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Consulting Engineers Limited

LEVENSEAT
GASIFICATION PLANT
SUPPORTING INFORMATION

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1 INTRODUCTION

Levenseat Ltd are proposing to build a MRF and gasification facility at the existing Levenseat Waste Management facility. The MRF and gasification facility will be known as the Levenseat Thermal Waste Treatment Plant.

The MRF and gasification facility will have a nominal design capacity for the receipt of approximately 220,000 tonnes per annum of waste. The facility will be designed to recover recyclates from the incoming commercial and industrial waste and to generate up to approximately 12.34 MW of electricity from the gasification of the residual element which is not suitable for recycling.

This document and its annexes contain the supporting information for the application for a variation to a PPC Permit. They should be read in conjunction with the formal application form. In this section 1, we have provided an overview of the MRF and gasification plant. In section 2, we have provided further information in response to specific questions in the application form. In section 3, we have responded to the specific questions designed to demonstrate that the proposed gasification plant would comply with the requirements of the Waste Incineration Directive. The requirements of Sector Guidance Notes (SGNs) S5.01 and S5.06 and any other relevant sector guidance have been addressed throughout this document.

1.1 The Applicant

Levenseat Ltd (Levenseat) is a waste management company which has been engaged in the waste management industry since 1986. Levenseat operates both landfill and recycling operations. Levenseat currently handles approximately 200,000 tonnes per year of wastes including household, commercial, industrial, inert and organic wastes.

The company currently operates from 3 sites: Muldron Landfill (Restoration Phase), Torphin Quarry Restoration (a landfill for inert material only plus treatment of contaminated soils) and the Levenseat Waste Management site. The Levenseat Waste Management Site comprises a fully engineered 2 million cubic metre landfill (non-hazardous wastes) and a five hectare materials recycling facility.

Levenseat is committed to on-going enhancement of their facilities and improvement of the service they provide to both private sector customers and local authorities. Levenseat's management pride themselves on their innovative and environmentally sympathetic approach to waste management.

1.2 The Site

The Levenseat site is located on the west side of the A706, 2km north of Forth and 2km south of the junction with the A71 at Breich. The site entrance is just within West Lothian on the border with South Lanarkshire. The site is located approximately 3km south of Fauldhouse.

The existing landfill site extends to some 10 hectares and is located in a former sandstone quarry and accessed from the A706 along a tarmac roadway to the south-east corner of the site.

The site is perched at the top of the north facing hillside of Leven Seat Hill. Elevations on the site range from 350m AOD to 320m AOD and are highly variable due to the current use of the site, particularly within the landfill area. In general, however, the site falls towards the north.

The access road off the A706 is located on the opposite side of the hill and therefore falls away from the site in a south-easterly direction to an approximate elevation of 328m AOD.

The Levenseat site is a well-established fully integrated waste management facility that offers a broad spectrum of waste handling, sorting and recycling facilities.

1.3 The Application

This application is being submitted as a variation to the existing landfill PPC permit. A plan which identifies the location of the MRF and gasification facility is presented in Annex 1.

1.3.1 The Activities

Activities covered by this application include:

(1) Operation of a materials recovery facility;
(2) gasification plant consisting of one gasification line processing RDF from the fuel storage bunkers;
(3) electricity generation and export to the National Grid;
(4) production of inert bottom ash material that will be transferred off-site to a suitably licensed waste treatment facility for recovery/disposal; and
(5) generation of an air pollution control residue that will be transferred to a suitably licensed hazardous waste facility for disposal.

The following table lists the scheduled and directly associated activities.

Table 1.1: Scheduled and Directly Associated Activities

Type of Activity	**Schedule Activity**	**Description of Activity**
Installation	5.4 Part A b) ii)	Operation of a materials recycling facility to process the incoming waste to recover recyclates from the incoming waste and to produce an RDF which is suitable to be processed in a close coupled gasification plant.
Installation	5.1 Part A b)	The waste incineration of SRF in a gasification plant with an aggregated nominal design capacity of approximately 12.9 tonnes per hour.
Directly Associated Activities		
Directly Associated Activities		The export of electricity to the national grid.
Directly Associated Activities		Standby electrical generation to provide electrical power to the plant in the event of an interruption in the supply.

1.3.2 Type of Variation

A Substantial Change as stated within Part 1 – General, Regulation (2) paragraph (1) of the Pollution Prevention and Control (Scotland) Regulations (2012) (The Regulations) is defined as follows:

> *'a change in operation which SEPA considers may have a significant negative effect on human health or the environment, or which in itself constitutes the carrying out of an activity described in Part 1 of Schedules 1 or 2 that exceeds any threshold capacity specified in those Schedules. '*

Part 2, Schedule 1, Chapter 5, Section 5.1 Part A (b) of the Regulations defines the threshold of installation activities for the incineration of non-hazardous waste as:

> *'Incineration of non-hazardous waste with the exception of waste which is biomass or animal carcasses in an incineration or co-incineration plant.'*

Part 2, Schedule 1, Chapter 5, Section 5.4 Part A (b) ii) of the Regulations defines the threshold of installation activities for the pre-treatment of waste prior to incineration as:

> *'Recovery or a mix of recovery and disposal of non-hazardous waste at an installation with a capacity exceeding 75 tonnes per day by one or more of pre-treatment of waste for incineration or co-incineration.'*

Therefore, as the both of the additional activities proposed by this PPC permit variation introduce new Schedule 1 activities as stated in Part 2, Schedule 1, Chapter 5of the Regulations, the proposed variation is considered a Substantial Variation.

1.3.3 Installation Boundary

As can be seen from drawing '1481-008-R1 PPC Permit Boundary', part of the MRF and gasification plant will be located within the existing installation boundary, additional land will be required to be included within the installation boundary to include all of the MRF and gasification plant.

An Initial Site Report is included with this application to provide data on the existing ground conditions for the additional land associated with the extended installation boundary.

1.4 The MRF and Gasification Facility

The activities being applied for within this application are as follows:

(1) Materials Recycling Facility; and
(2) Gasification Plant

1.4.1 Material Recycling Facility (MRF)

The MRF has been designed to process 42 tonnes per hour of commercial and industrial (C&I) waste or municipal solid waste (MSW). The proposed plant will allow Levenseat to produce a high grade SRF fraction (to be baled and wrapped for export from the site), along with an RDF fraction (to be sent to the gasification plant). The system layout will allow for the recovery and removal (through a combination of automatic and manual separation methods) of; wood, old corrugated card (OCC), ferrous metals, non-ferrous metals, mixed plastics, mixed paper and non-combustibles.

1.4.1.1 Waste Reception

The C&I/MSW input material will be delivered into the facility by Rear-End Loaded vehicle (REL) or similar delivery vehicle. The material will be deposited into the dedicated input material storage hall. The input material to be processed will be fed into the system from the input material storage hall by the use of a 360 degree grab, front end shovel or similar plant, depending upon the application. The material will be deposited on the infeed conveyor.

1.4.1.2 Initial Processing

The material will discharge from the infeed conveyor onto a swan neck chain roller conveyor which will incline to feed the 300mm minus trommel. The reason for including a trommel at the early stage of processing is to distribute the throughput to provide a more efficient sorting/removal process at the pre-sort stage and reduce the amount of shredding required therefore enhancing recovery of materials.

All material sized at 300mm and below will fall through the apertures of the trommel, discharging onto a transfer conveyor which will cover the span of the trommel, ensuring all material falling through the apertures are received by it. The material will eventually be deposited onto a sorting conveyor. All material passing through the trommel and sized above 300mm, will discharge at the exit point of the trommel drum and onto a different sorting conveyor.

The sorting conveyors go through a manual sort cabin where manual sorting operatives will identify and remove reject material, OCC and wood respectively, placing them into the designated chute which will deposit them into an output storage bunker located below the pre-sort enclosure. Whilst wood and OCC are quite specific and easily identifiable fractions, the reject fraction will cover a broad spectrum of material types, and can typically encompass materials that could be detrimental to the system and could include bulky items. Once the reject, OCC and wood fractions have been removed, the material exits the manual sorting station.

The material sized above 300mm, will feed a primary shredder. The shredder will ensure that all material passing through it will be reduced to a size of 300mm or below. The material sized below 300mm will bypass the primary shredder as it will be below 300mm already.

The material is then sent to a shaker screen which separates it into 3 fractions:

- 40-300mm;
- 6-40mm; and
- <6mm (fines).

1.4.1.3 <6mm Fraction

The <6mm fraction will be sent directly to the RDF output stream, to a dedicated storage bay, or blended back into the 6-40mm fraction depending on the operator’s choice (to allow flexibility in processing the waste).

1.4.1.4 6-40mm Fraction

The 6-40mm fraction will be transferred to a dryer which is heated by steam from the gasification plant, discussed in section 1.4.1.9. Following drying, the fraction passes through an overband magnet (to remove ferrous metals) and then to a heavy/light separator. The heavy fraction is sent to a storage bay whilst the light fraction can be mixed into the SRF or the RDF sent to the gasification plant.

1.4.1.5 40-300mm Fraction

The 40-30mm fraction is conveyed to a further heavy/light separator which sorts it into 4 further fractions:

- 40-300mm heavy Fraction
- 40-300mm mid-heavy Fraction
- 40-300mm light Fraction
- 40-300mm super light Fraction

The 40-300mm heavy fraction (mainly brick, rock, food, heavy pieces wood & plastics and rejects) is conveyed to a bunker for export and disposal elsewhere.

The 40-300mm mid-heavy fraction is conveyed to a ballistic separator from where the 2D fraction goes to a secondary shredder and the 3D fraction goes through separation stages to remove ferrous metals (via an overband magnet), non-ferrous metals (via an eddy-current separator) and plastics (via optical sorting units) before being conveyed to the RDF output to the gasification plant.

The 40-300mm light fraction is conveyed to a ballistic separator from where the 2D fraction is sent to the RDF output and the 3D output is fed through the ferrous, non-ferrous and plastics separation described above.

The 40-300mm super light fraction will be screened into <100mm and >100mm fractions with the <100mm fraction going to the secondary shredder and the >100mm fraction going through paper/plastic optical sorting stages with the remaining material going to the SRF feed.

The secondary shredder, taking the feeds noted above, reduces the size of the SRF material to below 30mm and conveys it to the baler or storage bunker.

1.4.1.6 RDF Export

The RDF material, blended from the fractions noted above, is transferred by an enclosed conveyor to the fuel reception hall of the gasification plant, discussed in section 1.4.2.3.

1.4.1.7 SRF Export

The MRF has an option to divert RDF to an SRF export facility within the building where it can be baled and sent to thermal treatment plants external to the installation. It is anticipated that this facility would be used when the gasification plant was offline (for maintenance or because of faults) or to process excess material above that required to feed the gasification plant.

1.4.1.8 Dust Suppression

The plant will be equipped with general dust capture over specific areas where dust is known to be generated. A central system covers most areas with standalone units covering areas which may cause blockages in the central system. The standalone units discharge captured dust as solid blocks into the RDF stream to be taken to the gasification plant. The central system pulls the extracted air to a central filter unit which deposits dust in barrels for disposal elsewhere. The proposed layout of the capture points is shown in Figure 1 below.

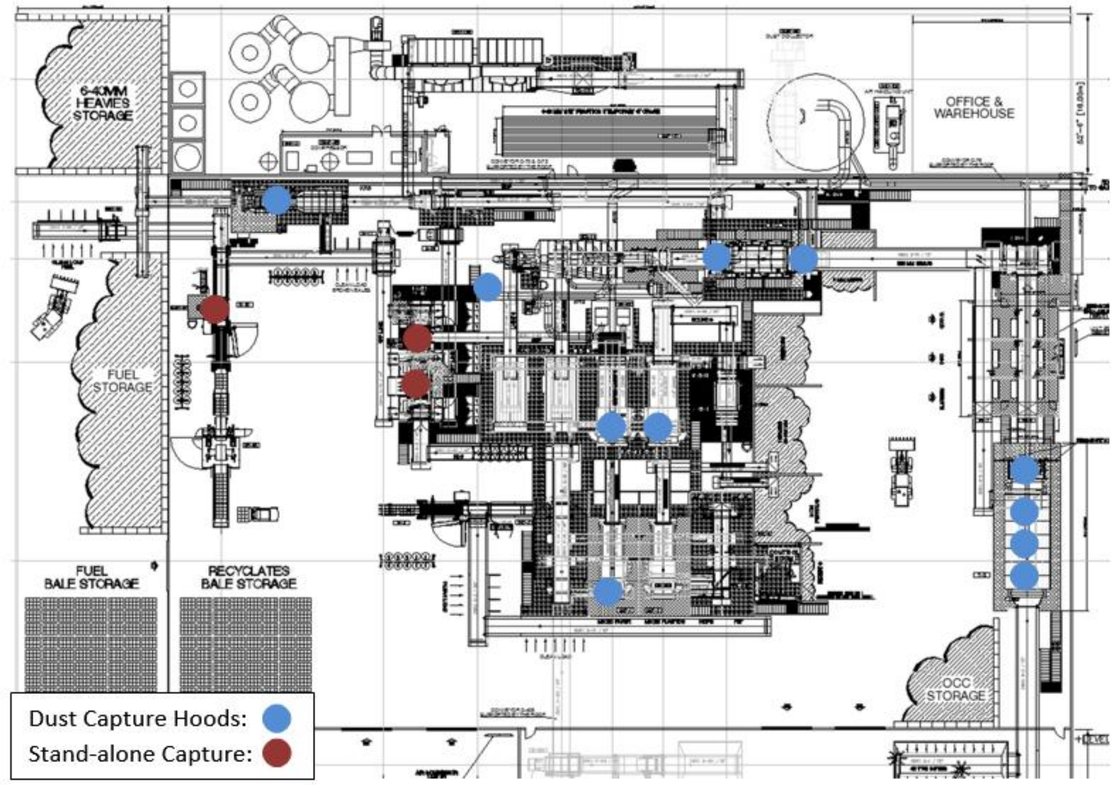


Figure 1: Dust Suppression Drawing

1.4.1.9 MRF Dryer

The MRF dryer will be designed to dry 12 tonnes per hour of -40mm screened waste from the MRF. The MRF dryer will reduce the moisture content of this fraction from 48% to less than 15%. The MRF dryer will produce approximately 7.5 tonnes per hour of dried output for further separation into fuel and non-combustibles.

