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VERUS ENERGY OAK LIMITED
KELVIN ERF
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1 Introduction

Verus Energy Oak Limited (herein referred to as Verus Energy), is developing the Kelvin Energy Recovery Facility (the Facility) to incinerate Municipal Solid Waste (MSW), Commercial and Industrial waste (C&I), and Refuse Derived Fuel (RDF), on land at Giffords Recycling Complex, West Bromwich.

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

1.1 The Applicant

Verus Energy was established to develop, construct and operate an energy recovery facility fuelled by non-hazardous waste materials at the Giffords Recycling Complex, West Bromwich.

Verus Energy is an independent specialist developer of advanced energy recovery plants in the UK which support the diversion of waste from landfill to the generation of recoverable energy.

1.2 The Site

The site is located within the existing Giffords Recycling Complex located on Kelvin Way, which lies approximately 1km to the south of West Bromwich town centre.

The southwestern area of the site lies within the boundary of CBS Packaging, which currently comprises hardstanding. The land within the remainder of the site currently comprises hardstanding areas, with industrial buildings associated with the Giffords Recycling Complex.

The buildings within the site are currently utilised for the manufacture and refurbishment of wooden pallets. The surrounding industrial area is characterized by large, modern industrial buildings and related facilities.

The site is accessed from Giffords Way which exits Kelvin Way to the north. Kelvin Way (A4182) offers connections to the M5 motorway, which runs along the southern and south-eastern boundaries of the site.

A site location plan is presented in Annex 1.

1.3 The Listed Activity

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

Table 1 - Environmental Permit Activities

Type of Activity	Schedule Activity	Description of Activity
Installation	Section 5.1 Part A1 (b)	The co-incineration of pre-processed refuse derived fuel (RDF), MSW and C&I in a waste incineration plant with a nominal design capacity of greater than 3 tonnes per hour.
Directly Associated Activities		
Directly Associated Activities		The receipt and storage of MSW, C&I, and pre-processed waste (RDF) prior to incineration.
Directly Associated Activities		The handling, storage and transfer of residues for transfer off-site.
Directly Associated Activities		The export of electricity and potential export of heat from the Installation.

The Stationary Technical Unit (the Installation) includes the fuel reception; fuel storage; water, fuel oil and air supply systems; furnace; boiler; steam turbine/generator set; facilities for the treatment of exhaust gases; on-site facilities for treatment or storage of residues and waste water; stack; and devices and systems for controlling combustion operations and recording and monitoring conditions.

The nominal operating capacity of the Installation will be approximately 45 tonnes per hour of mixed non-hazardous wastes, with a nominal calorific value of 10 MJ/kg. The plant will have an estimated availability of around 8,000 hours. Therefore, the plant will have a nominal design capacity of approximately 360,000 tonnes per annum.

The facility will have a maximum capacity of up to 400,000 tonnes per annum. This will allow for variations in the net calorific value of the fuels being combusted (as shown in the firing diagram the range will be from 8 MJ/kg to 14 MJ/kg) and for the plant operating for more than the predicted 8,000 hours in a particular year.

An Installation boundary drawing as agreed with the EA Site Inspector during pre-application discussions is presented in Annex 1.

1.4 The Installation

The main activities associated with the Installation will be the combustion of fuel to raise steam and the generation of electricity in a steam turbine/generator.

The installation will be based around five main process areas comprising the Tipping Hall, Waste Bunker, Boiler Hall, Turbine Hall with air cooled condenser, FGT system, Ash Storage building, and a stack of up to 100m in height. In addition, the site will include the following infrastructure:

(1) Two weighbridges (in and Out);
(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) SNCR reagent tank;
(7) Fly ash silo;
(8) Lime silo;
(9) Transformers;
(10) Grid connection compound; and

(11) Firewater storage tanks.

The Installation will have a design thermal fuel input capacity of approximately 125 MWth through a single combustion line. As stated previously the installation will combust fuels with a range of net calorific values - 8 MJ/kg to 14 MJ/kg.

The steam turbine will generate up to 39 MWe with 35 MWe exported to the national grid.

The Installation has been designed for the export of heat to local heat users. A CHP Assessment is presented in Annex 7.

The process is illustrated in Figure 1 below. A larger copy is also included in Annex 1.

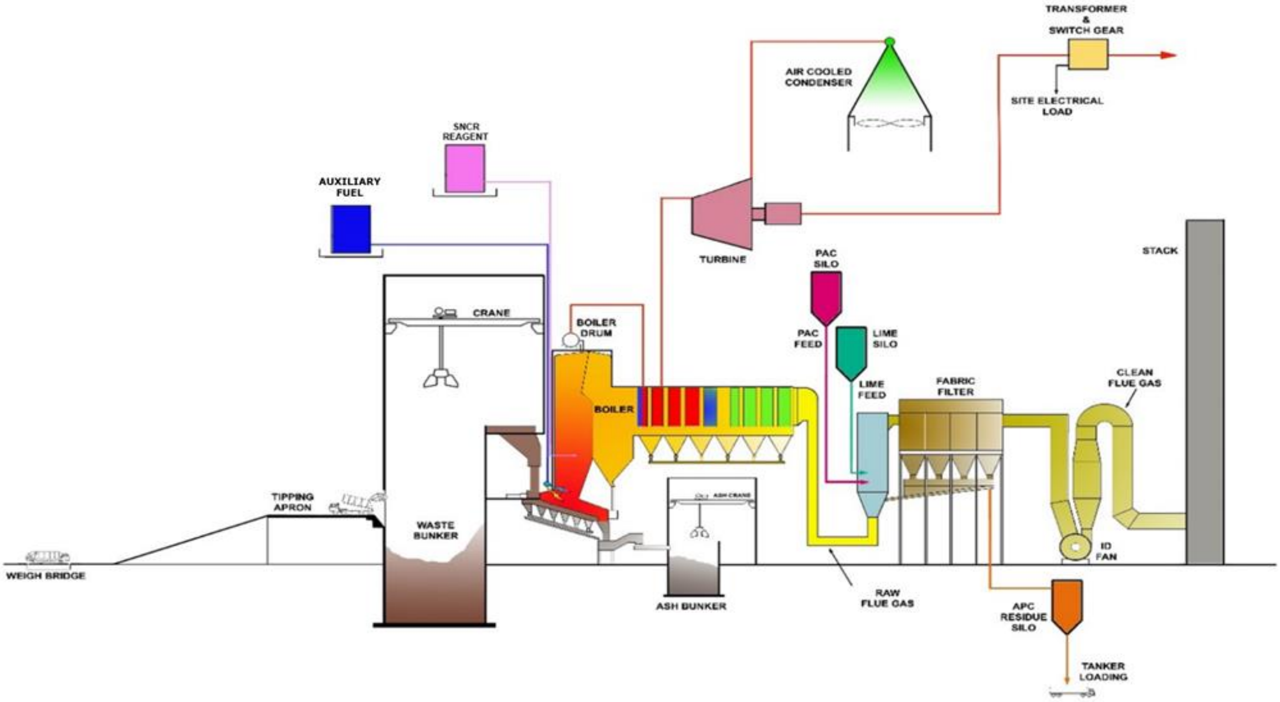

Figure 1.1 - Indicative Process Diagram

1.4.1 Raw Materials

The Installation will receive deliveries of MSW, C&I, and RDF by road.

The Installation will also use consumables including:

(1) lime;
(2) activated carbon;
(3) SNCR reagent;
(4) auxiliary fuel; and
(5) other boiler treatment chemicals.

1.4.1.1 Waste Reception and Preparation

Waste will be sourced from commercial and industrial sources by waste contractors. In the case of RDF, the waste will be pre-processed to produce a fuel prior to being transported to the Facility. Raw MSW and C&I will be received directly, without pre-processing.

Incoming waste will be delivered in covered vehicles or containers. The vehicles will be weighed on a weighbridge before proceeding to the Tipping Hall. The waste will then be tipped into the bunker.

The bunker will have a capacity of approximately 5 days of storage. This will enable the Facility to maintain operation during an extended weekend/bank holiday without waste being delivered to the Facility.

1.4.1.2 Reagents

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

Air which is displaced by the SNCR reagent solution from deliveries of SNCR reagent will be vented back into the tanker via a filter and the tank will be fitted with an emergency pressure valve which will discharge to atmosphere via a filter.

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

Lime and activated carbon will be delivered to the plant for storage in silos. Both the lime and the activated carbon will be transported pneumatically from the delivery vehicle to the correct storage 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.

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

1.4.2 Combustion Process

The combustion system is a based on the grate technology (moving grate) which is a proven technology for the combustion of waste derived fuels in Europe and the UK. The fuel will be transferred into the furnace and will fall onto the grate and will burn out gradually.

The hearth, a mechanical moving grate design, will ensure continuous mixing of the fuel and hence promote good combustion. In a moving grate, the fuel is moved mechanically by means of reciprocating or rotating grate elements from the feed end, through a drying zone, a main combustion zone and, finally, a burn out zone. The purpose of the grate is to move and mix the fuel and to distribute primary combustion air evenly across the bed of material. Bottom ash (the inert burnt-out residue from the combustion process) is conveyed off the end of the grate where it is quenched with water and transferred to a storage area for transfer off-site.

