FICHTNER

Consulting Engineers Limited

Replacement of Lakeside EfW

Lakeside EfW Ltd

Supporting information

ENGINEERING + CONSULTING

Document approval

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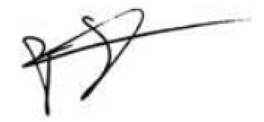
Checked by:	James Sturman		Senior Consultant	15/07/2019

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Contents

1 Introduction

Lakeside Energy from Waste Limited (Lakeside EfW Ltd) (the Applicant) is applying to the Environment Agency (EA) under the Environmental Permitting Regulations (EPRs) for an Environmental Permit (EP) to operate an Energy from Waste (EfW) plant, to be known as Lakeside EfW. The EfW will be located alongside a High Temperature Incinerator (HTI) which itself will be solely operated by Grundon Waste Management Limited. The EfW and HTI will be 'like-for-like' replacements of the existing Lakeside facilities which are currently regulated by the EA. The proposed EfW and HTI are required to replace the existing Lakeside facilities due to the proposed expansion of Heathrow Airport requiring the existing facilities to be demolished.

The proposed Lakeside EfW plant (the Facility) will comprise an Energy from Waste plant and associated infrastructure, which will be fuelled by incoming municipal and commercial & industrial non-hazardous waste. This will be located on a plot approximately 600 m northwest of the existing Lakeside EfW and HTI facilities.

This document and its appendices contain the supporting information for the application for an Environmental Permit (EP) for the Facility. They should be read in conjunction with the formal application form. In Section 1, we have provided an overview of the proposed Facility. In Section 2, we have provided further information in response to specific questions in the application form.

1.1 The Applicant

Lakeside EfW Ltd is a joint venture between Grundon Waste Management Limited and Viridor, two of the UK's leading recycling and waste management companies, and is the Applicant for the Facility. Lakeside EfW Ltd is registered in England (Company Number: 03861722) and has a registered address of Thames House, Oxford Road, Benson, Wallingford, Oxfordshire, OX10 6LX.

Lakeside EfW Ltd was responsible for the development of the original Lakeside EfW facility, operational since 2010. Lakeside EfW has been recognised by the industry for contributing towards the green agenda, and it has won multiple awards.

1.2 The Site

The Site is located south west of the M4's junction 4B, on a triangular patch of land bordered by the M4 to the north, M25 to the east and the A4 Colnbrook Bypass to the south. Colnbrook centre lies across the A4 on the opposite side. A sewage treatment works, operated by Thames Water, lies directly to the east of the proposed EfW location. The nearest residential properties on Old Slade Lane lie approximately 450 m northeast of the installation boundary.

The Site is located on an area which was historically occupied by gravel pits and landfill sites. The land is now adopted green belt, currently comprising scrub and open grassland (to the north) with some grazing land to the south. Parts of the Site and surrounding area are currently utilised by Richings Park Clay Shooting Club.

Once operational, the Site will be accessible via a new road off the A4 Colnbrook bypass, approximately 650 m west of the existing Lakeside Road junction.

A site location plan and a drawing showing the extent of the installation boundary are presented in Appendix A. All of the activities associated with the operation of the Facility will be undertaken within the installation boundary.

A Site Condition Report is included within Appendix B. The Site Condition Report provides data on the ground conditions for the Site at the time of submission of this EP application.

1.3 The Activities

The Facility will consist of a single Schedule 1 installation activity (as defined in the Environmental Permitting Regulations) and directly associated activities. These include:

1. twin line waste incineration plant processing incoming waste which is delivered to the Facility via road;
2. generation of power for export to the National Grid, and the potential for heat export to local heat users;
3. production of inert bottom ash material that will be transferred off-site to a suitably licensed waste treatment facility for recovery/disposal; and
4. generation of an air pollution control residue that will be transferred to a suitably licensed hazardous waste facility for disposal or recovery.

The following table lists the Schedule 1 activities from the Environmental Permitting Regulations, and directly associated activities.

Table 1: Scheduled and directly associated activities

Type of Activity	Schedule 1 Activity	Description of Activity
Installation	Section 5.1 Part A(1) (b)	The incineration of non-hazardous waste in a waste incineration plant with a nominal design capacity of 27.9 tonnes per hour.
Installation	Section 5.1 Part A(1) (b)	The incineration of non-hazardous waste in a waste incineration plant with a nominal design capacity of 27.9 tonnes per hour.
Directly associated activities		
Directly Associated Activities		The export of electricity the National Grid, and the potential to export heat to local heat users.
Directly Associated Activities		Standby electrical generation to provide electrical power to the plant in the event of an interruption in the supply.
Directly Associated Activities		The receipt, storage and handling of non-hazardous waste prior to incineration.
Directly Associated Activities		The handling, storage and transfer of residues for transfer off-site.

The Stationary Technical Unit comprises waste reception; waste storage; water, fuel oil and air supply systems; waste furnaces; boilers; steam turbine/generator set; facilities for the treatment of flue gases; on-site facilities for treatment or storage of residues and waste water; two flues contained within a common windshield; and devices and systems for controlling combustion operations and recording and monitoring conditions.

The nominal capacity of the Facility will be approximately 55.8 tonnes per hour of mixed non-hazardous wastes, with a net calorific value (NCV) of 10.0 MJ/kg. The Facility will have a nominal design capacity of approximately 440,000 tonnes per annum (tpa), assuming an availability of approximately 7,884 hours (i.e. 90%). However, allowing for variations in the NCV of the waste, and the plant operating continuously throughout the year, the maximum capacity of the Facility will be approximately 489,000 tpa.

1.4 The Facility

The main activities associated with the Facility will be the combustion of incoming waste to raise steam and the generation of electricity via a steam turbine/generator set.

The waste incineration process will be based around process areas comprising the waste reception area, waste bunker, boiler hall, turbine hall with air cooled condenser, FGT systems, ash storage building, and two individual flues (1 per line) within a common 55 m windshield. In addition, the site will include the following infrastructure:

1. Weighbridges;
2. Offices, control room and staff welfare facilities;
3. Site fencing and security barrier;
4. External hard standing areas for vehicle manoeuvring/parking;
5. Internal access roads and car parking;
6. Transformers;
7. Grid connection compound; and
8. Firewater storage tanks.

Allowing for the maximum capacity of the Facility and an NCV of 10.0 MJ/kg, the boilers will have a combined thermal capacity of approximately 155 MWth. The Facility has been designed to export power to the National Grid. The turbine has been designed to generate up to 44 MWe of electricity (design maximum) with a parasitic load of approximately 5 MWe. The Facility will therefore export up to 39 MWe to the national grid.

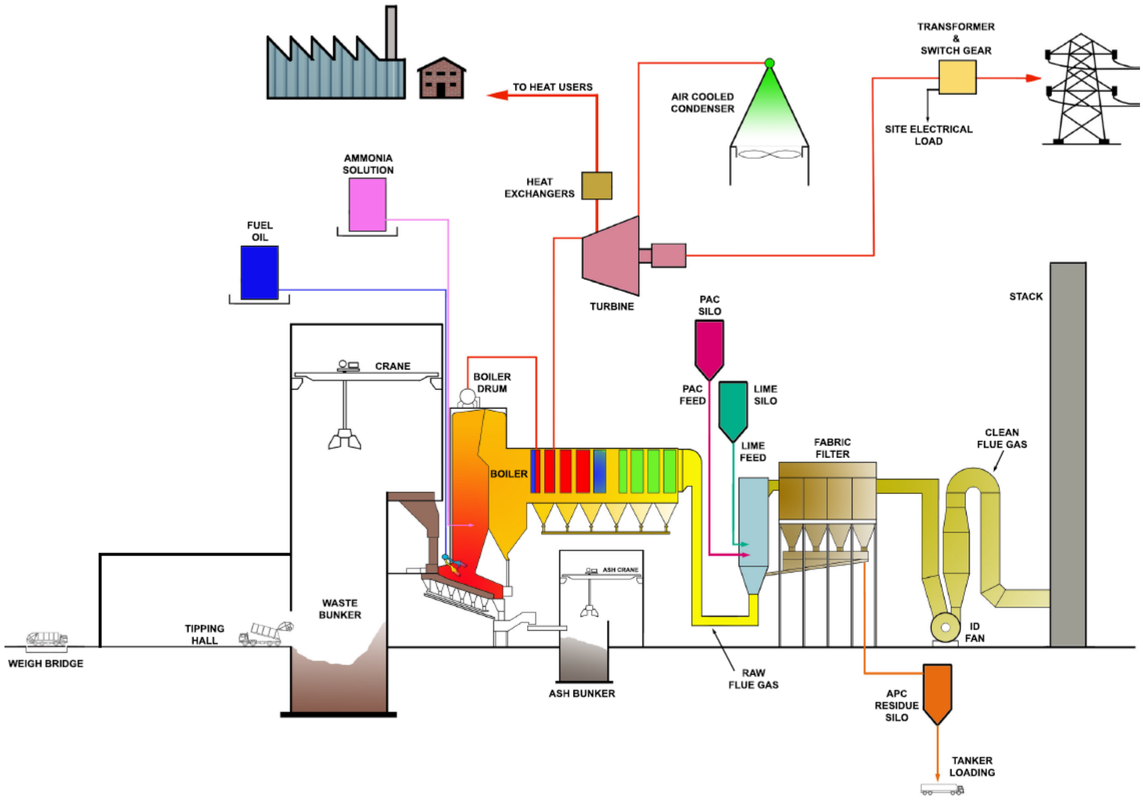
The Facility will be constructed as ‘CHP Ready’ and will be capable of exporting up to 20 MWth to local heat users. The exact amount of heat exported will depend on the number of interested local heat users and the feasibility of suggested district heating schemes. However, from the heat users identified in the CHP assessment (refer to Appendix G), the potential heat export identified is a maximum of approximately 1MWth.

The nominal design capacity of the thermal treatment lines is approximately 27.9 tonnes of waste per hour per line, with an average NCV of 10.0 MJ/kg. The Facility will have an assumed availability of approximately 7,884 hours per annum (90% availability). On this basis, the Facility will have a nominal design capacity of approximately 440,000 tonnes per annum. However, allowing for a maximum availability of 8,760 hours per annum, and any fluctuations in the NCV of the waste, the maximum capacity of the Facility is approximately 489,000 tonnes per annum.

The electricity generated by the Facility will be available for export to the National Grid.

An indicative process diagram for the Facility is presented in Figure 1. A larger copy is also included in Appendix A.

Figure 1: Process schematic



1.4.1 Raw materials

The Facility will receive deliveries of incoming waste by road. The Facility will also use consumables including:

1. lime;
2. activated carbon;
3. ammonia;
4. auxiliary fuel; and
5. other boiler treatment chemicals.

1.4.1.1 Waste reception and preparation

Incoming waste will be delivered to the Facility by enclosed road vehicles which are suitable for bulk transfer of waste.

The vehicles will be weighed on a weighbridge and periodically inspected at the gatehouse before being directed to the Tipping Hall in the waste reception area, which will be a fully enclosed building which will be maintained under slight negative pressure to reduce any emissions of odour, dust or litter. The waste will then be tipped into the bunker, from where a grab transfers the incoming waste to the feed hopper. The grab will also be used to homogenise the incoming waste and to identify and remove any unsuitable or non-combustible items.

Vehicles will be weighed again upon exit from the Facility, to determine the mass of the waste that has been delivered.

The waste bunker will have a capacity of approximately 7,000 tonnes (or 24,192 m^3), sufficient for approximately 4 days of storage. This will enable the Facility to maintain operation during weekends and bank holiday periods.

1.4.1.2 Reagents and auxiliary fuels

All consumables and reagents (lime, ammonia and activated carbon) will be delivered to the Facility by road.

All liquid chemicals will be stored in controlled areas, with secondary containment facilities having a volume of 110% of the stored capacity.

Lime (Calcium Hydroxide – $Ca(OH)_2$) and powdered activated carbon (PAC) will be delivered to the Facility for storage in silos. Both the lime and the activated carbon will be transported pneumatically from the delivery vehicle to the correct storage silo. The exhaust air will be de-dusted using a fabric filter located on the top of the silo. Silos will be fitted with high level alarms. The top of the silos will be equipped with a vent fitted with a fabric filter. Cleaning of the filter will be done automatically with compressed air after the filling operation. Filters will be inspected regularly for leaks.

Ammonia will be used a reagent in the NOx abatement system, used for NOx reduction, will be stored in a designated area which is provided with suitable secondary containment.

Auxiliary fuel (fuel oil) will be used on site for the auxiliary support burners and any mobile plant and equipment.

Boiler feedwater water will be supplied from an onsite water treatment plant. Boiler treatment chemicals will also be present in small quantities on site, stored in suitable storage facilities.

1.4.2 Combustion process

The combustion chamber will utilise a moving grate which will agitate the fuel bed to promote a good burnout of the waste and a uniform heat release. In a moving grate, the fuel is moved mechanically by means of reciprocating grate elements from the feed end, through a drying zone, a main combustion zone and, finally, a burn out zone.

The furnace will be designed to ensure that the exhaust gases are raised to a minimum temperature of 850°C, with a minimum of 2 seconds flue gas residence time at this temperature to ensure the destruction of dioxins, furans, PAHs and other organics. An adequate air supply will also be maintained to give the correct volume of oxygen for optimum combustion. The main source of airflow will be controlled through the grate. Flue gas temperatures within the furnace will be continually monitored and recorded, and audible and visible alarms will trigger in the control room if the temperature starts to fall towards 850°C. The control system will regulate combustion conditions and control the boiler.

Primary combustion air will be drawn from the waste reception areas to maintain negative pressure in waste reception areas and fed into the combustion chambers beneath the grates. Secondary combustion air will be injected into the flame bodies above the grates to facilitate the combustion of waste on the grates and minimise levels of oxides of nitrogen (NOx) emissions. Further up the furnace, above the combustion zones, ammonia will be injected. The ammonia reacts with the oxides of nitrogen formed in the combustion process forming water, carbon dioxide and nitrogen. By controlling the flow rate of ammonia introduced into the flue gas stream, the concentration of NOx will be reduced to achieve the required emission limit.

The combustion chamber will be provided with auxiliary burners, that will be of a low NOx design, and combust fuel oil. The auxiliary burners will be raise the temperature within the combustion chamber to the required 850°C prior to the feeding of waste into the furnace. There will be interlocks preventing the charging of waste until the temperature within the combustion chamber has reached 850°C. During normal operation, if the temperature falls below 850°C the auxiliary burners will be initiated to maintain the temperature above this minimum. Air flow for combustion will be controlled by measuring excess oxygen content in the flue gas. This will be set to maximise the efficiency of the heat recovery process while maintaining the combustion efficiency.