Air extracted from the MRF dryer will be treated in the MRF dryer scrubber.

1.4.1.10 MRF Dryer Scrubber

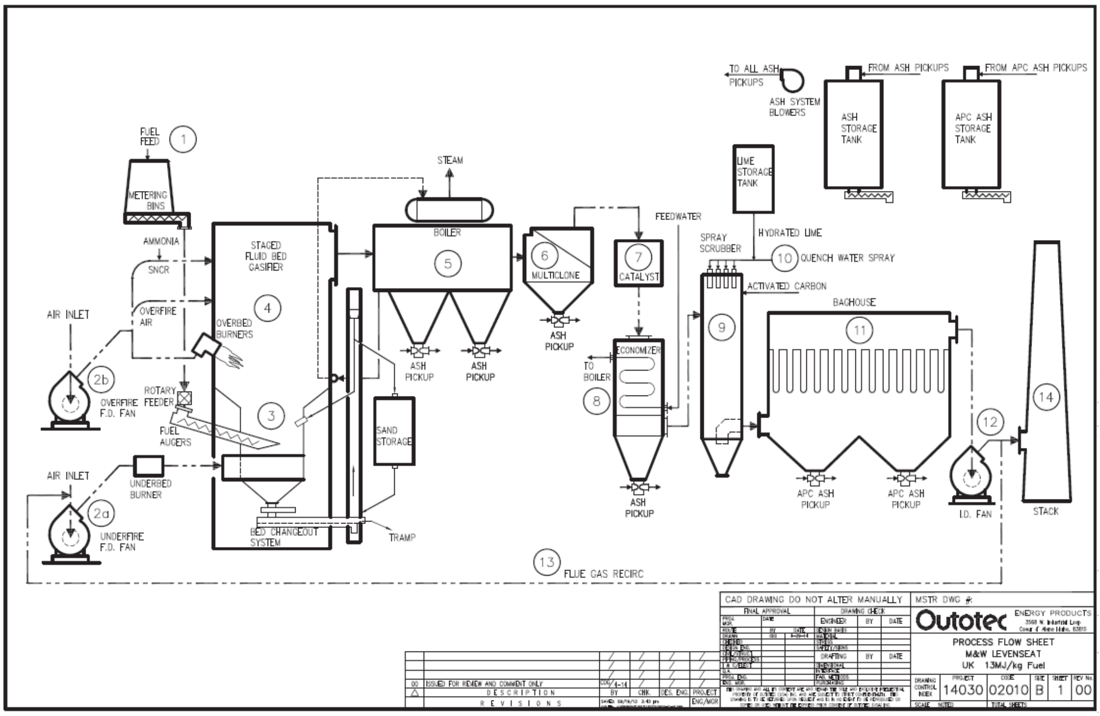
The MRF dryer will be fitted with a two-stage scrubber to abate emissions of odour from the facility. The first stage of the scrubber will be used to remove ammonia and VOCs from the output air from the dryer. The second stage will be used to remove hydrogen sulphides from the flue gases from the dryer. The first stage will use a reagent of sulphuric acid and second stage will use reagents of sodium hypochlorite and sodium hydroxide.

The scrubbed gases from the MRF scrubber are released to air via a stack.

1.4.2 Gasification Plant

1.4.2.1 Overview

The Gasification facility will consist of a single stream fluidised bed gasification facility which will have a nominal design capacity of approximately 100,000 tonnes per annum of RDF with net calorific value of 13.01 MJ/kg. A process flow diagram for the gasification plant is shown below. A larger version is presented in Annex 1.



The gasification plant is designed to gasify fuels with a net calorific value of between 10.1 – 17.5 MJ/kg. A firing diagram which shows the design capacities for the gasification plant is shown in Annex 1. As can be seen from the firing diagram the maximum capacity of the gasification plant is up to approximately 131,000 tonnes per annum, assuming a net calorific value of the pre-processed fuel of 10.1 MJ/kg.

1.4.2.2 Raw Materials & Reagents

The fluidised bed will comprise a granular bed material. The bed material will be crushed refractory clay specifically selected for the process and operating parameters of the gasifier, and for its resistance to thermal shock and abrasion.

A bed dosing system will be provided to introduce limestone into the fluidised bed. This will help reduce the effects of ash softening by coating the ash particles, and will also abate acid gases formed from sulphur and chlorine compounds in the RDF.

The bed dosing system will comprise a storage silo complete with pneumatic vibrator on the discharge cone to aid material flow. Limestone will be metered from the storage silo into a high pressure blowline through an eductor. The blowline will discharge at the fuel feed port into the fluidised bed cell. A single high pressure blower will supply conveyance air to the blowline.

The silo will be filled pneumatically from suitably equipped delivery trucks. Pneumatic transport air will be exhausted through a silo vent filter, positioned on top of the storage bin, to collect fugitive emissions during filling operations.

1.4.2.3 RDF Storage

Fuel will be conveyed, in an enclosed conveyor, from the MRF building to the RDF storage building. The RDF storage building has been designed with capacity for up to 4 days continuous operation of the gasifier.

The RDF will discharge from the high level conveyor onto a distribution conveyor located at high level in the Fuel Store Building. The distribution chain, which runs the length of the storage hall, is fitted with seven intermediate slide gate valves and one over-carry discharge point.

From the first three slide gate valves, the material is discharged onto high level stockpiling conveyors that provide efficient filling of the Push Floor RDF Storage Hall.

From the remaining slide gate valves, the material is discharged onto the floor below to provide static stockpiles. The height of these stockpiles will be maintained using a level instrument.

The push floor stockpiles will be maintained using a front end loader. The push floor system will be used to store up to approximately 1,400m^3 of RDF.

The push floor system will comprises two separate systems, each system having four separate ladders. Each system will have capacity to provide 100% of the required fuel to the gasifier fuel feed system.

The RDF is pulled towards the hydraulic cylinders and towards the bunker discharge opening by the reciprocating action of the Push Floor and falls into the lower section of one of the two chain conveyors. The chain conveyors pull the RDF towards the outlets and into one of two strand chain conveyors.

The material is conveyed along the top deck where it drops onto the bottom deck. On the bottom deck the RDF is pulled towards the head of the conveyor. On the bottom deck the RDF can discharge into the gasifier metering bins and any over carry is discharged from the head of the conveyor back into the storage hall.

The RDF store will be maintained at negative pressure which will be induced by the extraction of combustion air for the gasifier.

1.4.2.4 RDF Feed System

RDF from the Fuel Store will be conveyed to the Process section of the RDF storage building. The RDF from the supply conveyor will discharge into the fuel metering bins via the bin inlet slide gate mounted between the discharge of the fuel distribution conveyor and the metering bin inlet. Fuel level sensors will monitor the level in the fuel metering bin controlling the operation of the fuel conveying system.

The fuel metering bins will be equipped with weighing sensors. The fuel metering bins will be designed with sloping walls to minimise bridging. The bin outlet slide gate will be positioned at the discharge of the metering bin and the fuel feed auger to the gasifier. The discharge slide gate will automatically close if either a high temperature is detected in the feed system or high pressure is detected in the gasifier.

Each fuel metering bin will discharge into the fuel feed system delivering the fuel to the fluidised bed.

1.4.2.5 Gasification Process

The fluidised bed staged gasifier proposed for this project will have a design thermal capacity of approximately 46.3 MWth based on an RDF with a net calorific value of 13.01 MJ/kg and a set-point RDF feedrate of up to 12.9 tonnes per hour – nominal design capacity.

The processes within the gasifier can be divided into two zones:

- the gasification zone, in which the RDF will be gasified within the fluidised bed; and
- the oxidation zone, in which the syngas and any tars and char will be combusted.

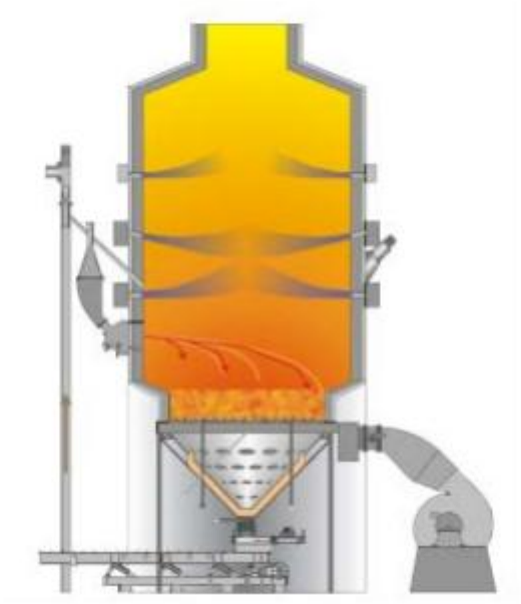


Figure 2: Staged Gasification Design

The bed will comprise a granular material and a fluidising air system.

The fluidised bed material, such as crushed refractory clay, will be specifically selected for the process and operating parameters of the gasifier; and for its resistance to thermal shock and abrasion.

Air required for fluidisation and gasification will enter the fluidized bed vessel through the fluidising air plenum. The air will be distributed from the plenum through individual air manifolds and into the fluidising nozzles that extend across the base of the gasifier. These nozzles will be spaced to provide a uniform airflow through the bed material to ensure complete fluidisation of the bed.

The air manifolds will be fitted with slip sleeve expansion mechanisms and cleanout ports on the end opposite the air plenum and will be spaced to allow bed and inert material to flow between them. The manifolds will have cooling air ports to reduce the temperature of the bed and tramp material being drawn out of the system.

The fluidising air system will comprise the under fire air fan, carbon steel ducting, dampers and expansion joints.

Depending on the fuel feed rate, flue gas will be recirculated in order to modify the temperature and oxygen levels within the bed.

The over fire air will be delivered into the gasifier through multiple nozzles in the walls of the gasifier above the fluidised bed. Each set of nozzles will be supplied with air from a dedicated header and damper assembly giving individual control of the over fire air optimising the thermal oxidation and temperature profile within the gasifier.

The over fire air system will comprise the over fire air fan, carbon steel ducting, dampers and expansion joints. In order to reach the operating temperature, the under fire air system will operate in conjunction with the under bed pre-heat burner.

The under bed burner will be mounted in a refractory lined duct out of the normal air path of the fluidising air. During start up, over bed burners will operate in conjunction with the under bed burner system, providing the energy to heat the bed material and vapour space. The burners will be fired with gas oil.

In order to comply with the Industrial Emissions Directive, the gasifier will be designed to ensure that the combustion temperature will be greater than 850°C with a minimum residence time of two seconds.

The holes will be sized and positioned in the inner cone to create an even draw-down across the entire active bed region. Cooling air from the under bed fan will be distributed through the manifolds to cool the bed material as it flows toward the discharge outlet.

The drawdown cone will be complete with a slide gate valve at the bottom discharge. A manually operated isolation slide valve will be located above the automatic slide valve and will be used to isolate the automatic slide gate valve for maintenance.

The bed material, inerts and clinkers will be discharged onto a common vibrating screen conveyor. The vibrating screen will incorporate a perforated plate to separate inerts and clinkers from the reusable bed material. The vibrating screen will discharge the bed material into the bucket elevator whilst the inerts and clinkers will be discharged into a skip for disposal.

The bucket elevator will lift the clean bed material above the active bed for reinjection, thereby maintaining a constant level of bed material in the vessel. A hopper will be incorporated into the system near ground level to facilitate manual makeup of the bed material.

A bed material storage silo will be provided to store and automate bed material handling for the fluidised bed system. Bed material will be diverted from the bucket elevator discharge to the storage silo by a pneumatically operated valve. This will allow the vessel to be emptied for inspection or maintenance purposes and will also permit the automated refill and makeup to maintain the proper vessel bed material inventory during operation.

A feed system will be provided to introduce a limestone additive into the fluidised bed. This will help to reduce the effects of ash softening by coating the ash particles.

The limestone system will comprise a storage silo complete with pneumatic vibrator on the discharge cone to aid material flow. Additives will be metered from the storage silo into a high pressure blowline through an eductor. The blowline will discharge at the fuel feed port into the fluidized bed cell. A single high pressure blower will supply conveyance air to the blowline.