Primary air for combustion will be fed to the underside of the grate by a single inverter-driven fan. Secondary air will be injected higher in the grate to create turbulence and ensure complete combustion with minimum levels of oxides of nitrogen (NOx). The volume of both primary and secondary air will be regulated by a combustion control system. SNCR reagent will be injected into the combustion chamber to react with the oxides of nitrogen, chemically reducing them to nitrogen and water.

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. Gas temperatures 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.

The plant will also be fitted with auxiliary burners, which will be designed for firing on an auxiliary fuel. The burners will be set to operate when the temperature within the furnace drops to 860-870°C. These auxiliary burners will also be fired during plant start up and shut down.

1.4.3 Energy Recovery

The heat released by the combustion of the fuel is recovered in a water tube boiler, which is integral to the furnace and will produce (in combination with superheaters) high pressure superheated steam. The steam from the boiler will then feed a steam turbine which will generate approximately 39 MW of electricity. The site electrical load will be approximately 4 MW, leaving approximately 35 MW of electrical power available for export to the local public electricity supply network.

After the turbine, the steam will be cooled using an air-cooled condenser. The condensed steam is returned as feed water in a closed-circuit pipework system to the boiler.

The Installation will have the potential to export up to 14.0 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 Installation.

1.4.4 Flue Gas Treatment

The flue gas treatment system consists of:

(1) Selective Non-Catalytic Reduction (SNCR);

(2) hydrated lime and activated carbon injection; and

(3) a fabric filter.

Concentrations of NOx will be regulated by the careful control of combustion air and the use of the SNCR process in which an SNCR reagent will be injected into the high temperature region of the boiler to further reduce the amount of NOx in the gas stream.

Hydrated lime and activated carbon 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 components, 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 adjacent to the FGT system.

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).

1.4.5 Ash Handling

The main material produced by the installation will be bottom ash. Bottom ash is the burnt-out residue from the combustion process. Bottom ash collected at the end of the combustion grate and boiler ash collected at the bottom of the boiler passes will be removed by a wet ash conveyor. The extractor will comprise a water-filled trough (or ash quench) into which the ash will fall. The ash will be transferred from the ash quench to the bottom ash storage area via inclined conveyor. The purpose of the ash quench is to cool and moisten the bottom ash to limit particulate emissions and to ensure an airtight seal to the furnace to avoid air ingress. The bottom ash storage area is designed with a capacity of 5 days of bottom ash.

1.4.6 Site Drainage

Process effluents from water treatment and boiler blowdown will be re-used within the ash quench system. Small quantities of process effluent generated by the Installation will be discharged to sewer in accordance with a trade effluent consent which will be secured from the sewerage undertaker.

Uncontaminated rainwater from building roofs will be discharged to the site surface water drainage system. Surface water run-off from roadways, vehicle movement areas and areas of hardstanding will be collected and discharged into the site surface drainage system having passed through interceptors.

The drainage infrastructure for the Facility is subject to detailed design. However, surface water will be discharged to sewer via a combined drain.

1.4.7 Emissions Monitoring and Stack

An induced draught fan will draw the flue gas through the boiler and the flue gas cleaning system and release the cleaned flue gas via a stack which is 100m.

A Continuous Emission Monitoring Station (CEMS) will be installed to monitor the concentrations in the flue gas before it leaves the Installation through the stack. In addition, periodic sampling and measurement will be carried out.

1.4.8 Ancillary Operations

A water treatment plant will produce demineralised water which will be used as feed water for the boilers.

Water for fire-fighting will be stored in dedicated firewater tank with a dedicated pump set.

A 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.

2 Other Information For Application Form

2.1 Raw Materials

2.1.1 Types and Amounts of Raw Materials

Table 2 - Types and amounts of raw materials (for the Schedule 1 Activities)

Material	Storage		Estimated Consumption (tonnes per annum)	Description
	Number of silos/ tanks	Storage facility		
Fuel oil (assumed	1	Tank	2,000[(1)]	Assumed to be fuel oil. Selection of fuel to be determined following appointment of technology provider
Ammonia Solution (25%) (assumed)	1	Tank	2,200	Ammonia hydroxide
Lime	1	Silo	16,800	Dry, hydrated or conditioned
Activated carbon	1	Silo	550	Powdered
Other boiler treatment chemicals			<50	Corrosion inhibitor, scale inhibitor, biocide, ion exchange resins (sodium hydroxide, sulphuric acid)

Note:
(1) Assumed to be used as only auxiliary fuel.

Table 3 - Raw materials and their effect on the environment

Product	Chemical composition	Expected quantity	Units	Environmental medium			Impact potential	Comments
				Air	Water	Land		
Fuel oil or gas	Low sulphur (<0.1%)	2,000	tpa	100	0	0	Low impact	Used for plant start-ups and maintaining good combustion conditions in the boiler. Plant combustion products released to atmosphere after passing through flue gas treatment plant.
Ammonia/urea solution	NH_4OH	2,200	tpa	100	0	0	Low impact	Reacts with nitrogen oxides to form nitrogen, oxygen, and water vapour. Any unreacted SNCR reagent is released to atmosphere at low concentrations, and is continuously monitored.
Lime	$Ca(OH)_2$ > 95%	16,800	tpa	0	0	100	Low impact	Injected lime is removed with the APC residues at the bag filter and disposed of as hazardous waste at a suitable licensed facility.
Activated carbon	C	550	tpa	0	0	100	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.

Various other materials will be required for the operation and maintenance of the plant, including:

(1) hydraulic oils and silicone-based oils;

(2) electrical switchgear;

(3) gas emptying and filling equipment;

(4) oxyacetylene, TIG, MIG welding gases;

(5) CO2 / fire-fighting foam agents; and

(6) test and calibration gases.

These will be supplied to a standard specification 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 Environment Agency.

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

A range of chemical substances and hazardous materials associated with the energy plant process, including SNCR reagent, lime and activated carbon, will be stored on site. These materials will be stored in accordance with current guidance. All liquid chemicals will be stored in controlled areas, with secondary containment facilities having a volume of 110% of the stored capacity.

The SNCR reagent and boiler water treatment chemicals will be stored in suitable containers or stainless steel bunded storage tanks provided with a pressure relief valve and vent scrubber system, as appropriate. In the event of a spillage, the bunds will retain the liquid.

Lime and activated carbon, used within the Air Pollution Control process, will be stored within separate storage silos and will be dosed with separate dosing controls. Storage will be in dedicated steel silos with equipment for filling from a tanker through a sealed pipe work system. 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. Delivery to site will be by bulk powder tanker.

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

Fuel oil will be used on site for the auxiliary support burners and mobile plant and equipment. The fuel can be stored in a dedicated storage tank.

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 Reagent Selection

2.1.3.1 Acid Gas Abatement

There are several reagents available for acid gas abatement. Sodium hydroxide (NaOH) or hydrated lime ($Ca(OH)_2$) can be used in a wet scrubbing system. Quicklime (CaO) can be used in a semi-dry Air Pollution Control system. Sodium bicarbonate ($NaHCO_3$) or dry lime (referred to as hydrated lime) can be used in a dry Air Pollution Control system.

Wet scrubbing and semi-dry abatement are not considered, since these abatement techniques have been eliminated by the BAT assessment in Annex 6 section 2. The two alternative reagents for a dry system – lime and sodium bicarbonate – are therefore assessed further.

The level of abatement that can be achieved by both reagents is similar. However, the level of reagent use and therefore residue generation and disposal is different and requires a full assessment following the methodology in Horizontal Guidance Note H1. The assessment is detailed in Annex 6 section 4 and is summarised in the table below.

Table 4 – Acid Gas Abatement BAT Data (to abate 1kmol of HCl)

Item	Unit	$NaHCO_3$	$Ca(OH)_2$
Mass of reagent required	kg	109.0	67.0
Mass of residue generated	kg	84.0	85.0
Cost of reagent	£/tonne	155	94
Cost of residue disposal	£/tonne	150	125
Overall Cost	£/ kmol	29.5	16.9
Ratio of costs		1.74	1.00

In summary, there is a small environmental benefit for using sodium bicarbonate, in that the mass of residues produced is smaller. There is a small environmental benefit for using sodium bicarbonate, in that the mass of residues produced is smaller. However, there are a number of significant disadvantages:

- The residue has a higher leaching ability than lime-based residue, which will limit the disposal options;
- The reaction temperature doesn't match as well with the optimum adsorption temperature for carbon, which is dosed at the same time;
- The sodium bicarbonate system has a slightly higher global warming potential due to the reaction chemistry; and
- The costs per kmol HCl abated are almost 75% higher.

Hence, the use of lime is considered to be BAT for the Facility.

2.1.3.2 NOx Abatement

An SNCR system, proposed for the abatement of NOx, can by operated with dry urea, urea solution, or aqueous ammonia solution. There are advantages and disadvantages with all options.

(1) Urea is easier to handle than ammonia; the handling and storage of ammonia can introduce additional risk.

(2) Dry urea needs big-bags handling whereas urea solution can be stored in silos and delivered in tankers.

(3) Ammonia tends to give rise to lower nitrous oxide formation than urea. Nitrous oxide is a potent greenhouse gas.

(4) Ammonia emissions (or 'slip') can occur with all reagents, but good control will limit this.

(5) The Sector Guidance on Waste Incineration considers all options as suitable for NOx abatement.

