the total organic carbon content of slag and bottom ashes is less than 3% or their loss on	**Section 2.2.3.3** – Furnace Conditions

Article	Requirements	Supporting Evidence
	ignition is less than 5% of the dry weight of the material. If necessary, waste pre-treatment techniques shall be used.	
50 (2)	Waste incineration plants shall be designed, equipped, built and operated in such a way that the gas resulting from the incineration of waste is raised, after the last injection of combustion air, in a controlled and homogeneous fashion and even under the most unfavourable conditions, to a temperature of at least 850 °C for at least two seconds.	**Section 2.5.3** – Process Monitoring
50 (3)	Each combustion chamber of a waste incineration plant shall be equipped with at least one auxiliary burner. This burner shall be switched on automatically when the temperature of the combustion gases after the last injection of combustion air falls below the temperatures set out in paragraph 2. It shall also be used during plant start-up and shutdown operations in order to ensure that those temperatures are maintained at all times during these operations and as long as unburned waste is in the combustion chamber. The auxiliary burner shall not be fed with fuels which can cause higher emissions than those resulting from the burning of gas oil as defined in Article 2(2) of Council Directive 1999/32/EC of 26 April 1999 relating to a reduction in the sulphur content of certain liquid fuels (OJ L 121, 11.5.1999, p. 13.), liquefied gas or natural gas.	**Section 2.5.3** – Process Monitoring **Section 2.1.4** – Auxiliary Fuel Selection
50 (4)	Waste incineration plants and waste co-incineration plants shall operate an automatic system to prevent waste feed in the following situations: (a) at start-up, until the temperature set out in paragraph 2 of this Article or the temperature specified in accordance with Article 51(1) has been reached;	**Section 2.2.4** – Waste Charging
	(b) whenever the temperature set out in paragraph 2 of this Article or the temperature specified in accordance with Article 51(1) is not maintained;	**Section 2.2.4** – Waste Charging
	(c) whenever the continuous measurements show that any emission limit value is exceeded due to disturbances or failures of the waste gas cleaning devices.	**Section 2.2.4** – Waste Charging
50 (5)	Any heat generated by waste incineration plants or waste co-incineration plants shall be recovered as far as practicable.	**Section 2.7** – Energy Efficiency
50 (6)	Infectious clinical waste shall be placed straight in the furnace, without first being mixed with other categories of waste and without direct handling.	No infectious waste with specialised requirements will be accepted.
52 (1)	The operator of the waste incineration plant or waste co-incineration plant shall take all necessary precautions concerning the delivery and reception of waste in order to prevent or to limit as far as practicable the pollution of air, soil, surface water and groundwater as well as other negative effects on the environment, odours and noise, and direct risks to human health.	**Appendix B** – Site Condition Report and **Section 2.2** **Appendix C** - Noise Assessment **Appendix I** - Odour Management Plan

Article	Requirements	Supporting Evidence
		Appendix H - Environmental Risk Assessment
52 (2)	The operator shall determine the mass of each type of waste, if possible, according to the European Waste List established by Decision 2000/532/EC, prior to accepting the waste at the waste incineration plant or waste co-incineration plant.	**Section 2.2.1** – Waste to be Processed and **Section 2.2.2** – Waste Handling.
53 (1)	Residues shall be minimised in their amount and harmfulness. Residues shall be recycled, where appropriate, directly in the plant or outside.	**Section 2.8** – Residue Recovery and Disposal
53 (2)	Transport and intermediate storage of dry residues in the form of dust shall take place in such a way as to prevent dispersal of those residues in the environment.	**Section 2.8** – Residue Recovery and Disposal
53 (3)	Prior to determining the routes for the disposal or recycling of the residues, appropriate tests shall be carried out to establish the physical and chemical characteristics and the polluting potential of the residues. Those tests shall concern the total soluble fraction and heavy metals soluble fraction.	**Section 2.8** – Residue Recovery and Disposal

2.11.2 BAT Conclusions for Waste Incineration (EU 2019/2010)

The following section presents information on how the development will comply with the requirements of the BAT Conclusions for Waste Incineration. These conclusions have only relatively recently been adopted, and therefore at the time of writing there is little, if any, prior art on their implementation in the UK. These requirements apply in addition to those of the Industrial Emissions Directive.

Error! Reference source not found. highlights where in this submission further detail can be found on each BAT Conclusion. Only those BAT Conclusions relevant to this development are included here. Excluded are those relating to sludge or hazardous waste firing or technology that is not intended to be deployed as part of the development. Unless otherwise stated, these BAT elements are narrative in nature. Where specific performance levels are required (a BAT Associated Emission Level, or similar) this is highlighted.

