1.0 Overview

The waste-to-energy facility will treat up to up to 240,000 tonnes per annum of hazardous and non-hazardous residual household, commercial and industrial waste which is currently landfilled or exported. Up to 24,000 tonnes per annum of suitable hazardous waste will be treated at the facility. The facility will maximise the extraction and recovery of valuable material (in the form of ferrous and non-ferrous metals) and energy (in the form of 21 megawatts of electricity(MW_e)) resources from residual waste.

The heat produced by the combustion process will be recovered and will generate approximately 21MW_e of which up to 18.5MW_e will be exported to the National Grid. The electricity produced by the waste-to-energy facility will be enough to supply the power needs of approximately 30,000 households.

The main infrastructure elements of the waste-to-energy facility include:

- Security building/gate house and weighbridges
- Main process building, with a stack extending to 75mOD
- Aqueous waste storage tank and tanker unloading area
- Turbine hall and aero-condenser structure
- Electricity substation, compound and grid connection.

Other ancillary elements include:

- Light fuel oil storage tank, aqueous ammonia storage tank and unloading area
- Laboratory
- Administration building
- Firewater storage tank and pump house
- Surface water attenuation tank and firewater retention tank.

Refer to Figures 4.7 to 4.10 of the EIAR accompanying this application for the overall layout plans of the proposed development. The location of the main unit operations of the facility are shown in figure 1.1 below. This Operational Report should be read in conjunction with the text in Chapter 4 of the EIAR and where appropriate, references will be made in this report to relevant sections of the EIAR Chapter to avoid duplication of the information provided.

This document will first address the processes associated with the waste-to-energy facility activity in section 2 below, which is broadly represented by the main infrastructure elements listed above. The ancillary elements will be addressed in section 3 of this document. An overview of the complete process is provided in Figure 4.11 of the EIAR and reproduced in figure 1.2 below.

The selected technology is proven and reliable and is very similar to the existing plant in Carranstown, Co. Meath. In the design of the facility, Best Available Techniques (BAT) were taken into account (see Attachment 4-7-6 on the BREF WI). Different combustion and flue gas cleaning technologies were considered based on the targeted waste streams for treatment, what is currently available in the market and technologies that have been proven at a similar scale to that proposed in this application. The reason for selecting the final design and consideration of alternatives is given in Chapters 3.5 and 3.6 of the EIAR accompanying this application.

Attachment 4-8-1 Operational Report

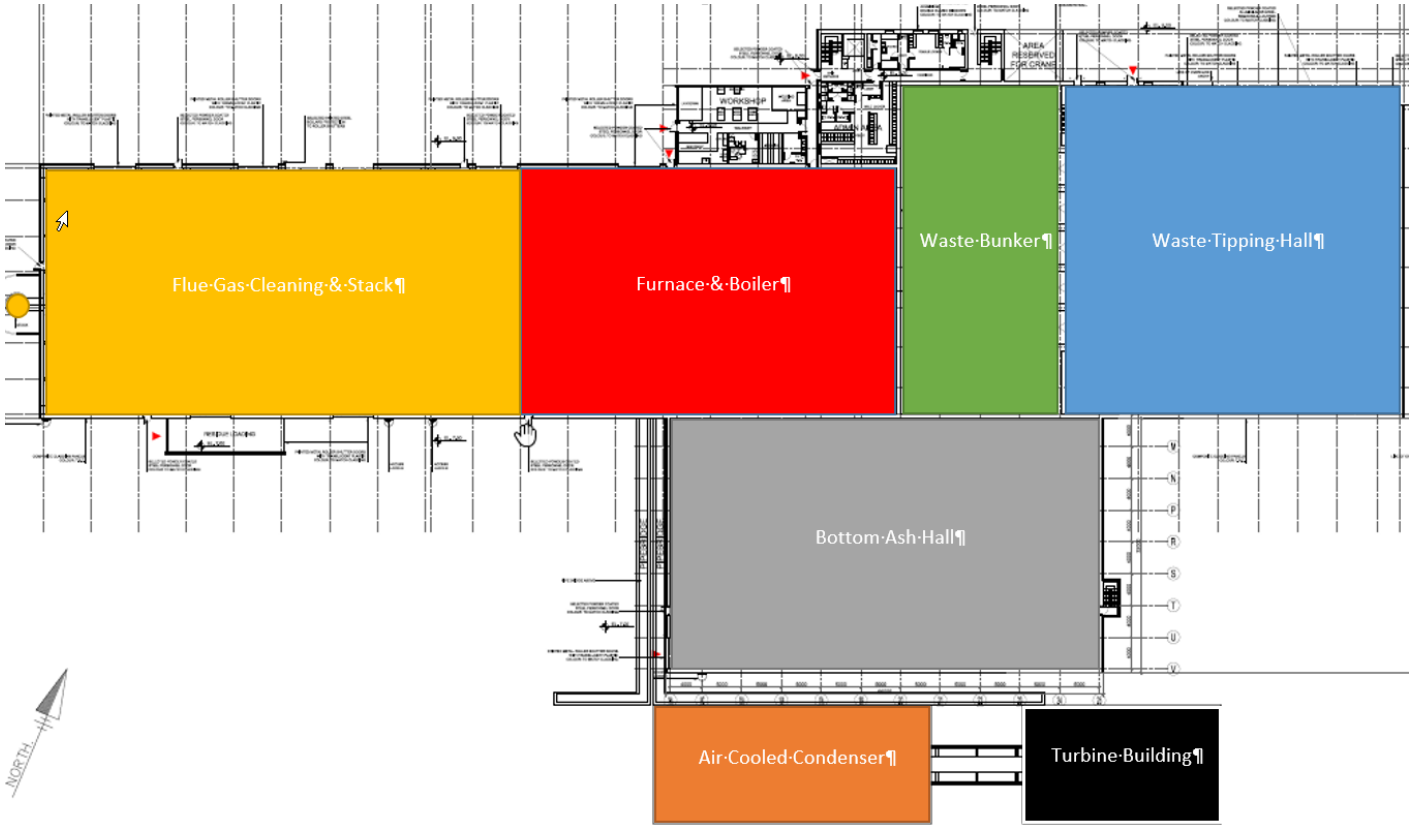


figure 1.1

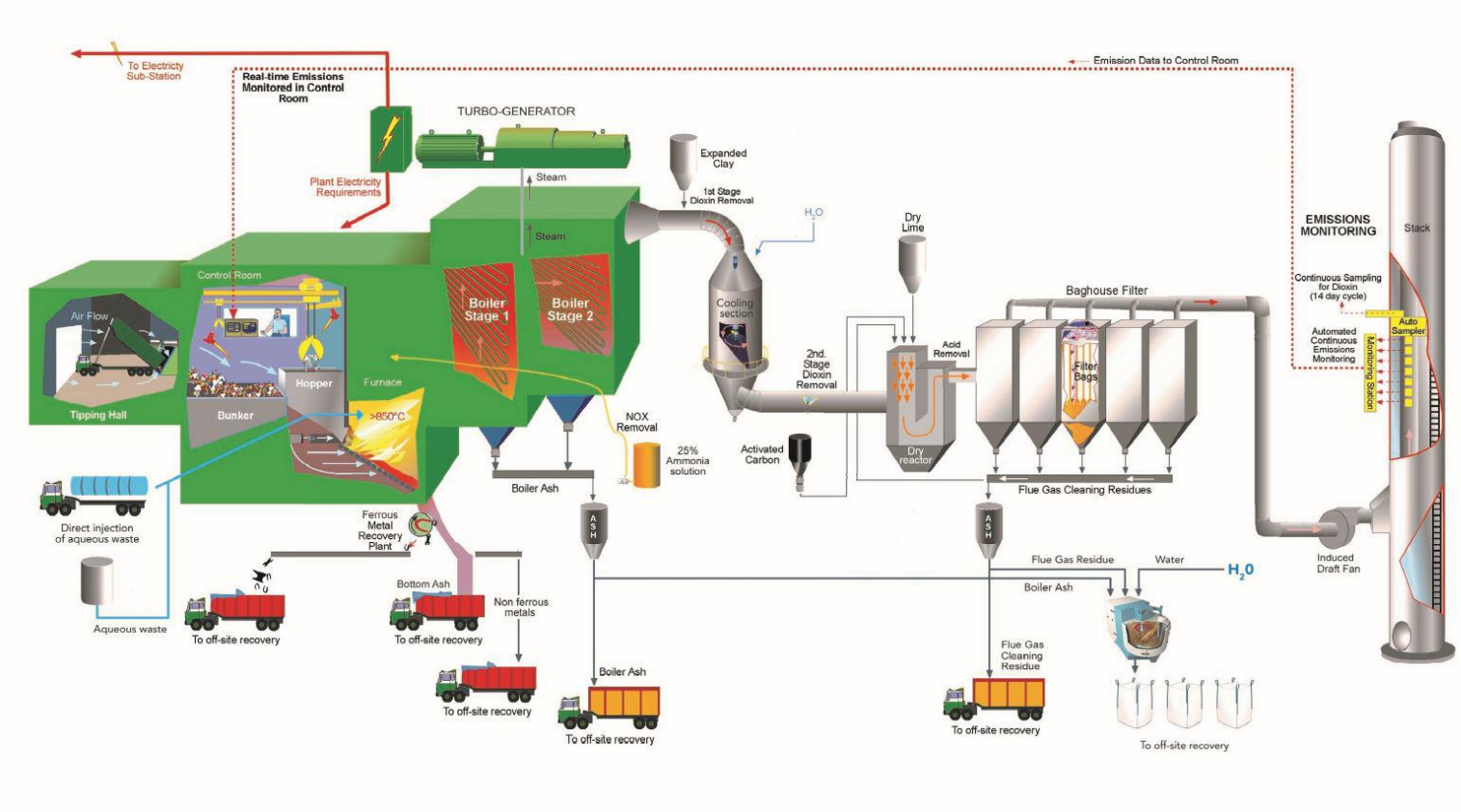

To Electricty Sub-Station
Real-time Emissions Monitored in Control Room
Emission Data to Control Room
TURBO-GENERATOR
Plant Electricity Requirements
Steam
Steam
Expanded Clay
1st Stage Dioxin Removal
H_2O
Dry Lime
EMISSIONS MONITORING
Stack
Continuous Sampling for Dioxin (14 day cycle)
Automated Continuous Emissions Monitoring
Auto Sampler
Monitoring Station
Control Room
Air Flow
Tipping Hall
Bunker
Hopper
Furnace
>850°C
Boiler Stage 1
Boiler Stage 2
Cooling section
2nd. Stage Dioxin Removal
Acid Removal
Baghouse Filter
Filter Bags
Dry reactor
Activated Carbon
NOX Removal
25% Ammonia solution
Boiler Ash
Flue Gas Cleaning Residues
Direct injection of aqueous waste
Aqueous waste
To off-site recovery
Ferrous Metal Recovery Plant
Bottom Ash
To off-site recovery
Non ferrous metals
To off-site recovery
Boiler Ash
To off-site recovery
Flue Gas Residue
Water
H_2O
Boiler Ash
Flue Gas Cleaning Residue
To off-site recovery
To off-site recovery
Induced Draft Fan

figure 1.2

2.0 Unit Operations

The waste-to-energy process can be divided into five main unit operations or process elements as follows:

- waste acceptance
- waste handling, storage and feeding
- combustion process
- energy recovery process
- flue gas cleaning.