Due to the advantages and disadvantages of both reagents, both reagents are considered to represent BAT. As agreed with the Site Inspector during pre-application discussions, the selection of reagent for the SNCR system will not be made until a technology provider has been selected. On this basis, it is proposed that a Pre-Operational Improvement Condition is included within the EP which requires the Operator to submit further information to the EA on the reagent to be used within the SNCR system and the controls associated with the delivery, receipt, storage and handling of the chosen reagent.

2.1.3.3 Auxiliary Fuel

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

> *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 [850°C]. 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 fuel 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, liquefied gas or natural gas.

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

(1) natural gas;

(2) liquefied gas (LPG); or

(3) fuel oil.

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

Natural gas can be used for auxiliary firing. As stated previously, auxiliary firing will only be required intermittently. When auxiliary firing, large volumes of gas would be required. These would need to be supplied from a high-pressure gas main. At the time of submission of the EP application, the proximity to a high-pressure gas main is unknown. Dependant on the proximity of the site to a high-pressure gas main and suitable available capacity within the system, this may be an available technology. This will need to be confirmed during detailed design.

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. A storage tank can be easily installed at the Facility.

A fuel oil tank can be easily installed at the Installation. 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.

As presented above, the use of natural gas, LPG and fuel oil are all considered to represent BAT for the installation. The selection of an auxiliary fuel will be subject to detailed design. Therefore, it is proposed that an Improvement Conditions is included within the EP which required confirmation of the selected auxiliary fuel prior to commencement of commissioning.

For the purposes of the environmental assessments submitted with this application, it is assumed that the auxiliary fuel will be fuel oil.

2.2 Incoming Waste

The Installation is designed for the combustion of waste fuels with a Net Calorific Value (NCV) of 8 MJ/kg to 14 MJ/kg. The nominal design capacity of the Installation is 45 tonnes per hour of fuel with an NCV of 10 MJ/kg. The expected operational availability is 8,000 hours per annum (~91%), which is regarded as typical for an EfW plant in the UK. Therefore, the nominal design capacity for the installation is 360,000 tonnes per annum.

The plant is designed to operate continuously throughout the year, 7 days a week, 24 hours a day, with the exception of plant shutdowns. Planned and unplanned shutdown time periods will vary from year to year.

However, the annual fuel input capacity could increase or decrease depending on the availability of the plant. If the Installation performed above average and/or operated above the nominal availability during the year, it could be required to shut down unnecessarily if there was no 'headroom' allowance in the annual permitted tonnage.

Moreover, there will also be fluctuations in the net calorific value of the incoming fuel. If the net calorific value of the fuel received is lower than expected, the plant will operate at a higher mechanical throughput than its nominal design capacity. In this case, it again could be required to shut down unnecessarily before the end of the year if there was no 'headroom' allowance in the annual permitted tonnage.

To allow for the above (i.e. higher availability or lower CV fuel), the maximum capacity of the Installation is approximately 400,000 tonnes per annum.

2.2.1 Waste to be Processed

The RDF will be sourced from facilities for the pretreatment of waste, whilst the C&I and MSW will not undergo any pre-treatment before arriving at the Facility.

The table below presents the fuels to be combusted within the Facility.

Table 5 – Waste to be Processed in the Facility

EWC Code	Description of Waste
Wastes from agriculture, horticulture, aquaculture, forestry, hunting, and fishing	
02 01 03	Plant tissue waste
02 06 01	Materials unsuitable for consumption or processing
Wastes from wood processing and the production of panels and furniture pulp, paper, and cardboard	
03 01 01	Waste bark and cork
03 01 05	Sawdust, shavings, cutting wood, particle board, and veneer other than mentioned in 03 01 04
03 03 01	Waste bark and wood
03 03 07	Mechanically separated reject from pulping of waste paper and cardboard
Wastes from the leather, fur, and textile industries	
04 02 10	Organic matter from natural products (e.g. grease, wax)
04 02 21	Waste from unprocessed textile fibres
04 02 22	Waste from processed textile fibres
Waste packaging	
15 01 01	Paper and cardboard packaging
15 01 02	Plastic packaging

Table 5 – Waste to be Processed in the Facility	
15 01 03	Wooden packaging
15 01 05	Composite packaging
15 01 06	Mixed packaging
15 01 09	Textile packaging
Wastes not otherwise specified in the list	
16 03 04	Off-specification batches – inorganic
16 03 06	Off specification batches – organic
Construction and demolition wastes	
17 02 01	Wood
17 02 03	Plastic
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 04	Wastes whose collection and disposal is not subject to special requirements in order to prevent infection
18 02 03	Wastes whose collection and disposal is not subject to special requirements in order to prevent infection
Waste from waste and water treatment	
19 02 03	Premixed wastes composed only of non-hazardous wastes
19 05 01	Non-composted fraction of municipal and similar wastes
19 05 02	Waste aerobic treatment of solid wastes from non-composted fraction of animal and vegetable waste
19 05 03	Off-specification compost
19 06 04	Digestate from aerobic treatment of municipal waste
19 06 06	Digestate from anaerobic treatment of animal and vegetable waste
19 12 01	Paper and cardboard
19 12 04	Plastic and rubber
19 12 07	Wood
19 12 08	Textiles
19 12 10	Combustible waste (refuse derived fuel)
19 12 12	Other wastes (including mixtures of materials) from mechanical treatment of wastes other than those mentioned in 19 12 11
Municipal wastes	
20 01 01	Paper and cardboard
20 01 08	Kitchen and canteen waste
20 01 10	Clothes
20 01 11	Textiles
20 01 38	Wood
20 01 39	Plastics

Table 5 – Waste to be Processed in the Facility	
20 02 01	Biodegradable waste
20 03 01	Mixed municipal waste
20 03 02	Waste from markets
20 03 03	Street cleaning residues
20 03 07	Bulky waste

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 RDF, MSW and C&I to the Facility. Contracts will be in place with these suppliers to provide the RDF, MSW and C&I 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. Verus Energy 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 Verus Energy.

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 tipping hall floor for visual inspection. Crane drivers and other operatives will be trained in order to undertake these tasks.

2.2.2.2 Non-conforming wastes

Documented procedures for 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. Verus Energy would propose to provide the EA with a summary of the documented procedures prior to commencement of operations. This would include procedures for the rejection of wastes which do not conform with the waste which the Facility is permitted to receive.

Following delivery to the Facility, waste loads which are identified as containing the restricted wastes will be quarantined prior to transfer off-site.

2.2.2.3 Receiving Waste

The following measures will be adopted for the receipt of wastes:

- A high standard of housekeeping will be maintained in all areas. Suitable equipment will be provided to clean up spilled materials.
- Loading and unloading of vehicles will only be undertaken in designated internal 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 all the waste 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.
- All incoming wastes will be:
  - delivered in covered vehicles or containers; and
  - unloaded in the enclosed waste reception areas.
- 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 removal.
- Further inspection will take place by the plant operatives during vehicle tipping and waste unloading.

2.2.3 Waste Minimisation Audit (Minimising the Use of Raw Materials)

A number of specific techniques will be employed to minimise the production of residues, focussing 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 can improve the operational stability of the plant, leading to reduced reagent use and reduced residue production. Fuels combusted in the Facility will originate from a variety of sources. The process of mixing incoming wastes from different sources (by the cranes) within the waste bunker will serve to improve the homogeneity of fuel input to the boiler.

2.2.3.2 Dioxin and Furan Reformation

As identified within the sector guidance for the Incineration of Waste (EPR5.01), there are a number of BAT design considerations required for the boiler. The boiler has been designed to minimise the formation of dioxins and furans as follows:

- Slow rates of combustion gas cooling will be avoided via boiler design to ensure the residence time is minimised in the critical cooling section and avoid slow rates of combustion gas cooling to minimise the potential for de-novo formation of dioxins and furans.

- The gas residence time in the critical temperature range will 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 will be considered during the detailed design phase to ensure that dioxin formation is minimised throughout the process.
- It is reported in the Environment Agency guidance note EPR5.01 that the injection of ammonia compounds into the furnace – an SNCR NOx abatement system – inhibits dioxin formation and promotes their destruction. SNCR is to be utilised in the Facility.
- Transfer surfaces will 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. Following detailed design of the boiler, a detailed CFD study will be undertaken to confirm that the design will fulfil the residence time and temperature requirements of the IED.
- Minimising the volume in the critical cooling sections will ensure high gas velocities.
- Boundary layers of slow moving gas along boiler surfaces will 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 reduce the Total Organic Carbon (TOC) content of the bottom ash to less than 3%; and/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 – Acid Gases

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 plant preventative maintenance regime 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 lime dosing. 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.

A layer of reagent will accumulate on the surface of the bag filters whilst the flue gas treatment systems are operating. These will not be cleaned off the bag filters until after the waste incineration plant has been shut down. Therefore, this will provide abatement of any particulates, including acid gases and heavy metals, until the shutdown process has been completed.

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 rate for the activated carbon and lime dosing systems will have separate controls.

2.2.3.5 Flue Gas Treatment Control – NOx

The SNCR system will require the injection of a SNCR reagent into the radiation zone of the boiler at several levels.

The first boiler pass is divided virtually into several vertical segments. Each segment consists of a distribution module and injection nozzles on several levels. The configuration of the nozzles makes it possible to achieve full-area coverage of the injection medium across the entire cross section of the radiation zone.

Beside the optimal adjustment of the reagent injection an even operation of the incineration process is crucial for an optimum NOx separation by means of the SNCR process. This is ensured by the following measures.