1.4.3 Energy recovery

Heat will be recovered from the flue gases by means of water tube boilers integral with the furnaces. Heat will be transferred in each case through a series of heat exchangers. The hot gases from the furnaces would first pass through evaporators that raise the steam. The hot flue gases would then pass into the boilers. The boilers will each consist of a series of passes containing evaporators, superheaters and economisers.

Superheated steam from the boilers will be supplied to a single high-efficiency turbine which, through a rotating shaft, turns a generator to produce electricity. The superheated steam will be supplied at a temperature of 440°C under a pressure of 60 bar abs. The turbine will have a series of extractions at different pressure that will be used for preheating air and water in the steam cycle. The remainder of the steam will pass out of the final low-pressure condensing stage. To generate the pressure drop to drive the turbine, the steam will be condensed back to water. A fraction will condense at the exhaust of the turbine in the form of wet steam. The majority will be condensed in the air-cooled condenser (ACC) following the turbine at a pressure well below atmospheric. The condensed steam will be returned as feed water in a closed-circuit pipework system to the boilers.

The turbine will generate approximately 44 MWe. The parasitic load for the Facility will be approximately 5 MWe, with approximately 39 MWe of power available for export to the National Grid.

The Facility will be constructed as CHP-Ready, with the potential to export up to 20 MWth of heat to local heat users. Whilst such export of heat would reduce the electrical output of the installation, the net effect would be to increase the overall thermal efficiency of the Facility. A CHP Assessment has been developed, refer to Appendix G.

1.4.4 Flue Gas Treatment

After the heat recovery stages, the flue gas passes to the flue gas treatment (FGT) system. This consists of:

1. Selective Non-Catalytic Reduction (SNCR);
2. hydrated lime and activated carbon injection; and
3. a fabric filter.

The abatement of oxides of nitrogen (NOx) will be achieved by careful control of combustion air and selective non-catalytic reduction (SNCR). NOx will be formed in the boiler at high temperature from nitrogen in the waste and in the combustion air. Ammonia will be injected at the combustion chamber directly into the hot flue gases above the flame. In the SNCR system NOx is chemically reduced to nitrogen, carbon dioxide and water by the ammonia.

After heat recovery and NOx abatement, hydrated lime and powdered activated carbon (PAC) will be injected into the flue gases upstream of the fabric filter in order to abate acidic gases, heavy metals and any remaining dioxins and furans. The hydrated lime will abate the emission of acidic gases, including hydrogen fluoride, hydrogen chloride and sulphur dioxide. The activated carbon will abate emissions of mercury, organic compounds and dioxins. The hydrated lime and activated carbon will be stored in separate silos.

Following the injection of lime and activated carbon, the flue gas will then pass through the fabric filter, which will remove the particulates and reaction products, collectively known as Air Pollution Control residues (APCr). The residues cake the outside of the filter bags with the units periodically cleaned by a reverse jet of air, displacing the filtered solids into chutes beneath and storing them in silos. The dosing rate for the acid gas reagent will be controlled by the upstream acid gas pollutant concentration measurements and proportioned to the volumetric flow rate of the flue gases. As fresh reagents are added, an equivalent amount of residue collected from the bag filters will be removed.

There will be online monitoring of the pressure drop within bag filter compartments to identify when there has been bag filter failure. If a pressure drop is identified, bag filter compartments will be isolated to prevent uncontrolled emissions and repaired before being brought back on-line.

The cleaned gas will be monitored for pollutants and discharged to atmosphere via two flues (1 per line) within a common 55 m windshield.

1.4.5 Ash handling

The main residue produced by the Facility will be bottom ash, which is the burnt-out residue from the combustion process. Bottom ash is collected at the end of the combustion grate and falls into the discharger, which comprises a water-filled trough (or ash quench). The purpose of the ash quench is to cool and moisten the bottom ash to limit particulate emissions (dust generation) and to ensure an airtight seal to the furnace to avoid air ingress to the combustion chamber from the boiler house. Boiler ash, the ash fraction that collects within a boiler, will also be conveyed to the discharger, and will mix with the bottom ash within the quench to form the residue known as Incinerator Bottom Ash (IBA).

The quenched ash will be transferred, via an inclined enclosed conveyor, to the IBA storage area. There will be regular collections of IBA from the IBA storage area for transfer off-site to a suitably licensed waste facility.

Ash handling will be undertaken in enclosed buildings, with the ash maintained wet from quenching to prevent the fugitive release of any dust emissions off site. In addition, any overflow from the ash quench will be contained in the process effluent drainage system and hence there will not be any release of effluent from the ash quench system.

1.4.6 Site drainage

Surface water run-off from buildings, roadways and carparks will be collected via rainwater downpipes, linear drainage channels and external gullies. This collected water will then pass through oil interceptors and silt traps, before being discharged at greenfield runoff rates (via below-ground attenuation tanks and a rising main) into a drainage ditch to the north of the site. The surface water drainage systems split and are discharged into two separate discharge points along the ditch. This will allow improved dissipation of the discharge along the entire ditch length. The site surface water drainage system will also be divided accordingly.

There will be periodic monitoring of surface water drainage to verify that the design measures are providing sufficient protection for the prevention of the release of any contaminated effluent off-site.

Under 'normal operation' there will not be any discharges of process effluent from the Facility. Where practicable, process effluents from water treatment and boiler blowdown will be re-used within the process – mainly in the ash quench system. In the event that excess effluents are generated by the process, they will be discharged, via a sampling point, to sewer in accordance with a trade effluent consent which Lakeside EfW Ltd will obtain from Thames Water.

Domestic effluent from welfare facilities will be pumped into the foul sewage network.

1.4.7 Emissions monitoring and stack

The cleaned gas is monitored for pollutants and discharged to atmosphere through two flues enclosed within a common 55 m windshield and has been identified as the maximum acceptable stack height by the Civil Aviation Authority.

A Continuous Emission Monitoring Station (CEMS) will be installed to monitor concentrations of the following pollutants in the flue gas:

- particulates;
- sulphur dioxide;
- hydrogen chloride;
- carbon monoxide;
- nitrogen oxides;
- ammonia; and
- VOCs, expressed as total organic carbon.

In addition, periodic sampling and measurement will be carried out for:

- Group 3 heavy metals: antimony (Sb), arsenic (As), lead (Pb), chromium (Cr), cobalt (Co), copper (Cu), manganese (Mn), nickel (Ni), vanadium (V);
- cadmium (Cd) and thallium (Tl);
- mercury (Hg);
- hydrogen fluoride;
- dioxins and furans; and
- dioxin-like PCBs.

Periodic measurements will be carried out four times in the first year and twice per year thereafter.

The Continuous Emission Monitoring (CEM) system will be MCERTS approved. There will be two CEMS, one per waste incineration line, and an installed back-up CEMS systems available in the event of a CEMS failure.

1.4.8 Ancillary operations

The Facility will require a top-up water supply of approximately 10 m^3/hr. The primary requirement of water is to maintain the water level in the boiler systems (steam cycle). Water would be primarily sourced from mains water, but process effluents will also be used in the ash quench system. A water treatment plant will treat the mains water to produce high quality feedwater for use within the boilers. 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 a dedicated firewater tank with a duty electric pump and standby diesel pump.

An emergency diesel generator will provide power to safely shutdown the Facility. The generator will provide sufficient power to run or shut the plant down in the event of the loss of a grid connection. The diesel generator is only expected to operate for short-term periods (i.e. <50 hours per year) for testing purposes.

2 Other information for application form

2.1 Raw materials

2.1.1 Types and amounts of raw materials

The main (>5 tonnes) raw materials which will be stored at the Facility are presented in Table 2, with indicative values for their annual tonnages. Information on the potential environmental impact of these raw materials is included in Table 3.

Table 2: Types and amounts of raw materials and consumption rate at design load (for Schedule 1 Activities)

Schedule 1 Activity	Material	Maximum storage capacity [tonnes]	Annual throughput [tonnes per annum]	Description including any hazard code
Section 5.1 Part A (b)	Low sulphur fuel oil	350	1,560	Low sulphur fuel oil
	Ammonium Hydroxide	120	1,270	25% ammonium hydroxide solution
	Lime	170	4,700	Calcium Hydroxide
	Activated carbon	110	130	Powdered
	Boiler treatment chemicals	< 10	< 70	Oxygen scavenger, pH control, biocide, water treatment regeneration chemicals

Table 3: Raw materials and their effect on the environment

Environmental Medium								
Product	**Chemical composition**	**Typical quantity**	**Units**	**Air**	**Land**	**Water**	**Impact potential**	**Comments**
Low sulphur fuel oil	Typically <1% sulphur	1,560	tonnes / year	100	0	0	Low impact	Fuel for start-up and shutdown of the Facility.
Hydrated lime	$Ca(OH)_2$	4,700	tonnes / year	0	100	0	Low impact	Lime is hydrated, injected and removed with the APC residues at the bag filter and disposed of as hazardous waste at a suitable licensed facility.
Activated Carbon	C	110	tonnes / year	0	100	0	Low impact	Injected carbon is removed with the APC residues at the bag filter and disposed of as hazardous waste at a suitable licensed facility.
25% ammonia solution	$NH_3(aq)$	1,270	tonnes / year	100	0	0	Low impact	Reacts with nitrogen oxides to form nitrogen, carbon dioxide and water vapour. Any unreacted ammonia (a chemical intermediate) is released to atmosphere at low concentrations. Dosing will be controlled as to minimise slip
Water	H_2O	78,840	m^3 / year	50	0	50	Low impact	Water is used for various uses, including: • Treated water make-up; • Cleaning water; • Ash quench.
Water Treatment Chemicals	Oxygen scavenger, pH control, biocide, water treatment regeneration chemicals	< 70	tonnes / year	0	0	100	Low impact	Oxygen scavenger, pH control, biocide, water treatment regeneration chemicals will be used to create feedwater and for the treatment of the boiler feedwater.

Various other materials, which will be used in small quantities (<5 tonnes per annum) will be required for the operation and maintenance of the Facility, including:

1. hydraulic oils and silicone-based oils;
2. isolation media within electrical switchgear;
3. refrigerant gases for the air conditioning plant;
4. glycol/antifreeze for cooling;
5. oxyacetylene, TIG, MIG welding gases;
6. CO2 / firefighting foam agents; and
7. ignition, test and calibration gases.

These will be supplied to standard specifications offered by main suppliers. All chemicals will be handled in accordance with COSHH Regulations as part of the quality assurance procedures and full product data sheets will be available on-site.

Periodic reviews of all materials used will be made in the light of new products and developments. Any significant change of material, where it may have an impact on the environment, will not be made without firstly assessing the impact and seeking approval from the EA.

The Operator will maintain a detailed inventory of raw materials used on-site and have procedures for the regular review of new developments in raw materials.

2.1.2 Reagent storage

The details of the storage facilities for the storage of raw materials, reagents and residues are presented within section 5.2 of the Site Condition Report, refer to Appendix B. Materials will be stored in accordance with current guidance. All liquid chemicals will be stored in controlled areas, with suitably designed secondary containment facilities having a volume of 110% of the stored capacity.

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. There will also be portable bottles of oxygen and acetylene gas stored on site for welding purposes. The gas bottles will be kept secure in a separate compound.

2.1.3 Raw materials and reagents selection

2.1.3.1 Acid gas abatement

There are several reagents available for acid gas abatement. Sodium Hydroxide (NaOH) or lime (CaO) can be used in a wet FGT system. Quicklime (CaO) can be used in a semi-dry FGT system. Sodium bicarbonate ($NaHCO_3$) or hydrated lime ($Ca(OH)_2$) can be used in a dry FGT process.

The reagents for wet scrubbing and semi-dry abatement are not considered, since these abatement techniques have been eliminated by the BAT assessment in Appendix F section 4.1. The two alternative reagents for a dry system – lime and sodium bicarbonate - have therefore been assessed further.

The level of abatement that can be achieved by both reagents is similar. However, the level of reagent used and therefore residue generation and disposal is different and requires a full assessment following the methodology in Horizontal Guidance Note H1 whilst it is noted that this guidance has subsequently been withdrawn, the replacement guidance is not as prescriptive in the methodology required. Therefore, for the purposes of the BAT assessment, the requirements of the withdrawn guidance have been applied. The assessment is detailed in Appendix F and is summarised in the table below.

Table 4: Acid gas abatement BAT data

Item	Unit	$NaHCO_3$	$Ca(OH)_2$
Mass of reagent required	kg/h	109.0	67.0
Mass of residue generated	kg/h	84.0	85.0
Cost of reagent	£/tonne	155	94
Cost of residue disposal	£/tonne	150	125
Overall Cost	£/op.hr/kmol	29.5	16.9
Ratio of costs		1.74	

Note: Data based on the abatement of one kmol of hydrogen chloride.

Whilst the use of sodium bicarbonate will lead to less residue than a lime-based system, this is significantly outweighed by the advantages of using lime as a reagent, which are as follows:

- Lime has higher removal rates of acid gases than sodium bicarbonate, which is reflected in the quantities of reagent consumed.
- Lime based APCr has a lower leaching rate than sodium bicarbonate based APCr. Therefore, there are greater waste management options available for lime based APCr. there are different options for the recovery of materials from lime based APCr, i.e. it can be recovered into substitute products displacing virgin materials. Veolia are aware that currently the only 'available' option for the management of sodium bicarbonate APCr is disposal in a landfill.
- The reaction temperature for lime systems match well with the optimum adsorption temperature for carbon, which is dosed at the same time.
- The lime system has a slightly lower global warming potential due to the reaction chemistry.
- The costs per kmol of hydrogen chloride abated are almost 75% higher for a sodium bicarbonate system.

Taking all of the above into consideration, the use of lime is considered to represent BAT for the Facility.

2.1.3.2 NOx abatement

NOx abatement systems can be operated with dry urea (prills), urea solution or aqueous ammonia solution. There are advantages and disadvantages with all options:

- urea is easier to handle than ammonia - the handling and storage of ammonia can introduce an additional risk;
- ammonia tends to give rise to lower nitrous oxide formation than urea;
- dry urea can be contained in Flexible Intermediate Bulk Containers (FIBCs or 'big-bags'), whereas ammonia solution is usually stored in silos and delivered in tankers; and
- ammonia emissions (or 'slip') can occur with both reagents, but good control will limit this.