2.1 Waste Acceptance

Chapter 4.7.1 of the EIAR accompanying this application describes the acceptance process for both solid and aqueous wastes. Control of this process is governed by Indaver's waste acceptance procedure and waste handling procedure (see Attachments 4-3-5-2 and 4-3-5-3 respectively) for both solid and liquid non-hazardous and hazardous wastes. The key tenet of the procedures is to ensure that before arrival on site, the waste has been deemed suitable for treatment and that when the waste actually arrives on site, that it is presented in a way that facilitates the successful treatment of that waste with the minimum amount of effort or manipulation.

Upon arrival at the facility, every delivery is controlled and an electronic ID badge issues to each driver to record the vehicle registration number, weight, type of waste by LoW code, time of entry and exit etc. No waste delivery can cross the weighbridge without a badge being issued.

A radiation monitoring system will be installed on the incoming weighbridge and all waste deliveries to the site will pass through this device. In the event that the device detects ionising radiation in a delivery, the protocols outlined in Attachment 4-3-5-2-1 (Annex 1 to the Waste Acceptance Procedure contained in Attachment 4-3-5-2) will be followed. Typically, the delivery will be held in the quarantine area outside the tipping hall (see drawing CD5008 Chemical & Waste Storage Areas) until the correct course of action is decided upon.

Two weighbridges will record the entry and exit weight of each delivery and automatically record this on Indaver's ERP software SAP. A traffic light system on the incoming and outgoing weighbridge controls the movement of the accepted waste

deliveries. Each delivery is planned in advance by the Indaver planning team and if the delivery is not registered on the SAP system, then it cannot be accepted.

The process flow diagrams from the waste acceptance procedure are shown below in figures 2.1 & 2.2.

A speed limit of 25 kmph will be set to control traffic onsite. This limit will be signposted at the entrance of the facility. The inbound weighbridge and bypass lane are located at a sufficient distance from the site entrance to ensure any queuing onsite does not disrupt traffic on the public road. This space allows for up to 10 HGV's to queue on awaiting entry to the facility.

Both inbound and outbound traffic can pass through a bypass lane if they do not require weighing (such as maintenance deliveries or contractors). This will help to maintain the flow of traffic onsite and avoid queuing. Barriers at the incoming and outgoing bypass lanes are controlled from the security building. Details of the on-site traffic flows for waste and residues can be seen in drawing CD5013-Site Traffic Movements. As indicated on this drawing, road signage will guide solid waste, aqueous waste and vehicles for residue collection to the correct location on site. Speed limit signage will also be widely employed.

Traffic to and from the facility will be managed via a detailed HGV mobility management plan which is outlined in Chapter 7.11.3 of the EIAR. The hours of waste acceptance (Monday – Friday 06:00 to 20:00 & 09:00 to 14:00 on Saturdays) are outlined in Chapter 4.6.1 of the EIAR. To avoid peak hour traffic on the existing road network, waste deliveries to the facility will be limited to 3 per hour during peak traffic periods in the morning and evening.

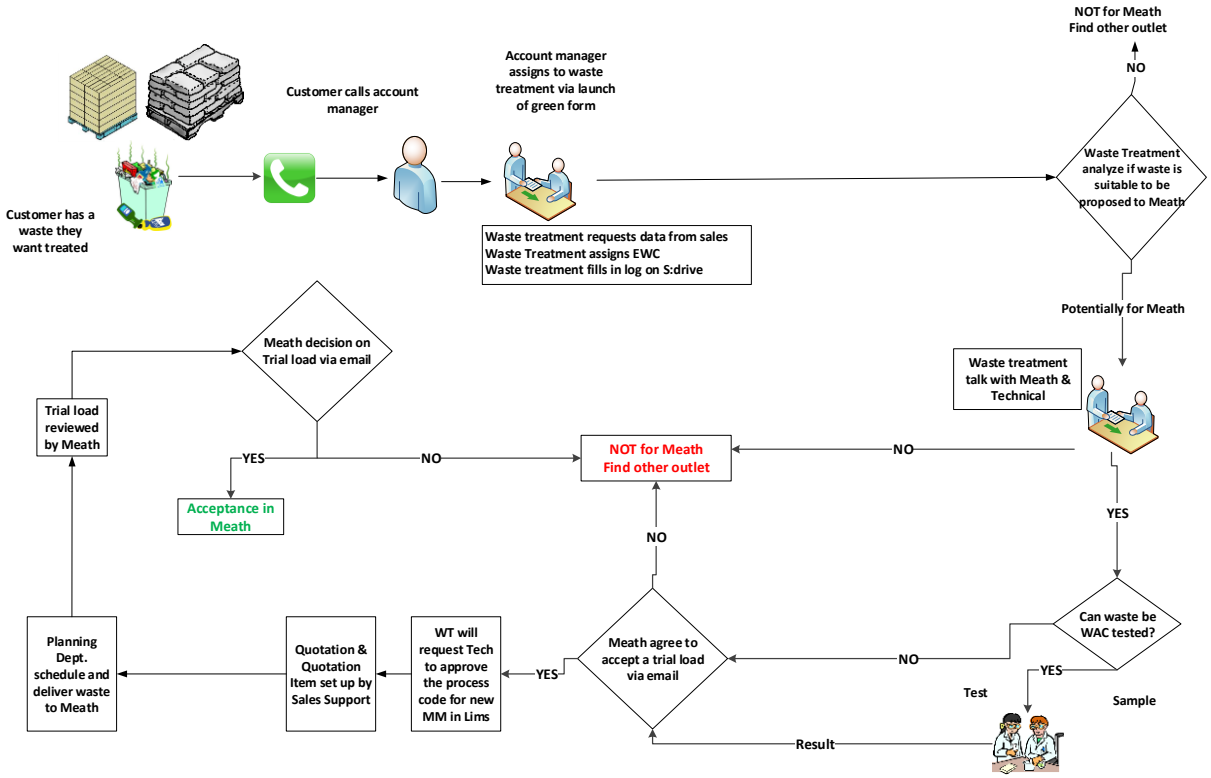


Figure 2.1 Non-hazardous waste acceptance process flow diagram

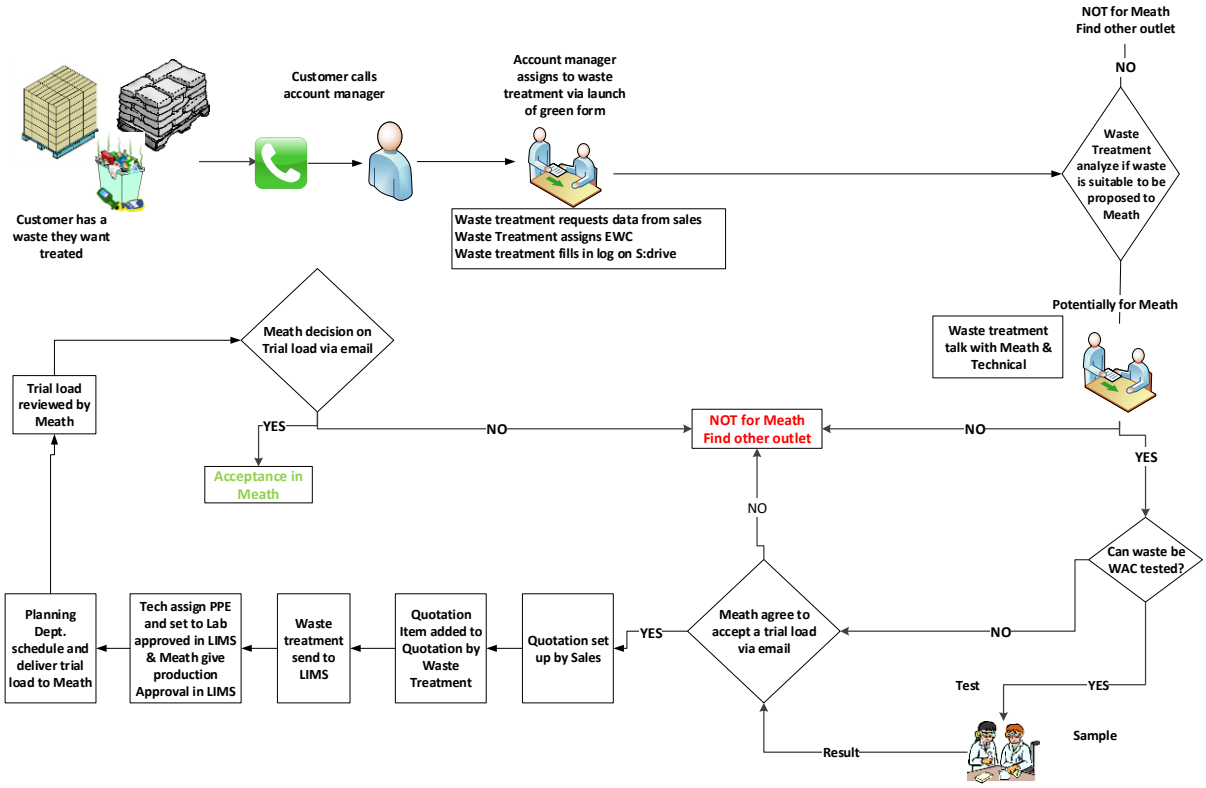


Figure 2.2 Hazardous waste acceptance process flow diagram

On average, between 4 and 5 deliveries are processed per hour and the types of deliveries will vary from standard municipal solid waste (MSW) in large ejector or walking floor trailers (22 to 24 tonne per delivery) to MSW in bin collection lorries (6 to 12 tonne per delivery). Solid hazardous waste will typically be delivered on pallets in 40 foot curtain sided vehicles (2 to 20 tonne per delivery) and aqueous wastes will be delivered in road tankers or tank containers (20 to 24 tonne per delivery). Full details of the variety of waste streams proposed for treatment is provided in section 4.3 of the application form and in Attachments 4-3-4 and 4-3-6 to this application.