- The total flow of SNCR reagent (controlled by the NOx emission measurement) is distributed equally to the distribution modules. The distribution module directs a mixture of SNCR reagent solution and compressed air to the injection levels according to the following description:
  (1) SNCR reagent is directed to the level with the optimal flue gas temperature.
  (2) All active levels are charged with air at full pressure.
  (3) All non active levels are charged with air at reduced pressure for cooling of the nozzles.
  (4) When a level is deactivated, the line is purged with air at full pressure for a few seconds.
  (5) For controlling NOx in accordance with the proposed emissions limits, three injection levels are used and all distributors are controlled by one temperature measurement at the ceiling of the first boiler pass.
- Each injection level consists of two nozzles at different angles to achieve a good coverage in the complete segment. The pressure drop in the nozzle tip is designed to lead to a good dispersion of the SNCR reagent solution droplets. The high injection velocity is designed to prevent fouling of the nozzles.
- The optimal adjustment of the reagent injection and steady operation of the combustion process is crucial for maximising NOx reduction through the SNCR system. This will be ensured by the following measures:
  - Integrated combustion control system including an automatic adjustment to the quality of the waste incinerated.
  - Consistent oxygen and temperature profiles in the secondary combustion chamber by means of the swirl created by secondary air injection.
  - Subsequent radiation pass without any internals, thus ensuring a prolonged reaction zone for the NOx reduction.

Following commissioning of the facility it is proposed to submit to the Agency a report which describes the performance and optimisation of the SNCR system and combustion settings to minimise oxides of nitrogen (NOx) emissions within the emission limit values described in this permit with the minimisation of nitrous oxide emissions. It is proposed that the report includes an assessment of the level of NOx and N2O emissions that can be achieved under optimum operating conditions.

2.2.3.6 Waste Management

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

2.2.3.7 Fuel Charging

The Facility will meet the 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 mandatory IED emission limits are not exceeded. Auxiliary burners fired with an auxiliary will be installed and will be used to maintain the temperature in the combustion chamber. The burners will be of a low-NOx design.
- 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.
- 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 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.
- In a breakdown scenario, operations will be reduced or closed down as soon as practicable until normal operations can be restored.

The 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 principal sources of process water within the Facility will be make up water for the boiler. Other water consuming processes include the following:

(1) wet ash conveyor; and

(2) SNCR injection nozzles.

The key points listed below should be noted.

(1) The water system has been designed with the key objective of minimal consumption of potable water.

(2) Most of the steam produced 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 flue gas treatment system.

(3) Lost condensate will be replaced with demineralised treated water.

(4) Process effluents will be collected in the Reuse Water Tank to be re-used within the Facility. Excess process effluents will be discharged to sewer.

(5) The Installation will have completely separate cooling water; foul sewer; and storm water systems (surface drainage).

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.

Waste water from showers, toilets, and other mess facilities will be discharged into the foul sewer drainage system.

2.3.1.2 Process Water

All process waters will be supplied by mains water.

Demineralised water will be used to compensate for boiler blow down losses. The Installation will have a water treatment plant, based on ion exchange or reverse osmosis technology. It is anticipated that the Facility will consume approximately 9 m^3/hr of mains water. The water treatment plant will be designed to continuously supply demineralised water.

Waste water will be collected in a waste water pit. Effluent collected in the waste water pit will be re-used in the ash quench system. Under normal operating conditions, waste water will be generated from the following processes:

(1) regeneration of the ion exchange resins in the demineralised water treatment plant or concentrate from the reverse osmosis system;
(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 waste water pit will provide acid dosing for pH adjustment and settlement of waste waters collected within the incineration lines. Effluent from the waste water pit will be discharged to sewer as trade effluent in accordance with a trade effluent consent.

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

An Indicative Water flow diagram is presented within

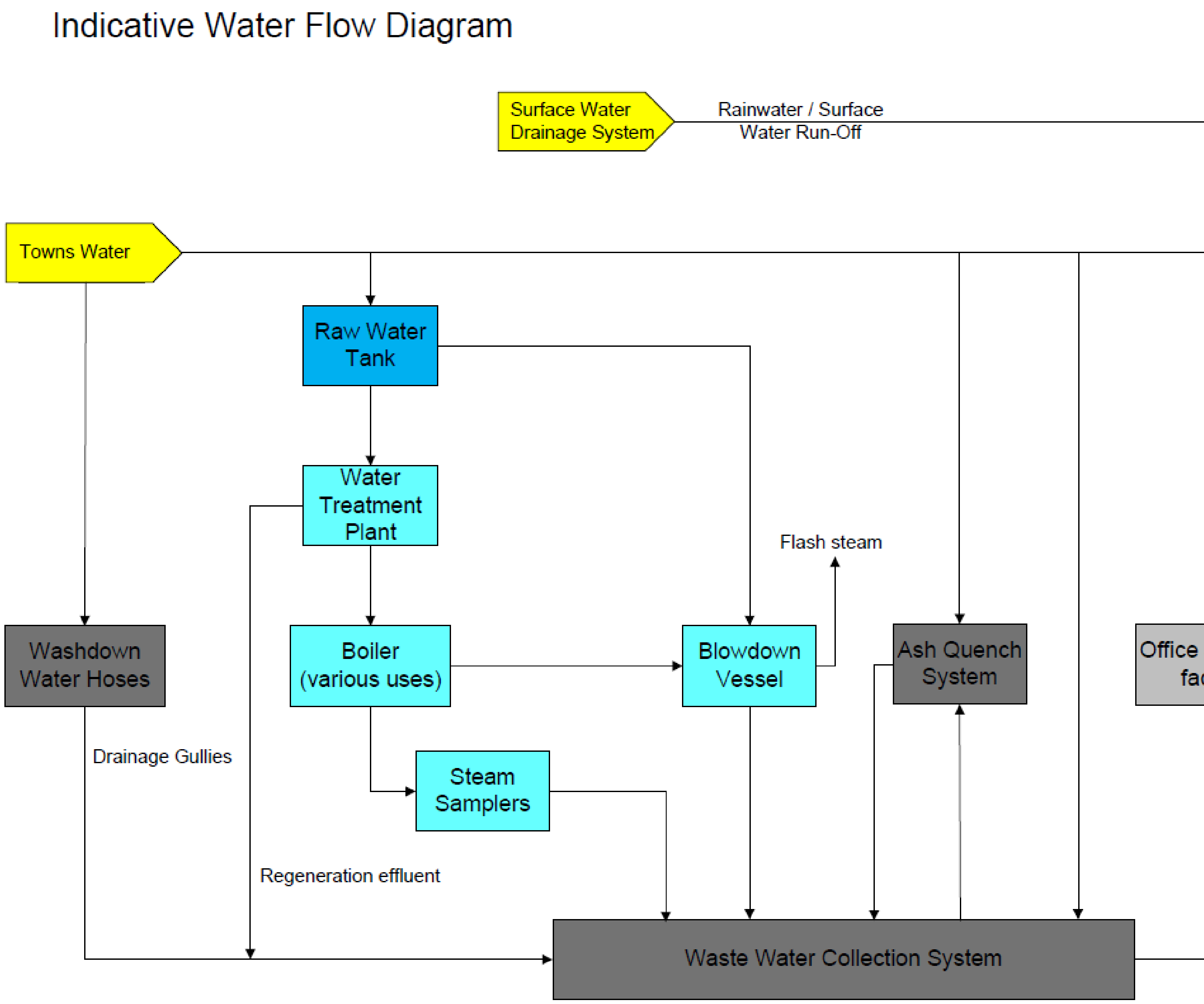

Figure 2. A larger version of this drawing is included within Annex 1.

A water mass balance for the nominal design of the Facility is presented in Annex 1.