The full BAT text is not replicated here, due to its length, and where BAT represents to employ one or more of a list of techniques, the full list is not repeated. However, cross referencing is provided with the BAT Conclusions document itself. For example selective non-catalytic reduction is a best available technique and under BAT 29 in the BAT Conclusions document it is item (c). In **Error! Reference source not found.** it is referred to as BAT 29(c).

Table 14: Summary Table of BAT Conclusion Compliance

BAT	Requirements	Supporting Evidence
BAT 1	In order to improve the overall environmental performance, BAT is to elaborate and implement an environmental management system (EMS).	Refer to **Section 2.9** – Management Systems
BAT 2	…determine either the gross electrical efficiency, the gross energy efficiency, or the boiler efficiency of the incineration plant as a whole or of all the relevant parts of the incineration plant.	Refer to **Section 2.7** – Energy Efficiency

BAT	Requirements	Supporting Evidence
BAT 3	…is to monitor key process parameters relevant for emissions to air and water	Refer to **Section 2.5.1** – Monitoring of Emissions to Air and **Section 2.9** – Management Systems
BAT 4	BAT is to monitor channelled emissions to air with at least the frequency given below and in accordance with EN standards. If EN standards are not available, BAT is to use ISO, national or other international standards that ensure the provision of data of an equivalent scientific quality.	Refer to **Section 2.5.1** – Monitoring of Emissions to Air
BAT 5	BAT is to appropriately monitor channelled emissions to air from the incineration plant during OTNOC.	Refer to **Section 2.5.1** – Monitoring of Emissions to Air and **Section 2.9** – Management Systems
BAT 6	BAT is to monitor emissions to water from FGC and/or bottom ash treatment…	Not relevant, the flue gas cleaning plant will have no waste water product, and bottom ash (IBA) will be processed off site by a competent contractor.
BAT 7	BAT is to monitor the content of unburnt substances in slags and bottom ashes at the incineration plant…	Refer to **Section 2.5.4** – Validation of Combusting Conditions and **Section 2.2.3.3** – Furnace Conditions
BAT 9	In order to improve the overall environmental performance of the incineration plant by waste stream management…	Refer to **Section 2.2** – Incoming Waste Management General performance will be maintained by determining the types of waste that can be incinerated (BAT 9(a)), set-up and implementation of waste characterisation and pre-acceptance and acceptance procedures (BAT 9(b&c)).
BAT 10	In order to improve the overall environmental performance of the bottom ash treatment plant, BAT is to include output quality management features in the EMS.	Incinerator Bottom Ash (IBA) will be processed off site by a competent contractor. Refer to **Section 2.8.1** – Incinerator Bottom Ash (IBA)
BAT 11	In order to improve the overall environmental performance of the incineration plant, BAT is to monitor the waste deliveries as part of the waste acceptance procedures… including, depending on the risk posed by the incoming waste, the elements given below. *[for MSW]* — Radioactivity detection — Weighing of the waste deliveries — Visual inspection — Periodic sampling of waste deliveries and analysis of key properties/substances (e.g. calorific value, content of halogens and metals/metalloids). For municipal solid waste, this involves separate unloading.	Refer to **Section 2.2** – Incoming Waste Management
BAT 12	In order to reduce the environmental risks associated with the reception, handling and storage of waste…	Waste will only be stored in the bunker building with no need for drainage (BAT 12(a)) and bunker capacity will be provided adequate for the operation of the plant and delivery times (BAT 12(b)).