2.2 Waste handling, storage and feeding (solid waste)

A description of the solid waste handling, storage and feeding system is included in Chapter 4.7.2.1 to 4.7.2.3 of the EIAR accompanying this application. All solid waste (including sludges) will be discharged to the concrete bunker (40m x 20m x 10m) via the enclosed tipping hall. The waste bunker and tipping hall are kept under negative air pressure to avoid the egress of odour and the extracted air is used as primary air for combustion in the furnace.

When the facility is in shutdown for annual maintenance or otherwise, the air extraction from the bunker and tipping hall will be maintained and managed by passing it through a carbon filter or bio-filter unit. The carbon type or bio-filter media will be specifically sourced mitigate odours from residual Municipal Solid Waste. The filter unit will be a semi-mobile unit (approximately the size of a standard shipping container) and may be placed in the yard area outside the tipping hall or inside the tipping hall itself. The fan, ducting and extract points from the bunker and tipping hall will be permanently installed.

The minimum storage capacity of the bunker will be approximately 4,100 tonnes of solid waste (assuming filling of the bunker to the tipping hall floor level and a density of 0.5 tonnes/m^3) or 5 days processing. The maximum storage capacity of the bunker will be approximately 8,000 tonnes.

Solid waste is then mixed by one of two grab cranes and fed to the hopper which feeds the furnace via the connecting waste chute. The feeding rate of solid waste to the furnace will be approximately 30 tonnes per hour. The cranes can operate in manual, semi-automatic or fully automatic mode for waste mixing and feeding. Waste feeding is typically in automatic mode and level measurements in the waste chute beneath the hopper will dictate the feeding rate directly to the crane to ensure there is always enough waste to both create a seal between the hopper and the underpressure in the furnace and guarantee a supply of waste for the feeding rams.

Further details of waste handling, control and feeding in the waste bunker are provided in Chapters 4.7.2.3 and 4.7.2.4 of the EIAR. A process flow diagram of the waste handling, storage and feeding system is outlined in figure 2.3 below.

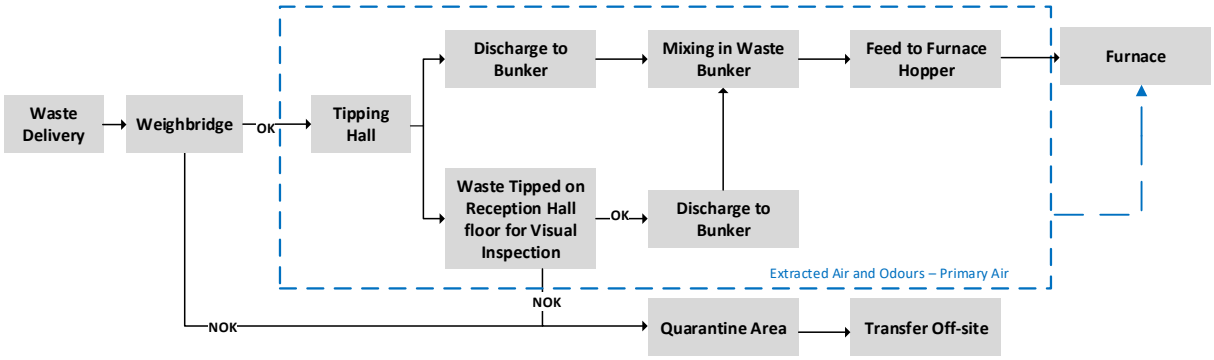


figure 2.3

A solid waste inspection area will be provided within the tipping hall where certain solid waste deliveries can be tipped and inspected for conformity. This inspection area is marked on drawing CD5009-Chemical & Waste Storage. A front loader with a bucket will then transfer the waste to the bunker via the tipping gates. If the waste load is rejected for treatment, then it will be re-loaded and quarantined in the quarantine area outside the tipping hall (see drawing CD5009 Chemical & Waste Storage) until a suitable outlet for the waste is sourced or sent directly back to the customer.

Palletised waste will be unloaded for inspection on the concrete hardstand area outside the tipping hall. Once the required checks are complete, the pallets will be brought into the tipping hall and tipped into the bunker using a forklift. The pallets may also be staged inside the tipping hall prior to tipping into the bunker. This area is also marked on drawing CD5009-Chemical & Waste Storage. Full details of the waste handling procedures on site are provided in Attachment 4-3-5-3 Draft Waste Handling Procedure.

2.3 Waste handling, storage and feeding (liquid waste)

A description of the liquid waste handling and storage system is included in Chapters 4.7.1 and 4.7.2.5 of the EIAR accompanying this application. All liquid wastes will be sampled and analysed prior to unloading to the 250 m^3 storage tank or direct injection to the furnace. The tank will be kept under a nitrogen blanket for safety and any overpressure from the aqueous waste unloading operation will be piped under forced ventilation to a secondary air injection point in the furnace. During shutdown periods, aqueous waste can still be accepted into the storage tank and any over-pressure from

the un-loading operation or the storage tank itself will be vented through an activated carbon unit to remove any solvent vapours that may be present. The carbon unit will be located adjacent to the storage tank.

The unloading area will be a contained area to guarantee that in the event of a spill, there is no ingress to the surface water collection network on the site. This is further described in Chapter 4.14.3 of the EIAR and in section 3.3 below.

The analysis of the waste will determine whether it is suitable for treatment or not (in line with the acceptance procedure and the waste acceptance criteria for aqueous waste) and if suitable, whether it will be unloaded into the storage tank or injected directly to the furnace. If rejected for treatment, then alternative arrangements will be made for transport to a suitably licensed facility in Ireland or overseas.

The capacity of the unloading facility to accept aqueous waste will typically be two to four tankers (approximately 24 tonnes per delivery) per day as it takes approximately 1 hour to unload and 1 to 2 hours for the laboratory analysis (if sampled and analysed on site). The timing of the deliveries and whether the analysis is available or upon arrival will dictate the daily throughput up to a maximum of eight deliveries in any one day.

Once unloaded to the storage tank, the aqueous waste within the tank is then mixed via re-circulation and pumped to a lance or series of lances in the roof of the furnace directly above the grate. The feeding rate will be approximately 1 to 2 tonnes per hour. Based on 8,000 operating hours per annum, approximately 16,000 tonnes of suitable aqueous wastes could be treated at the facility.

Empty tankers leaving the site will be washed using either a simple water hose or by the insertion of a cleaning head through the top manlid of the tanker. This equipment will be installed in the service yard directly north of the storage tank. Contaminated washings from this operation will be transferred to the aqueous waste storage tank.

The layout and locations of the storage tank, unloading area, nitrogen generation unit, potential tanker cleaning equipment and activated carbon unit can be seen on drawing CD5003 Site Layout Drawing.

The process control for aqueous waste unloading, storage and injection is described in Chapter 4.7.2.5 of the EIAR. A process flow diagram of the waste handling, storage and feeding system is outlined in figure 2.4 below.

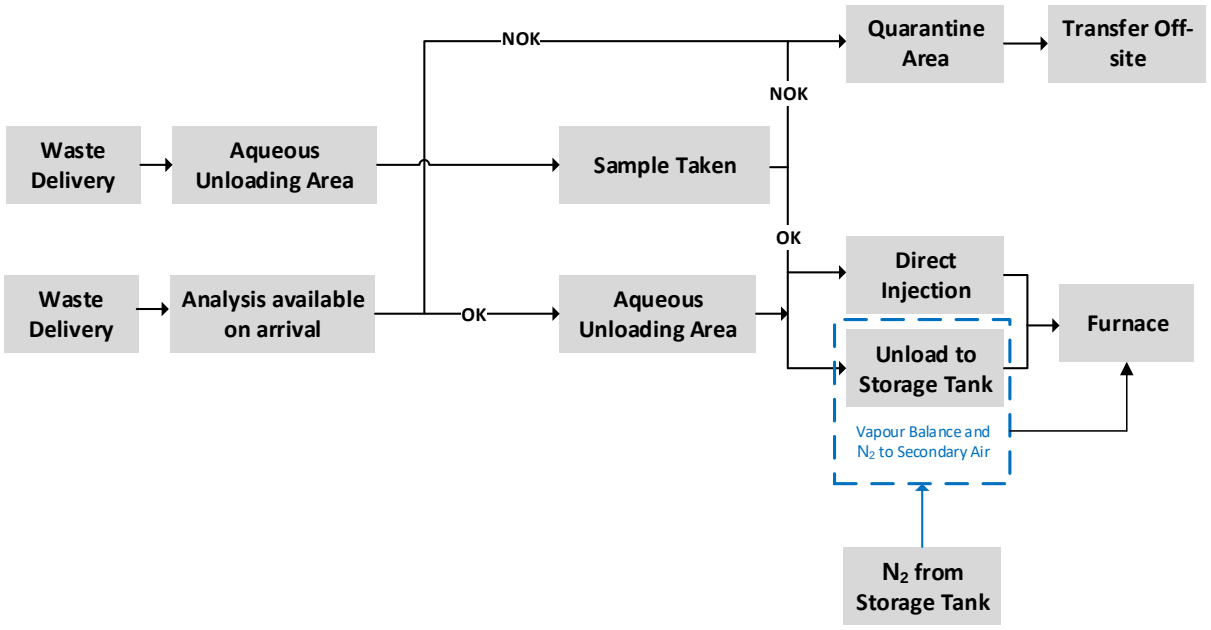


figure 2.4:

