arc 21 Residual Waste Management Project

PPC Permit Application
PPC 0460/14A
Response to Schedule 4 Notice
Issued 22nd December 2014
Hightown Quarry Residual Waste Management Facility

EEW Energy from Waste UK Limited

January 2015

Plan Design Enable

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Document history

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Glossary of Terms

See original application for PPC permit, dated October 2014, as duly made on 30th October 2014.

Introduction

The arc21 Waste Authority ("**the Authority**"), comprising the constituent Councils of Antrim, Ards, Ballymena, Belfast, Carrickfergus, Castlereagh, Down, Larne, Lisburn, Newtownabbey and North Down, has initiated the arc21 Residual Waste Treatment Project ("**the project**") to procure a private sector partner to design, build, operate and maintain the following waste management facilities:

- an MBT facility to treat residual municipal waste ("contract waste"); and,
- an EfW facility to treat the outputs produced by the MBT facility and directly imported waste ("third party waste" or "non-contract waste").

The project is part of the integrated solution proposed in the arc21 Waste Management Plan adopted in 2003, and subsequently reviewed in 2006, and will contribute to the delivery of the Northern Ireland Waste Management Strategy (Towards Resource Management) and the statutory obligations established by the Waste & Contaminated Land (Northern Ireland) Order 1997 and the Landfill Allowances Scheme (Northern Ireland) Regulations 2004 (NILAS - SRNI 2004 No. 416).

The Becon Project Consortium **("Becon" or "the Consortium")**, led by EEW Energy from Waste **("EEW")**, has developed a proposal which will deliver the service requirements of the project. As part of the tender process under the project, Becon is required to develop a detailed design of their proposals and achieve all relevant legislative permissions including planning consent and relevant environmental permits, including the Pollution Prevention and Control (PPC) permit.

An application for the PPC permit was therefore submitted to the Northern Ireland Environment Agency ("**NIEA**") and was duly made by NIEA under reference number PPC 0460/14A as of 30th October 2014.

In order to progress the determination of the application, NIEA has now issued a Notice under Paragraph 6 of Schedule 4 to the Pollution Prevention and Control (Industrial Emissions) Regulations (Northern Ireland) 2013. The Notice is dated 22nd December 2014 and requires the submission of further information within four weeks of the date of the Notice, which means that the additional information must be submitted by 19th January 2015. A meeting was held with NIEA on 7th January 2015 to discuss and clarify the questions included in the Notice. The responses set out below take into account the outcomes of those discussions.

This document provides the necessary response to the questions or requests for clarification set out in the Schedule to the Notice and is intended to be considered in conjunction with the original application for the permit.

The responses below are numbered so as to correspond with their listing in the Schedule to the Notice.

1.0WASTE PRE-ACCEPTANCE

(i) Confirm the testing procedure for WDF acceptance

Waste pre-acceptance and acceptance protocols are already described in sections 2.2.1.1 and 2.2.1.2 of the original application.

Since a significant majority of the waste to be received at the facility is to be delivered under long term contractual arrangements with the Authority, from known and consistent sources, the requirement for pre-acceptance technical appraisal of the waste will be incorporated into the contract via a Waste Acceptance Plan. All delivered wastes will be assessed and processed in accordance with the Waste Acceptance Plan.

These arrangements will apply equally to third party waste delivered directly to the EfW as well as contract waste delivered to the MBT.

It is worth emphasising that it is in the interests of efficient operation that the operator of the Hightown Quarry RWMF receives the correct waste types and processes them appropriately. Non-conforming wastes can lead to mechanical failures and inconsistent operation of the MBT and EfW (in the case of wastes delivered directly to the EfW).

Since the precise procedures and contractual arrangements under the Waste Acceptance Plan have yet to be finalised, we propose to submit the necessary waste pre-acceptance and waste acceptance procedures and protocols to NIEA, for agreement, prior to start-up of the Hightown Quarry RWMF.

(ii) Is the testing related to the RDF provider or each delivery?

Waste pre-acceptance and acceptance protocols are described in sections 2.2.1.1 and 2.2.1.2 of the original application but for clarity, testing will be related to both the waste provider and the waste stream itself.

These arrangements will apply equally to third party waste delivered directly to the EfW as well as contract waste delivered to the MBT.

Since the precise procedures and contractual arrangements under the Waste Acceptance Plan have yet to be finalised, we propose to submit the necessary waste pre-acceptance and waste acceptance procedures and protocols to NIEA, for agreement, prior to start-up of the Hightown Quarry RWMF.