BAT	Requirements	Supporting Evidence
BAT 14	In order to improve the overall environmental performance of the incineration of waste, to reduce the content of unburnt substances in slags and bottom ashes, and to reduce emissions to air from the incineration of waste…	Bunker crane mixing will be used to homogenise waste (BAT 14(a)). The plant will also employ an OEM supplied control system (BAT 14(b)) and optimised during commissioning (BAT 14(c)). Refer to **Section 2.2.3** – Waste Minimisation
BAT 14	BAT-associated environmental performance levels for unburnt substances in slags and bottom ashes from the incineration of waste. *Either a TOC (1-3 dry wt %) or LOI (1-5 dry wt %) applies.*	Burnout in the furnace is achieved by optimising fuel flow and combustion air supply and will ensure the Total Organic Carbon (TOC, 3 %) or Loss on Ignition (LOI, 5 %) of the Incinerator Bottom Ash (IBA) meet the requirements of BAT. Refer to **Section 2.2.3** – Waste Minimisation
BAT 15	In order to improve the overall environmental performance of the incineration plant and to reduce emissions to air, BAT is to set up and implement procedures for the adjustment of the plant's settings, e.g. through the advanced control system as and when needed and practicable, based on the characterisation and control of the waste	Refer to **Section 2.2.3** – Waste Minimisation, **Section 2.2.4** – Waste Charging and **Section 2.5.3** – Process Monitoring
BAT 16	In order to improve the overall environmental performance of the incineration plant and to reduce emissions to air, BAT is to set up and implement operational procedures (e.g. organisation of the supply chain, continuous rather than batch operation) to limit as far as practicable shutdown and start-up operations.	The Installation is designed to recover energy continuously from the waste, rather than thermally treat it in batches. This achieves a high number of hours on load each year (circa 7,884 hours). Plant operation and maintenance will be designed to maximise operation. Refer to **Section 2.2.3** – Waste Minimisation and **Section 2.2.4** – Waste Charging
BAT 17	In order to reduce emissions to air and, where relevant, to water from the incineration plant, BAT is to ensure that the FGC system and the waste water treatment plant are appropriately designed (e.g. considering the maximum flow rate and pollutant concentrations), operated within their design range, and maintained so as to ensure optimal availability.	There will be no liquid discharge from the flue gas cleaning plant. Otherwise, flue gas cleaning plant will be procured and specified with guarantees to cover performance for the defined fuel range.
BAT 18	In order to reduce the frequency of the occurrence of OTNOC and to reduce emissions to air and, where relevant, to water from the incineration plant during OTNOC, BAT is to set up and implement a risk-based OTNOC management plan as part of the environmental management system.	Refer to **Section 2.9** – Management Systems
BAT 19	In order to increase the resource efficiency of the incineration plant, BAT is to use a heat recovery boiler.	Heat will be recovered from the flue gases, steam raised and electricity generated. Heat export is also an aim of the project, but in early operation only power export is expected.

BAT	Requirements	Supporting Evidence
		Refer to **Section 2.7** – Energy Efficiency
BAT 20	In order to increase the energy efficiency of the incineration plant, BAT is to use an appropriate combination of…*techniques*	Of the techniques listed as BAT flue gas flow will be minimised in operation and design (BAT 20(b)), as will heat losses (BAT 20 (c)). The boiler will also be optimised to be robust and efficient with regard to steam conditions. Cogeneration is also being considered (BAT 30(g)) but will not be employed from initial operation. Refer to **Section 2.7** – Energy Efficiency
BAT 20	BAT-associated energy efficiency levels (BAT-AEELs) for the incineration of waste. *25-35% gross electrical efficiency for new plant*	Plant electrical efficiency will be 30 % gross. Refer to **Section 2.7** – Energy Efficiency
BAT 21	In order to prevent or reduce diffuse emissions from the incineration plant, including odour emissions…	Refer to **Section 2.4.3** – Odour Emissions and **Appendix D6 -** Odour Management Plan
BAT 23	In order to prevent or reduce diffuse dust emissions to air from the treatment of slags and bottom ashes, BAT is to include in the environmental management system…	Bottom ash (IBA) will be processed off site by a competent contractor.
BAT 24	In order to prevent or reduce diffuse dust emissions to air from the treatment of slags and bottom ashes, BAT is to use an appropriate combination of *techniques*	Bottom ash (IBA) will be processed off site by a competent contractor. Prior to transport off-site, handling will be in enclosed lines and buildings with air egress controlled by design (BAT 24(c)). Ash quench will be used (BAT 24(d)).
BAT 25	In order to reduce channelled emissions to air of dust, metals and metalloids from the incineration of waste, BAT is to use one or a combination *techniques*	BAT is not prescriptive, but it is envisaged that a fabric filter (BAT 24(a)) coupled with sorbent injection (BAT 24(c)) will form a part of the integrated air pollution control scheme for the development.
BAT 25	BAT-associated emission levels (BAT-AELs) for channelled emissions to air of dust, metals and metalloids from the incineration of waste Dust 2–5 mg/Nm^3 Cd+Tl 0.005–0.02 mg/Nm^3 Sb+As+Pb+Cr+Co+Cu+Mn+Ni+V 0.01–0.3 mg/Nm^3	Refer to **Appendix E** – BAT Assessment
BAT 26	In order to reduce channelled dust emissions to air from the enclosed treatment of slags and bottom ashes with extraction of air…BAT is to treat the extracted air with a bag filter.	IBA will be processed off site by a competent contractor. Prior to transport off-site, handling will be in enclosed lines and buildings with air egress controlled by design. Ash quench will be used.
BAT 26	BAT-associated emission levels (BAT-AELs) for channelled dust emissions to air from the enclosed treatment of slags and bottom ashes with extraction of air Dust 2–5 mg/Nm^3	Refer to **Appendix E** – BAT Assessment
BAT 27	In order to reduce channelled emissions of HCl, HF and SO_2 to air from the incineration	BAT is not prescriptive, but it is envisaged that a semi-dry (BAT 27(b)) or dry (BAT