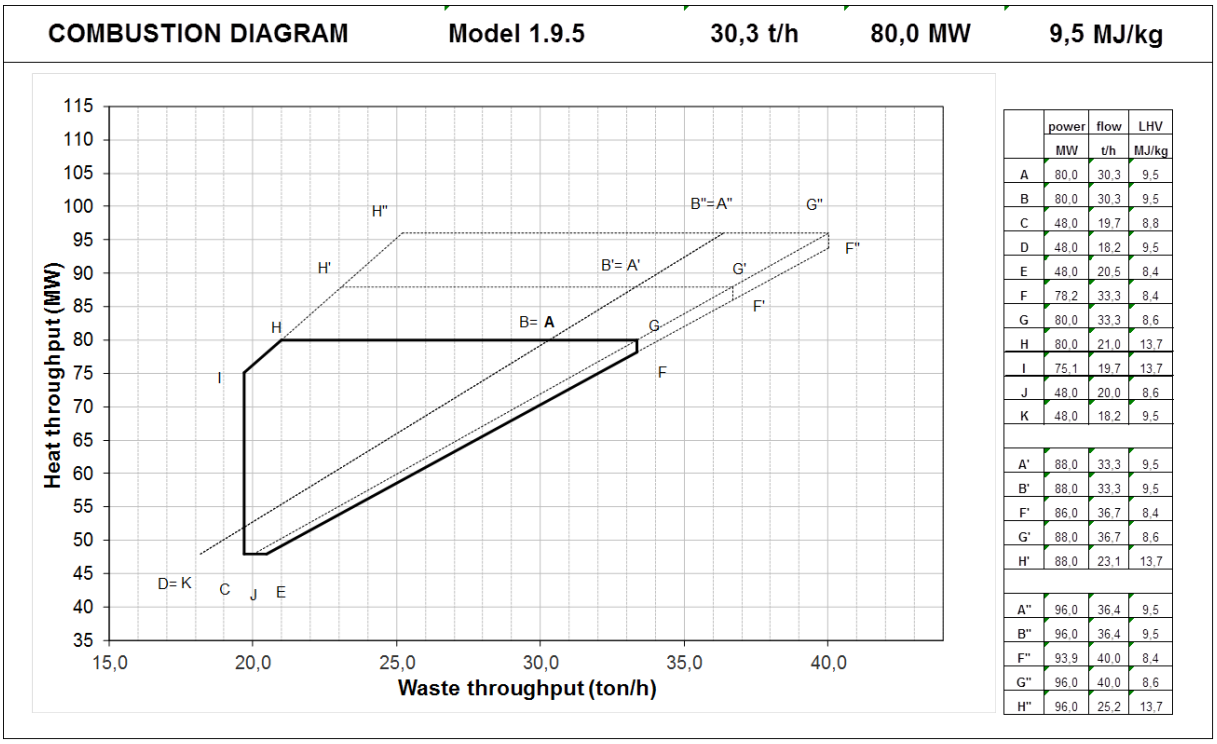
2.4 Combustion Process

The combustion process utilises a conventional grate furnace to burn solid and aqueous waste at temperatures in excess of 850°C and to convert them to bottom ash and hot flue gases using primary air extracted from the tipping hall and bunker area and secondary air extracted from the roof area of the main process building. The energy in the hot flue gases is then extracted in a conventional steam boiler where approximately 97 tonnes per hour of steam at 420 °C and 53 bar is sent to a steam turbine (see section 2.5 below) for the generation of electricity. The cooled flue gases are then cooled further and cleaned in the flue gas treatment section of the plant (see section 2.6 below). The induced draft fan (ID fan) installed between the baghouse filter and the stack (see figure 1.1 above) maintains underpressure in the furnace and the flue gas cleaning system to draw the flue gases through and discharge the cleaned flue gases to atmosphere via the stack.

A description of the combustion process in the moving grate furnace and the supporting combustion air system is included in Chapters 4.7.3.1 and 4.7.3.2 of the EIAR accompanying this application. A process flow diagram for the moving grate furnace is provided in figure 2.6 below. The process control of the furnace is described in Chapter 4.7.3.3 of the EIAR and the inputs/outputs and the potential for emissions from the furnace as outlined in Chapters 4.7.3.4 and 4.7.3.5 respectively.

The capacity of the furnace will be approximately 30 tonnes per hour and the average residence time in the furnace of the waste will be 1 hour. This throughput is highly dependent on the calorific value of the waste and the interdependence of these factors

is outlined in Attachments 4-3-2 and 4-3-4 included in this application. In short, the capacity of the boiler to absorb the heat generated by the combustion of the waste (boiler size) defines the capacity of the plant. The grate furnace physical size is then calculated based on the range of waste and associated CV values defined by the operator. This exercise produces the combustion diagram for the waste-to-energy plant and an example of an 80 MW plant is given below in figure 2.5.



	power MW	flow t/h	LHV MJ/kg
A	80,0	30,3	9,5
B	80,0	30,3	9,5
C	48,0	19,7	8,8
D	48,0	18,2	9,5
E	48,0	20,5	8,4
F	78,2	33,3	8,4
G	80,0	33,3	8,6
H	80,0	21,0	13,7
I	75,1	19,7	13,7
J	48,0	20,0	8,6
K	48,0	18,2	9,5
A'	88,0	33,3	9,5
B'	88,0	33,3	9,5
F'	86,0	36,7	8,4
G'	88,0	36,7	8,6
H'	88,0	23,1	13,7
A"	96,0	36,4	9,5
B"	96,0	36,4	9,5
F"	93,9	40,0	8,4
G"	96,0	40,0	8,6
H"	96,0	25,2	13,7

figure 2.5

Typically, the plant will operate at load point A on the diagram, which is at 100% thermal load with a waste throughput of 30.3 tonnes per hour and with an associated calorific value of 9.5 MJ/kg (or energy content of the waste). The operators dictate the set point (eg 100% thermal load) and the control system adjusts the required parameters, such as the waste feeding rate from the waste pushers to maintain that set point. If the CV of the waste is higher, then the amount of waste that can be processed will be less (moving to the left of load point A and staying on 80MW thermal load). If the CV is lower, then more waste can be processed (e.g. at load point G 33.3 tonnes per hour can be processed). The plant can also operate above and below the 80MW thermal load (in the extremes as low as 48MW and up to 96MW) but in normal operations it will fluctuate between 90% and 110% of the 80MW designed load on a daily basis.

A process flow diagram for the operation of the furnace is provided below in figure 2.6. The inputs to the furnace are waste, heat (from fuel oil at startup), primary air and secondary air. Primary air is introduced from underneath the grate (to support combustion and also to cool the grate itself) and the flow of air is automatically controlled by the control system depending on the point in the combustion that the plant is operating at. Although there are many interacting control parameters, the main control for primary air is the set point for the oxygen content at the outlet of the boiler which will vary from supplier to supplier but will be between 5.5% and 6.5% as a wet measurement at the boiler outlet.

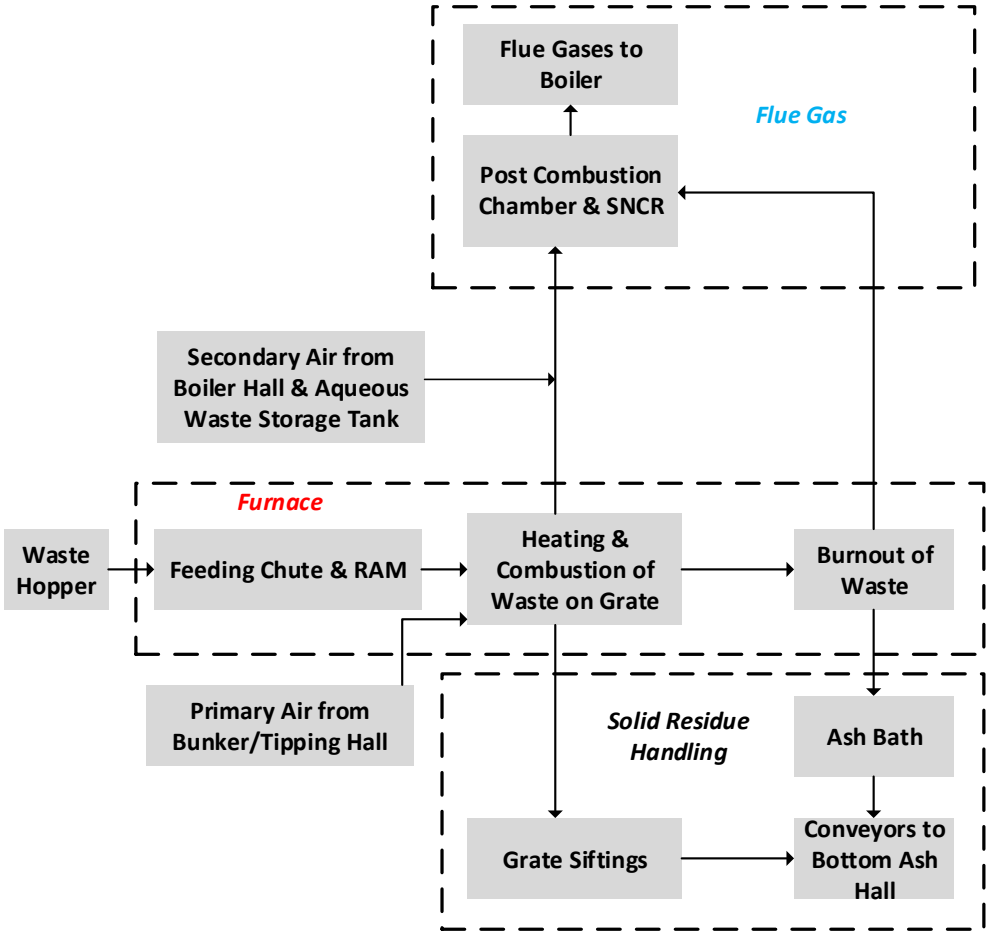


Figure 2.6

The primary air will be pre-heated using steam from the process to a temperature of 100 – 140 °C. The degree of pre-heating will be determined by the CV of the incoming waste. The distribution of primary air over the three main zones (drying, combustion and burnout) is also controlled to ensure optimum conditions for combustion and burnout of the waste. Visual monitoring of the flame front with cameras by the operators ensure that there is good burnout of the waste. The speed of waste feeding and the speed of movement of the grate are also controlled in line with the above to achieve the same goal of waste burnout.

Secondary air is also injected to the furnace in the transition zone between the furnace roof and the boiler to ensure complete combustion of any volatile organics and also to assist the mixing/homogenisation of the flue gas temperature for NO_x reduction. The total amount of air (primary + secondary) is adjusted in function of the oxygen set point at the outlet of the boiler, whilst ensuring that the minimum temperature of 850 °C for 2 seconds (T2S) is maintained at all times.

Auxiliary burners using fuel oil are utilised to maintain the T2S temperature in the furnace if required. Under normal operation, the use of the burners is not required. If the temperature drops below a set point (typically 875 °C), then the burners will start automatically in order to maintain the T2S temperature. If the burners fail to start and then T2S temperature cannot be maintained, then the entire plant will be shut down.

The normal operation of the burners is required during start up as no waste can be fed into the furnace until the minimum T2S temperature is achieved. The burners can also be utilised during the shutdown process to control the cooling rate of the refractory in the furnace and boiler.

2.5 Energy Recovery Process

As outlined in section 2.4 above, energy is recovered from the hot flue gases exiting the furnace in a conventional steam boiler. Hot flue gases enter the first stage of the boiler (first empty pass) at approximately 1,000°C and conduct heat to the water-filled walls of the boiler radiantly. This cools the flue gases to approximately 700°C before entering the convective part (with tube bundles hanging in the path of the flue gases) of the boiler comprising a protective evaporator, a series of banks of superheaters and finally the economiser. It is in the superheaters that high pressure steam (53 bar) at 420°C is produced and sent to the steam turbine and generator set which produces electricity from the steam. The steam temperature in the superheaters is regulated to 420°C by the automatic injection of boiler feedwater at dedicated points in the superheater tube bundles. Approximately 97 tonnes per hour of steam will be generated in the superheaters and sent to the turbine. The low pressure (-0.9 bar) and temperature (45°C approx.) steam exhausted from the turbine outlet is sent to a series of large fans (air cooled condenser), converting the low pressure steam to condensate which is then recycled back into the boiler feedwater system.