The silo will be filled pneumatically from suitably equipped delivery trucks. Pneumatic transport air will be exhausted through a silo ventfilter, positioned on top of the storage bin, which collects fugitive emissions during filling operations.

The limestone silo will have a storage capacity of 7 days based on 100% MCR with the design point fuel.

The gasifier vessel will be complete with all supports, penetrations for overfire air, view ports, SNCR nozzles, access ports, temperature and pressure probes, syngas probe ports, bed reinjection and fuel in feed.

1.4.2.6 Energy Recovery

The steam generating system will combine heat transfer surfaces in the vapour-space area with evaporative surface areas in the waste-heat boiler.

Flue gases from the gasifier will enter the steam generator through a vertical tube, natural circulation and evaporative screen section. Wide tube spacing and relatively cool saturated temperatures will reduce the potential for ash bridging and provide initial flue gas cooling. Lower flue gas temperatures will also reduce fouling of the downstream superheater tubes.

The superheated steam from the boiler will be used to drive a steam turbine. The turbine generator arrangement would generate electrical power for export to the local electricity distribution network. The turbine facility will be 'CHP enabled' with capability to export heat to local heat users. To facilitate this, the turbine will be equipped with steam extraction points to allow low pressure steam to be supplied directly to heat users, or to be condensed in heat exchangers in order to provide hot water. Air-cooled condensers will be used to condense the residual steam from the steam turbine.

1.4.2.7 Flue Gas Treatment

The flue gas cleaning system will include a series of stages including:

(1) NOx reduction;
(2) Primary particulates abatement;
(3) Acid gas abatement;
(4) Control of heavy metals and dioxins; and
(5) Secondary particulate removal.

The cleaned flue gases will be discharged to atmosphere through a 55 m stack. A height of 55 m provides sufficient dispersion to ensure that the development does not result in an unacceptable impact on human health or sensitive environmental receptors. A CEMS unit would record the contaminants being discharged to the atmosphere.

<u>NOx reduction</u>

Nitrogen oxides can be formed by three mechanisms:

- Thermal NOx;
- Fuel NOx; and
- Prompt NOx.

Thermal NOx formation will depend on the temperature and residence time of the reaction products and oxygen levels within the furnace. Fuel NOx depends on the nitrogen content of the fuel; whilst prompt NOx is formed by the reaction of hydrocarbon radicals with atmospheric nitrogen during combustion.

In order to reduce NOx formation during the combustion of the syngas, the system will be controlled to give stable temperature and combustion conditions within the oxidation zone of the gasification chamber. The oxidation zone of the gasification chamber operates at temperatures below 1100°C in order to reduce the formation of thermal NOx.

The primary abatement of oxides of nitrogen (NOx) will be achieved by using a selective non-catalytic reduction (SNCR) system. The SNCR system will operate by injecting a reducing reagent, urea solution, into the gasifier, which reacts with NOx at temperatures between 900°C and 1000°C. The reaction breaks down the NOx into nitrogen gas and water vapour.

The urea solution will be injected into the vapour space of the gasifier through an array of liquid atomising nozzles. In order to achieve low NOx levels and low ammonia slip values, the ammonia injection control system will take account of the fuel, steam load conditions and the temperature within the furnace.

The ammonia reagent will be delivered by road tanker and pumped into a GRP double wall storage tank. The tank will be complete with max/min level switches and leakage detection. From the storage tank, the ammonia will be pumped to the mixing and metering module.

Primary particulates abatement

During normal operation the flue gas which exits the boiler will pass through a multicyclone which reduces the level of particulates entering the selective catalytic reduction unit. The multicyclone dust collector will comprise a bank of cyclone tubes. The inlet vanes of each tube will impart a rotating motion to the gas generating a centrifugal force that concentrates particles of entrained dust at the interior walls of the collecting tubes. The particles will then fall and discharge from the bottom of the tube. The clean gas will exit through the outlet at the top of the collecting tube, whilst the fly ash drops into the hopper and is removed via a rotary valve airlock. The fly ash from the multicyclone will be transported by the pneumatic conveying system to the fly ash silo.

Acid gas abatement

Acid gases formed during the gasification process, including sulphur dioxide (SO_2) and hydrogen chloride(HCl), will be neutralised by the injection of a reagent into the flue gas stream. Hydrated lime will be used as the reagent for acid gas abatement.

The reaction with the acid gases forms calcium sulphite, calcium sulphate and calcium chloride, along with water vapour.

The hot flue gas will be ducted from the outlet of the economiser to the spray dryer. The system will comprise a reaction tower; water delivery and spray system; reagent storage and delivery / mixing system.

The hot flue gas flows into the scrubber where it will react with a spray of water and hydrated lime. The injection rate of the reagent will be controlled by the upstream measurement of the HCl content in the flue gas, thus optimising the efficiency of gas scrubbing and hydrated lime usage. The dust like material separated within the fabric filter among reaction salts will still contain a certain portion of un-reacted lime.

Hydrated lime will be delivered as dry powder by road tanker. The hydrated lime will be fed from the road tanker into the silo via a pneumatic filling pipe.

The exhaust air generated during the filling operation will be filtered prior to discharge to atmosphere. The silo will be complete with systems to protect against excess pressure and vacuum. The hydrated lime will be discharged from the silo via a rotary airlock valve and transported to the injection point by a pneumatic conveying system.

The hydrated lime silo will have a storage capacity of 7 days, and a volume of approximately 30 m^3.

Control of heavy metals and dioxins

Heavy metals will be removed from the flue gases by the injection of powdered activated carbon into the flue gas along with effective particulate removal by the bag filters. This is a reliable and well-proven method for reducing mercury concentrations by 90% or more. For other metals, efficient particulate abatement will minimize heavy metal releases to atmosphere.

In addition to controlling the emissions of heavy metals, the powdered activated carbon system is also effective in controlling the release of dioxins to the atmosphere.

The primary method of minimising the generation of dioxins and furans will be through the careful control of the combustion conditions within the gasifier. The residence times of the flue gases, along with the temperature and oxygen content in the combustion system. will be such that any dioxins and furans are efficiently destroyed.

The *de novo* synthesis (reformation) of dioxins will be minimised by the careful design of the boiler and flue gas system temperature profile.

Any dioxins and furans generated will be effectively removed by the injection of powdered activated carbon into the flue gas stream along with effective particulate removal by the fabric filters. This is a reliable and well-proven method for abating emissions of dioxins and heavy metals in waste incineration and gasification facilities in the UK and Europe.

Particulate removal

Pulses of compressed air will be initiated automatically based on a time sequence and/or when the filter pressure differential reaches a set point.

The pulses will remove the accumulated cake ash from outside the bags. This ash will drop into hoppers located beneath the cells and then be stored in the APCR silo.

The APCR silo will have a storage capacity of seven days based on 100% MCR with the design point fuel.

Leaks in filter bags will be detected by installing differential pressure indicators for each compartment in the bag filter. In the event of a filter bag leak, the compartment will be isolated to enable the flue gas treatment system to continue operating normally, enabling the bag to be repaired or replaced.

During a cold start-up, the filter bags will be protected using an electric trace heating system. Where required, the hoppers will be insulated and trace heated to minimise the risk of acid condensation and corrosion.

1.4.2.8 Stack

The flue gases will be drawn through the plant by the induced draft fan. The fan will be designed for balanced draft operation, maintaining a slight negative pressure within the gasification chamber.

A proportion of the flue gases will be re-circulated to the gasifier and the oxidiser for mixing with local ambient air to control gasification and syngas oxidation reaction conditions.

The balance of the flue gases will then be discharged to atmosphere via the stack. The stack will incorporate access ladders and a platform for access to the CEMS probes mounted in the stack.

The stack will include aircraft warning lighting and lightning protection.

1.4.2.9 Emissions Monitoring

Emissions from the stack will be continuously monitored for:

- particulates;
- sulphur dioxide;
- hydrogen chloride;
- carbon monoxide;
- nitrogen oxides
- ammonia; and
- VOCs, expressed as total organic carbon.
- In addition periodic sampling and measurement will be carried out for metals [cadmium (Cd), thallium (Tl), mercury (Hg), antimony (Sb), arsenic (As), lead (Pb), chromium (Cr), cobalt (Co), copper (Cu), manganese (Mn), nickel (Ni), vanadium (V)], hydrogen fluoride (HF), dioxins and furans and dioxin like PCBs. Periodic measurements will be carried out four times in the first year and twice per year thereafter.

The Continuous Emission Monitoring (CEM) system will be MCERTS approved. There will be a back-up CEMS system available in case of CEMS failure.

1.4.2.10 Emergency Generators

A Low Voltage (LV) standby diesel generator will be provided to support safe shut down of the gasification process and associated critical loads in the event of a power failure or fault on the electricity supply network.

1.4.2.11 Liquid Effluent and Site Drainage

Uncontaminated rainwater from building roofs and roadways which has passed through an interceptor will be discharged into a swale which will be located around the perimeter of the MRF and gasification plant.

Effluents from domestic sources will be discharged into an on-site septic tank for solids capture with the effluent feeding into the on site waste water treatment plant. Surface water run-off from roadways and vehicle manoeuvring areas adjacent to the gasification building will pass through a compliant Class 1 Bypass Separator, prior to release into a swale which is located around the perimeter of the MRF and gasification plant. In case of a fire, an isolation valve will prevent the discharge of the effluent into the swale and will divert the contaminated fire water into a ‘fire water attenuation tank’.

Process effluents from the MRF and gasification facility will be collected in the process effluent drainage system. This will discharge into the existing waste water treatment plant for treatment prior to discharge.

Surface water from the roadways surrounding the MRF building will be discharged to the swale located around the perimeter of the MRF and gasification plant. In case of a fire, an isolation valve will prevent the discharge of the effluent into the swale and will divert the contaminated fire water into a ‘fire water attenuation tank’.

1.4.2.12 Ancillary Operations

The gasification plant will require a water supply of approximately 4m^3/hr. The primary requirement of water is to maintain the water level in the boiler system (steam cycle). Water would be primarily sourced from mains water but process waste water may also be used in the ash quench system. The feed water for the boiler for the gasification plant will be treated in an on-site water treatment plant.

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

2 OTHER INFORMATION FOR APPLICATION FORM

2.1 Raw Materials

2.1.1 Types and amounts of raw materials

The types and amounts of raw materials which will be used is presented in Table 2.1. Information on the potential environmental impact of these raw materials,= is included in Table 2.2.

Table 2.1: Types and Amounts of Raw Materials

Activity	Material	Storage Capacity		Annual Usage (tonnes per annum unless stated)	Description including any hazard code
		Number of tanks	Storage Capacity (tonnes unless stated)		
S5.4 (A) (b)(ii)	Sulphuric acid	1	20	100	40% solution
	Sodium Hydroxide	1	20	50	25% solution
	Sodium Hypochlorite	1	20	50	15% solution
S5.1 (A) (c)	Fuel oil for auxiliary firing	1	60	120	Low sulphur (<0.1%) fuel oil
	Hydrated Lime	1	10	1600	Powder
	Limestone	1	30	300	Granular crushed limestone
	Urea solution	1	30	1400	50% solution
	Activated carbon	1	1	30	Powdered
	Fuel oil for back-up generator	1	60	10	Low sulphur (<0.1%) fuel oil
	Boiler treatment chemicals		0.3	3	Corrosion inhibitor, scale inhibitor, biocide, ion exchange resins

Table 2.2 - Raw materials and their affect on the environment

Product	Chemical Composition	Typical Storage Quantity on site	Units	Air	Land	Water	Impact Potential	Comments
				Environmental Medium				
Sulphuric acid	H_2SO_4 40% solution	20	Tonnes per year	100	0	0	Low impact	Used as a reagent in the MRF dryer air abatement system
Sodium hydroxide	NaOH 25% solution	20	Tonnes per year	100	0	0	Low impact	Used as a reagent in the MRF dryer air abatement system
Sodium Hypochlorite	NaClO 15% solution	20	Tonnes per year	100	0	0	Low impact	Used as a reagent in the MRF dryer air abatement system
Fuel oil for auxiliary firing	Low sulphur (<0.1%)	60	Cubic metres per year	100	0	0	Low impact	Used for gasification plant start up and fuel for auxiliary engines. Products from the combustion in the boiler released to atmosphere after passing through flue gas treatment plant.
Hydrated Lime	$Ca(OH)_2$	10	Tonnes per year	0	100	0	Low impact	Injected hydrated lime is removed with the APC residues at the bag filter and disposed of as hazardous waste at a suitable licensed facility.
Limestone	$CaCO_3$	30	Tonnes per year	100	0	0	Low impact	Limestone is injected into the fluidised bed (gasification zone) to react with the acid gases produced from gasification. This will be removed from the fluidised bed with the recycling of the bed material.
Urea solution	$(NH_2)_2CO$ (50% solution)	30	Tonnes per year	0	100	0	Low impact	Reacts with nitrogen oxides to form nitrogen, oxygen and water vapour. Small quantities of unreacted urea solution (referred to as ammonia slip) are released to atmosphere at low concentrations, and is continuously monitored.