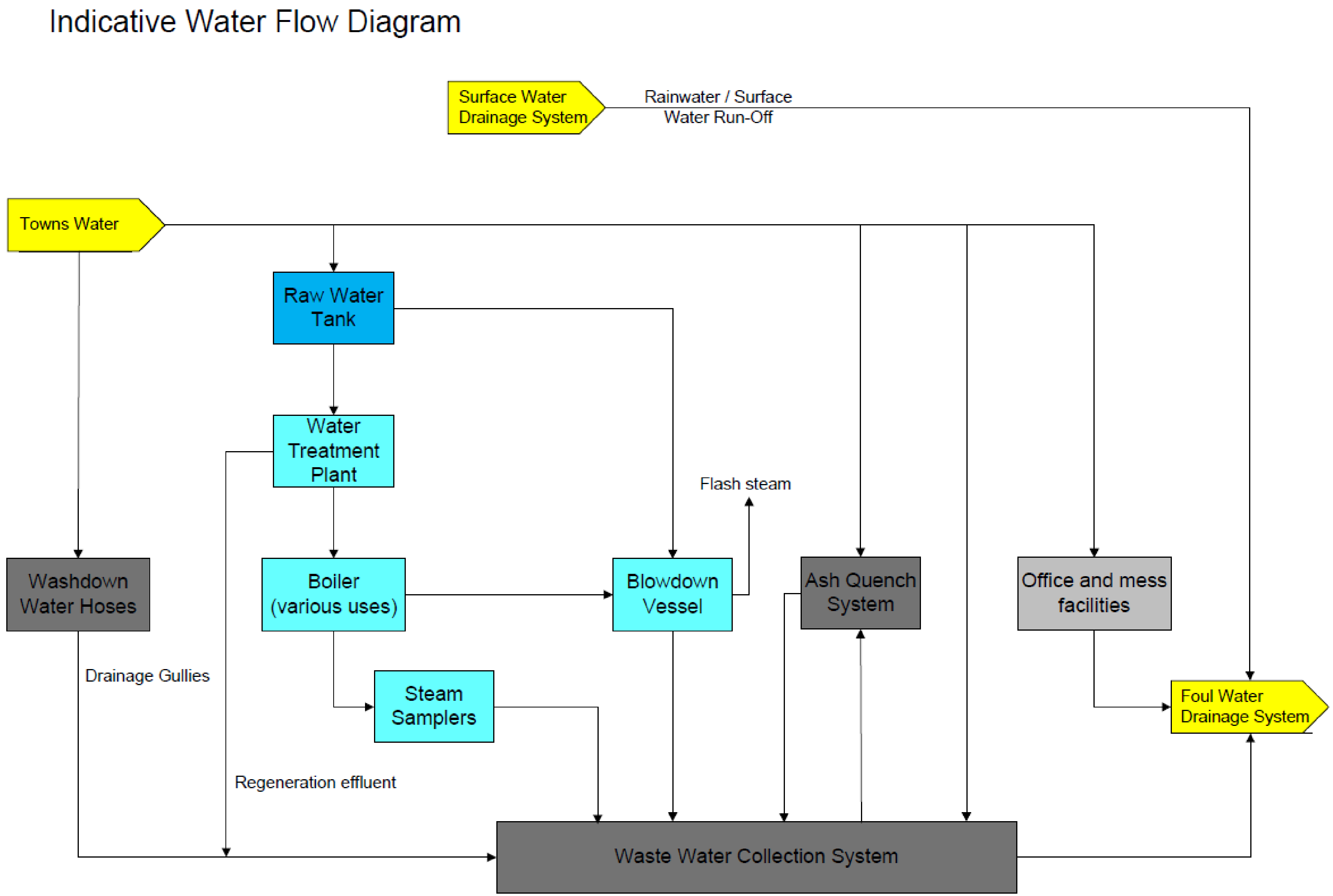

Figure 2 – Indicative Water Flow Schematic

2.4 Emissions

2.4.1 Point Source Emissions to Air

The full list of proposed emission limits for atmospheric emissions is shown in Table 6. This includes the information requested in Table 2 of the Application Form Part B3. The emission limits presented in the table below are based on the relevant co-incineration emission limits as defined in Annex 4, Part 4 of the IED.

Table 6 – Proposed Emission Limits

Parameter	Units	Half Hour Average	Daily Average	Periodic Limit
Particulate matter	mg/Nm^3	30	10	-
VOCs as TOC	mg/Nm^3	20	10	-
Hydrogen chloride	mg/Nm^3	60	10	-
Hydrogen fluoride	mg/Nm^3	-	-	2
Carbon monoxide	mg/Nm^3	100	50	-
Sulphur dioxide	mg/Nm^3	200	50	-
Oxides of nitrogen (NO and NO_2 expressed as NO_2)	mg/Nm^3	400	200	-
Cadmium & thallium and their compounds (total)	mg/Nm^3	-	-	0.05
Mercury and its compounds	mg/Nm^3	-	-	0.05
Sb, As, Pb, Cr, Co, Cu, Mn, Ni and V and their compounds (total)	mg/Nm^3	-	-	0.5
Dioxins & furans ITEQ	ng/Nm^3	-	-	0.1
All expressed at 11% oxygen in dry flue gas at 0°C and 1 bar-a.				

A plan showing the location of all emission points to air is presented in Annex 1.

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. Where appropriate, these will be vented to the tanker during refilling. Bulk liquid storage tanks will be fitted with high level controls and alarms.

Lime and APCr silos will be filled by bulk tanker. These raw materials will be offloaded pneumatically into the relevant silos with displaced air vented through a reverse pulse jet filter. Silos will be fitted with high-level control and alarm. Silos will be equipped with a vent fitted at the top with a fabric filter. Filter residues will be returned to the silo. Cleaning of the filter is done automatically with compressed air after the filling operation. The filter will be inspected regularly for leaks.

All waste handling operations will be undertaken within enclosed buildings, and therefore will minimise fugitive emissions of dust from the installation.

2.4.3 Point Source emissions to Water

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

Surface water run-off from all external areas of hardstanding (roads and storage areas) will be discharged into the surface water system having passed through interceptors. All surface water run-off will be collected in the site surface water drainage system and discharged to sewer via the combined sewerage system for the site.

2.4.4 Point Source Emissions to Sewer

The Facility will give rise to process effluents of boiler blowdown, waste water from the water treatment process and washdown waters. Process effluents will be recirculated through the ash quench system. All excess process effluents which cannot be recirculated will be collected in the waste water system, prior to discharge to sewer via emission point S1, shown in the emission point drawing within Annex 1. It should be noted that the location of the emission point shown is subject to detailed design of the site drainage system.

A Trade Effluent Consent for the discharge of effluent to sewer from the Facility will be applied for and secured prior to commencement of commissioning of the Facility.

2.4.5 Contaminated Water

External areas of hardstanding will be provided with kerbed containment, where appropriate, to prevent any potential spills from causing pollution of the ground/groundwater and surface water.

All chemicals will be stored in an appropriate manner incorporating the use of bunding and other measures (such as acid and alkali resistant coatings) to ensure appropriate containment. The potential for accidents, and associated environmental impacts, is therefore limited.

Adequate quantities of spillage absorbent materials will be made available on-site, at an easily accessible location(s), where liquids are stored. A site drainage plan, including the locations of foul and surface water drains and interceptors, will be made available on-site.

Tanker off-loading of chemicals will take place within areas of concrete hardstanding with falls to a gully and/or a sump.

Storage tanks will be bunded at 110% of the tank capacity and the offloading point will be fully contained with the appropriate capacity to contain any spills during fuel or SNCR reagent delivery.

Process water drains within the Installation will drain to the sedimentation basin.

Site drainage for external areas will be fitted with a shut-off alarm, linked to the fire detection systems to contain any contaminated water from firefighting from external areas. Additional storage will be available from site kerbing.

In accordance with the EMS, spillages will be reported to the site management and a record of the incident will be made. The relevant authorities (Environment Agency/ Health and Safety Executive) will be informed if spillages/leaks are significant.

The effectiveness of the Emergency Plan for spillages is subject to Management Review and will be reviewed following any major spillages and revised as appropriate.

2.4.6 Odour

The storage and handling of waste derived fuels 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. The facility will include a number of controls to minimise odour from the installation during normal and abnormal operation as follows:

- Waste Delivery Vehicles

  All waste will be delivered to the Installation in covered vehicles, which will contain any fugitive emissions within the delivery vehicles.
- Waste Storage

  Odour will be controlled contained within the waste reception areas by maintaining these areas at a negative pressure. Air from the tipping hall and waste bunker will be extracted to be used as combustion air within the waste incineration plant.

  If additional odour abatement is required within the waste reception and storage areas, a sprinkler dust suppression system will be used. This will emit a very fine spray to suppress dust.
- Bunker Management

  The Facility's operators will employ bunker management procedures (mixing and periodic emptying and cleaning) to avoid the development of anaerobic conditions within the waste bunker, which could generate further odorous emissions.
- Planned &Unplanned Shutdowns

  Prior to periods of planned maintenance, bunker management procedures will reduce the amount of material in the bunker before shutdown.

  The doors of the waste chutes will be closed to contain any odour. Misting sprays may be used to reduce odour from the waste storage area.

2.5 Monitoring Methods

2.5.1 Emissions Monitoring

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

The three main objectives of monitoring are:

(1) to provide the information necessary for safe and efficient 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 at the stack 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) TOC; and

(8) particulates.

In addition, the 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.

The continuously monitored emissions concentrations will also be checked by an independent testing company at frequencies agreed with the Environment Agency.

The following parameters will also be monitored by means of spot sampling at frequencies agreed with the Environment Agency:

(1) hydrogen fluoride;

(2) nitrous oxide;

(3) heavy metals; and

(4) dioxins and furans.

The methods and standards used for emissions monitoring will be in compliance with Environment Agency Guidance Note S5.01 and the Industrial Emissions Directive. In particular, the CEMS equipment will be certified to the MCERTS standard and will have certified ranges which are no greater than 1.5 times the relevant daily average emission limit.

It is anticipated that:

(1) HCl, CO, SO_2, NOx (NO, and NO_2), and NH_3 will be measured by an FTIR-type multi-gas analyser;

(2) VOCs will be measured by an FID-type analyser;

(3) particulate matter will be measured by an opacimeter; and

(4) oxygen will be monitored by a zirconium probe.

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 Industrial Emissions Directive as a minimum. The flue gas sampling points, techniques and the sampling platform will comply with Environment Agency Technical Guidance Notes M1 and M2.

The CEMs system will be installed and maintained in accordance with the requirements of QAL1, QAL2, and QAL3.

<u>Reliability</u>

IED Annex VI Part 8 Paragraph 1.2 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. The IED 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 will be carried out at regular intervals as recommended by the manufacturer and by the requirements of BS EN14181. 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.