The flue gases exiting the boiler will be cooled to 160°C before entering the flue gas treatment section of the plant. Of the 80MW of heat put into the plant from the waste, almost 85% (66.7 MW) of this is converted directly into steam which in turn generates approximately 21MW of electricity (MW_e). The plant itself will have an electrical

demand of approximately 2.5 MW_e, leaving 18.5 MW_e available for export to the national grid.

Process flow diagrams for the boiler (flue gas side) and steam turbine (boiler water/steam side and turbine) can be seen in Figures 4.13 and 4.14 of the EIAR respectively and an overall heat balance is shown in Figure 4.14, also in the EIAR. An integrated process flow diagram (steam side plus flue gas side) is shown below in figure 2.7.

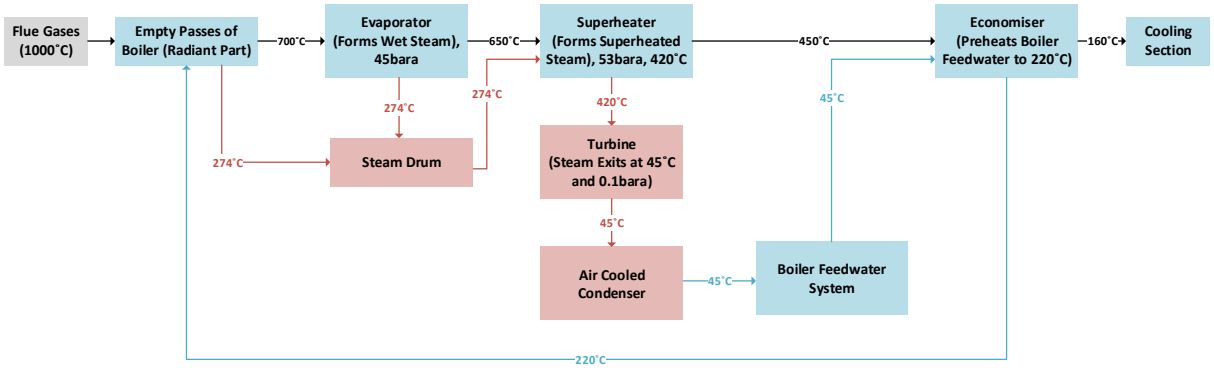


figure 2.7

It is important to note that a waste-to-energy plant must operate with the turbine and generator set in frequency control mode, meaning that the speed of rotation of the turbine blades modulates with the actual steam outflow from the superheaters. Hence the turbine "follows" the amount of steam produced by the plant and this is because the fuel being burned is not homogeneous. In a conventional power plant, the turbine and generator set will typically operate in power control mode where the electrical output is set and the correct amount of fuel is burned to generate the required amount of power.

The process description of the boiler is also provided in Chapter 4.8.1.1 of the EIAR. The process control, emissions and inputs and outputs are described in Chapters 4.8.1.2 to 4.8.1.4.

The process description of the steam turbine is provided in Chapter 4.8.2.1 of the EIAR. The process control, emissions and inputs and outputs are described in Chapters 4.8.2.2 to 4.8.2.4.

2.6 Flue Gas Cleaning Process

The flue gas cleaning system proposed can be described as a semi-dry system comprising a cooling section, a dry reactor, a bag house filter, the induced draft (ID)

fan and the stack where the emissions monitoring equipment is located. Each of these steps will be addressed in the following sections starting with the reduction of NO_x.

2.6.1 Control of Nitrogen Oxides (NO_x)

The first flue gas cleaning step actually happens in the first pass of the boiler for the reduction of nitrogen oxides (NO_x). NO_x are produced as part of all combustion processes, mainly due to the presence of nitrogen (N_2) in the air which is used to support combustion and also from the presence of nitrogen compounds in the waste feed. Selective non-catalytic reduction (SNCR) technology will be utilised to control levels of NO_x in the flue gases to the levels specified in the Industrial Emissions Directive (IED) by the injection of an aqueous ammonia solution (24.9%) or urea (SNCR re-agent) into the first pass of the boiler directly above the furnace. The reaction of NO_x with the re-agent results in the production of N_2 and water vapour.

The rate of injection of the SNCR re-agent will be automatically controlled according to the NO_x levels measured in the stack, the ammonia level measured in the stack and the temperature profile at the injection points in the first pass of the boiler. The temperature window (950°C to 1,000°C) for efficient use of the SNCR re-agent is important and accurate measurement of the temperature profile in this section of the guides the SNCR system to inject at the correct place in the first pass to ensure that NO_x levels are controlled without excessive over-use of the re-agent. The temperature is measured using optical equipment to ensure that the injection of re-agent is directed at the correct places. The continuous measurement of the ammonia levels in the stack ensure that over-dosing does not occur. On average, 100kg/hr of re-agent will be consumed by the process and can peak up to approximately 160kg/hr. A process flow diagram for the SNCR de-NOx system is provided in figure 2.8 below.

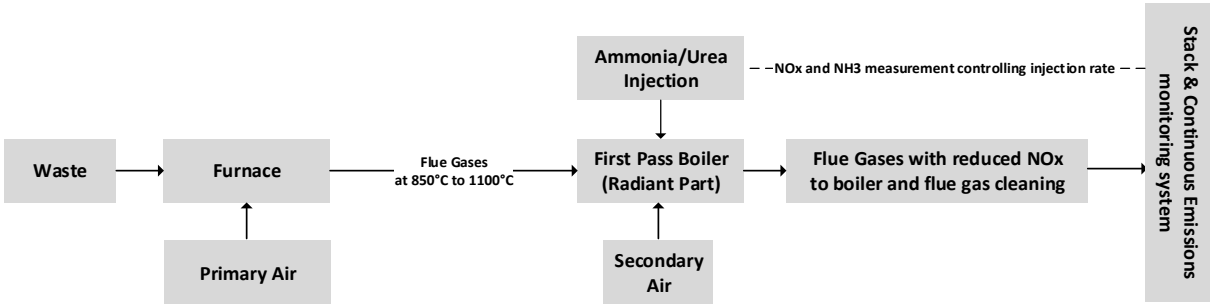


figure 2.8

The process description of the SNCR system is also provided in Chapter 4.7.4.1 of the EIAR. There will be no emissions from this process. The process control, emissions and inputs and outputs are described in Chapters 4.7.4 to 4.7.4.4.

If, for any reason, the SNCR system fails and the re-agent cannot be injected, then the NO_x levels would increase in the stack and then entire plant would be shut down until the SNCR system is repaired.

2.6.2 Flue Gas Cooling

When the flue gases have completed their path through the boiler, they emerge at approximately 160°C. The flue gases are further cooled prior to the injection of lime and activated carbon/clay. Clean water recycled from the process will be used and will be topped up with process water to cool the flue gases to approximately 145°C. Standard thermocouples will monitor the inlet and outlet temperature and the rate of water injection will be automatically controlled to maintain the outlet set-point of 145°C.

The water is injected into a cooling tower as a fine mist of water droplets using atomising air through a series of nozzles. The diameter and the height of the tower will be optimised in the final design to ensure adequate residence time (5 – 10 seconds) for contact of the flue gases with the water mist whilst ensuring that all of the water is fully evaporated at the cooling tower exit. The consumption of water in the cooling tower will be approximately 1.5 tonnes per hour. The flue gas cooling system, process control, emissions and inputs/outputs are also described in Chapters 4.9.2 and 4.12 of the EIAR and a schematic for the process flow of the flue gas treatment and cooling is shown in figure 2.9 below.

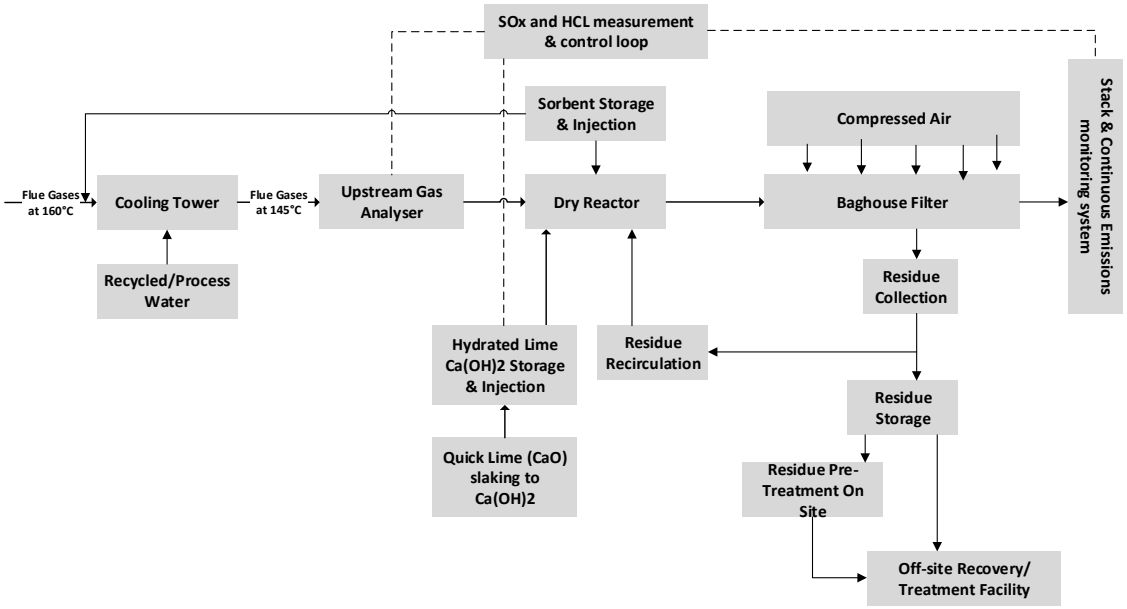


figure 2.9

In the event that the cooling water injection fails, this may result in an increased use of lime downstream but would not have any other adverse impacts as the baghouse filter can operate at a temperature of 160°C and the flue gases would leave the stack at a

slightly elevated temperature. Due to the simple nature of this equipment, any fault would be corrected in a relatively short period of time.

2.6.3 Flue Gas Cleaning – Lime and Sorbent addition

The cooled flue gases then pass into a dry reaction duct where hydrated lime and either activated carbon, activated clay or an activated carbon/clay mix (sorbent) is injected to remove acid pollutants and dioxins/heavy metals. The amount of lime to be injected is controlled automatically based on an upstream measurement of hydrochloric acid and sulphur dioxide in the un-treated flue gases between the boiler outlet and the cooling tower in combination with the measurements made in the stack. Continuous flue gas analysis measurements are recorded in both locations and a control loop in the automated control system calculates the rate of injection required and adjusts accordingly.