The Environment Agency's sector guidance on waste incineration, titled *"Incineration of waste (EPR5.01)"*, considers all options as suitable for NOx abatement. It is proposed to use aqueous ammonia solution as a reagent in the SNCR system. The Operator considers that the climate change impacts associated with the use of urea outweigh the handling and storage issues associated with ammonia solution as they can be overcome by good design of the ammonia tanks and pipework and the use of suitable procedures for the safe handling and delivery of ammonia.

2.1.3.3 Auxiliary fuel

As stated in Article 50 (3) of the Industrial Emissions Directive:

"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 (1) OJ L 121, 11.5.1999, p. 13., liquefied gas or natural gas."

Therefore, as identified by the requirements of IED the only available fuels that can be used for auxiliary firing are:

1. liquefied gas (LPG);
2. fuel oil; or
3. natural gas.

Auxiliary burner firing on a well-managed waste combustion plant is only required intermittently, i.e. during start-up, shutdown and when the temperature in the combustion chamber falls to the minimum 850°C.

LPG is a flammable mixture of hydrocarbon gases. It is a readily available product and can be used for auxiliary firing. As LPG turns gaseous under ambient temperature and pressure, it is required to be stored in purpose-built pressure vessels. If there was a fire within the site, there would be a significant explosion risk from the combustion of flammable gases stored under pressure. Considering the proximity of the Facility to the nearby sewage treatment works and the M4, LPG is not considered to be a suitable auxiliary fuel for the Facility.

Natural gas can be used for auxiliary firing and is safer to handle than LPG. As stated previously, auxiliary firing will only be required intermittently. When firing this requires large volumes of gas, which would need to be supplied from a high-pressure gas main within reasonable distance of the Facility. A high-pressure gas main with sufficient available capacity is not currently available in the local area. Therefore, the supply of natural gas is not currently determined as being feasible for the purposes of auxiliary firing for the Facility.

A low sulphur fuel oil tank can be easily installed at the Facility. Whilst it is acknowledged that fuel oil is classed as flammable, it does not pose the same type of safety risks as those associated with the storage of 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.

Taking the above into consideration, low sulphur fuel oil is considered to represent BAT for auxiliary firing at the Facility.

2.2 Incoming waste management

2.2.1 Waste to be processed in the facility

The Facility will be used to recover energy from non-hazardous incoming MSW and C&I waste, with European Waste Catalogue Codes listed in Table 5 as follows:

Table 5: Waste to be processed in the Facility

EWC Code	Description of Waste
Wastes from agriculture, horticulture, aquaculture, forestry, hunting and fishing, food preparation and processing	
02 02	***Wastes from the preparation and processing of meat, fish and other foods of animal origin***
02 02 02	Animal-tissue waste
02 02 03	Materials unsuitable for consumption or processing
02 03	***Wastes from fruit, vegetables, cereals, edible oils, cocoa, coffee, tea and tobacco preparation and processing; conserve production; yeast and yeast extract production, molasses preparation and fermentation***
02 03 04	Materials unsuitable for consumption or processing
02 05	***Wastes from the dairy products industry***
02 05 01	Materials unsuitable for consumption or processing
02 06	***Wastes from the baking and confectionery industry***
02 06 01	Materials unsuitable for consumption or processing
02 06 02	Wastes from preserving agents
02 07	***Wastes from the production of alcoholic and non-alcoholic beverages (except coffee, tea and cocoa)***
02 07 01	Wastes from washing, cleaning and mechanical reduction of raw materials
02 07 02	Wastes from spirits distillation
02 07 04	Materials unsuitable for consumption or processing
Wastes from wood processing and the production of panels and 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 05	De-inking sludges from paper recycling
03 03 07	Mechanically separated rejects from pulping of waste paper and cardboard
03 03 08	Wastes from sorting of paper and cardboard destined for recycling
03 03 10	Fibre rejects, fibre-, filler- and coating-sludges from mechanical separation
Wastes from the leather, fur and textile industries	
04 01	***Wastes from the leather and fur industry***
04 01 08	Waste tanned leather (blue sheetings, shavings, cuttings, buffing dust) containing chromium
04 01 09	Wastes from dressing and finishing

EWC Code	Description of Waste
04 02	***Wastes from the textile industry***
04 02 09	Wastes from composite materials (impregnated textile, elastomer, plastomer)
04 02 10	Organic matter from natural products (for example grease, wax)
04 02 15	Wastes from finishing other than those mentioned in 04 02 14
04 02 21	Wastes from unprocessed textile fibres
04 02 22	Wastes from processed textile fibres
Wastes from the manufacture, formulation, supply and use (MFSU) of coatings (paints, varnishes and vitreous enamels), adhesives, sealants and printing inks	
08 01	***Wastes from MFSU and removal of paint and varnish***
08 01 12	Waste paint and varnish other than those mentioned in 08 01 11
08 01 18	Wastes from paint or varnish removal other than those mentioned in 08 01 17
08 02	***Wastes from MFSU of other coatings (including ceramic materials)***
08 02 01	Waste coating powders
08 03 18	Waste printing toner other than those mentioned in 08 03 17
08 04	***Wastes from MFSU of adhesives and sealants (including waterproofing products)***
08 04 10	Waste adhesives and sealants other than those mentioned in 08 04 09
Wastes from the photographic industry	
09 01	***Wastes from the photographic industry***
09 01 07	Photographic film and paper containing silver or silver compounds
09 01 08	Photographic film and paper free of silver or silver compounds
09 01 10	Single-use cameras without batteries
09 01 12	Single-use cameras containing batteries other than those mentioned in 09 01 11
Wastes from shaping and physical and mechanical surface treatment of metals and plastics	
12 01	***Wastes from shaping and physical and mechanical surface treatment of metals and plastics***
12 01 05	Plastics shavings and turnings
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 which is contaminated and not suitable for recycling
15 01 02	Plastic packaging
15 01 03	Wooden packaging
15 01 05	Composite packaging
15 01 06	Mixed packaging which is contaminated and not suitable for recycling
15 01 09	Textile packaging

EWC Code	Description of Waste
15 02	***Absorbents, filter materials, wiping cloths and protective clothing***
15 02 03	Absorbents, filter materials, wiping cloths and protective clothing other than those mentioned in 15 02 02
Wastes not otherwise specified in the list	
16 01	***end-of-life vehicles from different means of transport (including off-road machinery) and wastes from dismantling of end-of-life vehicles and vehicle maintenance (except 13, 14, 16 06 and 16 08)***
16 01 03	End-of-life tyres
16 01 19	Plastic
16 01 22	Components not otherwise specified
16 02	***Wastes from electrical and electronic equipment***
16 02 14	Discarded equipment other than those mentioned in 16 02 09 to 16 02 13
16 02 16	Components removed from discarded equipment other than those mentioned in 16 02 15
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
Construction and demolition wastes (including excavated soil from contaminated sites)	
17 02	***Wood, glass and plastic***
17 02 01	Wood
17 02 03	Plastic
17 03	***Bituminous mixtures, coal tar and tarred products***
17 03 02	Bituminous mixtures other than those mentioned in 17 03 01
17 06	***Insulation materials and asbestos-containing construction materials***
17 06 04	Insulation materials other than those mentioned in 17 06 01 and 17 06 03
17 08	***Gypsum-based construction material***
17 08 02	Gypsum-based construction materials other than those mentioned in 17 08 01
17 09	***Other construction and demolition wastes***
17 09 04	Mixed construction and demolition wastes other than those mentioned in 17 09 01, 17 09 02 and 17 09 03
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 01 09	Medicines other than those mentioned in 18 01 08

EWC Code	Description of Waste
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
18 02 08	Medicines other than those mentioned in 18 02 07
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 physical/chemical treatments of waste (including dechromatation, decyanidation, neutralisation)***
19 02 03	Premixed wastes composed only of non-hazardous wastes
19 02 10	Combustible wastes other than those mentioned in 19 02 08 and 19 02 09
19 03	***Stabilised/solidified wastes***
19 03 05	Stabilised wastes other than those mentioned in 19 03 04
19 03 07	Solidified wastes other than those mentioned in 19 03 06
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 99	Wastes not otherwise specified
19 08	***Wastes from waste water treatment plants not otherwise specified***
19 08 01	Screenings
19 08 02	Waste from desanding
19 08 09	Grease and oil mixture from oil/water separation containing edible oil and fats
19 09	***Wastes from the preparation of water intended for human consumption or water for industrial use***
19 09 01	Solid waste from primary filtration and screenings
19 10	***Wastes from shredding of metal-containing wastes***
19 10 04	Fluff-light fraction and dust other than those mentioned in 19 10 03
19 10 06	Other fractions other than those mentioned in 19 10 05
19 12	***Wastes from the mechanical treatment of waste (for example sorting, crushing, compacting, pelletising) not otherwise specified***
19 12 01	Paper and cardboard which is contaminated and not suitable for recycling
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)

EWC Code	Description of Waste
19 12 12	Other wastes (including mixtures of materials) from mechanical treatment of wastes other than those mentioned in 19 12 11
19 13	***Wastes from soil and groundwater remediation***
19 13 02	Solid wastes from soil remediation other than those mentioned in 19 13 01
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 (rejects from materials recovery plants only)
20 01 08	Biodegradable kitchen and canteen waste
20 01 10	Clothes
20 01 11	Textiles
20 01 25	Edible oil and fat
20 01 28	Paint, inks, adhesives and resins other than those mentioned in 20 01 27
20 01 30	Detergents other than those mentioned in 20 01 29
20 01 32	Medicines other than those mentioned in 20 01 31
20 01 36	Discarded electrical and electronic equipment other than those mentioned in 20 01 21, 20 01 23 and 20 01 35
20 01 38	Wood other than that mentioned in 20 01 37 (rejects from materials recovery plants only)
20 01 39	Plastics (rejects from materials recovery plants only)
20 01 41	Wastes from chimney sweeping
20 01 99	Other fractions not otherwise specified
20 02	***Garden and park wastes (including cemetery waste)***
20 02 01	Biodegradable waste
20 02 03	Other non-biodegradable wastes
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 06	Waste from sewage cleaning
20 03 07	Bulky waste
20 03 99	Municipal Waste not otherwise specified

As stated in Section 1.4, the maximum capacity of the Facility will be approximately 55.8 tonnes per hour of mixed non-hazardous wastes, with a net calorific value (NCV) of 10.0 MJ/kg. The Facility will have a nominal design capacity of approximately 440,000 tonnes per annum (tpa), assuming an availability of approximately 7,884 hours. However, allowing for variations in the NCV of the waste, and the plant operating continuously throughout the year, the maximum capacity of the Facility will be approximately 489,000 tpa.

Checks will be made on the paperwork accompanying each delivery to ensure that only waste for which the plant has been designed will be accepted.

For waste delivered in road vehicles, it will not be practical to inspect the waste before it is tipped into the bunker. Therefore, the incoming waste will be observed by the waste reception area operator as it is tipped and by the crane driver and control room operator as it is mixed. Where practicable, unacceptable waste will be removed from the bunker for further inspection and quarantine, prior to transfer off-site to a suitable disposal/recovery facility.

The waste bunker will allow for back-loading of waste in the event of unplanned periods of prolonged shut-down. The crane maintenance arrangement can be used as a back-loading facility to remove any oversized items or non-combustible items identified within the bunker.

Any unacceptable waste will be rejected and stored in a designated area in the waste reception area. The management systems for the Facility will include procedures to control the inspection, storage and onward disposal of unacceptable waste. Unacceptable wastes could include items which are considered to be non-combustible, large/bulky items or items of hazardous waste. All unacceptable wastes will be loaded into a bulker or other appropriate vehicle for transfer off-site either to the producer of the waste or to a suitably licensed waste management facility. Certain unacceptable 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

2.2.2.1 Waste acceptance and pre-acceptance procedures

Contracts will be held with a limited number of waste treatment facilities and waste providers that will supply waste to the Facility. Contracts will be in place with these suppliers to provide the incoming waste in accordance with a fuel specification.

Documented procedures for pre-acceptance and acceptance of all wastes will be developed prior to the commencement of operation of each of the waste treatment processes, in accordance with the documented management systems for the Facility.

Documented procedures for the management and operation of the Facility will be developed prior to commencement of operations. Lakeside EfW Ltd would propose to provide the EA with a summary of the documented procedures prior to commencement of operation. This would include waste pre-acceptance and waste acceptance procedures for all wastes which the Facility is permitted to receive – following issuing of a permit by the EA.

The pre-acceptance and acceptance checks on wastes being delivered to the Facility will include audits of waste producers and/or fuel suppliers to review their operations to confirm that the waste which they are transferring to the Facility is in accordance with the waste descriptions, specifications and EWC codes that will be provided by Lakeside EfW Ltd.

Procedures will be implemented on site for the review of incoming wastes at the weighbridges and for checking incoming wastes against the agreed specifications on a regular basis. This will include depositing waste loads onto the waste reception area floor for periodic visual inspection. Crane drivers and other operatives will be trained in order to undertake these tasks.

2.2.2.2 Receiving waste

Prior to the receipt of waste at the Facility, pre-acceptance and acceptance procedures will be developed which comply with the Indicative BAT requirements of EPR5.01, including:

- A high standard of housekeeping will be maintained in all areas and suitable equipment will be provided and maintained to clean up spilled materials.
- Vehicles will be loaded and unloaded in designated areas provided with impermeable hard standing. These areas will have appropriate falls to the process water drainage system.
- Fire-fighting measures will be designed by consultation with the Local Fire Officers, with particular attention paid to the waste reception and storage areas.
- 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.
- Incoming waste will be:
  - delivered in enclosed vehicles; and
  - unloaded in the enclosed waste reception area.
- Design of equipment, buildings and handling procedures will ensure there is insignificant dispersal of litter.
- Inspection procedures will be employed to ensure that any wastes which would prevent the waste incineration process from operating in compliance with its permit are segregated and placed in a designated storage area pending transfer off-site.
- Further inspection will take place by the plant operatives during vehicle tipping and waste unloading.

2.2.3 Waste minimisation (minimising the use of raw materials)

A number of specific techniques will be employed to minimise the generation of residues, focusing on the following:

1. feedstock homogeneity;
2. Dioxin & Furan reformation;
3. furnace conditions;
4. Flue Gas Treatment control; and
5. waste management.

All of these techniques meet the Indicative BAT requirements from the Sector Guidance Note on Waste Incineration.

2.2.3.1 Feedstock homogeneity

Improving feedstock homogeneity will improve the operational stability of the Facility, leading to reduced reagent use and reduced residue production. Incoming waste will originate from a variety of sources and suppliers. The mixing of incoming wastes within the bunker will improve the homogeneity of the waste input into the boiler.