<u>Start-up and shut-down</u>

The emission limit values under the Industrial Emissions Directive do not apply during start-up and shutdown. Therefore, a signal would be sent from the main plant control system to the CEMS package to indicate when the plant is operational and burning waste. The averages would only be calculated when this signal was sent, but raw monitoring data would 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 flue gas cleaning plant, control systems, monitoring equipment, grate and ash extractors are all running;

(3) Exhaust gas O_2 is less than 15% (wet measurement); and

(4) The combustion grate is fully covered with fuel.

Shutdown begins when all of the following conditions are met.

(1) The feed chute damper is closed;

(2) The waste remaining on the grate is burned out;

(3) The flue gas treatment systems are running;

(4) Exhaust gas O_2 is equal to or greater than 15% (wet measurement); and

(5) The auxiliary burner is maintaining the temperature at greater than 850°C within the boiler.

2.5.1.2 Monitoring Emissions to Land

Disposal of residues to land will comply with all relevant legislation.

2.5.1.3 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 used 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;
- Cooling water abstraction and discharge;
- 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) Waste 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.

(4) The concentration of HCl 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.

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. A CFD model will be developed for the design of the Facility to demonstrate that the 850ºC temperature and 2 second residence time will be achieved. In addition, during commissioning recognised methodologies, as detailed in Guidance Note EPR5.01, will be undertaken to confirm that the design achieves the relevant combustion condition requirements as set out in the IED.

It will also be demonstrated during commissioning that the EfW 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. The detailed CFD model for the design will be made available to the EA following detailed design of the boiler.

SNCR reagent solution will be injected into the flue gases at a temperature of between 850 and 1000°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 reagent 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.

Measuring Oxygen Levels

The oxygen concentration at the boiler exit of the waste incineration plant 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 combustion airflows and fuel feed rate.

2.6 Technology Selection

2.6.1 Combustion Technology

It is proposed that the combustion technology for the plant will be a moving grate. Moving grate systems are relatively simple and well proven. The Incinerator Sector Guidance Note EPR5.01 discusses a number of alternative technologies for the combustion of waste, and waste derived fuels (RDF).

Moving Grate Furnaces

As stated in the Sector Guidance Note, these are designed to handle large volumes of solid waste derived fuel, such as those proposed for the Facility. Moving Grate Furnaces are therefore regarded as being an appropriate combustion technology for the Installation.

Fixed Hearth

These are not considered suitable for large volumes of waste derived fuels, such as those proposed for the Facility. They are best suited to low volumes of consistent waste. Fixed Hearth technologies are therefore not regarded as being an appropriate combustion technology for of the Installation.

As confirmed in the Sector Guidance Note, fixed hearth designs can have difficulty in meeting the Chapter IV (Waste Incineration and Co-incineration) IED standards, mainly due to the semi-batch nature of the fuel travel on the grate and de-ashing operations. This is a further justification for not applying this technology to the Installation.

Pulsed Hearth

Pulsed hearth technology has been used for the combustion of solid fuels. However, pulsed hearth Installations have had difficulties in achieving reliable and effective burnout of fuel and it is considered that the burnout criteria required by Chapter 4 of the IED would be difficult to achieve. Pulsed Hearth Furnaces are therefore not regarded as being an appropriate combustion technology for the Installation.

Rotary Kiln

Rotary Kilns have been proven to achieve good fuel agitation and associated burn-out 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 waste incineration technologies due to the large areas of refractory lined combustion chamber.

An oscillating kiln is used for the incineration of municipal waste at one site in England and some sites in France. The energy conversion efficiency in these systems is lower than that of other waste incineration 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 the design capacity of the Facility approximately 7 furnaces would be required to achieve the maximum capacity design throughput. This is not considered practical and would lead to significant efficiency losses.

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 disposal of waste derived fuels, however these systems are not considered proven.

Currently there are no operational pyrolysis or gasification systems which are of a capacity required to process the proposed design capacity for the Facility. Therefore, these systems are not considered to be available and have not been considered any further.

Fluidised Bed

Fluidised bed combustion can sometimes lead to slightly lower NOx generation, although injection of ammonia solution is still required to achieve the emission limits specified in the Industrial Emissions Directive. Fluidised bed technologies are designed to treat large quantities of waste derived fuels and are therefore regarded as being an appropriate combustion technology for the Facility.

Fluidised Beds are only appropriate when the fuel is consistent. Any deviations in fuel composition can results in operational issues with the fluidised bed. Some fluidised bed suppliers will require fuel to achieve a very tight fuel specification which can require an additional pre-treatment process to be installed to ensure that the fuel composition is appropriate for combustion.

A BAT assessment of a grate, fluidised bed and kiln combustion technologies has been carried out in Annex 6 section 5. The conclusions are summarised below.

2.6.1.1 Conclusions

The table below compares the two available combustion technology options. This assessment considers the available technologies for the proposed nominal design capacity.

Table 7 – Comparison, Combustion Options

		Grate	Fluidised Bed
Global Warming Potential	t CO_2 p.a.	-101,000	-99,000
Ammonia Consumption	t.p.a.	2,200	2,500
Residues		-	Less bottom ash, more fly ash
Total Materials Costs	p.a.	£5,200,000	£5,610,000
Power Revenue	p.a.	£15,400,000	£15,235,000

The grate has a lower global warming potential than the fluidised bed, however it would use over 10% more ammonia to abate emissions of NOx.

Both combustion technologies will produce similar quantities of ash, although the fluidised bed produces more fly ash.

The material costs are approximately 5% higher for the fluidised bed than the grate, whereas the grate system will have a slightly higher power revenue. This is considered to outweigh the higher ammonia consumption. However, it is acknowledged that it is marginal and should be noted that this assessment is based on the assumption that the incoming waste will not require any additional treatment and will be suitable for combustion within a fluidised bed.

As stated within the qualitative BAT assessment, refer to section 2.6.1 of the Supporting Information, grate combustion systems are designed for large quantities of heterogenous waste, whereas fluidised bed systems are more sensitive to inconsistencies within the fuel. Due to the robustness of grate combustion systems, they are considered to represent BAT for the Facility.

2.6.2 NOx Reduction System

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).

Flue Gas Recirculation (FGR)

The process will employ flue gas recirculation. This primary control measures reduces NOx generation by diluting the flame in the combustion chamber, decreasing the reaction temperature and oxygen availability.

It is important to emphasise that FGR itself does not reduce NOx emissions to the levels required by the IED and so it would not avoid the need for further abatement.

Selective Non-catalytic Reduction

NOx levels will primarily be controlled by monitoring and controlling the combustion air fed into the boiler. Selective non-catalytic NOx reduction (SNCR) methods will also be installed, using a SNCR reagent.

Selective Catalytic Reduction

The use of Selective Catalytic Reduction (SCR) has also been considered. In this technique, the reagent is injected into the flue gases immediately upstream of a reactor vessel containing layers of catalyst. The reaction is 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.

Since the other flue gas cleaning reactions take place at an optimum temperature of around 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.

A quantitative BAT assessment of the available technologies has been undertaken and is included in Annex 6. This assessment uses data obtained by Fichtner from a range of different projects using the technologies proposed in this application. Specifically for the scale of project proposed, the conclusions of the assessment are summarised below.

Table 8 – Comparison Table, NOx Abatement Options

		SNCR	SCR	SNCR + FGR
NOx released after abatement	t p.a.	450	160	450
NOx removed	t p.a.	340	630	340
Photochemical Ozone Creation Potential (POCP)	t ethylene-eq p.a.	-17,200	-6,100	-17,200
Global Warming Potential	t CO2 p.a.	1,100	4,100	1,500
Ammonia	t p.a.	2,200	1,800	2,200
Annualised Cost	£ p.a.	£710,000	£2,224,000	£865,000
Average cost per tonne NOx abated	£ p.t NOx.	£1,870	£3,530	£2,280

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

(1) increases the annualised costs by more than £1.4 million;

(2) abates an additional 290 tonnes of NOx per annum;

(3) reduces the benefit of the facility in terms of the global warming potential by more than 2,500 tonnes of CO2;

(4) reduces reagent consumption by approximately 1,400 tonnes per annum; and

(5) costs more than an additional £1,240 per additional tonne of NOx abated.

The additional costs associated with an SCR are not considered to represent BAT for the Installation. Therefore, SNCR is considered to represent BAT for the Installation.

The two SNCR options, with and without FGR, are very similar. FGR results in a reduction of reagent consumption, but requires more power to operate, and therefore it has a higher global warming potential and slightly higher total annualised costs.

The choice of whether to include FGR is supplier dependent. Some furnace suppliers 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 have focused on reducing NOx generation through the control of primary and secondary air supply and the furnace design, and they can gain little if any benefit from the use of FGR. On this basis, and since the differences between the two options are small, the use of FGR for the proposed installation will be considered during the technology procurement process. It is proposed that a pre-operation conditions is included within the EP, which requires that the Operator provides confirmation to the EA of the final designs for the abatement of NOx.

2.6.3 Acid Gas Abatement System

There are currently three technologies widely available for acid gas treatment on waste combustion 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 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 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 lime and reaction products are collected on a bag filter, where further reaction can take place.

(3) Dry, involving the injection of solid lime into the flue gases as a powder. The lime is collected on a bag filter to form a cake and most of the reaction between the acid gases and the lime takes place as the flue gases pass through the filter cake. In its basic form, the dry system consumes more lime 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 represent BAT for this type of EfW facility, due to the production of a large volume of hazardous liquid effluent and a reduction in the power generating efficiency of the plant.