Table 2.2 - Raw materials and their affect on the environment

				Environmental Medium				
Product	**Chemical Composition**	**Typical Storage Quantity on site**	**Units**	**Air**	**Land**	**Water**	**Impact Potential**	**Comments**
Activated carbon		1	Tonnes per year	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 suitably licensed facility.
Fuel oil for back-up generator	Low sulphur (<0.1%)	60	Tonnes per year	0	0	100	Low impact	Used as fuel for the auxiliary/back-up engines which will be used to safely shutdown the plant in case of loss of grid connection. Products from the combustion in an engine released to atmosphere via the stack for the gas engines.
Boiler treatment chemicals	Tri Sodium Phosphate, Ammonia	0.3	Tonnes per year	0	0	100	Low impact	Used for regeneration of water treatment plant. Bio-degradable, no bioaccumulation potential and negligible ecotoxicity.

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) refrigerant gases for the air conditioning plant;
(4) oxyacetylene, TIG, MIG welding gases;
(5) CO_2 / fire fighting foam agents; and
(6) test and calibration gases.

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

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

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 Raw Material & Reagent Storage

The details of the storage facilities for the storage of raw materials and reagents are presented within section 3.2 of the Initial Site Report, refer to Annex 2.

2.1.3 Raw Materials and Reagents Selection

2.1.3.1 Acid Gas Abatement

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

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

The level of abatement that can be achieved by both reagents is similar. However, the level of reagent 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 2 section 4 and is summarised in the table below.

Table 2.3 – Acid Gas Abatement BAT Data

Item	Unit	$NaHCO_3$	$Ca(OH)_2$
Mass of reagent required	kg/h	110	70
Mass of residue generated	kg/h	80	90
Cost of reagent	£/tonne	160	90
Cost of residue disposal	£/tonne	150	130
Overall Cost	£/op.hr/kmol	36	24
Ratio of costs		1.53	1.00

Note: Data based on abatement of one kmol of Hydrogen Chloride

In summary, 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 sodium bicarbonate residue has a higher leaching ability than lime-based residue, and therefore may require additional treatment prior to disposal, making it more expensive to dispose of;
- the reaction temperature for sodium bicarbonate doesn't match as well with the optimum adsorption temperature for activated carbon, which will be dosed at the same time as the acid gas reagent; and
- the costs of sodium hydroxide are approximately 33% higher than using a lime system.

Thus, the use of lime is considered to represent BAT for the gasification plant.

2.1.3.2 NOx Abatement

The SNCR system can be operated with dry urea, urea solution or aqueous ammonia solution. There are advantages and disadvantages with all options:

- urea is easier to handle than ammonia - the handling and storage of ammonia can introduce an additional risk;
- dry urea needs big-bag handling whereas urea solution can be stored in silos and delivered in tankers; and
- ammonia emissions (or 'slip') can occur with both reagents, but good control will limit this.

The Sector Guidance on Waste Incineration considers all options as representing BAT for NOx abatement. It is proposed to use Urea solution for the SNCR system, because the climate change impacts of urea solution outweigh the handling and storage issues associated with the use of ammonia.

2.1.3.3 Gasification Auxiliary Fuel

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

> *The auxiliary burner shall not be fed with fuels which can cause higher emissions than those resulting from the burning of gas oil as defined in Article 2(2) of Council Directive 1999/32/EC of 26 April 1999 relating to a reduction in the sulphur content of certain liquid fuels (1) OJ L 121, 11.5.1999, p. 13., liquefied gas or natural gas.*

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

(1) 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, shutdown and when the temperature in the combustion chamber falls to 850°C.

Natural gas can be used for auxiliary firing and is safer to handle than LPG. As stated previously, auxiliary firing will only be required intermittently. When firing this requires large volumes of gas, which would be need to be supplied from a high-pressure gas main. The installation of a high-pressure gas main to supply gas for auxiliary firing to the facility would be very expensive.

LPG is a flammable mixture of hydrocarbon gases. It is a readily available product, and can be used for auxiliary firing. As LPG turns gaseous under ambient temperature and pressure, it is required to be stored in purpose built pressure vessels. If there was a fire within the site, there would be a significant explosion risk from the combustion of flammable gases stored under pressure.

A gas oil tank can be easily installed on the site. Whilst it is acknowledged that gas 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 gas 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 gas oil.

Therefore, low sulphur light fuel oil will be used for auxiliary firing.

2.1.4 Incoming Waste Management to the MRF

The waste will be delivered to the site in enclosed and/or covered vehicles. The incoming waste will be tipped in the reception area.

The MRF will typically accept residual solid waste, therefore much of the requirements of the relevant sector guidance note (S5.06) such as representative sampling and testing are considered to be adequately achieved by visual inspection and paperwork checks.

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

The MRF and gasification plant shall develop pre-acceptance and acceptance procedures which comply with the Indicative BAT requirements in the Sector Guidance Note, including:

- A high standard of housekeeping will be maintained in all areas and suitable equipment to clean up spilled materials will be provided and maintained.
- Loading and unloading of vehicles will take place in designated areas provided with impermeable hard standing. These areas will have appropriate falls to the process water drainage system.
- Fire fighting measures will be designed by consultation with the Local Fire Officers, with particular attention paid to 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.
- Incoming waste will be:
  - delivered in covered vehicles; and
  - unloaded into the enclosed reception area.

- Design of equipment, buildings and handling procedures will ensure there is insignificant dispersal of litter.
- Further inspection will take place by the plant operatives during vehicle tipping and waste mixing.
- Unacceptable waste will be rejected and returned to the waste producer or quarantined for later disposal, as appropriate, in accordance with the environmental management system for the installation.

2.1.4.1 Waste to be Received in the MRF

The MRF will be designed to receive and treat waste to recover recyclates and process any on-recoverable materials into a fuel to be processed within the gasification facility.

The MRF will have a design capacity to treat approximately 42 tonnes of incoming waste per hour. The MRF is forecast to process waste for 18 hours per day, 6 days per week. Hence, the capacity of the MRF is approximately 220,000 tonnes per annum. The dryer can operate 24 hours per day 7 days per week.

The incoming wastes to be processed within the MRF are presented within the following list of European Waste Catalogue (EWC) Codes:

Table 2.4 – Waste To Be Processed in the MRF

EWC Code	Description
02	**Wastes From Agriculture, Horticulture, Aquaculture, Forestry, Hunting And Fishing, Food Preparation And Processing**
02 01	Wastes From Agriculture, Horticulture, Aquaculture, Forestry, Hunting And Fishing
03	**Wastes From Wood Processing And The Production Of Panels And Furniture, Pulp, Paper And Cardboard**
03 01	Wastes From Wood Processing And The Production Of Panels And Furniture
03 03	Wastes From Pulp, Paper And Cardboard Production And Processing
04	**Wastes From The Leather, Fur And Textile Industries**
04 01	Wastes From The Leather And Fur Industry
04 02	Wastes From The Textile Industry
09	**Wastes From The Photographic Industry**
09 01	Wastes From The Photographic Industry
12	**Wastes From Shaping And Physical And Mechanical Surface Treatment Of Metals And Plastics**
12 01	Wastes From Shaping And Physical And Mechanical Surface Treatment Of Metals And Plastics
15	**Waste Packaging; Absorbents, Wiping Cloths, Filter Materials And Protective Clothing Not Otherwise Specified**
15 01	Packaging (Including Separately Collected Municipal Packaging Waste)
15 02	Absorbents, Filter Materials, Wiping Cloths And Protective Clothing

Table 2.4 – Waste To Be Processed in the MRF	
EWC Code	**Description**
16	**Wastes Not Otherwise Specified In The List**
16 01	End-Of-Life Vehicles From Different Means Of Transport (Including Off-Road Machinery) And Wastes From Dismantling Of End-Of-Life Vehicles And Vehicle Maintenance (Except 13, 14, 16 06 And 16 08)
17	**Construction And Demolition Wastes (Including Excavated Soil From Contaminated Sites)**
17 02	Wood, Glass And Plastic
18	**Wastes From Human and Animal Health Care and/or Related Research (except kitchen and restaurant waste not arising from immediate health care)**
18 01	Wastes from natal care, diagnosis, treatment or prevention of disease in humans
18 02	Wastes from research, diagnosis, treatment or prevention of disease involving animals
19	**Wastes From Waste Management Facilities, Off-Site Waste Water Treatment Plants And The Preparation Of Water Intended For Human Consumption And Water For Industrial Use**
19 02	Wastes From Physico/Chemical Treatments Of Waste (Including Dechromatation, Decyanidation, Neutralisation)
19 05	Wastes From Aerobic Treatment Of Solid Wastes
19 12	Wastes From The Mechanical Treatment Of Waste (For Example Sorting, Crushing, Compacting, Pelletising) Not Otherwise Specified
19 13	Wastes From Soil And Groundwater Remediation
20	**Municipal Wastes (Household Waste And Similar Commercial, Industrial And Institutional Wastes) Including Separately Collected Fractions**
20 01	Separately Collected Fractions (Except 15 01)
20 03	Other Municipal Wastes

2.1.4.2 Waste to be Processed in the Gasification Facility

The gasification facility will receive the pre-processed RDF fuel from the MRF. This will be transferred by conveyor from the MRF to the gasification plant where it will be stored within the fuel storage area prior to gasification.

The gasification plant will have a nominal design capacity of approximately 12.7 tonnes per hour with a net calorific value of 13.01 MJ/kg. The gasification plant will have an operational availability of 7,500 hours per annum. On this basis the gasification plant will have a nominal design capacity of approximately 95,000 tpa of RDF.

As shown in the firing diagram, the gasification plant will be designed to process fuels with a range of net calorific values between 10.1 and 17.5 MJ/kg. Fluctuations in the net calorific value of the treated waste will lead to variations in the waste throughput. On this basis the maximum capacity of the gasification facility can be calculated using the lower end of the net calorific value for fuels. As stated within the firing diagram, with an NCV of 10.1 MJ/kg the maximum design capacity of the gasification facility is approximately 16.8 tonnes per hour. Assuming the same annual availability, the gasification plant will have a maximum capacity of up to approximately 131,000 tonnes per annum. Levenseat would request that this is the capacity for the gasification facility stated within the PPC permit.

In addition to receiving processed fuels from the MRF, the gasification facility will also be designed to receive pre-processed fuel from external sources. It is assumed that all of the waste treated in the gasifier will have the following EWC codes:

Table 2.5 – Waste To Be Treated within the Gasification Plant

EWC Code	Description of Waste
19	**Wastes From Waste Management Facilities, Off-Site Waste Water Treatment Plants And The Preparation Of Water Intended For Human Consumption And Water For Industrial Use**
19 12	Wastes From The Mechanical Treatment Of Waste (For Example Sorting, Crushing, Compacting, Pelletizing) Not Otherwise Specified

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

A number of specific techniques will be employed to minimise the production of waste residues. All of these techniques meet the Indicative BAT requirements from the relevant Sector Guidance Notes.

2.1.5.1 MRF waste minimisation

MRF Dryer Scrubber

The two stage scrubber will be fitted with high-efficiency low-pressure-drop vertical-flow demisters. These will minimise the carryover and minimise losses of scrubbing solution.

The level of the scrubber reagent will be controlled by an electro valve. Reagent dosage will be controlled by a pH meter for sulphuric acid and sodium hydroxide, and a redox meter for sodium hypochlorite.

The scrubbing liquor is recirculated through centrifugal pumps.

2.1.5.2 Gasification plant waste minimisation

Feedstock Homogeneity

Improving feedstock homogeneity can improve the operational stability of the plant, leading to reduced reagent use and reduced residue production. The off site pre-treatment of waste and transfer into the storage, will serve to improve the homogeneity of fuel input to the gasification process.

Boiler Cleaning

The boiler will be fitted with soot blowers to prevent deposits of ash from accumulating on the surfaces of the boiler.

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 LOI content of the bottom ash to less than 5% by optimising SRF feed rate and combustion air flows. SNCR reagent dosing will be optimised to prevent ammonia slip.

Flue Gas Treatment Control

Close control of the flue gas treatment system will minimise the use of reagents and hence minimise the residues produced.

Acid gas reagent usage will be minimised by trimming reagent dosing to accurately match the acid load using fast response upstream HCl monitoring. Variable speed screw feeders will ensure the lime dosing rate can be rapidly and precisely varied to match the acid load. The plant preventative maintenance regime will include regular checks and calibration of the acid gas reagent dosing system to ensure optimum operation.

Used acid gas reagents will be recirculated within the flue gas treatment process to minimise the use of lime.

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.

Waste Management

Details of waste management arrangements can be found in Section 2.8. In particular, bottom ash and residues from the flue gas treatment system will be stored and disposed of separately.

2.1.6 Water Use

2.1.6.1 Overview

The main use of water at the plant will be to make-up the water for the gasification boiler. The following key points should be noted:

- Most of the steam produced in the boiler will be recycled as condensate. The remainder will be lost as blowdown to prevent build-up of sludge and chemicals, through sootblowing and through continuously flowing sample points.
- The facility will have completely separate foul sewer systems and surface water systems (surface drainage).
- The water system has been designed with two key objectives:
- no process water discharge; and
- minimal consumption of potable water discharge into the receiving watercourse.
- Potentially contaminated rainwater from the roads, car park and other hardstanding will be contained by kerbs and collected before passing through a PPG3 compliant Class 1 Bypass Separator;
- Firewater will be provided by an on-site water tank which is connected to the towns water supply.

2.1.6.2 Process Water Use

The Gasification Plant will require potable water for providing feedwater for the boiler. This will be treated in a reverse osmosis facility to produce high quality boiler feedwater.