2.2.3.2 Dioxin & furan reformation

As identified within the EPR5.01, there are a number of BAT design considerations required for the furnace. The furnace has been designed to minimise the formation of dioxins and furans as follows:

- Slow rates of combustion gas cooling would be avoided via boiler design to ensure the residence time would be minimised in the critical cooling section, to minimise the potential for de-novo formation of dioxins and furans.
- The gas residence time in the critical temperature range would be minimised by ensuring high gas velocities exist in these sections. The residence time and temperature profile (between 450 and 200°C) of flue gas would be considered during the detailed design phase to ensure that dioxin formation would be minimised throughout the process.
- Transfer surfaces would be above a minimum temperature of 170°C subject to other reaction considerations.
- Computational Fluidised Dynamics (CFD) will be applied to the design, where considered appropriate, to ensure gas velocities are in a range that negates the formation of stagnant pockets / low velocities.
- Minimising the volume in the critical cooling sections will ensure high gas velocities.
- Boundary layers of slow-moving gas along boiler surfaces would be prevented via design and a regular maintenance schedule to remove build-up of any deposits that may have occurred.

2.2.3.3 Furnace conditions

Furnace conditions will be optimised in order to minimise the quantity of residues arising for further disposal. Burnout in the furnace will either reduce the Total Organic Carbon (TOC) content of the bottom ash to less than 3%, or Loss on Ignition (LOI) of the bottom ash to less than 5%, by optimising waste feed rate and combustion air flows.

2.2.3.4 Flue gas treatment control

Close control of the flue gas treatment system will minimise the use of reagents and hence minimise the APCr produced. SNCR reagent dosing will be optimised to prevent ammonia slip.

Lime usage will be minimised by trimming reagent dosing to accurately match the acid load using fast response upstream acid gas monitoring. The preventative maintenance regime for the Facility will include regular checks and calibration of the reagent dosing system to ensure optimum operation. Back-up feed systems will be provided to ensure no interruption in the lime dosing system. The bag filter is designed to build up a filter cake of unreacted acid gas reagent, which acts as a buffer during any minor interruptions in dosing.

Activated carbon dosing will be based on flue gas volume flow measurement. The activated carbon dosing screw speed frequency control responds automatically to the increase and decrease of flue gas volume. Maintaining a steady concentration of activated carbon in the flue gas and consequently on the filter bags will maintain the adsorption rate for gaseous metals and dioxins.

Activated carbon and lime will be stored in separate silos. The feed rates for the activated carbon and lime dosing systems will have independent controls.

2.2.3.5 Waste management

The arrangements for the management of residues produced by the Facility are presented in Section 2.9. In particular, IBA and APCr from the flue gas treatment system will be stored and disposed of separately.

The procedures for handling of the wastes generated by the facility will be in accordance with the Indicative BAT requirements in the Sector Guidance Note, refer to Section 2.2.2.

2.2.3.6 Waste charging

The Facility will meet the indicative BAT requirements outlined in the Incinerator Sector Guidance Note for fuel charging and the specific requirements of the IED:

- The combustion control and feeding system will be fully in line with the requirements of the IED. The conditions within the furnace will be continually monitored to ensure that optimal conditions are maintained and that the BAT-AEL emission limits are not exceeded. Auxiliary burners fired with low sulphur fuel oil will be installed and will be used to maintain the temperature in the combustion chamber;
- The waste charging and feeding systems will be interlocked with furnace conditions so that charging cannot take place when the temperatures drop below 850°C, both during start-up and if the temperature falls below 850°C during operation;
- The waste charging and feeding systems will also be interlocked with the continuous emissions monitoring system to prevent waste charging if the emissions to atmosphere are in excess of an emission limit value;
- The isolation doors that prevent the fire burning back up the chute will be double doors and/or have a water cooling system, to prevent ignition of waste in contact with the outside of the door;
- Following loading into the feeding chutes by the grab, the waste will be transferred onto the grates by hydraulic powered feeding units;
- The backward flow of combustion gases and the premature ignition of waste will be prevented by keeping the feed chute full of waste and by keeping the furnace under negative pressure;
- A level detector will monitor the amount of waste in the feed chute and an alarm will be sounded if the fuel falls below the safe minimum level. Secondary air will be injected from nozzles in the wall of the furnace to control flame height and the direction of air and flame flow; and
- In a breakdown scenario, operations will be reduced or closed down as soon as practicable until normal operations can be restored.

The waste feed rate to the furnace will be controlled by the combustion control system. If there is an intermediate waste feed-stop, requiring the auxiliary burners to operate to maintain the operation of the Facility without entering shutdown, the flue gas treatment systems will remain in operation.

2.3 Water use

2.3.1 Overview

The main use of water at the Facility will be to make up the water for the boilers (referred to as boiler feedwater). Other water consuming processes include the wet ash conveyor and the SNCR system injection nozzles. The following key points should be noted:

- Most of the steam used in the turbine boiler will be recycled as condensate. The remainder will be lost as blow-down to prevent build-up of sludge and chemicals, through soot blowing, the ash quench system and the FGT system. Lost condensate will be replaced with treated water.
- Under ‘normal operations’, there will not be any process emissions to water from the Facility.
- Where practicable, waste waters generated from the process would be reused/recycled within the process. These would be collected in an intermediate storage vessel (a wastewater chamber or pit) to be re-used in the Facility.

- Water from washdown, vehicle movement areas and areas of hardstanding will be discharged into on-site surface water drainage systems via oil interceptors, prior to storage in sub-surface attenuation crate systems.
- There will be periodic monitoring of surface water drainage to verify that the design measures are providing sufficient protection for the prevention of the release of any contaminated effluent off-site.
- The water system has been designed with two key objectives:
  - minimal process water discharge; and
  - minimal consumption of potable water.
- Firewater will be provided by an on-site water tank which is connected to the mains water supply.
- The Facility will have separate process water, foul sewer and surface/storm water systems.

2.3.1.1 Potable and amenity water

Water for drinking supplies for the offices and mess facilities will come from a potable water supply. The quantity of this water is expected to be small compared to the other water uses on site.

Wastewater from domestic uses, such as showers, toilets, and mess facilities, will be discharged into a foul sewer system for discharge to sewer.

2.3.1.2 Process water

Process water will be supplied by the mains potable water system.

Boiler feedwater water will be used to compensate for boiler blow down losses. The Facility will have a water treatment plant. It is anticipated that the Facility will consume approximately 10 m^3/hr of mains water. The water treatment plant is designed to continuously supply treated water.

Wastewater will be collected in a wastewater chamber. Effluent collected in the wastewater chamber will be re-used in the ash quench system. Under normal operating conditions, wastewater will be generated from the following processes:

1. effluent from the water treatment plant;
2. process effluent collected in site drainage system (e.g. boiler blowdown);
3. condensate from the condensate tank;
4. effluent generated through washing and maintenance procedures; and
5. water run-off collected from the bottom ash quench.

The wastewater chamber or pit will provide acid dosing for pH adjustment and settlement of process effluents so that it can be re-used within the ash quench.

Washdown water consumption will be minimised by the use of trigger controls on all wash hoses.

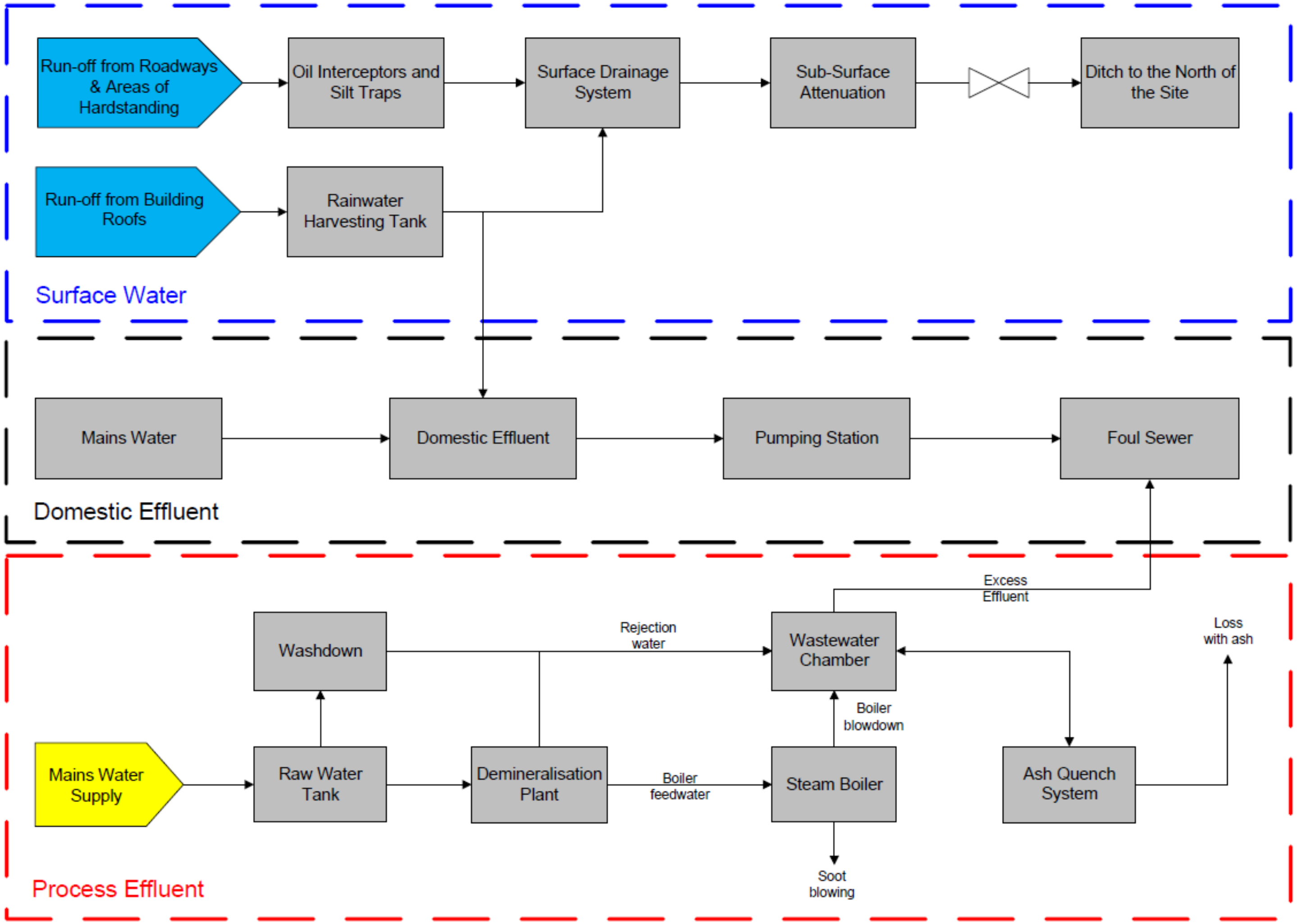
2.3.2 Water supply

Potable water from the mains water supply will be used to provide feedwater for the boiler. This will be treated in an on-site water treatment plant to produce high quality boiler feedwater. Wastewater from the water treatment plant will be re-used within the process, likely within the ash quench. Water for fire-fighting will come from the mains supply and be stored in dedicated firewater storage facilities.

A rainwater harvesting tank will capture rainwater from building roof areas. This water will be used on-site to support site activities and processes where appropriate.

An indicative water flow diagram for the Facility is presented in Figure 2 below. A larger version of this drawing is included within Appendix A.

Figure 2: Indicative water flow diagram



2.4 Emissions

2.4.1 Point source emissions to air

The source of point source emissions to air from the Facility are presented in the table below:

Table 6: Proposed emission points

Emission Point Reference	Source
A1	EfW line 1
A2	EfW line 2

The full list of proposed emission limits for atmospheric emissions is shown in the table below.

Table 7: Proposed emission limit values (ELVs)

Parameter	Units	Half Hour Average	10-minute Average	Daily Average	Periodic Limit
Emission Point A1					
Particulate matter	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		150	50	
Sulphur dioxide	mg/Nm^3	90		30	
Oxides of nitrogen (NO and NO_2 expressed as NO_2)	mg/Nm^3	200		100	
Ammonia				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
All expressed at 11% oxygen in dry flue gas at standard temperature and pressure. **Averaging period for carbon monoxide is 95% of all 10-minute averages in any 24-hour period.*					

The Final Draft Waste incineration BREF was published by the European IPPC Bureau in December 2018. Formal adoption of the BREF is expected in 2019. Upon adoption of the final BREF, the

Environment Agency will be required to review and implement conditions within all permits which require operators to comply with the requirements set out in the BREF. This will include the Proposed Development. As currently drafted, the BREF will introduce BAT-Associated Emission Limits (BAT-AELs) which are more stringent than the ELVs currently set out in the IED. For most pollutants it has been assumed that emissions from the Facility will comply with the BAT-AELs, or the emission limits from Annex VI Part 3 of the Industrial Emissions Directive (IED) for waste incineration plants where BAT-AELs are not applicable. However, for nitrogen dioxide and sulphur dioxide the proposed ELV's have been set at concentrations which will ensure that the impact on the local environment will be acceptable.

2.4.2 Fugitive emissions to air

In addition to the point source emissions to air, there will be potential fugitive emissions to air from refilling of raw material storage facilities, such as tanks and silos. Where appropriate, fugitive emissions will be prevented by venting the displaced air to the tanker during refilling.

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 control and alarm. The silos will be equipped with a vent fitted at the top with a fabric filter. Filter residues will be returned to the silo(s). Cleaning of the filter will be done automatically with compressed air after the filling operation. The filters will be inspected regularly for leaks.

All waste handling activities will be undertaken within enclosed buildings, and will minimise fugitive emissions of dust from the Facility. All waste will be delivered to the Facility in enclosed and contained waste delivery vehicles, which will contain any fugitive emissions from the delivery of waste to the Facility.

All ash handling (including transfer of ash into road vehicles for transport off-site) will be undertaken within enclosed buildings. The ash will be maintained wet from quenching to prevent the fugitive release of any dust emissions off site.

2.4.2.1 Waste handling and storage

Waste reception and handling will be undertaken in enclosed waste reception areas which prevent the release of litter and dusts. The waste will then be tipped into and stored within an enclosed bunker.

Primary combustion air will be drawn from the waste bunker area to maintain negative pressure in waste bunker area, and fed into the combustion chamber beneath the grate. Additional bunker management procedures, and the inclusion of a daily clean down of the waste reception areas, will minimise the release of litter and dusts.