BAT	Requirements	Supporting Evidence
	of waste, BAT is to use one or a combination of *techniques*	27(c)) absorber system will be used as part of this development.
BAT 28	In order to reduce channelled peak emissions of HCl, HF and SO_2 to air from the incineration of waste while limiting the consumption of reagents and the amount of residues generated from dry sorbent injection and semi-wet absorbers, BAT is to use technique (a) or both of the techniques given below. Optimised and automated reagent dosage Recirculation of reagents	BAT is not prescriptive, but it is envisaged that the development will employ (a) and possibly (b). These are BAT 28(a) and BAT 28(b).
BAT 28	BAT-associated emission levels (BAT-AELs) for channelled emissions to air of HCl, HF and SO_2 from the incineration of waste HCl 2–6 mg/Nm^3 HF 1 mg/Nm^3 SO_2 5–30 mg/Nm^3	Refer to **Appendix E** – BAT Assessment
BAT 29	In order to reduce channelled NO_x emissions to air while limiting the emissions of CO and N_2O from the incineration of waste and the emissions of NH_3 from the use of SNCR and/or SCR, BAT is to use an appropriate…*technique*	BAT is not prescriptive, but it is envisaged that the development will employ optimisation of the incineration process (BAT 29(a)) selective non-catalytic reduction (BAT 29(c)). Refer to **Appendix E** – BAT Assessment
BAT 29	BAT-associated emission levels (BAT-AELs) for channelled NO_x and CO emissions to air from the incineration of waste and for channelled NH_3 emissions to air from the use of SNCR and/or SCR NO_x 50–120 mg/Nm^3 CO 10–50 mg/Nm^3 NH_3 2–10 mg/Nm^3	Refer to **Appendix D1** – Air Quality Assessment and **Appendix E** – BAT Assessment
BAT 30	In order to reduce channelled emissions to air of organic compounds including PCDD/F and PCBs from the incineration of waste, BAT is to use *techniques…*	BAT is not prescriptive, but it is envisaged that the development will employ a range of techniques including optimisation of the incineration process (BAT 30(a)), control of waste feed (BAT 30(b)), on- and off-line boiler cleaning (BAT 30(c)), rapid flue-gas cooling (BAT 30(d)) and dry sorbent injection (BAT 30(e)) Refer to **Appendix E** – BAT Assessment
BAT 30	BAT-associated emission levels (BAT-AELs) for channelled emissions to air of TVOC, PCDD/F and dioxin- like PCBs from the incineration of waste TVOC 3–10 mg/Nm^3 PCDD/F 0.01–0.04 ng I-TEQ/Nm^3 PCDD/F + dioxin like PCBs 0.01–0.08 ng WHO-TEQ/Nm^3	Refer to **Appendix E** – BAT Assessment
BAT 31	In order to reduce channelled mercury emissions to air (including mercury emission peaks) from the incineration of waste, BAT is to use one or a combination *techniques…*	BAT is not prescriptive, but it is envisaged that the development will employ dry sorbent injection (BAT 31(b)) in combination with a fabric filter (BAT 24(a)).