Hydrated lime ($Ca(OH)_2$) will be prepared on site from quicklime (CaO). Deliveries of quicklime will be stored in an enclosed steel silo within flue gas section of the main process building (see Figure 1.1 above) and will have a capacity of approximately 180m^3. The quicklime will then be transported via enclosed screws to a lime slaker where water will be added (1 part water to 2 parts lime) to produce dry hydrated lime. Slaking will be done in batches and the hydrated lime will be stored in a 30m^3 vessel prior to injection in the dry reactor. The hydrated lime vessel will have enough capacity for 6 days operation without re-filling.

In order to ensure that the lime that is injected is used as efficiently as possible, a proportion of the flue gas cleaning residues that are collected in the baghouse filter are re-circulated into the dry reactor. The remainder of the flue gas cleaning residues are collected in one of two fully enclosed silos, each with a capacity of 240m^3 (or approximately 156 tonnes) each, located within the flue gas part of the main process building. Lime will be injected at an average rate of 304 kg per hour, but this will vary in function of the pollutant load of SO_2 and HCl in the raw flue gases. Refer to figure 2.9 above for the process flow diagram of the flue gas cleaning process.

The injection system from the hydrated lime storage vessel to the dry reactor will be pneumatic and will be duplicated (fully redundant) so that in the event of failure of one injection system the second one can be engaged immediately by the control panel operator without any interruption to the process. A more detailed process flow of the lime slaking, storage and injection system is shown in figure 2.10 below.

The sorbent is added at a constant rate as it is not possible to measure dioxins on a continuous basis. The sorbent will be stored in a 70m^3 fully enclosed steel silo and will be injected pneumatically at a rate of approximately 15 – 20 kg per hour (depending on the type of sorbent used). This silo will also be located in the flue gas cleaning area

of the main process building. The sorbent is injected at two points in the process, one upstream at the cooling tower and the second at the dry reactor itself. This is shown in figure 2.9 above. A single point of injection is sufficient for the process and the abatement of dioxins and heavy metals but a redundancy element is provided in the event of failure of one of the injection points.

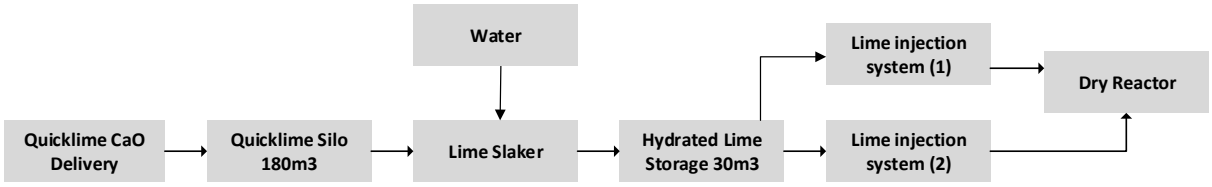


figure 2.10

The process description, process control inputs for the lime and sorbent injection process are also described in Chapters 4.9.2, 4.9.3 and 4.12 of the EIAR. There will be no emissions from the storage lime or sorbent, the hydrated lime preparation or the hydrated lime/sorbent injection processes. Inputs to the process will be lime, water, sorbent, recirculated flue gas cleaning residues and cooled flue gases. Outputs will be cleaned flue gases and flue gas cleaning residues.

2.6.4 Flue Gas Cleaning – Baghouse filter

The baghouse filter will contain multiple filter bags in separate compartments. The separate compartments will allow for maintenance and changing of filter bags whilst the filter is on-line. The dust laden flue gases will be sucked from the outside (foul side) to the inside (clean side) of the filter bags leaving a dust cake on the outside of the bags. The bags are supported with an inner steel cage to prevent the bags collapsing from the underpressure. The pressure drop over the bags will increase as more dust accumulates. A reverse pulse of clean compressed air will be blown inside the bag as soon as a pre-set pressure drop set-point is reached. The airwave will inflate the bag and make the carbon and particulates on the outside crack and fall into collection hoppers below.

From the hoppers, the flue gas cleaning residues are transported in enclosed conveyors to either one of the two storage silos (240m^3 each) or to the recirculation line back into the dry reactor.

In the event of a blockage in one of the compartments (indicated by an increased pressure drop over the filter), the compartment or cell can be isolated whilst the blockage is freed. The design capacity of such a filter is always that the plant can still run with one cell isolated. In the event of individual filter bag failure, the cell is isolated and once the failed bag has been located, a replacement can be readily installed.

There will be no emissions from the baghouse filter. The inputs will be compressed air, cleaned flue gases with entrained dust, sorbent and flue gas cleaning residues. Outputs from the baghouse filter will be cleaned flue gases to the stack and flue gas cleaning residues. The process description, process control, inputs and outputs for the baghouse filter are also described in Chapters 4.9.3 and 4.12 of the EIAR.

In the event of total failure of any of the above flue gas cleaning systems or the baghouse filter itself, then a plant shutdown sequence would be initiated as described in section 2.7 below.

2.6.5 Flue Gas Cleaning – ID Fan and Stack emissions monitoring

After the baghouse filter, the cleaned flue gases are discharged through the stack by the induced draft (ID) fan. The stack is 70m tall (from site ground level) and has been designed as part of the Air Quality assessment as provided in Chapter 8 of the EIAR.

Flue gas monitoring equipment will be installed to monitor emissions. The equipment will consist of continuous monitors and regular grab sampling according to the specifications laid down in EU and Irish legislation for incineration facilities.

The following parameters will be continuously measured in the stack: total dust, TOC, HCl, HF, SO_2, NO_x, CO, NH_3, Hg, temperature and O_2. These continuous measurements will be accessible in ‘real time’ in the control room.

The emission values will be relayed to both the control room, where the operators will have 24-hour access to this information and will be able react if necessary, and to the QESH (Quality, Environmental, Health & Safety) Department where they will be monitored for compliance with the relevant half-hourly, daily and monthly averages.

Although it is not a requirement of EU or Irish legislation, the monitoring equipment will include a state of the art continuous dioxin sampler.

Due to the very low levels of dioxins in the flue gases leaving the stack, no proven technology is currently available, which is capable of providing continuous monitoring. The continuous dioxin sampler will allow the dioxin emissions to be sampled continuously. A dioxin filter will be placed in the stack to collect dioxin emissions on a fortnightly basis.

This will then be removed and analysed in an independent laboratory. Laboratory testing of the samples will give dioxin emission concentrations and mass emission rates over a two-week period. This equipment is in use in existing Indaver facilities such as the Waste-to-Energy facility in Meath.

Discontinuous monitoring for monitoring for heavy metals Cadmium, Thallium, Antimony, Arsenic, Lead, Chromium, Cobalt, Copper, Manganese, Nickel, Vanadium and Tin. Further details are also provided in Chapter 4.11 of the EIAR.

2.7 Plant Shutdown Sequence

As outlined in several sections above, there are certain conditions that will trigger a plant shutdown. In short, when the corrective actions of the control system and the plant operators cannot keep a required parameter or set of parameters within the appropriate range, a plant shutdown sequence will be initiated.

The sequence can be triggered automatically by the control system itself or by a plant operator. The sequence follows a set of logical steps to stop:

- Stop waste feeding
- Bring on fuel oil burners to maintain minimum temperature of 850°C for as long as there is waste burning on the grate
- Maintain flue gas cleaning systems and ID fan
- Switch off burners
- When flue gases have reached approximately 60°C in the stack, then the flue gas cleaning systems and ID fan can be switched off.

The same sequence is followed when bringing the plant to a stop for annual planned maintenance outages. Furnace startup and shutdown procedures are outlined in Appendix 4.2 to Chapter 4 of the EIAR accompanying this application.

2.8 Automated Control System

The facility will be controlled by an interface computer system (screens, keyboard, and printers) from the Control Room. The system will monitor all the parameters and measurements required in order to have a good overview of facility performance. It will execute facility control loops, report low-level and high-level alarms and will control different levels of safety interlocking.

The control room will be located above the bunker. From here crane operators will visually inspect the waste and, using a grab and automated transfer system, will control waste entering the furnaces from the bunker.

The facility's automated computer system will be controlled and monitored from here. Emissions data from the emissions monitoring station located on the stack will also be monitored here.

The automated control system is also described in Chapter 4.10 of the EIAR accompanying this licence application and a description of the plant interlock system is also provided in Appendix 4.3 to Chapter 4 of the EIAR.

3.0 Ancilliary systems and infrastructure

In addition to the unit operations and systems described above there are some additional ancillary systems and infrastructure which support the plant which are described in the relevant sections below.

3.1 Site stormwater and sewer network

All of the underground drainage systems will be designed and constructed as a minimum to comply with the Building Regulations 2010, BS EN 752-4 Drain and Sewer Systems outside Buildings. The site stormwater network and management is described in detail in Chapter 4.14.3.1 of the EIAR accompanying this application.

The network has been designed to minimise any potential for off-site impacts. Drainage from roofed areas will collect in one network and all other areas of hardstanding will be collected in another. Further protection in areas where aqueous waste deliveries or where incoming raw materials are stored and handled has been provided in the form of bunds, double contained tanks, sumps and interceptors have been provided to reduce the risk of any contamination of the main stormwater drainage network. See figure 3.1 below which demonstrates this.

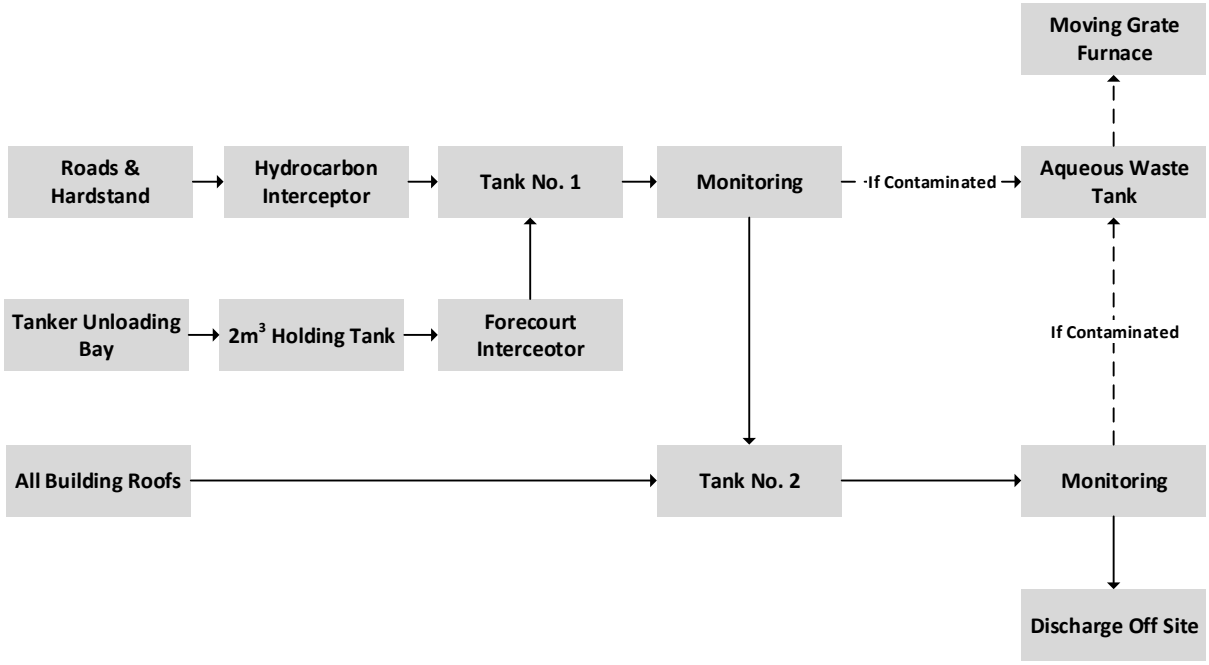


figure 3.1

Two monitoring chambers on the outflow from tank 1 and at the outflow from tank 2 combined with automatic shut-off valves will ensure that any contaminated water will be retained on site. The discharge rate from the final outfall chamber will be limited to the greenfield run-off rate of 18 l/s.