2.4.2.2 Silos

All silos will be fitted with bag filter protection to prevent the uncontrolled release to dusts during refilling.

Maintenance procedures will be developed for routine inspection and testing of the bag filters.

The APCr silos will be unloaded by a chute system. Dusty air from the unloading of silos will be extracted and vented to atmosphere via bag filters fitted to prevent the release of dusts from silos unloading operations.

2.4.3 Point source emissions to water

There will be no emissions of process effluent from the Facility discharged to water under normal operation.

Overflow from the ash quench will be contained in the process effluent drainage system and hence will not be released off-site. In addition, wastewater from ash handling areas will be collected in process drainage system and directed to the wastewater chamber or pit. The wastewater pit will provide acid dosing for pH adjustment if required and settlement of process effluents so that the process effluents are able to be 'recycled' and re-used in the ash quench. This will prevent the release of process water associated with ash handling into any surface water drainage. Should any excess process effluent be generated that cannot be re-used, it will be discharged to sewer in accordance with a Trade Effluent Consent. In addition, all ash handling arrangements (including loading into vehicles for transfer off-site) will be undertaken within enclosed buildings and on areas of hardstanding, preventing the release of any wastewater from the ash handling and quench system to the site surface water drainage system. All containers or vessels used for the transfer of ash off-site will be sealed to prevent the release of moisture contained within the ash, dust or excess water when in transport.

Surface water run-off from buildings, roadways and carparks will be collected via rainwater downpipes, linear drainage channels and external gullies. This collected water will then pass through oil interceptors and silt traps into two sub-surface attenuation tanks, before being discharged off-site into a diverted existing ditch to the north of the site boundary. The surface water drainage systems split and are discharged into two separate discharge points along the ditch – denoted by points W1 and W2 on the Emissions Points drawing (reference S2680-8000-0004) within Appendix A. This will allow improved dissipation of the discharge along the entire ditch length. The site surface water drainage system will also be divided accordingly.

Additional ditches will be created along the western and southern boundaries to intercept and convey surface runoff into the existing northern drainage ditch.

Depending on the outcome of infiltration testing, the possibility of using permeable paving in car parking areas and infiltration drainage to the north west of the site will be examined during detailed design. In addition, a class 1 bypass separator will be fitted to the surface water drainage system from the car parking area and vehicle movement areas.

In case of a fire or significant spill, an isolation valve will prevent the discharge of effluent off-site.

2.4.4 Point source emissions to sewer

Subject to formal approval from Thames Water, it is proposed to discharge all foul water from the Facility, which will principally be from domestic sources, into Thames Water's manhole located in close proximity to the existing sewage treatment works to the east of the site.

The only effluents discharged to sewer from the Facility under normal operation will be domestic effluents. In the event that there are excess effluents generated by the Facility, such as those generated during boiler blowdown, they will be discharged into the foul water drainage system and released to sewer in accordance with a Trade Effluent Consent first obtained from Thames Water.

2.4.5 Contaminated water

All chemicals will be stored in an appropriate manner incorporating the use of suitable secondary and other measures (for example, acid and alkali resistant coatings) to ensure appropriate containment and tertiary abatement measures. This may include areas of hardstanding with kerbed containment, to prevent any potential spills from causing pollution of the ground/groundwater and/or surface water. The potential for accidents, and associated environmental impacts, is therefore limited.

All storage facilities for chemicals will be designed in accordance with recognised industry good practice to prevent pollution, and UK government Guidance for Pollution Prevention (GPP).

Deliveries of all chemicals will be unloaded and transferred to suitable storage facilities. Areas and facilities for the storage of chemicals and liquid hazardous materials will be situated within secondary containment, such as bunds. 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.

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

Adequate quantities of spillage absorbent materials will be made available at easily accessible location(s), where chemicals are stored. A site drainage plan, including the location of process and surface water drainage will be made available on-site following completion of detailed design.

Process water drains within the Facility will drain to a wastewater chamber or pit.

Any spillage that has the potential to cause environmental harm or to leave the Facility will be reported to the site management and recorded in accordance with installations inspection, audit and reporting procedures. The relevant regulatory authorities (Environment Agency / Health and Safety Executive) will be informed as specified as required in accordance with the Facility's documented management procedures.

In the event of a fire, contaminated water used for fighting fires will be diverted through the wastewater drainage system and collected in a wastewater chamber or pit. Site drainage for external areas will be fitted with an isolation valve to prevent the discharge of water used for fire-fighting purposes off-site from the drainage system in the event of a fire. Additional storage will be available from the site kerbing and the attenuation area.

In accordance with the emergency response procedures which will be developed for the Facility, spillages will be reported to the site management and a record of the incident will be made. The relevant authorities (EA / Health and Safety Executive) will be informed if spillages/leaks are significant. The effectiveness of the emergency response procedures will be subject to Management Review and will be revised and updated as appropriate following any major spillages.

2.4.6 Noise

A noise assessment for the Facility is presented in Appendix C, and general measures for noise management within the Facility are detailed below.

Most noisy plant items will be installed within the main EfW building rather than outside and equipped with noise insulation if necessary. The air-cooled condensers have been designed to reduce noise and tonal components and have been located to the southwest of the site in order to minimise noise impact on permanent local receptors. Doors will be kept closed when not in use to prevent noise egress. A sound attenuator will be fitted to the exhaust of the EfW flue gas ID fan. Waste vehicle movements at night will be limited and regular maintenance of plant items will ensure noise does not become a problem.

Mobile plant will comply with the most up-to-date standards, including noise emissions. All mobile plant will be operated and maintained in accordance with the manufacturer's instructions. Mobile plant that does not comply with the agreed operating noise limits will be taken out of service until compliance is achieved.

Noise level checks will be carried out on a regular basis in operational areas of the EfW facilities where high noise levels may be present. Early warning of increasing noise levels will result in a noise reduction or mitigation programme.

2.4.7 Odour

The storage and handling of incoming waste is considered to have potential to give rise to odour. The Facility will be designed in accordance with the requirements of Environment Agency Guidance Note H4: Odour, and hence will include controls to minimise odour during normal and abnormal operation.

Combustion air will be drawn from above the waste pit, so that odours and airborne dust are drawn from the bunker into the incineration line (thus preventing their escape to atmosphere). Odour will also be controlled by keeping the doors between the waste tipping area and the waste bunker closed when there are no waste deliveries occurring.

Waste feed hoppers will be designed to ensure that emissions of dust and odour are minimised. By ensuring that the hopper dimensions exceed those of the grab, the potential for stray items of waste accumulating on the floor, and for dust and waste to be blown from the hoppers, will be minimised.

In the event of a plant shutdown, which might result in waste being held in the waste bunker for a period of time, the doors to the waste bunker will be kept shut. If necessary fresh waste will be used to cap older waste to minimise odours. A water-based deodoriser may also be hired to assist in odour management.

2.5 Monitoring Methods

2.5.1 Emissions Monitoring

Sampling and analysis of all regulated pollutants will be carried out to the relevant CEN or equivalent standards (e.g. ISO, national, or international standards). This ensures the provision of data of an equivalent scientific quality.

The Facility will be equipped with modern monitoring and data logging devices to enable checks to be made of process efficiency.

The purpose of monitoring has three main objectives:

1. To provide the information necessary for efficient and safe plant operation;
2. To warn the operator if any emissions deviate from predefined ranges; and
3. To provide records of emissions and events for the purposes of demonstrating regulatory compliance.

2.5.1.1 Monitoring Emissions to Air

The following parameters for the emissions from the Facility will be monitored and recorded continuously using a Continuous Emissions Monitoring System (CEMS):

1. Oxygen;
2. Carbon monoxide;

3. Hydrogen chloride;
4. Sulphur dioxide;
5. Nitrogen oxides;
6. Ammonia;
7. Volatile organic compounds (VOCs); and
8. Particulates.

In addition, the oxygen content, water vapour content, temperature and pressure of the flue gases will be monitored so that the emission concentrations can be reported at the reference conditions required by the Industrial Emissions Directive (IED).

Once operational, in addition to the CEMS system, emissions to air from the Facility will be subject to periodic surveillance tests by independent testing company's at frequencies to be agreed with the EA.

In addition to the CEMS system, the following emissions from the Facility will also be monitored by means of periodic spot sampling at frequencies agreed with the Environment Agency:

1. Group 3 Heavy Metals [antimony (Sb), arsenic (As), lead (Pb); Chromium (Cr), Cobalt (Co), Copper (Cu), Manganese (Mn), Nickel (Ni), Vanadium (V)];
2. Cadmium (Cd) and thallium (Tl);
3. Mercury (Hg);
4. Hydrogen fluoride;
5. Dioxins and furans; and
6. Dioxin like PCBs.

The methods and standards used for emissions monitoring will be in compliance with guidance note S5.01 and the IED. In particular, the CEMS equipment will be certified to the MCERTS standard.

Sampling and analysis of all pollutants including dioxins and furans will be carried out to CEN or equivalent standards (e.g. ISO, national, or international standards). This ensures the provision of data of an equivalent scientific quality.

The frequency of periodic measurements will comply with the emission limits within the EP as a minimum. The flue gas sampling techniques and the sampling platform will comply with Environment Agency Technical Guidance Notes M1 and M2.

All monitoring results shall be recorded, processed and presented in such a way as to enable the EA to verify compliance with the operating conditions and the regulatory emission limit values within the EP.

Periodic monitoring will be undertaken by MCERTS accredited stack monitoring organisations.

Reliability

IED Annex VI Part 8 allows a valid daily average to be obtained only if no more than 5 half-hourly averages during the day are discarded due to malfunction or maintenance of the continuous measurement system. IED Annex VI Part 8 also requires that no more than 10 daily averages are discarded per year.

These reliability requirements will be met primarily by selecting MCERTS certified equipment.

Calibration of the CEMS will be carried out at regular intervals as recommended by the manufacturer and by the requirements of BS EN 14181 and the BS EN 15267-3. Regular servicing and maintenance will be carried out under a service contract with the equipment supplier. The CEMS will be supplied with remote access to allow service engineers to provide remote diagnostics.

There will be one dedicated CEMS per combustion line and a stand-by CEMS in the event of a CEMS failure. This will ensure that there is continuous monitoring data available even if there is a problem with one of the duty CEMS.

Start-up and shut-down

The emission limit values under the emission limits within the EP do not apply during start-up and shutdown, but the abatement equipment will operate during start-up and shutdown. Therefore, a signal will be sent from the main plant control system to the CEMS system to indicate when the plant is operational and burning waste. The averages will only be calculated when this signal is sent, but raw monitoring data will be retained for inspection.

Start-up ends when all the following conditions are met:

1. The temperature within the combustion chamber is greater than 850°C.
2. The waste feeding prohibition is off, and the grate is covered by at least 80% waste.
3. The flue gas abatement system start-up sequence is completed.
4. The auxiliary burners have ceased operation following start-up.
5. Process measurements of dry O_2 are below 11%.
6. The automatic combustion control is set in auto mode.

Shutdown begins when all the following conditions are met:

1. Prohibition is activated;
2. The feed chute damper is closed once the waste hopper is empty;
3. The flue gas treatment systems are running;
4. The auxiliary burner is maintaining the temperature at greater than 850°C within the boiler;
5. The waste on the grates is burnt off; and
6. The temperature curve is followed as necessary.

2.5.1.2 Monitoring emissions to water

There will be no emissions of process effluent to water. Therefore, it is not proposed to undertake monitoring of emissions to water from the Facility.

2.5.2 Monitoring of process variables

The Facility will be controlled from a dedicated Control Room. A modern control system, incorporating the latest advances in control and instrumentation technology, will be utilised to control operations, optimising the process relative to efficient heat release, good burn-out and minimum particle carry-over. The system will control and/or monitor the main features of the plant operation including, but not limited to the following:

- Combustion air;
- Fuel feed rate;
- SNCR system;
- Flue gas oxygen concentration at the boiler exit;
- Flue gas composition at the stack;
- Combustion process;
- Boiler feed pumps and feedwater control;
- Steam flow at the boiler outlet;

- Steam outlet temperature;
- Boiler drum level control;
- Flue gas control;
- Power generation; and
- Steam turbine exhaust pressure.

The response times for instrumentation and control devices will be designed to be fast enough to ensure efficient control.

The following process variables have particular potential to influence emissions:

1. Fuel throughput will be recorded to enable comparison with the design throughput. As a minimum, daily and annual throughput will be recorded;
2. Combustion temperature will be monitored at a suitable position to demonstrate compliance with the requirement for a residence time of 2 seconds at a temperature of at least 850°C;
3. The differential pressure across the bag filters will be measured, in order to optimise the performance of the cleaning system and to detect bag failures; and
4. The concentration of hydrogen chloride in the flue gases upstream of the flue gas treatment system will be measured in order to optimise the performance of the emissions abatement equipment.

Water use will be monitored and recorded regularly at various points throughout the process to help highlight any abnormal usage. This will be achieved by monitoring the incoming water supplies and the boiler water makeup.

In addition, electricity and auxiliary fuel consumption will be monitored to highlight any abnormal usage.

2.5.2.1 Validation of combustion conditions

The Facility will be designed to provide a residence time, after the last injection of combustion air, of more than two seconds at a temperature of at least 850°C. This criterion will be demonstrated using Computational Fluid Dynamic (CFD) modelling during the design stage and confirmed by the recognized measurements and methodologies during commissioning in accordance with EPR5.01 and WRc guidance Note, titled '*Review of BAT for New Waste Incineration Issues: Part 2 Validation of Combustion Conditions*'.

It will also be demonstrated during commissioning that the Facility can achieve complete combustion by measuring concentrations of carbon monoxide, VOCs and dioxins in the flue gases and TOC of the bottom ash.

During the operational phase, the temperature at the 2-seconds residence time point will be monitored to ensure that it remains above 850°C. The location of the temperature probes will be selected using the results of the CFD model. If it is not possible to locate the temperature probes at precisely the 2-seconds residence time point, then a correction factor will be applied to the measured temperature.

Ammonia will be injected into the flue gases at a temperature of between 850 and 1,050°C. This narrow temperature range is needed to reduce NOx successfully and avoid unwanted secondary reactions. This means that multiple levels of injection points will be required in the radiation zone of the furnace.

Sufficient nozzles will be provided at each level to distribute the ammonia correctly across the entire cross section of the radiation zone. CFD modelling will be used to define the appropriate location and number of injection levels as well as number of nozzles to make sure the SNCR system achieves the required reduction efficiency for the whole range of operating conditions while maintaining the ammonia slip below the required emission level.

The CFD modelling will also be used to optimise the location of the secondary air inputs into the combustion chamber.