2.2 Emissions

2.2.1 Emissions to Air

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

Table 2.6 – Proposed Emission Points

Emission Point Reference	Source
A1	Gasification Stack
A2	Back-up diesel engines stack
A3	MRF Dryer Stack

The full list of proposed emission limits for atmospheric emissions for emission point A1 is shown in the table below. This includes the information requested in Table 2 of Application Form Part B3.

Table 2.7 – Proposed Emission Limits Values (ELV's)

Parameter	Units	Half Hour Average	Daily Average	Periodic Limit
Emission Points A1				
Particulate matter	mg/Nm^3	30	10	-
VOCs as Total Organic Carbon (TOC)	mg/Nm^3	20	10	-
Hydrogen chloride	mg/Nm^3	60	10	-
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	-
Hydrogen fluoride	mg/Nm^3	-	-	2
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

Table 2.7 – Proposed Emission Limits Values (ELV's)

Parameter	Units	Half Hour Average	Daily Average	Periodic Limit
Dioxins & furans ITEQ	ng/Nm^3	-	-	0.1
All expressed at 11% oxygen in dry flue gas at 0°C and 1 bar-a.				

For the proposes of the EP application, it is not considered appropriate to propose emission limits for the other emission points for the release of emissions to air from the installation.

2.2.2 Fugitive Emissions to Air

<u>Silos</u>

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

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

2.2.3 Emissions of Odour

The storage and handling of waste is considered to have potential to give rise to odour. The facility will be designed in accordance with the requirements of SEPA Guidance Note H4: Odour. The facility will include a number of controls to minimise odour from the installation during normal and abnormal operation.

<u>MRF Building</u>

Considering the remote location of the MRF and gasification plant, it is not expected that odour from the MRF building will have any unacceptable impacts upon sensitive receptors.

Odorous air will be contained within the MRF building which will be retained at a negative pressure. Air will be extracted from odorous areas/processes and will be filtered and used as input air to the dryer.

The doors for the MRF will be fast-acting roller shutter doors, and will therefore only be opened during periods where waste is being delivered to the facility.

During short periods of unplanned maintenance for the gasification plant, RDF produced will be baled & wrapped for export off site.

During long periods of unplanned shutdown of the MRF, waste will be loaded into skips for transfer offsite to a suitably licensed waste management facility.

<u>MRF Dryer</u>

The MRF dryer will be fitted with a scrubber system, which will extract air from the dryer and scrub the extracted air prior to release via a stack. The scrubber will remove a range of odour compounds including hydrogen sulphide and ammonia from the gases from the dryer. An assessment of the impact of emissions from the dryer is presented within the air quality assessment, refer to Annex 5.

<u>Gasification Fuel Storage Area</u>

The gasification facility, which will contain a fuel storage, will be maintained under slight negative pressure, to ensure that no odours are able to escape the building. The negative pressure will be created by drawing combustion air from the gasification building.

During periods of planned maintenance for the gasification plant, fuel production within the MRF will be reduced, until there is no waste within the fuel storage area within the gasification building. During periods of planned shutdown there will be no waste stored within the gasification plant.

During short periods of unplanned maintenance for the gasification plant all doors will be maintained closed to prevent the escape of odour from the gasification building.

During long periods of unplanned shutdown, waste will be transferred to the MRF for baling & wrapping.

2.2.4 Emissions to Water

In designing the drainage for the facility, the following assumptions have been made:

- the site's existing connections to the surface water and landfill drainage systems will be utilised;
- run-off from roof and hardstanding areas will be kept separate from process effluents and discharged into the existing SUDS system for the site;
- surface water run-off from all hardstanding areas will pass through a compliant Class 1 Bypass Separator prior to being combined with run-off from roofs; and
- where practicable process effluent from the Gasification plant will be recycled within the process.

A proposed drainage layout drawing is presented in Annex 1. This is subject to review following detailed design, but is intended to provide an indication of the expected process water flows for the MRF and gasification plant.

Foul drainage from welfare facilities, toilets and mess-rooms from the MRF and gasification facilities will be collected in a septic tank. A system for periodic inspection and emptying of the two septic tanks will be developed and implemented within the environmental management and maintenance systems for the facility. Effluents from the septic tank will be discharged into the existing drainage system for the landfill.

2.2.5 Emissions to Sewer

There will be no emissions to sewer from the MRF and gasification facility.

2.2.6 Contaminated water

External areas of hardstanding will be provided with curbed containment, where appropriate, to prevent any potential spills from causing pollution of the ground/groundwater. Surface water run-off from these areas will pass through an interceptor prior to release into a swale which will be located around the perimeter of the MRF and gasification plant.

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, where practicable.

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

In the event of a fire, there will be isolation valves fitted to the site drainage system. The contaminated firewater will be diverted into the fire water attenuation tanks. There will be one tank that serves the gasification plant and a separate tank that serves the MRF building. Contaminated firewater will be retained in these tanks until a suitable waste disposal option can be identified.

Site drainage for external areas will be fitted with a shut-off alarm, linked to the fire detection systems to contain any fire fighting water 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 (SEPA/ 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.

2.3 Monitoring Methods

2.3.1 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 monitoring has three main objectives:

(1) to provide the information necessary for efficient and safe plant operation;

(2) to warn the operator if any emissions deviate from predefined ranges; and

(3) to provide records of emissions and events for the purposes of demonstrating regulatory compliance.

2.3.1.1 Monitoring Emissions to Air

The following emissions from the gasification plant will be monitored and recorded continuously:

- carbon monoxide (CO);
- nitrogen oxides (NOx as NO_2);
- sulphur dioxide (SO_2);
- hydrogen chloride (HCl);
- ammonia (NH_3);
- organic compounds (TOC); and
- particulates.

The water vapour content, temperature, pressure and flow rate 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 SEPA.

The following parameters will be monitored by means of spot sampling at frequencies agreed with SEPA:

- hydrogen Fluoride;
- heavy metals; and
- dioxins and furans.

The methods and standards used for emissions monitoring will be in compliance with guidance note EPR 5.01 and the Industrial Emissions Directive (IED). 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:

- HCl, CO, SO2, NOx (NO+ NO_2) and NH_3 will be measured by an FTIR type multi-gas analyser;
- VOC will be measured by a FID type analyser;
- particulate matter will be measured by an opacimeter; and
- O_2 will be monitored by a zirconium probe.

The frequency of periodic measurements will comply with the Industrial Emissions Directive as a minimum. The flue gas sampling techniques and the sampling platform will comply with SEPA Technical Guidance Notes M1 and M2.

Reliability

The IED 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.

There will be two 'duty' CEMS (one per line) and a stand-by CEMS which could be transferred in, if required. This will ensure that there is continuous monitoring data available even if there is a problem with one of the duty CEMS systems.

Start-up and Shutdown

The emission limit values under the IED do not apply during start-up and shutdown when the plant is gasifying waste. 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:

- the fuel screw feeding units are operational and the grate is covered in fuel, gasification plant, ash extractors and flue gas treatment systems are all running;
- the temperature within the secondary combustion chamber is greater than 850°C;
- exhaust gas oxygen is less than 15% (wet measurement); and
- the gasification chamber is fully loaded with waste.

Shutdown begins when all the following conditions are met

- the fuel screw feeding units have been stopped;
- the waste in the combustion chamber has been gasified;
- the flue gas treatment systems are running; and
- the auxiliary burner is in service.

2.3.1.2 Monitoring Emissions to Land

Disposal of residues to land will comply with all relevant legislation. In particular the bottom ash will comply with the IED criterion of Loss on Ignition (LOI) less than 5%. Compliance with the LOI criterion will be demonstrated during commissioning and checked at periodic intervals agreed with SEPA throughout the life of the plant. Testing for LOI will be conducted by an independent laboratory.

2.3.1.3 Monitoring Emissions to Water

There will be no process effluent discharged to water from the installation. The only discharges to water from the installation will be uncontaminated rainwater.

It is not considered that there should be any requirements for undertaking monitoring of discharges to water from the installation.

2.3.2 Monitoring of Process Variables

2.3.2.1 Validation of Combustion Conditions

The gasification facility has been designed to provide a residence time, after the last injection of combustion air, of more than two seconds at a temperature of at least 850°C. This criterion has been demonstrated using Computational Fluid Dynamic (CFD) modelling, presented in Annex 4.

As stated within the CFD report:

> *'Based on preliminary designs of the OEP staged gasifier-combustor and other equipment for the Levenseat energy from waste facility, CFD analysis performed by OEP using Autodesk Simulation CFD 2015 predicts that the flue gases will remain in a qualifying combustion zone with excess oxygen for 9.7 seconds under the most unfavorable operating conditions. This is based on the governing stirred tank, or "time-of-flight," methodology when 67% percent of an injected tracer substance spike leaves the qualifying zone. In addition, the analysis predicts that the temperature profile throughout the qualifying zone will remain relatively uniform and above 850ºC.'*

Taking this into consideration the gasification facility is considered to comply with the 2-second residence time requirements of Chapter V of the IED.

During the commissioning stage of the gasification plant this will be verified using recognized measurements and methodologies.

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

Urea 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 oxidation zone.

Sufficient nozzles will be provided at each level to distribute the urea solution correctly across the entire cross section of the oxidation zone.

2.3.2.2 Measuring Oxygen Levels

The oxygen concentration at the boiler exit of the gasification 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.

2.3.2.3 Monitoring of Process Variables

The gasification plant will be controlled from the 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:

- Primary and secondary air;
- Fuel feed rate;
- SNCR system;
- Flue gas oxygen concentration at the boiler exit;
- Flue gas composition at the stack;
- Combustion process;
- Boiler feed pumps and feedwater control;
- Steam flow at the boiler outlet;
- Steam outlet temperature;
- Boiler drum level control;
- Flue gas control;
- Power generation; and
- Steam turbine exhaust pressure.

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

The following process variables have particular potential to influence emissions:

(1) Fuel throughput will be recorded to enable comparison with the design throughput. As a minimum, daily and annual throughput will be recorded;

(2) Combustion temperature will be monitored at a suitable position to demonstrate compliance with the requirement for a residence time of 2 seconds at a temperature of at least 850°C;

(3) The differential pressure across the bag filters will be measured, in order to optimise the performance of the cleaning system and to detect bag failures; and

(4) The concentration of 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 systems.

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 supplied to the water treatment plant.

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

2.3.2.4 Fuel Charging

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

- The combustion control and feeding system will be fully in line with the requirements of the IED. The conditions within the combustor will be continually monitored to ensure that optimal conditions are maintained and that the emission limits are not exceeded. Auxiliary burners fired with fuel oil will be installed and will be used to maintain the temperature in the oxidation chamber.
- Waste will not be charged when the temperature in the oxidation zone falls below 850°C, both during start-up and during operation.
- Waste will not be charged if the emissions to atmosphere are in excess of an emission limit value due to disturbance or failures of the abatement equipment.
- The gasification of the waste will be controlled using temperature measurements. Premature combustion of the waste will be prevented through the use of process control to ensure gasification within the fluidised bed.
- 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.

2.4 Technology Selection

2.4.1 Materials Recycling Facility

The Thermal Treatment of Waste Guidelines are applicable to all thermal treatment plants that recover energy from municipal waste and/or commercial and industrial waste, such at the proposed MRF and gasification facility. The Thermal Treatment of Waste Guidelines require that thermal treatment plants should only treat residual waste (i.e. waste remaining after all efforts have been made to extract recyclable materials, either prior to or after delivery to the plant) in order not to impede recycling and waste prevention efforts. The MRF will extract recyclable materials from the incoming waste to maximise recycling opportunities from the residual waste.

As identified in the BREF - “Waste treatment industries” - the sorting and separation techniques proposed for the MRF are regarded as appropriate techniques for separating residual waste into ‘recoverable materials’ and ‘high calorific’ fractions.

As identified in the BREF, the benefit of employing mechanical treatment is that it converts a heterogeneous mixture of waste materials, particularly from solid wastes such as that being treated in the MRF, and it will make the waste into a more homogeneous fuel which is suitable to be incinerated within the gasification plant.

As identified in the BREF, the production of solid waste fuel can be divided into a number of steps such as those employed within the MT Plant, which are:

- Metal separation;
- Size reduction;
- Classification/Sieving:
    - Materials undergo some kind of conversion to make them suitable for further processing steps;
    - Separation of coarse or fine particle sizes;
    - Sorting classification – the separation of the small size fractions;

- Automatic picking.

The MRF will include a primary shredder which will be used to reduce the particle size of incoming waste and also to ensure that any waste which is contained in bags has been opened to maximise the recovery of recyclates from the incoming waste. After sorting a secondary shredding stage prepares the resulting fuel.

It is considered that the waste sorting and separation techniques which will be employed in the MRF will represent BAT for the installation.

2.4.2 Gasification Technology

It is proposed that the combustion technology for the plant will be an advanced fluidised bed gasification plant.

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

(1) Grate Furnaces

As stated in the Sector Guidance Note, these are designed to handle large volumes of waste fuels. An air cooled grate system would not be capable of processing high CV fuels such as those proposed. Therefore, a grate furnace for the proposed fuel specification would need to be a water cooled grate. Water cooled grates typically have higher capital and maintenance costs than air cooled grates.