The dry and semi-dry systems can easily achieve the emission limits required by the Industrial Emissions Directive and both systems are in operation on plants throughout Europe. Both can be considered to represent BAT by the Environment Agency Sector Guidance Note EPR 5.01. 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 Annex 6 section 2.

The table below compares the options for acid gas treatment, using lime as the selected reagent identified in section 2.1.3.1. This assessment considers the available technologies for the proposed capacity.

Table 9 – Comparison Table, Acid Abatement Options			
		Dry	Semi-Dry
SO_2 abated	t p.a.	980	980
Photochemical Ozone Creation Potential (POCP)	t ethylene-eq p.a.	530	530
Global Warming Potential	t CO_2 p.a.	3,900	8,100
Additional water consumption compared to a dry system	t.p.a.		12,200
APC Residues	t p.a.	20,000	20,000
Annualised Cost	£ p.a.	£9,234,000	£9,027,000

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 Abatement

The Installation 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 the proposed waste incineration facility 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 combustion plant, and are regarded as being more suited to high temperature filtration.

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

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 Installation, which are:

(1) once though cooling (Water cooling);

(2) recirculation cooling (Water cooling); or

(3) air cooled condenser (ACC).

All are considered in Sector Guidance Note S5.01 as potential BAT solutions.

The difference between once through and recirculation cooling is that in the former, the water passes through the condenser once and is returned to the source water body, at a slightly higher temperature. In the latter, the cooling water circulated through a cooling tower before return to the cooled water to the condenser. Makeup water from the source water body is required to replace water lost to evaporation in the cooling tower and to replace water removed to control the build-up of solids in the circulating water.

Water cooled systems require a nearby watercourse to supply significant volumes of water and to receiving the off-site discharge of the heated cooling water. Whilst there is a canal adjacent to the site which could supply water for cooling purposes it would probably not be feasible to discharge the heated water back into the canal. Furthermore, the impact and costs of the alternative which is to discharging large volumes of abstracted water from the canal to sewer would be significant. Taking this into consideration, water cooling is not considered to be available.

Air cooled condensers use air rather than water to condense steam. The Installation will operate an Air Cooled Condenser (ACC) to condense the steam output from the turbine to allow return of the condensate to the boiler.

As water cooled systems are not considered available, an air cooled condenser is considered to be BAT for the Installation.

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

This section contains information how the plant 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 Installation:

- Article 22 – Site Closure
- Article 44 – Applications for Permits
- 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.

Articles 51 (Authorising to change operating conditions) and 54 (Substantial change) will not apply to this application. In addition, the requirements of Article 55 (Reporting & public information on waste incineration plants and waste co-incineration plants) will apply to the competent authority (the Environment Agency), not the applicant.

A table showing compliance with the Waste Incineration requirements of the Industrial Emissions Directive is presented below.

Table 10 – 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 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.	Refer to Annex 2.
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 2.8.2.1 of the Supporting Information.
	(c) the residues will be minimised in their amount and harmfulness and recycled where appropriate;	Refer to Section 2.9 of the Supporting Information

Table 10 – Summary Table for IED Compliance		
Article	**Requirement**	**How met or reference**
	(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 Annex 5
46 (2)	Emissions into air from waste incineration plants and waste co-incineration plants shall not exceed the emission limit values set out in parts 3 and 4 of Annex VI or determined in accordance with Part 4 of that Annex.	Refer to Section 2.4.1 of the Supporting Information
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 Section 2.4.5
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 Annex 5
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 2.2.3.7 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

Table 10 – Summary Table for IED Compliance		
Article	**Requirement**	**How met or reference**
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 2.5.1.1 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.
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.	TOC/LOI. Refer to Section 2.2.3.3 of the Supporting Information
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 2.2.3.7 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 Section 2.2.3.7 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 2.2.3.7 of the Supporting Information

Table 10 – Summary Table for IED Compliance		
Article	**Requirement**	**How met or reference**
	(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 2.2.3.7 of the Supporting Information
	(c) whenever the continuous measurements show that any emission limit value is exceeded due to disturbances or failures of the waste gas cleaning devices.	Refer to Section 2.2.3.7 of the Supporting Information
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.
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 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 and 2.2.2 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 Section 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 Annex 4
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 generated steam will be diverted to a steam turbine/generator set for the production of electricity. A fraction of the generated electricity will be used by the Installation and the remainder will be exported to the local electricity grid.

In the case of failure of the electricity supply, a diesel generator will be installed to run or safely shut down the Installation and to provide an emergency supply.

In considering the energy efficiency of the Installation, due account has been taken of the requirements of the Environment Agency's Horizontal Guidance Note H2 on Energy Efficiency.

2.8.2 Basic Energy Requirements

An indicative Sankey Diagram for the Installation is presented below:

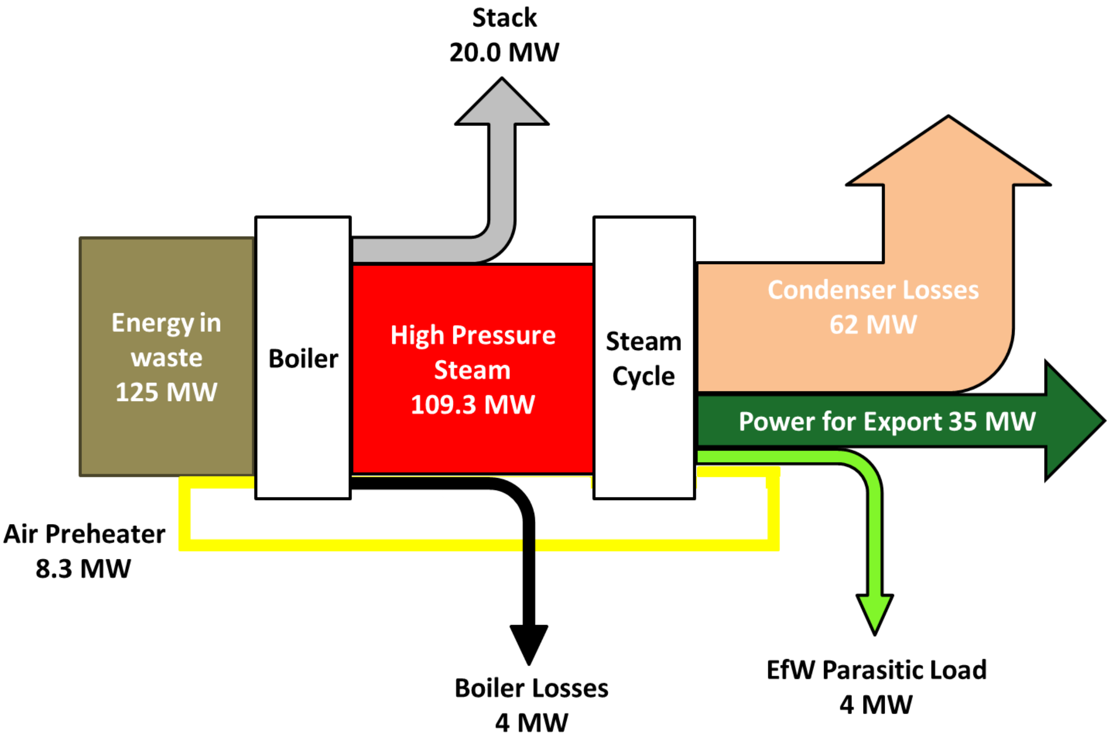

Figure 2.3 - Sankey diagram based on 45 tonnes/hour at 10 MJ/kg

It is estimated that the Installation will generate approximately 39 MW of electricity. Approximately 4 MW of this electricity will be used within the Installation, with the remaining 35 MW being exported to the national grid.

The plant will have a nominal design capacity of approximately 45 tonnes per hour of fuel, with a net calorific value of 10 MJ/kg. Assuming an operational availability of 8,000 hours per annum, the nominal design capacity of the plant is approximately 360,000 tonnes per annum. Therefore, the Installation will annually generate approximately 312,000 MWh and export 280,000 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 11 – Comparison Table

Parameter	Unit	Kelvin ERF	Benchmark	Source
Gross power generation, nominal design	MWh/t waste	0.86	0.415-0.644	BREF WI
Net power generation, nominal design	MWh/t waste	0.78	0.279-0.458	BREF WI
Internal power consumption, nominal design	MWh/t waste	0.09	0.062-0.257	BREF WI
Power generation (assumed net) for 100,000 tpa of waste	MW	9.7	5-9	EPR 5.01

As can be seen from the comparison, the Installation either achieves or exceeds all of the relevant benchmark values for energy efficiency.

2.8.2.1 Energy Consumption and Thermal Efficiency

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

(1) combustion air fans;
(2) induced draught fan;
(3) boiler feed water pumps;
(4) cooling water pumps;
(5) air compressors;
(6) fuel loading systems and ash and residue conveying systems; and
(7) offices and ancillary rooms.

The Installation will be designed with careful attention being paid to all normal energy efficiency design features, such as high efficiency motors, high standards of cladding and insulation, etc.

The plant will be designed to achieve a very high thermal efficiency applying the following measures.