2.5.2.2 Measuring oxygen levels

The oxygen concentration at the boiler exit of the Facility will be monitored and controlled to ensure that there will always be adequate oxygen for complete combustion of combustible gases. Oxygen concentration will be controlled by regulating the combustion airflows and the waste feed rate.

2.6 Technology selection (BAT)

Within this section, qualitative and quantitative BAT assessments have been presented for the following:

- combustion technology;
- NOx abatement technology;
- acid gas abatement technology;
- particulate matter; and
- steam condenser.

Where appropriate, the quantitative assessments draw on information and data obtained by Fichtner from a range of different projects using the technologies which have been identified as potentially representing BAT from an initial qualitative assessment.

2.6.1 Combustion technology

It is proposed that the waste treatment/energy recovery technology for the Facility will be a moving grate furnace. This is the leading technology in the UK and Europe for the combustion of the fuel types likely to be treated by the Facility. The moving grate comprises of inclined fixed and moving bars that will move the fuel from the feed inlet to the residue discharge. The grate movement turns and mixes the fuel along the surface of the grate to ensure that all fuel is exposed to the combustion process.

The Waste Incineration BREF and the BREF for Large Combustion Plants identify a number of alternative technologies for the combustion of waste fuels. The suitability of these technologies has been considered including different waste incineration technologies, as follows:

1. **Grate furnaces**

   As stated in the Sector Guidance Note, these are designed to handle large volumes of waste.

   Grates are the leading technology in the UK and Europe for the combustion of non-hazardous waste, such as that proposed to be treated at the Facility. The moving grate comprises an inclined fixed and moving bars (or rollers) or a vibrating grate that will move the fuel from the feed inlet to the residue discharge. The grate movement turns and mixes the fuel along the surface of the grate to ensure that all waste is exposed to the combustion process.

   Grate systems are designed for large quantities of heterogeneous waste, and so would be appropriate for the fuel to be processed at the Facility.

2. **Fixed hearth**

   These are not considered suitable for large volumes of waste. They are best suited to low volumes of consistent waste. Therefore, these systems are not considered suitable for the proposed design capacity and have not been considered any further.

3. **Pulsed hearth**

   Pulsed hearth technology has been used in the past for the combustion of waste derived fuels, such as those proposed in the Facility. However, there have been difficulties in achieving reliable and effective burnout of the waste and it is considered that the burnout criteria required by Article 50 (1) of the IED would be difficult to achieve. Therefore, these systems are not considered practical and have not been considered any further.

4. **Rotary and oscillating kilns**

   Rotary kilns are used widely within the cement industry which uses a consistent fuel feedstock and they have been used widely within the healthcare sector in treating clinical waste, but they have not been used in the UK for large volumes of waste derived fuels. The energy conversion efficiency of a rotary kiln is lower than that of other thermal treatment technologies due to the large areas of refractory lined combustion chamber.

   An oscillating kiln is used for the incineration of municipal waste at only two currently known sites in England and some sites in France. The energy conversion efficiency in these systems is lower than that of other thermal treatment technologies due to the large areas of refractory lined combustion chamber.

   The capacity per rotary or oscillating kiln unit is limited to 8 tonnes per hour, and for this application nearly seven kilns would be required to achieve the maximum design throughput. Considering the proposed capacity of the Facility, this is not considered practical and would lead to significant efficiency losses, therefore this option has not been considered any further

5. **Fluidised bed combustor**

   Fluidised beds are designed for the combustion of relatively homogeneous fuel. They are sensitive to inconsistencies within a fuel. Therefore, fluidised beds are appropriate for waste which has been pre-processed to produce an RDF, and so are not necessarily appropriate for wastes which have not been prepared as a fuel.

   While fluidised bed combustion can lead to slightly lower NOx generation, the injection of a NOx reagent is still required to achieve the relevant BAT-AEL's.

   Fluidised beds can have elevated emissions of nitrous oxide, a potent greenhouse gas. Some have been designed to minimise the formation of nitrous oxide.

6. **Pyrolysis/Gasification**

   In pyrolysis, the waste is heated in the absence of air, leading to the production of a syngas with a higher calorific value than from gasification. However, the process normally requires some form of external heat source, which may be from the combustion of part of the syngas.

   Various suppliers are developing pyrolysis and gasification systems for the incineration of waste derived fuels, however, systems such as these are not considered to be a robust and proven technology. Therefore, these systems have not been considered any further.

A quantitative BAT assessment for a grate and conventional fluidised bed has been undertaken and is presented in Appendix F, section 2. The conclusions of the assessment are summarised in the table below.

Table 8: BAT assessment – combustion techniques

Parameter	Units	Grate	Fluidised bed
Global warming potential	t CO2 eq p.a.	-107,000	-106,000
Ammonia consumption	t.p.a.	1,300	1,000
Residues (total ash)	t.p.a	118,000	123,100
Annual total materials cost (reagents plus residues)	p.a.	£4,960,000	£5,450,000
Annual power revenue	p.a.	£18,480,000	£18,240,000

The grate has a lower global warming potential than the fluidised bed, but would consume more ammonia during standard operation. On the other hand, the use of a fluidised bed will generate more residues than the moving grate and will have higher operating costs. These differences, while noticeable, are acknowledged to be marginal. This assessment is based on the assumption that the incoming waste will not require any additional pre-processing to be suitable for combustion within a fluidised bed. If the waste did require additional treatment this will significantly increase the material costs associated with the fluidised bed.

As stated above within the qualitative BAT assessment, grate combustion systems are designed for large quantities of heterogenous waste, whereas fluidised bed systems are more sensitive to inconsistencies within the fuel. The Operator has significant knowledge of moving grate systems; and does not consider that a fluidised bed is a suitable technology for the treatment of waste proposed to be processed at the Facility. Due to the robustness of grate combustion systems, and the fact that they are proven for the processing of waste at the existing Lakeside EfW, they are considered to represent BAT for the Facility.

2.6.2 NOx abatement systems

As stated within the relevant Environment Agency guidance document for Waste Incineration (EPR5.01), there are three recognised technologies available for the abatement of emissions of NOx:

1. Flue Gas Recirculation (FGR);
2. Selective Non-Catalytic Reduction (SNCR); and
3. Selective Catalytic Reduction (SCR).

1. **Flue gas recirculation (FGR)**

   For the purposes of the report, it is currently assumed that the Facility will not employ FGR. However, this is subject to discussions with technology providers during detailed design.

   It is important to understand that FGR is not a bolt-on NOx abatement technique. The recirculation of a proportion of the flue gases into the combustion chamber to replace some of the secondary air changes the operation of the plant in various ways, by changing the temperature balance and increasing turbulence. This requires the boiler to be redesigned to ensure that the air distribution remains even.

   Some suppliers of grates have designed their combustion systems to operate with FGR and these suppliers can gain benefits of reduced NOx generation from the use of FGR. Other suppliers of grates have focussed on reducing NOx generation through the control of primary and secondary air and the grate design, and these suppliers gain little if any benefit from the use of FGR.

It is also important to emphasise that, even where FGR does improve the performance of a combustion system, it does not reduce NOx emissions to the levels required by IED. Therefore, it would not alleviate the need for further NOx abatement systems.

2. **Selective non-catalytic reduction**

SNCR involves distributing a spray containing an aqueous ammonia or aqueous urea solution (the de-NOx reagent) into the flue gas flow path at an appropriate location (typically the secondary combustion chamber), at a gas temperature of 850 to 1,050°C. The reagent reacts with the NOx formed in the combustion process to produce a combination of nitrogen, water and carbon dioxide (when urea is used as the reagent). NOx levels are primarily controlled by monitoring the combustion air.

Extensive dosing of reagent or low reaction temperatures can lead to ammonia slip, resulting in the formation of ammonia salts downstream in the flue gas path and discharge to atmosphere of unreacted ammonia. Ammonia may be controlled under the plant's permit and can lead to secondary problems, so should be kept to a minimum. This can be addressed by employing systems to control the rate of reagent dosing.

SNCR is widely deployed across waste, biomass and coal power plants in the UK and Europe. It is proposed to use SNCR for the Facility to control NOx levels, alongside the monitoring of combustion air. Ammonia solution will be used as the SNCR reagent.

3. **Selective catalytic reduction**

The use of Selective Catalytic Reduction (SCR) has also been considered. In this technique, ammonia or urea solution is injected into the flue gases immediately upstream of a reactor vessel containing layers of catalyst. The NOx is converted into nitrogen, water and carbon dioxide, with the reaction most efficient in the temperature range 200 to 350°C.

The catalyst is expensive, and to achieve a reasonable working life it is necessary to install the SCR downstream of the flue gas treatment plant. This is because the flue gas treatment plant removes dust which would otherwise cause deterioration of the catalyst.

The reaction takes place at lower temperatures than SNCR methods, however, since the other flue gas cleaning reactions take place at an optimum temperature of approximately 140°C, the flue gases have to be reheated before entering the SCR. This requires some thermal energy which would otherwise be converted to electrical power output, reducing the overall energy recovery efficiency of the facility. The catalytic reactor also creates additional pressure losses to be compensated by a bigger exhaust fan, reducing further the overall energy efficiency.

SCR systems are considerably more complicated and more capital intensive than SNCR systems.

A quantitative BAT assessment of the available technologies has been undertaken and is presented in Appendix F, section 3. This assessment uses data obtained by Fichtner from a range of different projects using the technologies proposed in this application.

Table 9: BAT assessment – NOx abatement

Parameter	Units	SNCR	SCR	SNCR + FGR
NOx released after abatement	t p.a.	290	140	290
NOx abated	t p.a.	570	720	510
Photochemical Ozone Creation Potential (POCP)	t ethylene-eq p.a.	-11,100	-5,300	-11,100

Parameter	Units	SNCR	SCR	SNCR + FGR
Global Warming Potential	t CO2 p.a.	1,400	4,600	1,800
Ammonia used	t.p.a.	1,300	300	1,160
Total annualised cost	£ p.a.	£618,000	£2,778,000	£820,000
Average cost per tonne NOx abated	£ p.t NOx.	£1,080	£3,860	£1,610

As can be seen from the table above, applying SCR to the Facility:

1. increases the annualised costs by approximately £2.1 million compared to an SNCR system;
2. abates an additional 150 tonnes of NOx per annum compared to an SNCR system;
3. reduces the benefit of the facility in terms of the global warming potential by approximately 3,200 tonnes of CO_2 compared to an SNCR system;
4. reduces reagent consumption by approximately 1,000 tonnes per annum compared to an SNCR system; and
5. costs approximately 360% more per tonne of NOx abated more than an SNCR system.

The additional costs associated with SCR are not considered to represent BAT for the Facility. On this basis, SNCR is considered to represent BAT.

Including FGR to the SNCR system to abate NOx increases the cost per tonne of NOx abated by approximately 50%. It has no effect on the direct environmental impact of the plant, but it increases the impact on climate change by approximately 400 tonnes of CO_2 per annum while reducing ammonia consumption by approximately 140 tonnes per annum. Allowing for the increase in the costs of NOx abatement for a SCR system compared to the climate change and reagent consumption associated with FGR, an SNCR system with or without FGR is considered to represent BAT for the abatement of NOx within the Facility.

It is currently understood that the proposed designs do not include FGR. However, this is subject to discussions with the technology provider during detailed design.

2.6.3 Acid gas abatement system

There are currently three technologies widely available for acid gas treatment on similar plants in the UK.

1. Wet scrubbing, involving the mixing of the flue gases with an alkaline solution of sodium hydroxide or hydrated lime. This has a good abatement performance, but it consumes large quantities of water, produces large quantities of liquid effluent which require treatment and has high capital and operating costs. It is mainly used in the UK for hazardous waste incineration plants where high and varying levels of acid gases in the flue gases require the buffering capacity and additional abatement performance of a wet scrubbing system.
2. Semi-dry, involving the injection of quick lime as a slurry into the flue gases in the form of a spray of fine droplets. The acid gases are absorbed into the aqueous phase on the surface of the droplets and react with the quick lime. The fine droplets evaporate as the flue gases pass through the system, cooling the gas. This means that less energy can be extracted from the flue gases in the boiler, making the steam cycle less efficient. The quick lime and reaction products are collected on a bag filter, where further reaction can take place.
3. Dry, involving the injection of lime or sodium bicarbonate into the flue gases as a powder. The reagent is collected on a bag filter to form a cake and most of the reaction between the acid

gases and the reagent takes place as the flue gases pass through the filter cake. In its basic form, the dry system consumes more reagent than the semi-dry system. However, this can be improved by recirculating the flue gas treatment residues, which contain some unreacted lime and reinjecting this into the flue gases.

Wet scrubbing is not considered to be suitable for the Facility, due to the production of a large volume of hazardous liquid effluent, a reduction in the power generating efficiency of the plant and the generation of a visible plume.

Dry and semi-dry systems can easily achieve the BAT AELs required by the BREF and both systems have been demonstrated to achieve the proposed emission limits on operational plants in the UK and Europe, as presented within the Draft BREF. Furthermore, both are considered to represent BAT within EPR5.01. The advantages and disadvantages of each technique are varied which makes assessment complex; therefore, the assessment methodology described in Horizontal Guidance Note H1 has been used and is detailed in Appendix F section 4.

For the purposes of this application we have undertaken a quantitative assessment of the available technologies for the proposed capacity using data obtained by Fichtner from a range of different projects using the technologies identified within this assessment.

The table below compares the options available.

Table 10: BAT assessment – acid gas abatement

Parameter	Units	Dry	Semi-dry
SO_2 abated	t.p.a.	1,200	1,200
Photochemical Ozone Creation Potential (POCP)	t-ethylene eq	430	430
Global Warming Potential	tn-CO_2 eq p.a.	4,600	9,100
Additional water consumption compared to a dry system	t.p.a.		42,863
APC residues	t.p.a	18,000	17,700
Annualised cost	£ p.a.	£8,691,000	£9,753,000

The performance of the options is very similar.

The dry system only requires a small quantity of water for conditioning of the lime so that it is suitable for injection into the reaction chamber, whereas the semi-dry system requires the lime to be held in solution (quick lime). This requires significantly more water than a dry system.

The dry system has a reduced global warming potential and a reduced annualised cost However, the semi-dry option benefits from medium reaction rates that mean that a shorter residence time is required in comparison with a dry system. In addition, within a semi-dry system recycling of reagent within the process is not proven, but it is proven in a dry system.

Due to the low water consumption and proven capability for recycling of reagents, the dry system is considered to represent BAT for the Facility.