BAT	Requirements	Supporting Evidence
		Refer to **Appendix E** – BAT Assessment
BAT 31	BAT-associated emission levels (BAT-AELs) for channelled mercury emissions to air from the incineration of waste Hg 5–20 ug/Nm^3	Refer to **Appendix E** – BAT Assessment
BAT 32	In order to prevent the contamination of uncontaminated water, to reduce emissions to water, and to increase resource efficiency, BAT is to segregate waste water streams and to treat them separately, depending on their characteristics.	Under 'normal operations', there will not be any process emissions to water or sewer from the Installation Foul water generated by the Installation would be collected on the site via a series or pipes which would connect to a septic tank. The contents of the tank would be emptied on a regular basis by a tanker and taken offsite to a suitable sewage treatment facility. Refer to **Section 2.3** – Water Use and Drainage and **Section 2.4.5** – Contaminated Water
BAT 33	In order to reduce water usage and to prevent or reduce the generation of waste water from the incineration plant, BAT is to use one or a combination of *techniques…*	BAT is not prescriptive, but it is likely that the development will employ a waste water free flue gas cleaning technique (BAT 33(a)). And rainwater harvested from building roofs and gutters will be reused within the buildings, boiler blowdown will be used for the ash quench (BAT 33(c)) Refer to **Section 2.3.1** – Water Supply
BAT 34	In order to reduce emissions to water from FGC and/or from the storage and treatment of slags and bottom ashes, BAT is to use an appropriate combination of *techniques*	No liquid discharge is expected from FGC or from storage of bottom ash (IBA). IBA will be processed off-site by a competent contractor. Refer to **Section 2.8** – Residue Recovery and Disposal
BAT 35	In order to increase resource efficiency, BAT is to handle and treat bottom ashes separately from FGC residues.	These material streams will be stored and processed separately. IBA will be processed off-site by a competent contractor.
BAT 37	In order to prevent or, where that is not practicable, to reduce noise emissions, BAT is to use one or a combination of *techniques*	A range of these BAT measures will be employed: appropriate location of equipment and buildings (BAT 37(a)), operational measures (BAT 37(b)), low-noise equipment will be specified (BAT 37(c)), noise attenuation (BAT 37(d)) and noise control equipment/infrastructure (BAT 37(e)). Refer to **Appendix C** – Noise Assessment

2.12 Improvement Programme

Uniper is committed to continual environmental improvement of all their operations. Therefore, Uniper is proposing that a small number of improvement conditions be incorporated into the final EP. These have been set out below. It is understood that the proposed conditions are consistent with Environmental Permit which the EA has granted for waste combustion facilities in England.

2.12.1 Prior to Commissioning

Prior to commencement of commissioning of the Installation, Uniper will comply with the typical pre-operational conditions which will be included for this type of Installation, as follows;

- Submit to the Environment Agency for approval a protocol for the sampling and testing of incinerator bottom ash for the purposes of assessing its hazardous status. Sampling and testing would be carried out in accordance with the protocol as approved.
- Provide a written commissioning plan, including timelines for completion, for approval by the EA. The commissioning plan will include the expected emissions to the environment during the different stages of commissioning, the expected durations of commissioning activities and the actions to be taken to protect the environment and report to the EA in the event that actual emissions exceed expected emissions. Commissioning shall be carried out in accordance with the commissioning plan as approved.
- Submit a report on the details of computational fluid dynamics (CFD) modelling used in the design of the boiler. The report would demonstrate whether the BAT design stage requirements, given in Environment Agency sector guidance on waste incineration, titled 'Incineration of waste (EPR5.01)', have been completed. In particular, the report will demonstrate whether the residence time and temperature requirements would be met.
- Submit a written report to the Environment Agency demonstrating the performance and optimisation of the SNCR system, and combustion settings to minimise NO_x emissions. The report would also confirm and justify the selection of the reagent to be used within the SNCR system, and whether the design of the Installation will include flue gas recirculation for the abatement of NO_x. This would include provision of the procedures for the safe handling and management of the reagent, alongside an assessment of the level of NO_x and N_2O emissions that can be achieved under optimum operating conditions.

2.12.2 Post Commissioning Conditions

Following commissioning of the Installation, Uniper will comply with the typical Improvement Conditions which will be included for this type of Installation, as follows:

- Submit a written summary report to the Agency to confirm by the results of calibration and verification testing that the performance of Continuous Emission Monitors for parameters as specified within the EP complies with the requirements of BS EN 14181, specifically the requirements of QAL1, QAL2, and QAL3.
- Carry out checks to verify the residence time, minimum temperature and oxygen content of the exhaust gases in the furnace whilst operating under the anticipated most unfavourable operating conditions. Results shall be submitted to the EA.
- Provide a written proposal to the EA, for carrying out tests to determine the size distribution of the particulate matter in the exhaust gas emissions to air, identifying the fractions in the PM_{10} and $PM_{2.5}$ ranges. The report will detail a timetable for undertaking the tests and producing a report on the results.

- Submit a written report to the EA on the commissioning of the Installation. The report will summarise the environmental performance of the Installation as installed against the design parameters set out in the application.

Uniper Technologies Ltd
Technology Centre
Ratcliffe-on-Soar
Nottingham
NG11 0EE
United Kingdom

T +44 (0)115 936 2900
www.uniper.energy