(iii) Is the testing to be done prior to arrival onsite?

Waste pre-acceptance and acceptance protocols are described in sections 2.2.1.1 and 2.2.1.2 of the original application. Under those arrangements, waste will be characterised by testing and analysis prior to arrival onsite in accordance with pre-acceptance criteria set out under long term contractual arrangements with the Authority and other third party waste providers. Receipt of all waste into the facility will be subject to a Waste Acceptance Plan and the environmental management system (EMS) in operation throughout the facility.

These arrangements will apply equally to third party waste delivered directly to the EfW as well as contract waste delivered to the MBT.

Since the precise procedures and contractual arrangements under the Waste Acceptance Plan have yet to be developed and finalised, we propose to submit the necessary waste pre-acceptance and waste acceptance procedures and protocols to NIEA, for agreement, prior to start-up of the Hightown Quarry RWMF.

(iv) Is the testing to be done on site prior to offloading?

Waste pre-acceptance and acceptance protocols are described in sections 2.2.1.1 and 2.2.1.2 of the original application. Under those arrangements, waste will be characterised by testing and analysis prior to arrival onsite in accordance with pre-acceptance criteria set out under long term contractual arrangements with the Authority and other third party waste providers. Receipt of all waste into the facility will be subject to a Waste Acceptance Plan and the environmental management system (EMS) in operation throughout the facility.

Only waste that conforms to the descriptions and EWC codes listed on the environmental permit will be accepted and treated.

The weighbridge operator will carry out a random visual inspection of arriving deliveries at the site to establish the nature of material being delivered to the facility and its suitability for processing. A CCTV system will be deployed to allow the operator to see into the top of open vehicles and containers. Suspicious enclosed vehicles will be directed to the waste reception area, either in the MBT facility or directly to the EfW facility, where they can be subjected to inspection to ensure that the composition of its load meets the description of waste on the waste consignment note. If necessary, the load will be tipped on the reception area floor for a detailed inspection in order to determine disposition. Non-conforming wastes will be rejected.

Details of all Authorised Vehicles, including those delivering Contract Waste, Third Party Waste or collecting reject waste, recyclates or ash residues will be maintained on the site Management Information System (MIS). Liaison with the Authority and relevant Third Parties will ensure that, wherever possible, vehicles delivering waste to the facility are pre-registered on the system, i.e., listed as Authorised Vehicles. As part of this liaison process, the Authority and third parties will be advised on the types of vehicles which are suitable for accessing the Hightown Quarry RWMF. Similarly, it will be a requirement that the drivers of all of the vehicles delivering waste are suitably trained, competent and qualified.

Since the precise procedures and contractual arrangements under the Waste Acceptance Plan have yet to be finalised, we propose to submit the necessary waste pre-acceptance and waste acceptance procedures and protocols to NIEA, for agreement, prior to start-up of the Hightown Quarry RWMF.

2.0MBT

(i) Is there any continuous monitoring of a suitable odour surrogate for the odour control unit (Biofilter) associated with the MBT building?

Continuous monitoring of the biofilter exhaust, based on an odour surrogate, is not proposed.

Previous evaluation during initial design considered the use of a surrogate for continuous monitoring of the biofilter as an indicator of odour abatement performance. However, it was concluded that such continuous monitoring was likely to be unreliable because utilising hydrogen sulphide (H_2S) as the surrogate parameter would not be effective in this case. The expectation is that H_2S will only be present in trace quantities since the waste characterisation (pre-treated and biodried MSW) is entirely different from sewage sludge biofilter applications (where H_2S presence may be more significant), referenced by NIEA as a comparator. The Consortium's experience is that biofilters on similar duty to the Hightown Quarry MBT biofilter do not have continuous monitoring of an odour surrogate because it is ineffective.

Since we have concluded that continuous monitoring via a surrogate is currently not technically feasible, we have therefore proposed an alternative package of measures to demonstrate effective performance of the biofilter which are described in the original application and summarised again below.

During commissioning and the first year's operation of the MBT, two odour samples (comprising three exhaust air samples each) will be collected on separate occasions from the biofilter stack for olfactory panel tests in order to assess odour levels in the exhaust air. Depending on the results of these tests and the data from other monitoring, it is anticipated that up to two further similar tests may be conducted during the first full year of operation.