2.6.4 Particulate matter abatement

The Facility will use a multi-compartment fabric filter for the control of particulates. There are a number of alternative technologies available, but none offer the performance of the fabric filter. Fabric filters represent BAT for this type of thermal treatment plant for the following reasons:

1. Fabric filters are a proven technology and are used in a wide range of applications. The use of fabric filters with multiple compartments, allows individual bag filters to be isolated in case of individual bag filter failure.
2. Wet scrubbers are not capable of meeting the same emission limits as fabric filters.
3. Electrostatic precipitators are also not capable of abating particulates to the same level as fabric filters. They could be used to reduce the particulate loading on the fabric filters and so increase the acid gas reaction efficiency and reduce lime residue production, but the benefit is marginal and would not justify the additional expenditure, the consequent increase in power consumption and significant increase in the carbon footprint of the Facility.
4. Ceramic Filters have not been proven for this type of waste incineration plant design and are regarded as being more suited to high temperature filtration.

Fabric filters are considered to represent BAT for the removal of particulates for this Facility.

The bag filter will not require a flue gas bypass station, as the bag filters will be preheated allowing start-up without a bypass, which is considered to represent BAT.

For plants which include a bypass in their design, there is a risk that during normal operation, pollutant residues can build up in the inlet duct to a bypass station. If the bypass is then operated during start-up, as is common until the bag filter is at operating temperature, these residues will be emitted from the stack with no abatement.

2.6.5 Steam condenser

There are three potential BAT solutions considered in Sector Guidance Note EPR 5.01 as representing indicative BAT for the Facility, which are:

- Once-Through Cooling (OTC);
- Evaporative Condenser; and
- Air Cooled Condenser (ACC).

Water cooling can be achieved through once-through cooling systems or by a recirculating water supply to condense the steam. Both cooling systems require significant quantities of water, and a receiving watercourse for the off-site discharge of cooling water. In addition, a water abstraction source is needed, with mains water not an economically viable option.

Nearby waterbodies to the Facility include Colne Brook, and the lakes/ponds to the east such as Orlitts Lake and Old Slade Lake. Sill water bodies such as lakes and ponds are not considered to be a suitable supply of water due to cooling systems. In addition, the potential heating effects on the brook from the discharge of cooling water may have the potential to negatively affect the local freshwater ecosystem. Taking this into consideration, water cooling (and the use of evaporative condensers) is not considered to be available technology for cooling in the Facility.

Evaporative condenser systems use water which is evaporated directly from the condenser surface and lost to the atmosphere to provide the required cooling. They also require large volumes of water, and can create a visible plume from the condenser which will have a visual impact. As previously described, suitable options for water abstraction and discharge have not been suitably identified. Should a source be identified, the costs of discharging large volumes of abstracted water to sewer would still be significant. Taking all points into consideration, the use of evaporative condensers is not considered to be a suitable technology for cooling in the Facility.

ACCs do not require significant quantities of water. It is acknowledged that ACC's can have noise impacts, but mitigation measures can be applied to the design to ensure that the noise impacts associated with the ACC's are at an 'acceptable' level. Furthermore, ACC's do not create a visual impact (visible plume), unlike that from evaporative cooling.

The ACCs will be designed and guaranteed by the technology supplier with enough additional capacity to maintain turbine efficiency during any warmer summertime periods.

Taking the above into consideration, ACCs are considered to represent BAT for the Facility.

2.7 Specific requirements of the Industrial Emissions Directive (2010/75/EU)

This section presents information on how the Facility will comply with the Waste Incineration requirements of the Industrial Emissions Directive (IED).

Chapter IV of the IED includes 'Special Provisions for Waste Incineration Plants and Waste Co-incineration Plants'. Review of provisions for waste incineration as presented in the IED has identified that the following requirements could be applicable to the Facility:

- Article 46 – Control of Emissions;
- Article 47 – Breakdown;
- Article 48 – Monitoring of Emissions;
- Article 49 – Compliance with Emission Limit Values;
- Article 50 – Operating Conditions;
- Article 52 – Delivery & Reception of Waste;
- Article 53 – Residues; and
- Article 55 – Reporting & public information on waste incineration plants and waste co-incineration plants.

The following table identifies the relevant Articles of the IED and explains how the Facility will comply with them. Many of the articles in the IED impose requirements on regulatory bodies, in terms of the permit conditions which must be set, rather than on the operator. The table below only covers those requirements which the IED imposes on 'Operators' and either explains how this is achieved or refers to a section of the application where an explanation can be found.

Table 11: Summary table for IED compliance

Article	Requirement	How met or reference
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	Refer to Appendix B – Site Condition Report.

Article	Requirement	How met or reference
	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.	
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;	Refer to Section 2.2.1 of the Supporting Information.
	(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;	Refer to section 2.8 of the Supporting Information and Appendix G.
	(c) the residues will be minimised in their amount and harmfulness and recycled where appropriate;	Refer to Section 2.9 of the Supporting Information.
	(d) the disposal of the residues which cannot be prevented, reduced or recycled will be carried out in conformity with national and Union law.	Refer to Section 2.9 of the Supporting Information.
46 (1)	Waste gases from waste incineration plants and waste co-incineration plants shall be discharged in a controlled way by means of a stack the height of which is calculated in such a way as to safeguard human health and the environment.	Refer to Appendix E – Air Quality Assessment.
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	Refer to section 2.4.1.

Article	Requirement	How met or reference
	Annex VI or determined in accordance with Part 4 of that Annex.	
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.	Refer to Appendix B – Site Condition Report, and Appendix D – 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.	Refer to Abnormal Emissions Assessment - Appendix E.
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.	Refer to Section 1.4.8 of the Supporting Information.
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.	Refer to Section 2.5.1.1 of the Supporting Information.
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.	Refer to Section 2.5.1 of the Supporting Information.
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.	There will be no emissions from flue gas treatment systems to water/sewer from the waste incineration plant.

Article	Requirement	How met or reference
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 ignition is less than 5% of the dry weight of the material. If necessary, waste pre-treatment techniques shall be used.	Refer to section 2.5.2.1. TOC or LOI testing.
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.	Refer to Section 2.2.3.6 of the Supporting Information.
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 shut-down 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.	Refer to Sections 2.2.3.6 and 2.1.3.3 of the Supporting Information.
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;	Refer to Section 2.2.3.6 of the Supporting Information.
	(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;	Refer to Section 2.2.3.6 of the Supporting Information.
	(c) whenever the continuous measurements show that any emission limit value is exceeded due to	Refer to Section 2.2.3.6 of the Supporting Information.

Article	Requirement	How met or reference
	disturbances or failures of the waste gas cleaning devices.	
50 (5)	Any heat generated by waste incineration plants or waste co-incineration plants shall be recovered as far as practicable.	Refer to section 2.8 of the Supporting Information and Appendix G.
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.	This requirement will not apply as the Facility will not receive infectious clinical waste.
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.	Refer to Section 2.2 and 2.4.7 of the Supporting Information.
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.	Refer to Section 2.2.1 of the Supporting Information.
53 (1)	Residues shall be minimised in their amount and harmfulness. Residues shall be recycled, where appropriate, directly in the plant or outside.	Refer to Sections 2.2.3 and 2.9 of the Supporting Information.
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.	Refer to Section 2.9 of the Supporting Information.
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.	Refer to Section 2.9 of the Supporting Information.

2.8 Energy efficiency

2.8.1 General

The Facility will utilise steam boilers which will generate steam to be supplied to a turbine, for electricity generation and subsequent export off-site. Heat will also be generated and potentially exported off-site in the future.

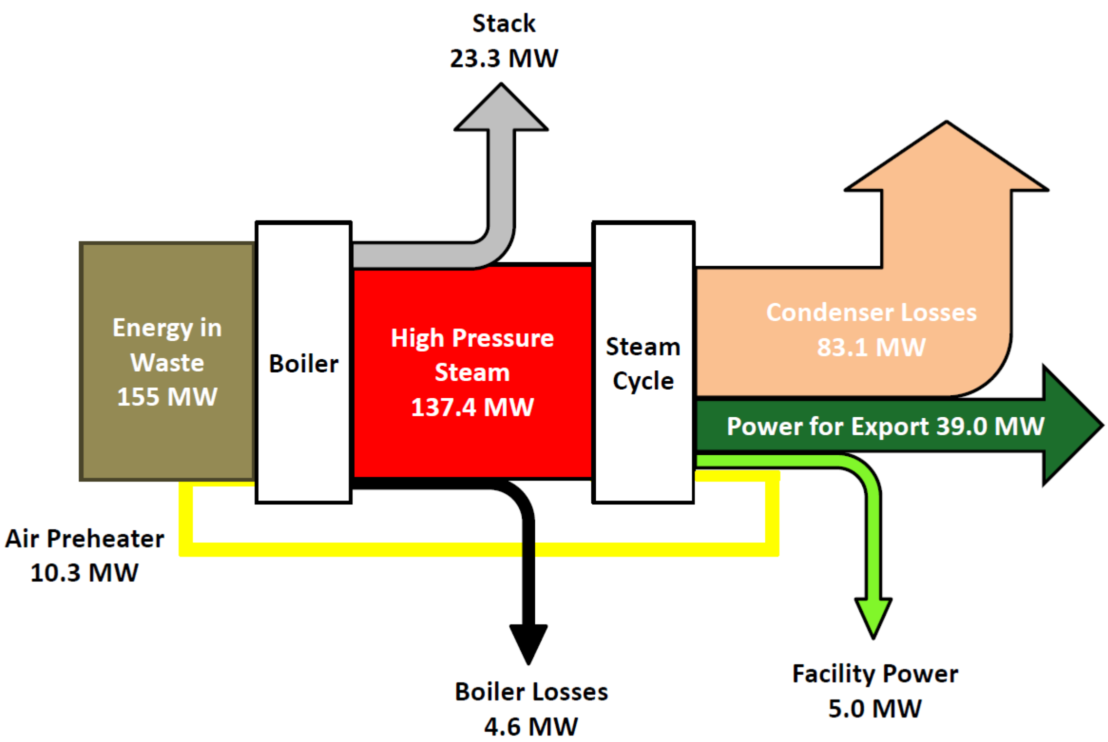
In case of failure of the electricity supply, an emergency diesel generator will be provided to safely shut down the Facility and to provide an emergency supply to the rest of the Facility.

In considering the energy efficiency of the Facility, due account has been taken of the requirements of DEFRA and EA guidance titled *'Energy efficiency standards for industrial plants to get environmental permits'*, dated February 2016.

2.8.2 Basic Energy Requirements

An indicative Sankey Diagram for the waste incineration plant for the 'no heat export' case is presented in Figure 3 below.

Figure 3: Indicative Sankey diagram for No Heat Case



The Facility has been designed to generate up to 44 MWe gross power and is capable of exporting up to 20 MWth of heat. However, from the heat users identified in the CHP assessment (refer to Appendix G), the potential heat export identified is a maximum of approximately 1MWth. The Facility will have a parasitic load of 5 MWe, therefore it will be capable of exporting up to 39 MWe of power.

The plant will have a nominal design capacity of approximately 55.8 tonnes per hour of fuel, distributed across both lines, with a net calorific value of 10.0 MJ/kg. Assuming an operational availability of 7,884 hours per annum, the nominal design capacity of the plant is approximately 440,000 tonnes per annum. Therefore, the Facility will annually generate approximately 347,000 MWh and export 308,000 MWh of electricity.

In the table below, these figures are compared with the benchmark data for MSW incineration plants, given in the Environment Agency Sector Guidance Note EPR5.01 and in the BREF for Waste Incineration (BREF WI).

Table 12: Facility design parameters comparison table

Parameter	Unit	Lakeside EfW	Benchmark
Gross power generation, nominal design	MWh/t waste	0.800	0.415-0.644

Parameter	Unit	Lakeside EfW	Benchmark
Net power generation, nominal design	MWh/t waste	0.708	0.279-0.458
Internal power consumption, nominal design	MWh/t waste	0.091	0.15
Power generation (assumed gross) for 100,000 tpa of waste	MWe	10	5-9

Benchmark sources: EPR 5.01 for power generation per 100,000 tpa of waste, BREF WI otherwise

2.8.2.1 Energy consumption and thermal efficiency

The most significant energy consumers are anticipated to be the following:

- primary and secondary combustion air fans;
- Induced Draft fans;
- boiler feed water pumps;
- ACC fans;
- air compressors;
- fuel loading systems and residue conveying systems; and
- offices and ancillary rooms.

The Facility has been designed with careful attention being paid to all normal energy efficiency design features, such as high efficiency motors, high efficiency variable speed drives, high standards of cladding and insulation etc.

The Facility will also be designed to achieve a high thermal efficiency. In particular:

- The boiler will be equipped with economisers and superheaters to optimise thermal cycle efficiency without prejudicing boiler tube life, having regard for the nature of the waste fuel that is combusted;
- Unnecessary releases of steam and hot water will be avoided, to avoid the loss of boiler water treatment chemicals and the heat contained within the steam and water;
- Low grade heat will be extracted from the turbine and used to preheat combustion air in order to improve the efficiency of the thermal cycle;
- Steady operation will be maintained where necessary by using auxiliary fuel firing; and
- Boiler heat exchange surfaces will be cleaned on a regular basis to ensure efficient heat recovery.
- The Facility has been designed to achieve R1 status, with verification tests undertaken after 1 year of running.

Due consideration will be given to the recommendations given in the relevant Sector Guidance Notes.

2.8.2.2 Operating and Maintenance procedures

An O&M manual and procedures will be developed for the Facility. The O&M manual and procedures will include for the following aspects:

1. Good maintenance and housekeeping techniques and regimes across the whole plant.

2. Plant Condition Monitoring will be carried out on a regular basis. This will ensure, amongst other things, that motors are operating efficiently, insulation and cladding are not damaged and that there are no significant leaks.
3. Operators will be trained in energy awareness and will be encouraged to identify opportunities for energy efficiency improvements.

Due consideration would be given to the recommendations given in the Environment Agency sector guidance on waste incineration, titled *'Incineration of waste (EPR5.01)'* and waste treatment activities *'Recovery and disposal of hazardous and non-hazardous waste (S5.06)'*.

2.8.2.3 Energy efficiency measures

An energy efficiency plan will be built into the operation and maintenance procedures of the Facility ensuring maximum practical, sustainable, safe and controllable electricity generation. This plan will be reviewed regularly as part of the environmental management systems.

During normal operation, procedures will be reviewed and amended, where necessary, to include improvements in efficiency as and when proven new equipment and operating techniques become available. These are assessed on the implementation cost compared with the anticipated benefits.