The existing 450mm diameter stormwater sewer in the public road will be upgraded as part of the project. The upgrade has been designed to cater for the 7 hours when the storm water outfall is tide locked by a 200 year design high tide, 2.73m top water level (TWL), combined with a 1 in 30 year rainfall event plus an allowance for climate change. This upgrade is discussed in more detail in Chapter 4.5.14 of the EIAR accompanying this licence application. Refer also to Drawing CD5013-Drainage Plan for details of the drainage network on the site.

Domestic effluent will be collected on site in an underground network and discharged to the Irish Water sewer located east of Ringaskiddy Village, which will then be pumped to the Lower Harbour wastewater treatment facility at Shanbally. Refer to Drawing CD5014-Sewer Drainage for more details.

Drawings CD5013-Drainage Plan and CD5014-Sewer Drainage show additional information on location and sizes of pipes, outlets etc.

3.2 Residue handling and transport systems

Solid residues produced by the process have been described above. In summary there are three solid residues produced by the process:

- Bottom ash – 52,000 tpa
- Boiler ash – 2,000 tpa
- Flue gas cleaning residues – 9,100 tpa.

The options for off-site treatment of these residues is discussed in detail in the Material Assets Chapter 15.5.3.8 of the EIAR accompanying this application. A description of the residues handling and transport for each solid residue in turn is outlined below.

Bottom Ash

The bottom ash will be at a high temperature when it exits the furnace. The bottom ash from the grate will be discharged into a water bath, and then via a conveyor to the ash hall. This process will take place within the building. Refer to figure 3.2 below for a schematic of the bottom ash handling operations.

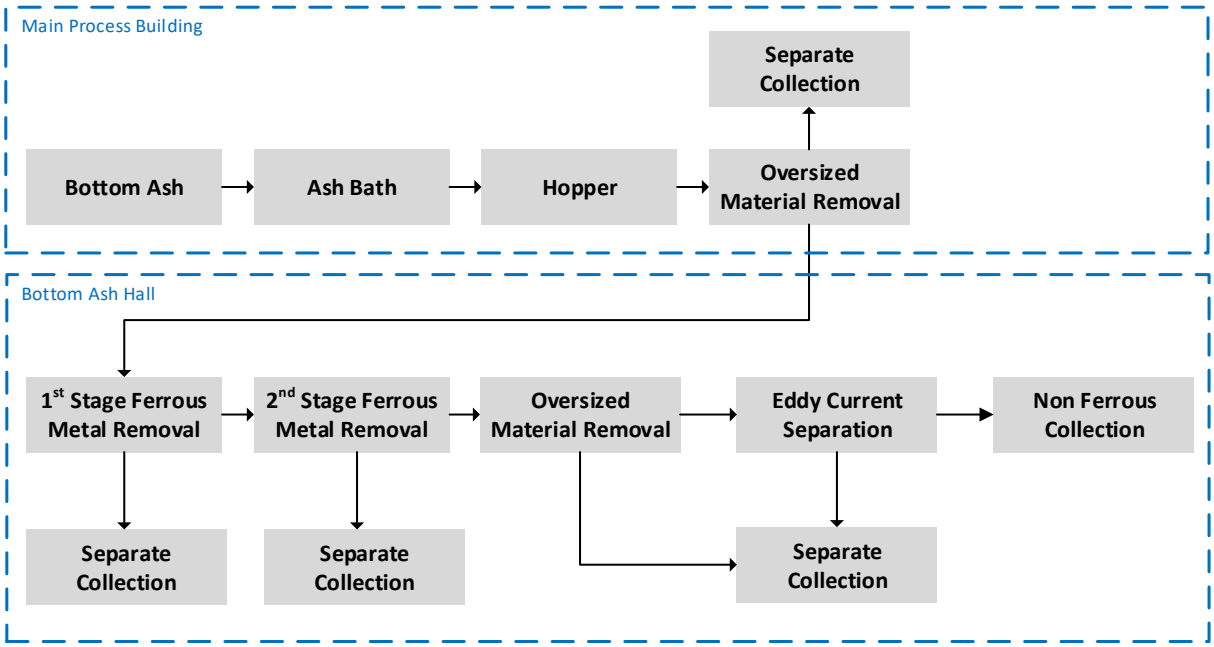


figure 3.2

Boiler Ash

Boiler ash will be collected in hoppers underneath the boiler and transported in an enclosed conveyor to the boiler ash silo. There will be a crusher to eliminate any agglomerations of boiler ash prior to discharge into the boiler ash silo. In the event of blockage of the entry to the silo, the conveyor will be equipped with a bypass system to a bagging station at ground level. The silo will be 100 m^3 in size and will have enough capacity to store 10 days of boiler ash production from the plant. The silo itself will be fitted with a self-cleaning particle filter (using compressed air) to ensure that there are no dust emissions from the silo. The silo will be located inside the main process building in the flue gas cleaning area. It will store the boiler ash prior to pre-treatment or transfer to tankers for transport off-site. There will be no emissions from the storage or transport of boiler ash on site. A process flow diagram for the transport and storage of boiler as is provided in figure 3.3 below.

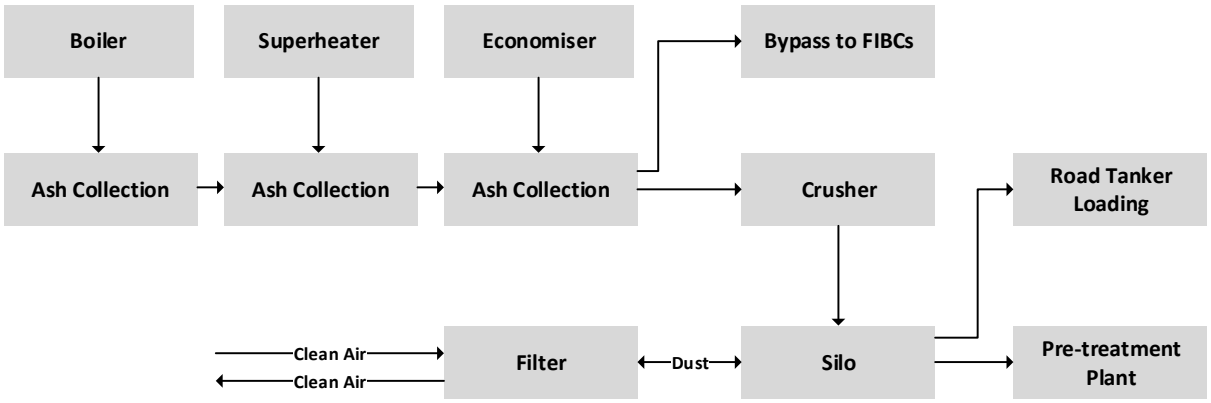


figure 3.3

Flue gas cleaning residues

Flue gas cleaning residues will be collected in enclosed hoppers underneath the baghouse filter and transported in fully enclosed conveyors to one of two flue gas cleaning residue silos. The silos will be fitted with self-cleaning filters similar to the one described above for the boiler ash silo. Each silo will be 240 m^3 in capacity which will provide enough storage for an average of 11 days storage from the process. If the pollutant load is high over a long period of time, this storage capacity could reduce to 7 days. The silos will be located inside the main process building in the flue gas cleaning area. A process flow diagram for the transport and storage of the flue gas cleaning residues is provided in figure 3.4 below.