These exhaust air samples will also be analysed in order to obtain an initial chemical characterisation of the exhaust air, which may allow identification of an appropriate odour surrogate which might then be correlated to identified odours or used to demonstrate effective operation of the biofilter and acid scrubbers. Depending on the outcome of these analyses, proposals for continuous monitoring of an odour surrogate, if one can be identified, may be developed. However, this would be post start-up / commissioning and likely to be after at least a year's operation to allow for confirmation of consistent exhaust gas characterisation.

It is intended that performance of the exhaust air collection and treatment system will be assured on a day-to-day operational basis by monitoring and maintenance of process conditions for optimum operation (e.g., scrubber liquor pH, circulation rate, etc.) and external monitoring for odour emissions in accordance with an Odour Management Plan, as a component of the overall site Environmental Impact Control Plan.

The Odour Management Plan will include a protocol for routine olfactory surveys by 'sniff testing' to be carried out at set distances downwind of the biofilter stack. Since MBT and EfW operatives may become desensitised to the presence of odour owing to regular exposure within the buildings, staff will be selected for this duty whose place of work is not normally within the MBT or the EfW, e.g., office-based supervisory or administrative staff. Appropriate training will be given. Sniff test surveys would be carried out whenever odour samples for olfactory panel tests are collected.

The data acquired by the odour testing programme and other operational data will be subject to regular operational review and a review with NIEA at the end of the first year to establish long term monitoring requirements thereafter.

A weather station (with data logging facility) will be installed during commissioning of the Hightown facility to maintain continuous records of weather conditions, wind speed and direction so that any odours detected offsite can be correlated with wind speed and direction to assist in determining the source.

The purpose of these measures, in particular, the olfactory surveys, is to demonstrate the effective performance of the exhaust air collection and treatment system and the absence of significant detectable odour at the site boundary and beyond. Based on previous operational experience with similar systems, we consider that the proposed control techniques and the associated measures for performance monitoring (via selected process control parameters and olfactory surveys) are proportionate to the risk that significant odour might occur and that the combination of these measures is BAT for the prevention of significant offsite odour from this facility.

(ii) Due to the fact that biological odour abatement systems can also be the source of odours what monitoring is carried out on the biofilter to prevent odours being released unintentionally from the biofilter?

The measures described in section 2.0 (i) above for the monitoring of the performance of the biofilter will also address the potential emission of odours which might be generated by the biological media utilised within the biofilter itself.

The generation of odours from such biological populations is largely a consequence of the development of anaerobic conditions within the filter itself. The design of the biofilter is expected to achieve highly uniform and consistent distribution of air throughout the filter, reducing the risk of localised anaerobic activity to an extremely low level. The biofilter design air flowrate is also high (135,000 m^3/h) and is expected to provide an airflow which exceeds the minimum required for the prevention of anaerobic activity. The overall performance of the exhaust air collection and treatment system will be further assured on a day-to-day basis by monitoring and control of process conditions for optimum operation (e.g., scrubber liquor pH, circulation rate, etc.) in accordance with the manufacturer’s recommendations.

Whilst it is therefore considered that the likelihood of odour generation from the biological population within the filter is extremely low, the monitoring proposals already presented above are considered to be sufficient to prevent the unintentional release of odours generated by the biofilter itself.

(iii) What provisions have been made if the MBT is shutdown, how will the biological systems be maintained in the biofilter?

Under normal operational conditions, it is expected that the MBT will never be fully shut down once operations have commenced. There will therefore always be material in the biodrying tunnels which will always provide at least a partial extracted air load on the biofilter to maintain the biological population.

In practice, it is not in the interests of operational efficiency to allow the biological population within the biofilter to expire because it can often take around a month to re-establish normal biological activity and effective operation of the biofilter.

Catastrophic equipment failure within the MBT is unlikely to lead to a complete shutdown since the mechanical element of the facility comprises two independent processing lines. Likewise, the biodrying activity is spread between 16 tunnels which reduces the likelihood of a complete shutdown through equipment failure to extremely low levels.

(iv) Confirm why has the sulphuric acid used in the acid scrubber not been included in the raw materials table 2.32?

The omission of sulphuric acid from the materials listing in Table 2.32 of the original application was an oversight.

An amended materials listing for the Hightown Quarry RWMF is provided below.