The management team will apply for ISO 50001 once the plant is operational.

2.8.3 Further energy efficiency requirements

In accordance with the requirements of the IED, heat must be recovered as far as practicable. In order to demonstrate this, the following points should be noted.

1. Economisers are installed to recover flue gas heat, compatibly with the temperature requirements of the flue gas treatment system.
2. The boiler will operate with superheated steam.

The Facility will not be subject to a Climate Change Levy agreement.

A CHP assessment has been developed for the Facility and is presented within Appendix G.

2.9 Residue recovery and disposal

2.9.1 Introduction

The main residue streams arising from the facility are:

1. Incinerator Bottom Ash; and
2. Air Pollution Control residues.

As described below, the waste recovery and disposal techniques will be in accordance with the indicative BAT requirements.

Prior to the transfer of residues to any residues off-site, where appropriate, the residues will be tested in accordance with the requirements of Technical Guidance WM2: '*Hazardous Waste: Interpretation of the definition and classification of hazardous waste*'.

Any materials which are to be transferred to landfill from the Facility will be Waste Acceptance Criteria (WAC) tested – leachability tested – to ensure that they meet the WAC for the landfill that they are to be transferred to.

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, Lakeside EfW Ltd will review the options for the recovery and recycling of all residues generated by the Facility.

2.9.2 Air Pollution Control residue

APCr is predominantly composed of calcium as hydroxide, carbonate, sulphate and chloride/hydroxide complexes. Typical major element concentration ranges for the UK residues are as follows:

- 30-36% w/w calcium;
- 12-15% w/w chlorine;
- 8-10% w/w carbonate (as C); and
- 3-4% w/w sulphate (as S).

Silicon, aluminium, iron, magnesium and fluorine are also present in addition to traces of dioxins and the following heavy metals: zinc, lead, manganese, copper, chromium, cadmium, mercury, and arsenic.

APCr is classified as hazardous (due to its elevated pH) in accordance with EA technical guidance *'WM3: Waste Classification – Guidance on the classification and assessment of waste'*. Hazardous waste requires specialist landfill disposal or treatment. It may be possible to send the residue to an effluent treatment contractor, to be used to neutralise acids and similar materials, or to another licensed waste management facility for recycling/treatment. Using the residues in this way avoids the use of primary materials. If these options are not available, it will be sent to a suitably licensed hazardous waste landfill for disposal as a hazardous waste.

APCr will be removed from site in enclosed tankers thereby minimising the chance of spillage and dust emissions. During the tanker filling operation displaced air would vent back to the silo, and any potential releases to atmosphere would pass through a fabric filter, preventing the release of fugitive dusts from unloading.

2.9.3 Incinerator Bottom Ash

Ash which is collected in the boiler (boiler ash) will be mixed with ash which comes off the end of the grate (bottom ash). The mixture of boiler ash and bottom ash, known as IBA, is normally a non-hazardous waste which can be recycled. If the boiler ash were to be mixed with the APCr, the mixture would be defined as hazardous waste and this would restrict the ability of the operator to transfer the boiler ash for recovery.

IBA has been used for at least 20 years in Europe as a substitute for valuable primary aggregate materials in the construction of roads and embankments. Lakeside EfW Ltd intend to transfer IBA from the waste incineration plant to an off-site IBA processing facility. If a suitable recovery facility will not accept the residue, it may be transferred for disposal in an off-site non-hazardous landfill.

Ash handling will be undertaken in enclosed buildings, with the ash maintained wet from quenching to prevent the fugitive release of any dust emissions off site. In addition, any overflow from the ash quench will be contained in the process effluent drainage system and hence will not be released off-site.

2.9.4 Summary

The expected quantities and properties of the main residue streams generated from the operation of the Facility are summarised in Table 13.

Table 13: Key residue streams from the Facility

Source/ Material	Properties of Residue	Storage location/ volume stored	Future annual quantity of residue produced (estimate)	Disposal Route and Transport Method	Frequency
IBA	Grate ash. This ash is relatively inert, classified as non-hazardous.	IBA storage area, approximately 1,500 tonnes (4 days') capacity	100,000 tonnes	To be removed from site for processing and recycling into secondary aggregate.	Daily
Fly Ash / APCr	Ash from the boiler and flue gas treatment, may contain some unreacted lime.	2 silos, approximately 320 tonnes (6 days') storage capacity	18,000 tonnes	Transfer to hazardous landfill for disposal.	Daily

2.10 Management

As defined in the Regulation 7 of the Environmental Permitting Regulations, the operator is 'the person who has control over the operation of a regulated facility'. Lakeside EfW Ltd will directly manage the day-to-day operation of the Facility. As such, Lakeside EfW Ltd will retain control of the Facility.

Lakeside EfW Ltd currently operate the existing Lakeside EfW facility in accordance with an integrated management system (IMS) which has been accredited to the BS EN ISO 14001, ISO 9001, ISO 50001 and OHSAS 18001 standards. Lakeside EfW Ltd propose that the existing management systems are transferred to the Facility.

The existing IMS defines the management structure as well as setting out roles and responsibilities of all staff. The IMS includes an Environmental Policy, Health and Safety Procedures and an Operation Guidance Manual which includes process plant operating procedures for both standard and emergency conditions. The Construction Design and Management Regulations will apply during the construction and commissioning period. In addition, management undertake inspections and reviews for quality control, performance measurements and staff appraisals.

Lakeside EfW Ltd regards the ISO 14001 certification to be of considerable importance and relevance to a waste treatment facility. It is an assurance to local authorities, regulator, neighbours, and others alike that the Facility's operation is undertaken in strict compliance with the regulations in force and with the management seeking continual improvements. It requires the company to work in a transparent way, to maintain and improve the confidence of regulators and neighbours, and to have a proactive approach to environmental improvement.

2.10.1 Scope and structure

The scope of the ISO 14001 certification will cover the receipt, handling and combustion of waste fuels and the transfer of residues off-site.

The scope of the ISO 14001 certification for the plant will cover three key areas. These are:

- The design and development of the plant;
- The operation of the plant; and
- The processing of controlled waste.

Where applicable, documented procedures will detail specifically how each activity is to be controlled. These will be contained in the Environmental Procedures Manual and identified related documents.

The site EMS will contain procedures for accident management that comply with the requirements set out in Agency guidance "*How to comply with your Environmental Permit*" EPR1.00. This will be in the form of an accident management plan that will be developed before the plant is commissioned.

2.10.2 General requirements

Lakeside EfW Ltd will maintain the IMS in accordance with the ISO 14001 standard. The IMS objectives and scope will ensure that the O&M contractor meets these requirements by:

- Identifying potential environmental impacts;
- Documenting and implementing standard procedures to mitigate and control these impacts;

- Determining a procedural hierarchy that considers the interaction of the relevant processes;
- Ensuring adequate responsibility, authority and resources to management necessary to support the IMS;
- Establishing performance indicators to measure the effectiveness of the procedures;
- Monitoring, measuring and analysing the procedures for effectiveness; and
- Implementing actions as required based on the results of auditing to ensure continual improvements of the processes.

2.10.3 Personnel

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 Facility will be managed, operated and maintained by experienced managers, boiler operators and maintenance staff. It is assumed that all staff associated with the operation of the Facility will be transferred from the existing Lakeside EfW facility to the Facility.

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

- The Operations Manager (employed by Lakeside EfW Ltd) will have day-to-day responsibility for operation of the plant, to ensure it is operated in accordance with the requirements of the permit and that environmental impact of operations is minimised. In this context, they would be responsible for designing and implementing operating procedures which incorporate environmental aspects.
- The Director of Operations (or 'General Manager' employed by Lakeside EfW Ltd) will have overall responsibility for the management of the plant, and compliance with the operating permit. This person will be employed by Lakeside EfW Ltd. They will also be responsible for waste management and scheduling. The general manager will have extensive experience relevant to their responsibilities.
- The EHS Manager (employed by Lakeside EfW Ltd) will be responsible for the development and management of the IMS, for the monitoring of authorised releases and for interaction with the Environment Agency.
- The Maintenance Manager (employed by Lakeside EfW Ltd) 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.

2.10.4 Competence, training and awareness

Lakeside EfW Ltd aims to ensure that any persons performing tasks for it, or on its behalf, which have the potential to cause significant environmental impact, are competent on the basis of appropriate education and training or experience.

Lakeside EfW Ltd will implement training procedures to make employees aware of:

- The importance of conformity with the environment policies and procedures and with the requirements of the EMS;
- Potentially significant environmental aspects associated with their work;
- Their roles and responsibilities in achieving conformity with the requirements of the EMS, including emergency preparedness and response requirements;
- The relevance and importance of their activities and how they contribute to the achievement of the environmental and quality objectives; and

- The potential consequences of the departure from specified procedures.

Lakeside EfW Ltd will ensure that the operation of the Facility will comply with industry standards or codes of practice for training (e.g. WAMITAB), where they exist. The EMS will contain an archiving procedure to ensure all training is recorded and all associated records are retained.

2.10.4.1 Competence

Line Managers will identify the minimum competencies required for each role. These will then be applied to the recruitment process to ensure that key role responsibilities are satisfied. Particular attention will be paid to potential candidate’s experience, qualifications, knowledge and skills.

2.10.4.2 Induction and awareness

Staff induction programmes are location and job role specific and will include, as a minimum, the induction of:

- The Environmental Policy;
- The Health and Safety Policy and Procedures; and
- The IMS Awareness Training.

2.10.4.3 Training

Staff training will be completed during commissioning of the Facility and before the plant is operational. Line Managers will identify and monitor staff training needs as part of the appraisal system. The training needs of employees will be addressed using on-the-job training, mentoring, internal training and external training courses/events.

Training records will be maintained onsite. The operation of the Facility will comply with the relevant industry standards or codes of practice for training, where they exist.

2.11 Closure

2.11.1 Introduction

The Facility is designed for an operational life of more than 45 years, but the actual operational lifetime is dependent on a number of factors including:

- the continued supply of waste; and
- the development of alternative methods competing for the same waste fuels.

When the Facility has reached the end of its operational life, it may be adapted for an alternative use or demolished as part of a redevelopment scheme and cleared and left in a fit-for-use condition.

2.11.2 Site closure plan

At the end of the economic life of the plant, the development site and buildings may be redeveloped for extended use or returned to its current status. The responsibility for this may well rest with other parties if the Facility is sold. However, Lakeside EfW Ltd recognise the need to ensure that the design, the operation and the maintenance procedures facilitate decommissioning in a safe manner without risk of pollution, contamination or excessive disturbance to noise, dust, odour, groundwater and surface watercourses.

To achieve this aim, a site closure plan will be prepared. Lakeside EfW Ltd would propose to develop a site closure plan and submit to the EA for approval prior to the commencement of commissioning of the Facility.

The following is a summary of the measures to be considered within the closure plan to ensure the objective of safe and clean decommissioning.

2.11.2.1 General requirements

- Underground pipework to be avoided except for supply and discharge utilities such as towns water, sewerage lines and gas supply;
- Safe removal of all chemical and hazardous materials;
- Adequate provision for drainage, vessel cleaning and dismantling of pipework;
- Disassembly and containment procedures for insulation, materials handling equipment, material extraction equipment, fabric filters and other filtration equipment without significant leakage, spillage, release of dust or other hazardous substance;
- Where practicable, the use of construction material which can be recovered (such as metals);
- Methodology for the removal/decommissioning of components and structures to minimise the exposure of noise, disturbance, dust and odours and for the protection of surface and groundwater;
- Soil and groundwater sampling and testing of sensitive areas to ensure the minimum disturbance (sensitive areas to be selected with reference to the site condition report and any ongoing monitoring undertaken during operation of the Facility).

2.11.2.2 Specific details

- A list of recyclable materials/components and current potential outlet sources;
- A list of materials/components not suitable for recycle and potential outlet sources;
- A list of materials to go to landfill with current recognised analysis, where appropriate;
- A list of all chemicals and hazardous materials, location and current containment methods; and
- A Bill of Materials detailing total known quantities of items throughout the site such as:
  - Steelwork;
  - Plastics;
  - Cables;
  - Concrete and Civils Materials;
  - Oils;
  - Chemicals;
  - Consumables;
  - Contained water and effluents; and
  - IBA and APCr.

2.11.2.3 Disposal Routes

Each of the items listed within the Bill of Materials will have a recognised or special route for disposal identified; e.g. Landfill by a licensed contractor, disposal by high sided, fully sheeted road vehicle or for sale to a scrap metal dealer, disposal by skip/fully enclosed container, dealer to collect and disposal by container.

2.12 Improvement programme

Lakeside EfW Ltd is committed to continual environmental improvement of their operations, and is therefore 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 EPs which the EA has granted for waste incineration facilities in England.

2.12.1 Prior to commissioning

Prior to commencement of commissioning of the Facility, Lakeside EfW Ltd will comply with the typical Pre-Operational Conditions which will be included for this type of installation, as follows:

- Submit a written report to the EA, on the details of the computational fluid dynamic (CFD) modelling used in the design of the boiler. The report will demonstrate whether the BAT design stage requirements, given in the sector EPR5.01, have been completed. In particular, the report will demonstrate whether the residence time and temperature requirements will be met.
- Submit a written report to the Environment Agency describing the performance and optimisation of the Selective Non-Catalytic Reduction (SNCR) system and combustion settings to minimise oxides of nitrogen (NOx) emissions.
- The report will include an assessment of the level of NOx and N_2O emissions that can be achieved under optimum operating conditions.
- Submit to the EA for approval a protocol for the sampling and testing of bottom ash for the purposes of assessing its hazard status. Sampling and testing shall 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 shall 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.

2.12.2 Post-Commissioning

Following commissioning of the Facility, Lakeside EfW Ltd will comply with the typical Post-Commissioning Conditions which will be included for this type of installation, as follows:

- 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 will 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 from the Facility. The report will detail a timetable for undertaking the tests and producing a report on the results.
- Submit a written summary report to the EA to confirm by the results of calibration and verification testing that the performance of Continuous Emission Monitors for parameters as specified in the EP will comply with the requirements of BS EN 14181, specifically the requirements of QAL1, QAL2 and QAL3.
- Submit a written report to the EA on the commissioning of the Facility. The report will summarise the environmental performance of the Facility as installed against the design parameters set out in the Application.

Appendices

A Plans and Drawings

B Site Condition Report

C Noise Assessment

D Environmental Risk Assessment

E Air Quality Assessment

F BAT Assessment

G CHP Assessment

H Fire Prevention Plan

I Planning Application and Permission

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