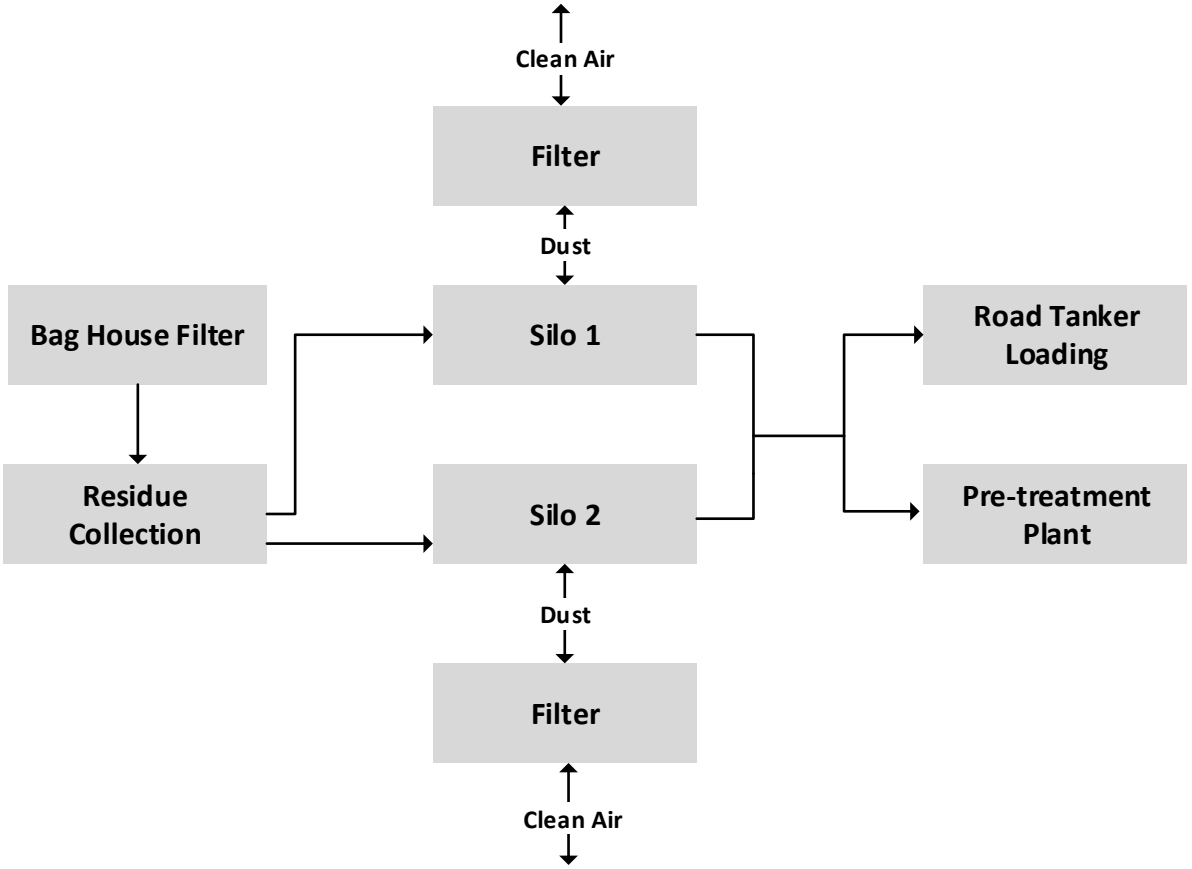


figure 3.4

Boiler ash and flue gas cleaning residue pre-treatment

As discussed in Chapters 4 and 15 of the EIAR, a pre-treatment plant for boiler ash and flue gas cleaning residues may be installed to send mixed and pre-treated residues to a saltmine in Ireland. This pre-treatment plant will be very similar to the installation commissioned in the Meath Waste to Energy facility in 2018, where boiler ash, flue gas cleaning residues and water are added together in pre-defined proportions in a mixer and the contents are discharged to a large $1m^3$ FIBC bag. The mixture in the bag hardens and is then sent on curtain-sided trailers to the saltmine for recovery.

Boiler ash and flue gas cleaning residues are transported in enclosed screws from the storage vessels to buffer vessels above the mixer. The water is also stored in a buffer vessel and the operator controls how much of each material is to be added into each batch. All three constituents discharge under gravity into the mixer and the mixer runs for 1 -2 minutes before discharging into a bag underneath. This system can produce 8 to 9 bags per hour and when run on a 5 day week it has sufficient capacity to pre-treat all of the flue gas cleaning residues and boiler ash produced by the plant. See figure 3.5 below for a process flow diagram of the pre-treatment process.

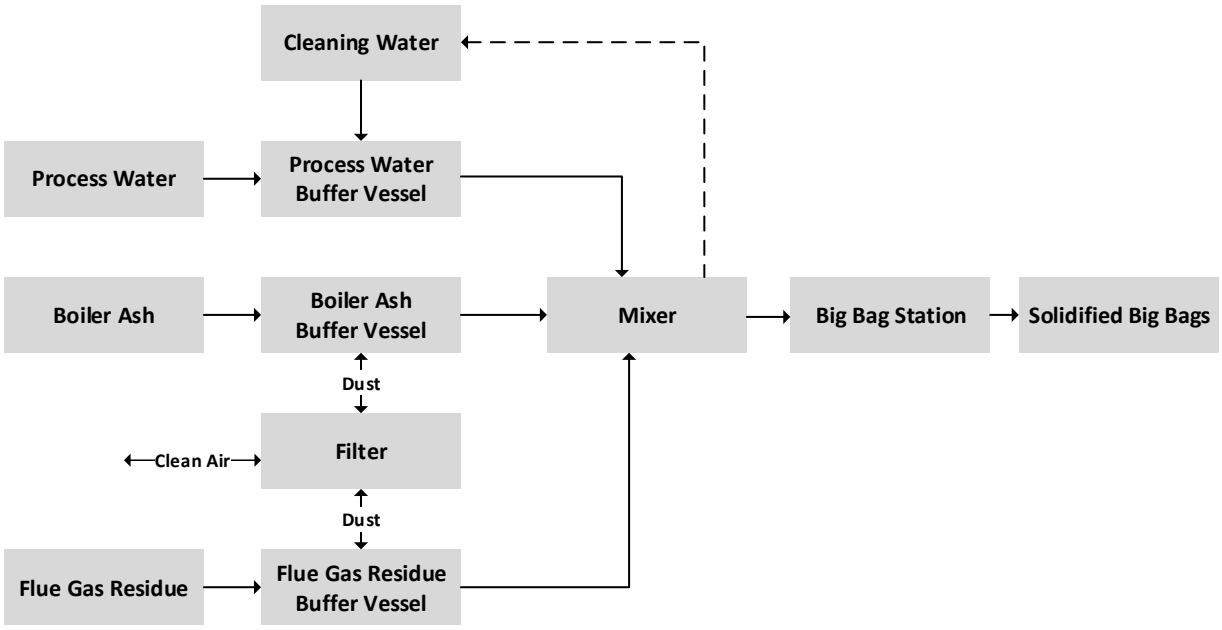


figure 3.5

3.3 Tanker Unloading area for Ammonia and Fuel Oil

The service yard to the south west of the main process building contains the following unloading and storage areas:

- Common tanker unloading area for aqueous ammonia and fuel oil
- Fuel Oil storage tank
- Ammonia storage tank
- Aqueous waste storage tank and unloading area.

The unloading area for aqueous ammonia and fuel oil drains to an underground 2m^3 tank to contain any minor spillages during unloading operations as show in figure 2.11 above. Separate connection points will be provided for both unloading operations. The ammonia tank will be double skinned (80m^3) and will be provided with leak detection. The fuel oil tank will also be double contained (60m^3) with leak detection. Both tanks will have top entry and exit points for the liquid transfer.

The aqueous waste unloading area will be contained and not connected to the main stormwater drainage network. In the event of a leak or spill this area will be capable of holding the full contents of a tanker (25m^3). The aqueous waste storage tank will be located within a bund and is 250m^3 in size.

3.4 Turbine building

As described in section 2.5, Energy Recovery above, a standard turbo-generator set (turbine) will be used to convert the energy in the steam from the boiler into electrical

energy for use in the plant and for export to the national grid. The turbine hall will be located to the rear and south of the main process building. It will be approximately 25m by 15m and circa 16m in height. Inputs to the turbine will be high pressure, high temperature steam. Outputs will be low pressure and temperature steam to the air cooled condenser and electrical power (approximately 21 MW_e) for distribution and use in the plant and export to the national grid. A process flow diagram of the turbine and air cooled condenser is provided in figure 3.6 below.

3.5 Air cooled condenser

As described in section 2.5, Energy Recovery above, an air-cooled condenser will be utilised to convert the low pressure, low temperature steam exhausted from the turbine back to condensate in an open fin and tube panel heat exchanger. The condensate is then re-circulated back into boiler feedwater system for re-use in the boiler. The aero-condenser structure will be located adjacent to the turbine hall. This structure will be approximately 35m by 15m and circa 16m high. It will support the air cooled condenser fans and will be open to allow free air flow. There will be no emissions from the air cooled condenser. The inputs will be low pressure steam at 45°C and ambient air. The outputs will be condensate at 45°C and heated ambient air. The air cooled condenser will be designed take the normal fluctuations in thermal load of the plant (short term increases to 120 % thermal load) but also to have the capacity to take high pressure and temperature steam when the turbine is in by-pass mode. The main steam-turbine bypass valve is utilised when the export of electricity is curtailed by the national grid control centre or when there is a fault or break in the import/sport line to the site. A process flow diagram for the turbine and air cooled condenser is provided in figure 3.6 below.

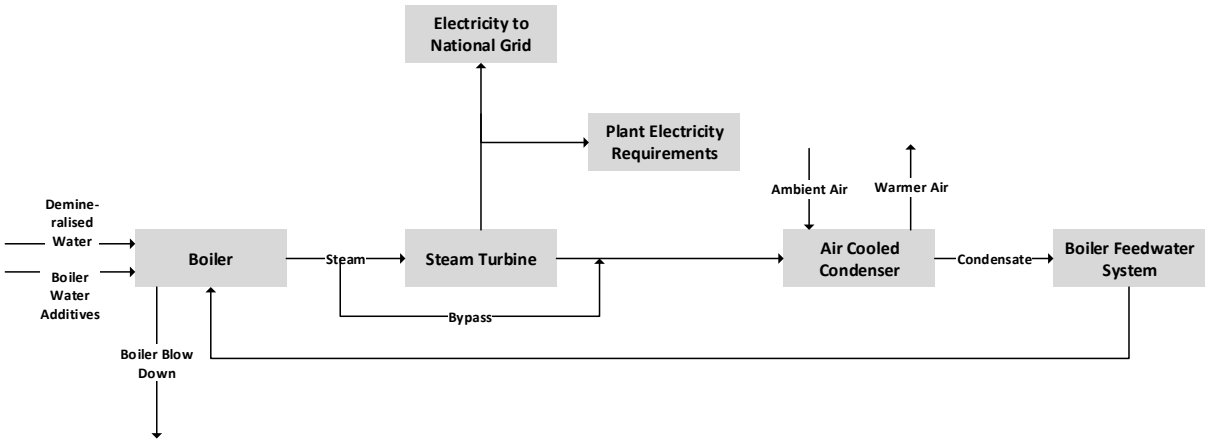


figure 3.6

3.6 Firewater storage tank and pumphouse

A 2,200m^3 storage tank will be provided for water to be used for firefighting. The tank and associated pump house will be located to the south of the main process building. The floor level of the pump house will be at circa 11mOD and the building will be approximately 17m long by 9.25m wide by 6m in height. The pump house will accommodate the fire-fighting water pumps and process water pumps.

3.7 Site Laboratory

If required for the faster turnaround of analysis of aqueous waste deliveries to the site, a small laboratory will be provided on the site. The laboratory would be equipped to provide the following analysis:

- pH
- Calorific Value
- Solvent content
- Halogens and Alkalis
- Water content.

The laboratory will be located within the administration block of the main process building.

3.8 General Administration Building

The administration building will be a two-storey building located to the west of the main entrance. The building will primarily contain office space and meeting rooms for staff but will also have a visitors' centre and a training centre. Parking for 57 cars will be provided adjacent to the admin building. This building will also house the security building.

The visitor centre will act as a gateway to the site, showcasing best practice in resource recovery management and sustainability. Indaver will strive to deliver a high quality, exciting experience for visitors. A viewing area will give visitors a 'birds-eye' view of the site. As the owners of Ireland's first waste-to-energy facility, Indaver understands and values the importance of education. Since Indaver has opened their gates of the Meath facility in 2011, they have welcomed more than 3,000 visitors onsite.