(2) Fixed Hearth

These are not considered suitable for large volumes of waste fuels. They are best suited to low volumes of consistent waste. Therefore these systems are not considered practical and have not been considered any further.

(3) Pulsed Hearth

Pulsed hearth technology has been used for waste fuels in the past, as well as other solid wastes. However, there have been difficulties in achieving reliable and effective burnout of waste and it is considered that the burnout criteria required by WID would be difficult to achieve. Therefore these systems are not considered practical and have not been considered any further.

(4) Rotary Kiln

Rotary kilns have achieved good results with clinical waste, but they have not been used in the UK for large volumes of waste fuels. The energy conversion efficiency of a rotary kiln is lower than that of other EfW technologies due to the large areas of refractory lined combustion chamber.

An oscillating kiln is used for the gasification 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 EfW 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. For a plant with the capacity of this application it would approximately 3 kilns to achieve the design throughput for the gasification plant. This is not considered practical and would lead to significant efficiency losses, therefore this option has not been considered any further.

(4) Fluidised Bed Combustor

Fluidised beds are designed for the combustion of relatively homogeneous fuel. Therefore fluidised beds are appropriate for pre-treated fuels. Where waste fuels have been pre-treated at a pre-treatment facility, such as that proposed for the plant, the pre-treated waste will already be suitable for feeding to the fluidised bed.

While fluidised bed combustion can lead to slightly lower NOx generation, the injection of ammonia or urea is still required to achieve the emission limits specified in the IED.

(5) Pyrolysis

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 the combustion of part of the syngas.

Various suppliers are developing pyrolysis systems for the disposal of waste fuels, however these systems are not considered proven.

Currently there are no pyrolysis systems which are of a capacity required to process the nominal design capacity. Therefore these systems are not suitable and have not been considered any further.

(6) Gasification

In gasification, the waste is heated in the presence of some air, but insufficient air to achieve full combustion. This leads to the production of a synthetic fuel gas, or syngas, which can then be used to generate electricity. There are three different types of gasification technology:

i) Conventional Gasification;
ii) Plasma Gasification; and
iii) Close-coupled gasification.

Each of these technologies is discussed below.

i) Conventional Gasification

The primary benefits which are claimed for conventional gasification are higher efficiency and lower emissions.

The higher efficiency is based on the use of gas engines or gas turbines, which are more efficient at generating electricity from syngas than a conventional steam turbine is at generating electricity from steam. However, the energy used to convert waste into syngas and to clean up the syngas so that it can be used in the gas engine tends to erode this advantage, so that the overall efficiency of a gasification or pyrolysis plant tends to be similar to the overall efficiency of a conventional combustion plant.

While there are a number of suppliers offering conventional gasification technologies in the UK, and while environmental permits have been granted for such plants, there is still limited operational experience. In particular, no developer of gasification has yet managed successfully to demonstrate at a commercial scale the combination of municipal waste gasification or pyrolysis with a gas engine or gas turbine. This is because the gasification process produces tars in the syngas, which need to be removed before the syngas can be used in a gas engine.

ii) Plasma Gasification

Plasma gasification uses a high temperature electric arc furnace to break down the components of the waste fuel into a residue which is presented as a vitrified solid and low molecular weight gases. This produces a fuel gas which then has to be cleaned of sulphur and chlorine gases but which contains very little condensable tars. It is these condensable tars which have proved difficult to deal with in attempts to produce a synthetic gas from waste suitable for use in a gas turbine or gas engine.

While the use of plasma gasification to make a syngas has been demonstrated in Japan and the USA, the use of this syngas to generate electricity in a gas engine has not been demonstrated at commercial scale. In addition, the power consumption is very high, due to the use of high temperature and the need to make oxygen for the process.

An alternative approach is to use a fluidised bed gasifier to generate the fuel gas and then a plasma arc furnace to break down the gases into low molecular weight components. The electricity required within the process is therefore significantly less than that required by a straight plasma arc process, although the overall efficiency of the process remains similar to that of conventional combustion. However, this process has a limited capacity and is yet to be proven in commercial operation.

Various technology providers are developing plasma gasification systems for the disposal of waste derived fuels. Only a small number of these can be considered to be proven with operational plants within Europe.

Plasma gasification can theoretically produce a more useful syngas than thermal gasification, but has a much higher electrical parasitic load and is in the early stages of commercial development for municipal waste treatment. It has been used successfully for treatment of hazardous wastes (the European BAT reference document for EfW refers entirely to plasma gasification for destruction of gaseous CFCs and other ozone depleting substances). However, there are no reference plants recovering energy from non-hazardous wastes in Europe (The only large scale commercial plant constructed in Europe closed in 2004). A handful of waste plants are operational worldwide, but the largest single stream plant only has the capacity to treat approximately 50,000 tonnes per annum.

As there are no operational plants which use plasma gasification technology within Europe, it is not considered to be a suitable alternative to the proposed design.

iii) Close-coupled gasification

This is the technology which is being proposed for the gasification plant.

Compared to some of the other gasification technologies, this is considered to be a proven technology, as there are a number of full-scale operational plants in Europe which comply with the requirements of Chapter IV of the IED.

In close-coupled gasification plants, the gasification chamber operates at a lower temperature than the combustion chamber for a conventional EfW plant. The syngas is then combusted within a separate section of the chamber to generate steam.

In close-coupled gasification, the combustion of syngas to generate steam is simpler than using syngas in a gas engine or turbine, as discussed above.

The process for gasification of the incoming waste fuels will incorporate a fluidised bed. As discussed previously, fluidised bed technology is appropriate where waste fuels, such as those to be treated within the gasification plant, have been pre-treated at a pre-treatment facility.

A quantitative BAT assessment for a water-cooled grate, conventional fluidised bed and close-coupled gasification technology has been undertaken and is presented in Annex 6 section 4. The conclusions of the assessment are summarised in the table below.

Table 2.8: – Comparison, Combustion Options

		Grate	Fluidised Bed	Close-coupled gasification
Global Warming Potential	t CO2 p.a.	-32,000	-31,000	-31,000
Urea consumption	t/a	2,520	1,400	1,400
Residues			Less bottom ash, more fly ash	Less bottom ash, more fly ash
Total annualised operating costs	£ p.a.	£2,519,000	£3,040,000	£3,040,000
Power Revenues		£3,239,000	£3,239,000	£3,887,000

The grate has a slightly lower global warming potential than the fluidised bed and close-coupled gasification system, however it would use approximately 80% more urea to abate the equivalent emissions of NOx.

The three combustion technologies will produce similar quantities of ash, with the fluidised bed and the close-coupled gasification system producing more fly ash.

Overall the total annualised operating costs are approximately 20% higher for fluidised bed and close coupled gasification than for a grate system. However, the financial incentives provided by the ROC revenues make close coupled gasification significant more financially appealing than conventional combustion technologies.

The lower reagent consumption associated with a fluidised bed system outweighs the additional costs associated with the grate based system. On this basis a fluidised bed is considered to represent BAT for the Installation. Furthermore, the financial incentives being offered through revenues generated from ROC's make close coupled gasification employing fluidised bed technology significantly more financially appealing than a conventional fluidised bed.

2.4.3 NOx Reduction System

The auxiliary burners will be of low NOx design.

NOx levels will primarily be controlled by monitoring the combustion air. Selective non-catalytic NOx reduction (SNCR) methods will also be installed, using urea as a reagent.

The use of Selective Catalytic Reduction (SCR) has also been considered. In this technique, the urea 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.

2.4.3.1 Flue Gas Recirculation (FGR)

The proposed installation will not employ flue gas recirculation.

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

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

The proposed technology has been demonstrated on other sites to meet the required emission limits for NO_x by using SNCR.

A BAT assessment of both SNCR and SCR has been carried out in Annex 6 section 3. The conclusions are summarised below.

2.4.3.2 Conclusion

Table 2.9 – Comparison Table, NOx Abatement Options

		SNCR	**SCR**
NOx released after abatement	t p.a.	130	40
NOx abated	t p.a.	370	460
Photochemical Ozone Creation Potential (POCP)		-5,000	-1,500
Global Warming Potential	t CO2 p.a.	300	1,100
Urea	t p.a.	1,400	740
Annualised Cost	£ p.a.	£256,000	£787,000
Cost per tonne NOx abated	£ p.t NOx.	£690	£1,710

For the installation, using SCR:

- increases the annualised costs by over £500,000;
- abates an extra 90 tonnes of NOx;
- reduces the benefit of the facility in terms of the global warming potential by 800 tonnes of CO_2;
- reducing urea consumption by approximately 660 tonnes; and
- costs an additional £1,020 per tonne of NOx abated.

The additional costs associated with SCR are not considered to represent BAT for the gasification facility. In addition, considering the installation will not have any significant impacts on receptors which are sensitive to emissions of oxides of nitrogen, SNCR is considered to represent BAT.

2.4.4 Acid Gas Abatement System

There are currently three technologies widely available for acid gas abatement in the UK:

1. (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. (2) Semi-dry, involving the injection of reagent 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. (3) Dry, involving the injection of reagent into the flue gases as a powder. The reagent is collected on a bag filter to form a cake and most of the reaction between the acid gases and the reagent takes place as the flue gases pass through the filter cake. In its basic form, the dry system consumes more reagent than the semi-dry system. However, this can be improved by recirculation of the flue gas treatment residues, which contain some un-reacted reagent and re-injecting this into the flue gases.

Wet scrubbing is not considered to represent BAT for this type of acid gas abatement process, due to the production of a large volume of hazardous liquid effluent and a reduction in the power generating efficiency of the ATT facility.

The dry and semi-dry systems can easily achieve the emission limits required by the IED and both systems are in operation on plants throughout Europe. Both can be considered to represent BAT by SEPA Sector Guidance Note S5.01. The advantages and disadvantages of each technique are varied which makes assessment complex. Therefore, the cost benefit analysis methodology described in Horizontal Guidance Note H1 has been used and is detailed in Annex 6.

The table below compares the options for acid gas treatment.

Table 2.10 – Comparison Table, Acid Gas Treatment Options

Parameter	Unit	Dry	Semi-Dry
SO2 abated	t p.a.	970	970
POCP		140	140
Global Warming Potential	t CO2 p.a.	1,100	2,100
APC Residues	t p.a.	5,500	5,500
Annualised Cost	£ p.a.	£2,472,000	£2,609,000

The performance of the options is very similar. The dry system has a much lower water consumption rate, 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.

The dry acid gas control system is considered to represent BAT for the Installation.

2.4.5 Particulate Matter

The gasification plant will use a two stage system for the abatement of particulates:

- Primary Particulate Abatement will consist of a multicyclone; and
- Secondary Particulate Abatement will consist of a multi-compartment fabric filter.

2.4.5.1 Primary Particulate Abatement

The installation will employ a multicyclone which will act as a primary particulate abatement system to reduce the level of particulates entering boiler and reduce fouling within the boiler. The multicyclone dust collector will comprise of a bank of cyclone tubes which will be located on the exit of the boiler. The inlet vanes of each tube will impart a rotating motion to the gas generating a centrifugal force that concentrates particles of entrained dust at the interior walls of the collecting tubes. The particles will then fall and be discharged from the bottom of the tube. The clean gas will exit through the outlet at the top of the collecting tube, whilst the fly ash drops into the hopper and is removed via a rotary valve airlock. This ash is then transferred to the boiler ash silo.

2.4.5.2 Secondary Particulate Control

The multi-compartment fabric filter will be used to remove fly ash carried over from the combustion process; reaction products from the flue gas treatment system, along with excess lime and contaminated activated carbon.

During operation, the build-up of lime and activated carbon on the filter media will enhance the overall performance of the flue gas system by providing residence time for the reagents to react with the acid gases and to improve the removal of heavy metals and dioxins.

2.4.5.3 Conclusions

There are a number of alternative technologies available for the abatement of particulates, but none offer the same level performance of a fabric filter:

(1) Fabric filters are a proven technology and 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 foot-print of the facility.

(4) Ceramic Filters have not been proven for this type of plant, and are regarded as being more suited to high temperature filtration.

The two stage system is considered to represent BAT. The multicyclone system will remove particulates from the flue gases exiting the oxidation chamber to reduce fouling of the boiler. The fabric filters will polish the flue gases prior to release to the environment to comply with the emission limits for particulates required by the IED.

2.4.6 Carbon monoxide and volatile organic compounds (VOCs)

Carbon monoxide and VOCs will be minimised by good control of the combustion process. SEPA Sector Guidance Note S5.01 states that primary combustion control measures for carbon monoxide are preferable to post combustion techniques such as catalytic oxidation, pulsed corona or re-burn, which are not commercially available at this scale.

The elemental carbon bound to the fuel reacts with oxygen supplied from the combustion air to form CO and/or CO_2. Both reactions are strongly exothermic and accordingly exert influence on the furnace temperature conditions. The quality of gas burn out, i.e. shifting the reaction equilibrium towards CO_2 improves with increasing temperature and excess air levels but only on the condition there is good mixing with the combustion air. Therefore the areas addressed in the plant design are:

- combustion temperature;
- gas residence time at adequate temperature; and
- degree of turbulence in the combustion zone.

A consistent and homogenous feed of fuel to the grate during operation will provide stable combustion control and minimise carbon monoxide production.