Table 2.32 Materials Inventory

Material	Estimated quantity per annum[1]	Use	Properties / active ingredients	Fate	Environmental impact	Alternatives / BAT justification
Incoming waste	MBT Facility: capacity up to 300,000 tonnes / year. EfW facility sized for 68MW_{Th} thermal input equivalent to the processing of up to 245,000 tonnes / year.	Extraction of recyclates. Combustion	Recyclable fraction of municipal waste Combustible fraction of residual municipal waste and commercial and industrial waste.	Recyclates directed to appropriate use. Burned with energy recovery.	Reduction in landfill use. Recovery of energy from waste. Generates emissions to air, incinerator bottom ash (IBA) and Air Pollution Control Residues (APCr).	Beneficial use of waste to recover recyclates and energy.
Hydrated Lime	Approximately 6,200 tonnes (produced from quick lime or purchased directly from the supplier).	Flue gas treatment reagent.	$Ca(OH)_2$	Reactive agent for acid gas control. Residues as APC residues to be disposed to landfill	Consumption of raw materials. Landfilling as hazardous waste.	BAT for acid gas removal.
Quicklime	Approximately 4,700 tonnes, if utilised.	Flue gas treatment reagent.	CaO	Consumed in hydrated lime reaction	Consumption of raw materials.	BAT for acid gas removal.
Activated Carbon	Approximately 200 tonnes	Flue gas treatment reagent.	Carbon	Reagent for control of dioxins, furans and mercury. Residues as APC residues to be disposed to landfill.	Consumption of non-renewable raw materials. Landfilling as hazardous waste.	BAT for heavy metal, dioxin and furan removal with associated bag filters.
Hydrochloric Acid	Approximately 7,000 litres, if utilised.	Neutralisation of ion exchange eluent	HCl	Neutralised and recycled as process water to the furnace bottom ash extraction system	Consumption of raw materials.	Likely to be BAT for ion exchange water treatment. BAT for process water recycle.
Sodium Hydroxide	Approximately 6,000 litres, if utilised.	Neutralisation of ion exchange eluent	NaOH	Neutralised and recycled as process water to the furnace bottom ash extraction	Consumption of raw materials.	Likely to be BAT for ion exchange water treatment. BAT for process water

[1] Based on current design information. To be confirmed prior to operational start-up under pre-operational condition.

Material	Estimated quantity per annum[1]	Use	Properties / active ingredients	Fate	Environmental impact	Alternatives / BAT justification
				system		recycle.
Aqueous ammonia solution	Approximately 700 tonnes	Flue gas treatment reagent for NO_x removal by SNCR	NH_4OH (≤ 25% aqueous)	Consumed in SNCR reaction	Consumption of non-renewable raw materials. Potential for ammonia slip to atmosphere (minimised by process control).	BAT for NO_x removal.
Sulphuric Acid 75%	Approximately 250 tonnes	Biodrying exhaust air treatment reagent for removal of ammonia prior to biofilter.	H_2SO_4 (≤ 75% aqueous)	Reaction with ammonia produces aqueous ammonium sulphate which is disposed of via treatment at an appropriately licensed waste treatment facility	Consumption of non-renewable raw materials. Appropriate treatment eliminates potential for impact.	BAT for pre-treatment of exhaust air for the removal of ammonia prior to the biofilter.
Light Fuel oil	Approximately 358,400 litres	Combustion in furnace auxiliary burners	Mineral oil	Burned, and combustion gases emitted.	Consumption of non-renewable raw materials. Emission of combustion gases to atmosphere.	BAT for auxiliary fuel. No alternatives identified.
Diesel	Approximately 400,000 litres, depending on the required operational hours of the emergency power generation set.	Combustion in emergency power generation set	Mineral oil	Burned, and combustion gases emitted.	Consumption of non-renewable raw materials. Emission of combustion gases to atmosphere.	BAT for diesel generator fuel. No alternatives identified.
Water treatment media and chemicals	Consumption of media and chemicals is dependent on the chosen technique	Water treatment/ demineralisation	Typically organic resins, acids, alkalis	Consumed in reaction or disposed to landfill	Consumption of non-renewable raw materials and use of landfill space.	Techniques are industry standard. No alternatives identified.

3.0EFW

(i) Can you confirm that there is an in-situ CEMS for monitoring acid gases at the boiler outlet?

As clarified at the meeting with NIEA on 7th January 2015, there will be an in-situ continuous raw flue gas analyser at the boiler outlet which will monitor the acid gases sulphur dioxide (SO_2) and hydrogen chloride (HCl). However, this analyser will be a process control unit which acts as an integral component of the control loops which operate the flue gas abatement train. Control outputs from the unit will determine the injection rates of flue gas treatment chemicals such as hydrated lime and activated carbon in accordance with measured concentrations of acid gases.