(1) The boilers will be equipped with economisers and superheaters to optimise thermal cycle efficiency without prejudicing boiler tube life, having regard for the nature of the fuel that is being burnt.
(2) Unnecessary releases of steam and hot water will be avoided, to avoid the loss of boiler water treatment chemical and the heat contained within the steam and water.
(3) 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.
(4) Steady operation will be maintained where necessary by using auxiliary fuel firing.
(5) Boiler heat exchange surfaces will be cleaned on a regular basis to ensure efficient heat recovery.
(6) Due consideration will be given to the recommendations given in the Sector Guidance Note.

2.8.2.2 Operating and Maintenance Procedures

An O&M manual will be developed for the Installation. The O&M procedures will include 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.

2.8.2.3 Energy Efficiency Measures

An energy efficiency plan will be built into the operation and maintenance procedures of the plant ensuring maximum, practical, sustainable, safe and controllable electricity generation.

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 will be assessed on the implementation cost compared with the anticipated benefits.

2.8.3 Further Energy Efficiency Requirements

Under the Industrial Emissions Directive, heat should 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 plant will not be subject to a Climate Change Levy agreement, although the energy generated will be exempt from the levy.

A CHP assessment has been developed for the Facility. This is presented in Annex 7.

2.9 Residue Recovery and Disposal

2.9.1 Introduction

The main residue streams arising from the Installation are:

(1) bottom ash from the combustion process (Residue Type RT1); and

(2) APC residue and fine ash particles (Residue Type RT2).

As described below, the waste recovery and disposal techniques will be in accordance with the indicative BAT requirements. The main wastes to be generated from the operation of the Installation are summarised in Table 12.

2.9.2 Air Pollution Control residues (APCr)

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

(1) 30-36% w/w calcium;

(2) 12-15% w/w chlorine;

(3) 8-10% w/w carbonate (as C); and

(4) 3-4% w/w sulphur (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.

It may be possible to send the residue to an effluent treatment contractor, to be used to neutralise acids and similar materials or to be used in the production of concrete building products. Using the residues in this way avoids the use of primary materials. If this option is not practicable then it will be sent to a secure 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 will vent back to the silo and any releases to atmosphere would pass through a fabric filter.

2.9.3 Bottom Ash

Boiler ash will be mixed with bottom ash. The mixture of boiler ash and bottom ash is a non-hazardous waste which can be typically be recycled in the manufacture of blocks. 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 recycle the boiler ash.

Bottom ash 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. Verus Energy intend to transfer bottom ash from the Facility to an off-site bottom ash reprocessing facility. If a suitable recovery facility will not accept the residue, it may be transferred for disposal in an off-site landfill.

2.9.4 Summary

The table below summarises the expected quantities and properties of the main residue streams.

Table 12 – Key residue streams				
Source/ material	**Properties of residue**	**Storage location/ volume stored**	**Annual quantity of residue (tonnes) - estimated**	**Disposal route and transport method**
Fly ash/ APCr	Fly ash and APC residues, which may contain unreacted lime.	APCr silos.	20,000	Recycled or disposed of in a licensed site for hazardous waste. Transport occurs by road vehicle.
Bottom ash	Grate ash, grate riddling, boiler ash. This ash is relatively inert, classified as non-hazardous.	Bottom ash storage area.	86,000	Sent to a suitable licensed recovery facility to be used for the manufacture of blocks for the construction industry.

2.10 Management

2.10.1 Introduction

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'.

Verus Energy expect that the day-to-day operation of the different waste treatment processes will be subcontracted to third party organisations through operation and maintenance (O&M) contracts. Verus Energy will ensure that under the O&M contract Verus Energy retain control of the Installation and it is operated to the exact instruction of Verus Energy.

Verus Energy will require the O&M contractors to implement environmental management systems in accordance with BS EN ISO 14001:2015 Environmental Management System Standard and with the operating and maintenance instructions of the designer of the plant.

2.10.2 Management Systems

Verus Energy will ensure that the O&M contractor will develop an EMS that clearly defines the Installations management structure as well a setting out roles and responsibilities of all staff. The development of the EMS will also include:

- An Environmental Policy;
- Health and Safety Procedures; and
- An operational guidance manual which will include 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 will undertake inspections and reviews for quality control, performance measurements, and staff appraisals.

2.10.2.1 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.

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.

2.10.2.2 General Requirements

Verus Energy will require the O&M contractor to maintain the EMS in accordance with the ISO:14001 standard. The EMS 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 EMS;
- 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

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

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

(1) The General Manager will be employed by Verus Energy and will have overall responsibility for management of the Installation and compliance with the operating permit. The general manager will have extensive experience relevant to his responsibilities.

(2) The Operations Manager will be employed by the O&M Contractor and will have day-to-day responsibility for the operation of the plant, to ensure that the plant is operated in accordance with the permit and that the environmental impact of the plant's operations is minimised. In this context, he or she will be responsible for designing and implementing operating procedures which incorporate environmental aspects.

(3) The Maintenance Manager will be employed by the O&M Contractor and 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

Verus Energy 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.

Verus Energy will ensure that the O&M contactor develops 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.

Verus Energy 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 EMS 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 (e.g. WAMITAB), where they exist.

2.11 Closure

2.11.1 Introduction

The Facility is designed for an operational life of 25- 30 years but its actual operational lifetime is dependent on a number of factors including the availability of the waste and the cost of operating the facility.

When the Installation 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 General

At the end of the economic life of the plant, the development site and buildings may be converted to other uses or form part of an appropriate landscape restoration plan. The responsibility for this may well rest with other parties if the Installation is sold. However, the Applicant recognises 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 achieve this aim a site closure plan will be prepared. 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

(1) Underground tanks and pipework to be avoided except for supply and discharge utilities such as towns water, sewerage lines and gas supply;

(2) Safe removal of all chemical and hazardous materials;

(3) Adequate provision for drainage, vessel cleaning and dismantling of pipework;

(4) Disassembly and containment procedures for insulation, materials handling equipment, material extraction equipment, fabric filters and other filtration equipment without significant leakage, spillage, dust or hazard;

(5) The use of recyclable materials where possible;

(6) 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;

(7) Soil sampling and testing of sensitive areas to ensure the minimum disturbance (sensitive areas to be selected with reference to the initial site report).

2.11.2.2 Specific Details

(1) A list of recyclable materials/components and current potential outlet sources;

(2) A list of materials/components not suitable for recycle and potential outlet sources;

(3) A list of materials to go to landfill with current recognised analysis, where appropriate;

(4) A list of all chemicals and hazardous materials, location and current containment methods;

(5) A Bill of Materials detailing total known quantities of items throughout the facility such as:

- Steelwork;
- Plastics;
- Cables;
- Concrete and Civils Materials;
- Oils;
- Chemicals;
- Consumables;
- Contained Water and Effluents; and
- Bottom Ash and APC Residues.

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

2.12.1 Pre-operational Conditions

Verus Energy would propose that the following conditions, which are typically included for this type of installation, as follows:

(1) Submit a written report to the Environment Agency on the commissioning of the Installation. The report will summarise the environmental performance of the plant as installed against the design parameters set out in the Application.

(2) Submit a report on the details of computational fluid dynamics (CFD) modelling to demonstrate that the design combustion conditions comply with the residence time and temperature requirements in Art. 50(2) of the IED.

(3) Submit a report confirming the selected auxiliary fuel to be used for start-up and shutdown of the Facility. The report will include details on the measures to be adopted to minimise the risk of pollution from the storage facilities for the auxiliary fuel.

(4) Submit a report which confirms whether FGR has been included within the final design of the Installation.

2.12.2 Commissioning Conditions

Prior to commissioning of the Facility, Verus Energy will comply with the typical Pre-operational Conditions which will be included for this type of installation, as follows:

(1) Submit to the Environment Agency for approval a protocol for the sampling and testing of bottom ash for the purposes of assessing its hazardous status. Sampling and testing shall be carried out in accordance with the protocol as approved.

(2) Provide a written commissioning plan, including timelines for completion, for approval by the Environment Agency. 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 Environment Agency in the event that actual emissions exceed expected emissions. Commissioning shall be carried out in accordance with the commissioning plan as approved.

2.12.3 Documented Management Procedures

Verus Energy will develop and implement documented procedures for the management and operation of the Facility prior to commencement of operations. Verus Energy would propose to provide the EA with a summary of the documented procedures prior to commencement of operation.

The documented procedures would include waste pre-acceptance and waste acceptance procedures for all wastes which the Facility is permitted to receive.

2.12.4 Post Commissioning

Following commissioning of the Facility, Verus Energy will comply with the typical Improvement Conditions which will be included for this type of installation, as follows:

- submit a written summary report to the Agency to confirm by the results of calibration and verification testing that the performance of Continuous Emission Monitors for parameters as specified within the EP complies with the requirements of BS EN 14181, specifically the requirements of QAL1, QAL2, and QAL3.
- carry out checks to verify the residence time, minimum temperature and oxygen content of the exhaust gases in the furnace whilst operating under the anticipated most unfavourable operating conditions. Results shall be submitted to the EA.
- provide a written proposal to the EA, for carrying out tests to determine the size distribution of the particulate matter in the exhaust gas emissions to air, identifying the fractions in the PM10 and PM2.5 ranges. The report will detail a timetable for undertaking the tests and producing a report on the results.

Annex 1 – Plans and Drawings

Annex 2 – Site Condition Report

Annex 3 – Noise Assessment

Annex 4 – Environmental Risk Assessment

Annex 5 – Air Quality Assessments

Annex 6 – BAT Assessment

Annex 7 – CHP Assessment

Annex 8 – Fire Prevention Plan

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