The position with hydrocarbons is similar to that of elemental carbon, in that they are destroyed by the same combustion conditions.

2.4.7 Dioxins and furans

The primary method of minimising the release of dioxins is through the careful control of the combustion conditions. The gas residence times, temperatures and oxygen content in the secondary combustion chamber are such that any dioxins/furans are efficiently destroyed. The de novo synthesis of dioxins is restricted through the design of the boiler and flue gas treatment system, where combustion gases cool rapidly from 450°C to less than 160°C.

The injection of activated carbon in the flue gases, is regarded as being an efficient method for the removal of dioxins from the flue gases. This is a technique which is used throughout the UK for the abatement of dioxins in waste incineration plant. The dosing rates for the activated carbon will use separate controls to the acid gas abatement systems.

In addition, soot blowers will be installed in the boiler to prevent the build-up of soot deposits within the boiler.

Bags impregnated with catalyst for destroying dioxins are available for the abatement of dioxins. However, these are not considered to represent BAT for the following reasons:

(1) The optimum temperature for the catalyst is 190-230°C. This is higher than the operational temperature of the acid gas abatement system.

(2) They do not remove heavy metals, especially mercury, so activated carbon injection would be required in addition to the catalytic bags. There is a strong correlation between flue gas temperature and the effectiveness of mercury removal. At the acid gas reaction temperature of 140°C to 160°C, the fabric filter system is consistently able to meet the heavy metal emission limits. At the higher temperatures associated with the catalytic oxidation reaction, heavy metal removal is significantly less effective. There would therefore have to be a

two stage filtration system with reheat, significantly increasing the capital cost and reducing the energy efficiency of the system. Furthermore, the fan power required to handle the flue gases at the elevated temperature would be significantly increased, increasing the site load and further reducing the power generation efficiency of the plant.

Therefore, the use of activated carbon and soot blowers are considered to represent BAT for the gasification plant.

2.4.8 Metals

The injection of activated carbon into the flue gas upstream of the fabric filter is a reliable and well-proven method for reducing mercury concentrations by 90% or more. For other metals, efficient particulate abatement will minimise metal releases.

As stated previously activated carbon will be dosed using separate controls to acid gas abatement.

2.5 Cooling System Selection

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

- air cooled condenser (ACC);
- once though cooling; and
- evaporative condenser.

Once through cooling systems require significant quantities of water. Taking into consideration the location of the site, there is no readily available and suitable supply of water. On this basis, once through cooling systems are not considered to be an available technology for cooling in the gasification plant.

Evaporative condenser systems also require large volumes of water. As there is no local available water supply. In addition, evaporative condensers have a significant potential for release of water vapour plumes. Considering the location of the site, this could provide a significant visual impact to the site to a wide area.

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

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

An ACC is considered to represent BAT for the installation.

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

This section presents information on 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 Facility:

- Article 46 – Control of Emissions;
- Article 47 – Breakdown;
- Article 48 – Monitoring of Emissions;
- Article 49 – Compliance with Emission Limit Values;
- Article 50 – Operating Conditions;
- Article 52 – Delivery & Reception of Waste;

- Article 53 – Residues; and
- Article 55 – Reporting & public information on waste incineration plants and waste co-incineration plants.

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

Table 2.11: - Summary Table for IED Compliance

Article	Requirement	How met or reference
22(2)	Where the activity involves the use, production or release of relevant hazardous substances and having regard to the possibility of soil and groundwater contamination at the site of the installation, the operator shall prepare and submit to the competent authority a baseline report before starting operation of an installation or before a permit for an installation is updated for the first time after 7 January 2013. The baseline report shall contain the information necessary to determine the state of soil and groundwater contamination so as to make a quantified comparison with the state upon 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 – Initial Site Report

Table 2.11: - Summary Table for IED Compliance		
Article	**Requirement**	**How met or reference**
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 2.1.4.2 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 2.7 of the Supporting Information and Annex 7 - Heat Plan
	(c) the residues will be minimised in their amount and harmfulness and recycled where appropriate;	Refer to Section 2.8 of the Supporting Information
	(d) the disposal of the residues which cannot be prevented, reduced or recycled will be carried out in conformity with national and Union law.	Refer to Section 2.8 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 – Air Quality Assessment
46 (2)	Emissions into air from waste incineration plants and waste co-incineration plants shall not exceed the emission limit values set out in parts 3 and 4 of Annex VI or determined in accordance with Part 4 of that Annex.	Refer to Section 2.2.1 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 Annex 2 – Site Condition Report.

Table 2.11: - Summary Table for IED Compliance		
Article	**Requirement**	**How met or reference**
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 – Air Quality Assessment: Abnormal Emissions Assessment
47	In the case of a breakdown, the operator shall reduce or close down operations as soon as practicable until normal operations can be restored.	Refer to Section 2.3.2.4 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 2.3.1.1 of the Supporting Information
48 (4)	All monitoring results shall be recorded, processed and presented in such a way as to enable the competent authority to verify compliance with the operating conditions and emission limit values which are included in the permit.	Refer to Section 2.3.1.1 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 from the gasification plant. Refer to Section 2.3.1.1 and 2.3.1.3 of the Supporting Information.
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 or LOI.

Table 2.11: - Summary Table for IED Compliance

Article	Requirement	How met or reference
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 Annex 8 - CFD model
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 2.1.3.3 and 2.3.2.4 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 2.3.2.4 of the Supporting Information
	(b) whenever the temperature set out in paragraph 2 of this Article or the temperature specified in accordance with Article 51(1) is not maintained;	Refer to Section 2.3.2.4 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 2.3.2.4 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 2.7 of the Supporting Information and Annex 7 - Heat Plan

Table 2.11: - Summary Table for IED Compliance

Article	Requirement	How met or reference
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 installation as it 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 2.1.4.2 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 2.8 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 2.8 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 2 – Initial Site Report
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 2.8 of the Supporting Information.

2.7 Energy Efficiency

2.7.1 General

Electricity will be generated by way of a steam turbine which would be driven through the combustion of a synthesis gas ‘*syngas*’. The steam from the boiler will supply a steam turbine generator to generate electricity.

The facility will supply electricity to the local electricity grid via a power transformer which increases the voltage to the appropriate level.

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

In considering the energy efficiency of the facility, due account has been taken of the requirements of SEPA's Horizontal Guidance Note H2 on Energy Efficiency and the BREF.

2.7.2 Basic Energy Requirements

It is estimated that the installation will generate approximately 12.34 MW gross of electricity. The MRF will have a parasitic load of 1.6 MWe and the gasification plant will have a parasitic load of 1.75 MWe, with a total parasitic load of 3.35 MWe. The MRF and gasification plant will be subject to detailed design. Indicative Sankey diagrams, including heat export for the MRF dryer and no heat export for the MRF dryer, are presented in Figure 3 and Figure 4:

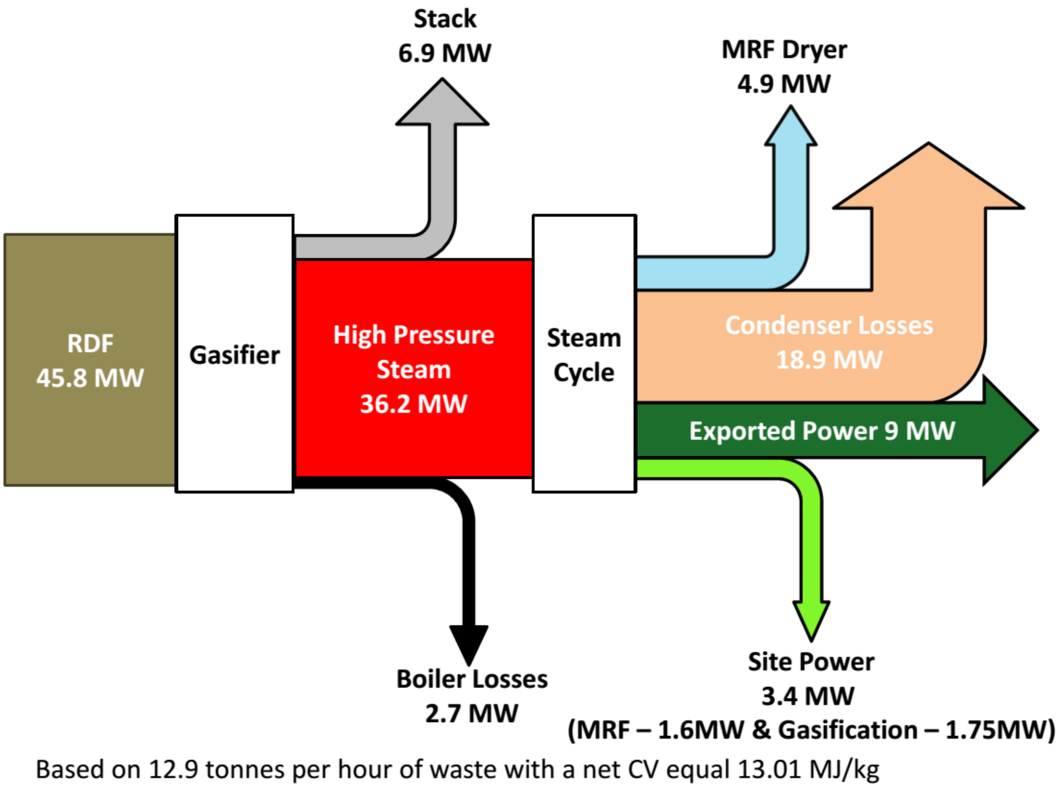


Figure 3: Indicative Sankey Diagram – Heat Export to MRF Dryer

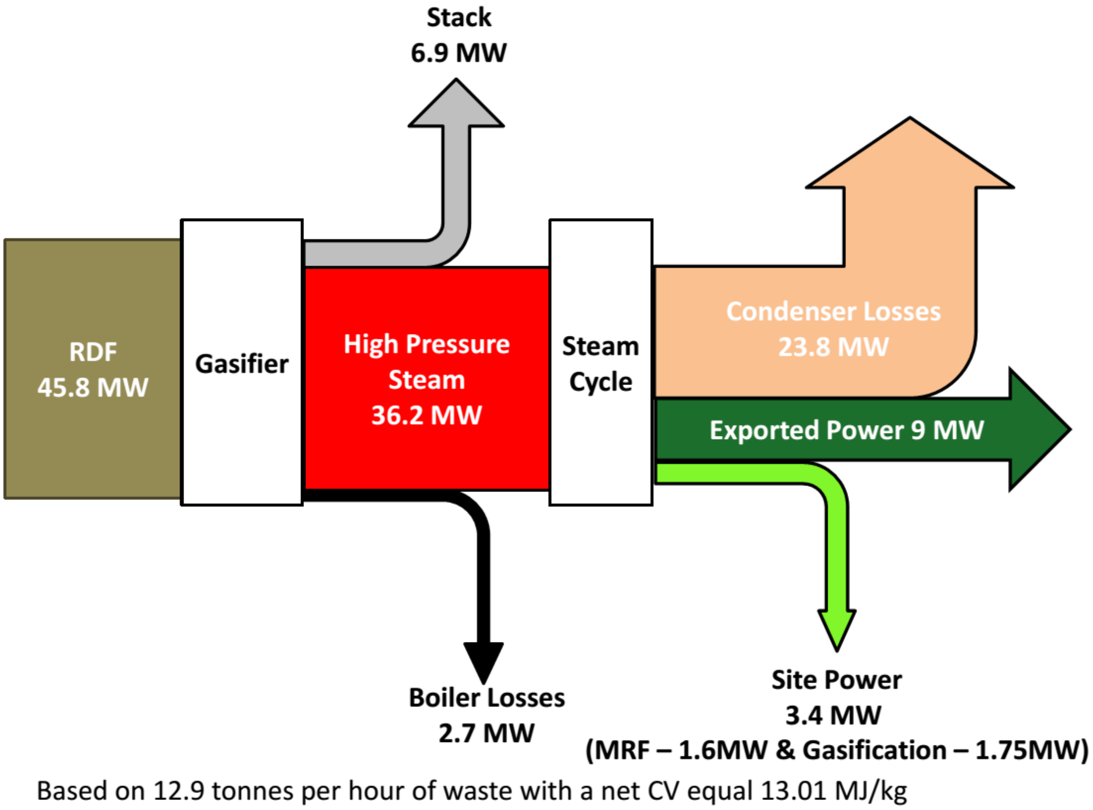


Figure 4: Indicative Sankey Diagram – No Heat Export to MRF Dryer

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

- MRF Dryer;

- MRF conveyors and waste handling equipment;
- Screens and shredders;
- Odour abatement plant;
- Gasification fans;
- Induced Draft fans;
- Boiler feed water and cooling water pumps;
- ACC fans;
- Air compressors;
- Fuel loading systems and residue conveying systems; and
- Offices and ancillary rooms.

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

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

- 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;
- Unnecessary releases of steam and hot water will be avoided, to avoid the loss of boiler water treatment chemicals and the heat contained within the steam and water;
- Steady operation will be maintained where necessary by using auxiliary fuel firing; and
- Boiler heat exchange surfaces will be cleaned on a regular basis to ensure efficient heat recovery.

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

2.7.2.1 Operating and Maintenance Procedures

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 carried out on a regular basis, to ensure, amongst other things, that motors are operating efficiently, insulation and cladding are not damaged and that there are no significant leaks; and

(3) operators trained in energy awareness and encouraged to identify opportunities for energy efficiency improvements.

2.7.2.2 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. This plan will be reviewed regularly as part of the environmental management systems.

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

2.7.3 Energy Efficiency Benchmarks

The gasification plant will have a nominal design capacity of approximately 12.9 tonnes per hour. The gasification plant will have an operational availability of 7,500 hours per annum.

The gasification plant is designed to combust a fuel with a net calorific value of 13.01 MJ/kg. The gasification plant will have a nominal design capacity of approximately 100,000 tonnes per annum. The gasification plant will generate up to 12.34 MWe, assuming that there is no heat export to either the MRF or other external heat users.

The section in the sector guidance note S5.01, titled 'Guidance for the Incineration of Waste and Fuel Manufactured from or Including Waste', relating to MSW incinerators suggests that 5MW to 8MW of energy should be recoverable per 100,000 annual tonnes of waste. The gasification plant is designed to generate in excess of 8 MW per 100,000 tonnes of waste per annum. The gasification plant is considered to meet the BAT requirements of S5.01.

If it is assumed that the gasification plant will be available for 7,500 hours per annum, allowing for periods of start-up or shutdown, then it will generate 92,550 MWh per annum. Thus it generates approximately 0.92 MWh/tonne of waste. This significantly exceeds the higher range of the benchmark range of 0.415 - 0.644 MWh/tonne of waste for electricity production per tonne of MSW (there are no benchmarks for the incineration of 'pre-processed' waste), as presented in the BREF.

The Facility will have a parasitic load of approximately 3.4 MWe, of which 1.75MWe will be consumed by the gasification plant. Again, assuming the plant is available for 7,500 hours per annum, it will consume approximately 13,100 MWh. On this basis, the specific energy consumption for the gasification plant is approximately 131 kWh/te. This compares favourably with the benchmark of 150 kWh/te as presented in the Waste Incineration BREF.

It is concluded that the Facility will achieve the benchmark levels for energy efficiency from both the relevant BAT Waste Incineration Sector Guidance Note and the waste incineration BREF.

SEPA's Horizontal Guidance Note H2 on Energy Efficiency requires the specific energy consumption (SEC) for the installation to be presented. Taking into consideration the information presented above the SEC is presented within the following table:

Table 2.12: Energy Consumption

Energy Source	Delivered Energy (MWhr)	Conversion factor from H1	Primary Energy (MWhr)	Percentage of Total
Electricity generated on site and used on site	25,500	0.2700	94,444	92.03%
Electricity imported from the National Grid	1700	2.4	4,080	3.98%
Fuel Oil	4,100	1	4,100	4.00%
Total	**45,510**		**102,624**	**100%**

(1) The gross efficiency of the gasification plant is 27%, refer to Annex 5 – Greenhouse Gas Assessment. This is the assumed conversion factor.

2.7.4 Further Energy Efficiency Requirements

The plant will not be subject to a Climate Change Levy agreement, although the electricity generated will be partially exempt from the levy.

2.7.4.1 Gasification Plant

In accordance with the Industrial Emissions Directive, heat should be recovered as far as practicable. In order to demonstrate this, the following points should be noted:

(1) The boiler will operate with superheated steam at a pressure of around 45 bar and a temperature of 400°C. Higher steam temperatures would potentially lead to more corrosion of the superheater tubes.

(2) As discussed earlier, the flue gas treatment system will be based on the dry injection of lime, rather than the injection of a wet slurry. The disadvantage of injecting a slurry is that the water in the slurry evaporates, absorbing energy. This means that the flue gas temperature entering the flue gas treatment system has to be higher, so that temperature of the flue gases reacting with the lime is maintained at around 140°C. With a dry system, the flue gases can be cooled to 140°C by extracting the energy into the condensate water, improving the efficiency of the heat recovery system.

(3) The ability to export heat has been included within the design. Heat will be used to the MRF dryer and also there is potential to export heat externally to the installation. This is discussed in more detail within the Heat Plan, refer to Annex 7.

2.8 Waste Recovery and Disposal

2.8.1 Introduction

The main residue streams arising from the facility are:

(1) Recyclates from the MRF
(2) Bottom Ash/Tramp material
(3) Ash from the gasification process; and
(4) Air Pollution Control Residues.

As described below, the waste recovery and disposal techniques will be in accordance with the indicative BAT requirements. The wastes generated are summarised in Table 2.13.

2.8.1.1 Recyclates from the MRF

A number of materials will be recovered from the incoming waste within the MRF. Recyclates recovered will include the following:

(1) Mixed paper;
(2) Ferrous metals
(3) Non-ferrous metals
(4) Cardboard
(5) Dense plastics
(6) Inerts
(7) Wood

In addition any non-combustible items which are not suitable for recovery will be screened and transferred for further processing or disposal at a suitably licensed waste management facility.

2.8.1.2 Bottom Ash/Tramp Material

Any non-combustible materials which are not screened in the MRF will fall through the bottom of the fluidised bed though a slide gate at the bottom of the cone. The bed material, inerts and clinkers will be discharged onto a common vibrating screen conveyor. The vibrating screen will incorporate a perforated plate to separate inerts and clinkers from the reusable bed material. The vibrating screen will discharge the bed material into the bucket elevator whilst the inerts and clinkers will be discharged into a skip for transfer off-site.

2.8.1.3 Ash from the Gasification Process

Boiler bottom ash, gasifier bottom ash, and multicyclone ash will be conveyed to the ash silo for storage prior to transfer to a suitably licensed waste management facility. The ash from the gasification process will not be combined with the Tramp Material or the Air Pollution Control residues.

2.8.2 Air Pollution Control Residues

APC residues 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:

- 30-36% w/w Calcium
- 12-15% w/w Chlorine
- 8-10% w/w Carbonate (as C)
- 3-4% w/w Sulphate (as S).

Silicon, Aluminium, Iron, Magnesium and Fluorine are also present in addition to traces of dioxins and the following heavy metals: Zinc, Lead, Manganese, Copper, Chromium, Cadmium, Mercury, and Arsenic.

APC residue is classified as hazardous (due to its elevated pH) and requires specialist landfill disposal or treatment. It may be possible to send the residue to an effluent treatment contractor, to be used to neutralise acids and similar materials. 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 suitably licensed hazardous waste landfill for disposal as a hazardous waste.

APC residues will be removed from installation in enclosed tankers thereby minimising the chance of spillage and dust emissions.

Table 2.13 – Key Waste Streams from the Installation

Source/ Material	Properties of Waste	Storage location	Future annual quantity of waste produced (approximate)	Disposal Route and Transport Method	Frequency
Mixed paper	Paper recovered from the incoming waste within the MRF	Baled outputs storage area	10,700	Transferred to a suitably licensed recovery facility. Transport occurs by road vehicle.	daily
Ferrous metals	Ferrous metals recovered from the incoming waste within the MRF	Ferrous bunker	4,300	Transferred to a suitably licensed recovery facility. Transport occurs by road vehicle.	daily
Non-ferrous metals	Ferrous metals recovered from the incoming waste within the MRF	Non-ferrous bunker	1,300	Transferred to a suitably licensed recovery facility. Transport occurs by road vehicle.	daily
Cardboard	Cardboard recovered from the incoming waste within the MRF	Baled outputs storage area	7,500	Transferred to a suitably licensed recovery facility. Transport occurs by road vehicle.	daily
Dense plastics	Dense plastics recovered from the incoming waste within the MRF	Baled outputs storage area	13,500	Transferred to a suitably licensed recovery facility. Transport occurs by road vehicle.	daily
Inerts	Inerts recovered from the incoming waste within the MRF	Inerts bunker	10,400	Transferred to a suitably licensed waste management facility. Transport occurs by road vehicle.	daily
Wood	Wood recovered from the incoming waste within the MRF	Wood bunker	2,500	Transferred to a suitably licensed waste management facility. Transport occurs by road vehicle.	daily
Rejects	Rejects recovered from the incoming waste within the MRF	Rejects bunker	2,500	Transferred to a suitably licensed waste management facility. Transport occurs by road vehicle.	daily
Heavy Fraction	Rejects recovered from the incoming waste within the MRF	Heavy bunker	20,000	Transferred to a suitably licensed waste management facility. Transport occurs by road vehicle	daily

Table 2.13 – Key Waste Streams from the Installation					
Source/ Material	**Properties of Waste**	**Storage location**	**Future annual quantity of waste produced (approximate)**	**Disposal Route and Transport Method**	**Frequency**
SRF (Solid recovered fuel)	High grade fuel recovered from the incoming waste within the MRF	Baled & Wrapped in storage area	15,000	Transferred to a suitably licensed recovery facility. Transport occurs by road vehicle	daily
Bottom Ash/Tramp Material	The non-combustible fraction which is removed from the fluidised bed.	Tramp material skip	7,500	Transferred to a suitably licensed waste treatment facility. Transport occurs by road vehicle.	daily
Boiler Ash/Multicyclone Ash	Bottom ash. This ash is relatively inert, classified as non-hazardous.	Ash silo.	800	Either sent to nearby landfill or sent to an ash recycling facility for further use as a secondary aggregate. A small fraction may be unsuitable for reuse and will be landfilled. Transport occurs by road vehicles.	daily
APCr	Fly Ash from boiler and air pollution control residues, may contain some unreacted lime.	APCr silo.	5,500	Transferred to a suitably licensed hazardous waste treatment facility. Transport occurs by road vehicle.	daily

2.9 Management

The Levenseat waste management site is currently operated in accordance with an environmental management system . This will be maintained and extended to include the operation of the MRF and gasification facility.

2.10 Closure

2.10.1 Introduction

The installation is designed for an operational life of approximately 30 years, but the actual operational lifetime is dependent on a number of factors including:

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

When the facility has reached the end of its operational life, it may be redeveloped for extended use or demolished as part of a redevelopment scheme and the site cleared and left in a ‘satisfactory state’, as defined in TG2: PPC Technical Guidance Note Content and Scope of Site Reports.

2.10.2 General

At the end of the economic life of the plant, the development site and buildings may be redeveloped for extended use or form part of an appropriate landscape restoration plan.

Levenseat 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 noise, dust, odour, groundwater and surface watercourses.

To achieve this aim a site closure plan will be prepared. It is anticipated that the closure plan will include the information listed below.

2.10.3 Site Closure Plan

The following is a summary of the measures to be considered within the site closure plan to ensure the objective of safe and clean decommissioning. A detailed Closure Plan will be developed and submitted to SEPA prior to the commencement of operation.

2.10.3.1 General Requirements

- Underground pipework to be avoided except for supply and discharge utilities such as towns water, sewerage lines and gas supply;
- Safe removal of all chemical and hazardous materials;
- Adequate provision for drainage, vessel cleaning and dismantling of pipework;
- Disassembly and containment procedures for insulation, materials handling equipment, material extraction equipment, fabric filters and other filtration equipment without significant leakage, spillage, release of dust or other hazard substance;
- The use of recyclable materials where practicable;

- Methodology for the removal/decommissioning of components and structures to minimise the exposure of noise, disturbance, dust and odours and for the protection of surface and groundwater;
- Soil and groundwater sampling and testing of sensitive areas to ensure the minimum disturbance (sensitive areas to be selected with reference to the initial site report and any ongoing monitoring undertaken during operation of the installation).

2.10.3.2 Specific Details

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

2.10.3.3 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 via road.

2.11 Improvement Programme

Levenseat is committed to continual environmental improvement of all of their operations, and are therefore proposing a number of improvement conditions be incorporated into the Environmental Permit.

2.11.1 Pre-operational Conditions

Prior to operation of the installation Levenseat will:

- provide a detailed commissioning plan, including timelines for completion, for approval by SEPA. 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 SEPA in the event that actual emissions exceed expected emissions. Commissioning shall be carried out in accordance with the commissioning plan as approved.

2.11.2 Commissioning

Prior to commissioning of the installation Levenseat will:

- submit a written report to SEPA 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.
- submit a written report to SEPA describing the performance and optimisation of the Selective Non Catalytic Reduction (SNCR) system and combustion settings to minimise oxides of nitrogen (NO_x) emissions within the emission limit values described in this permit with the minimisation of nitrous oxide emissions. The report will include an assessment of the level of NO_x and N_2O emissions that can be achieved under optimum operating conditions.
- submit a written summary report to SEPA to confirm by the results of calibration and verification testing that the performance of Continuous Emission Monitors for parameters as specified in Table S3.1 and Table S3.1(a) complies with the requirements of BS EN 14181, specifically the requirements of QAL1, QAL2 and QAL3.

2.11.3 Develop Site Closure Plan

Levenseat recognises that they will be required to develop a Site Closure Plan. Levenseat would propose that the existing site closure plan for the installation is extended to include the additional installation activities, and confirmation is submitted to SEPA, one year after commissioning of the installation.

Annex 1 – Drawings and Plans

Annex 2 – Initial Site Report

Annex 3 – Noise Assessment

Annex 4 – CFD Report

Annex 5 – Air Quality Assessment

Annex 6 – BAT Assessment

Annex 7 - Heat Plan

Annex 8

Annex 9 – Planning Permission

Annex 10 – Additional Information for Duly Making

Annex 11 - Grid Connection Offer

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