Whilst the analyser will be regularly maintained and calibrated according to an appropriate frequency for reliable measurement performance (based on manufacturer's recommendation), it will not be certified for compliance emission monitoring and reporting. It is therefore identified as an in-situ continuous process control monitoring system for the analysis of raw flue gas at the boiler outlet. It must be clearly distinguished from the stack-mounted Continuous Emissions Monitoring System (CEMS) which will be certified for emission monitoring and reporting for the purposes of compliance assessment.

(ii) Is the activated carbon impregnated with any substance such as sulphur to increase adsorption of elemental mercury (Hg^0) in the bag house filtration system?

The activated carbon to be deployed for flue gas treatment will not be impregnated with additives (e.g., sulphur) to increase adsorption of elemental mercury (Hg^0).

In EEW's experience, gained through many years of operating comparable municipal solid waste (MSW) thermal treatment plants, impregnated activated carbon is not required to maintain emissions which are compliant with the relevant performance benchmarks. Likewise, suppliers of flue gas treatment systems do not recommend impregnated activated carbon for this duty, even when providing performance guarantees. The use of impregnated activated carbon is more typically associated with the thermal treatment of hazardous waste, where the likelihood of mercury levels inherent in the waste is higher.

Our experience indicates that the abatement performance of non-impregnated activated carbon is appropriate for the treatment of MSW, as proven by numerous similar operations across Europe. Its use is therefore considered to be BAT for the treatment of flue gas at the Hightown Quarry RWMF.

(iii) How are fugitive emissions of odorous air controlled when the EFW plant is shut down, is there equipment in place to control odours when the tipping hall is not under negative pressure?

EEW's experience of operating other EFWs treating MSW is that, during shutdown periods, fugitive odour does not lead to nuisance or significant impacts outside the building, providing that appropriate key measures are in place.

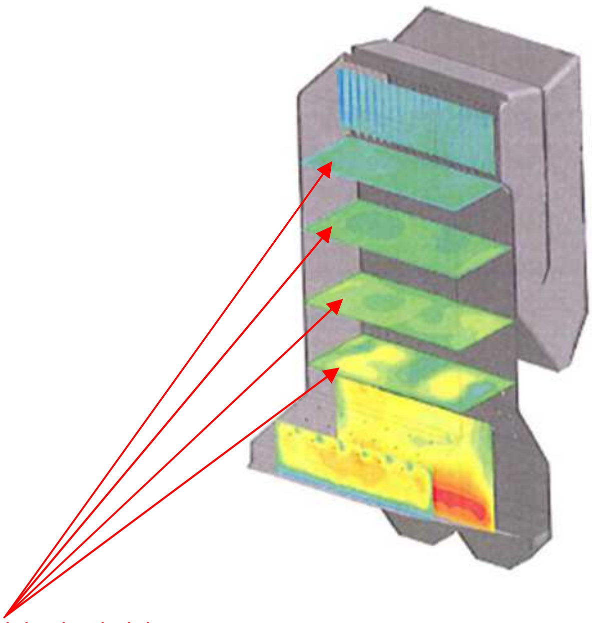
For shutdown periods, access to the EfW tipping hall will be minimised in order to keep the doors closed as much as possible. The majority of the waste received by the EfW during the shutdown will be delivered via enclosed conveyors directly from the MBT for storage in the EfW bunker, which will have been emptied of waste prior to shut down for this purpose. Stored waste will therefore have been freshly processed via the biodrying tunnels, thereby substantially reducing the odour potential of the waste.

EEW are unable to identify any significant environmental benefit arising from the deployment of additional abatement systems during EfW shutdowns for the brief periods twice per annum when planned EfW shutdowns occur. EEW considers that the proposed combination of operational measures will provide satisfactory control of odours during shutdown periods and therefore deliver BAT.

(iv) What steps have been taken to ensure the ammonia used as an SNCR is being injected at the correct height in the secondary combustion zone (freeboard), and that droplet size, temperature window and residence time have been considered at the design stage, to ensure adequate reaction to achieve NO_x lower than the emission limit values?

During the detailed design of the boiler, the manufacturer will conduct Computational Fluid Dynamics Modelling (CFD) of the furnace in order to assess gas residence times and flow profiles. The modelling will also locate the optimum levels in the boiler for the ammonia injection ports for the operation of SNCR for the reduction of NO_x. The injection ports will typically be configured in three or four banks which are located at different heights after the secondary combustion zone (see the example CFD modelling output below, which shows the modelled injection heights, indicated by the yellow-green “platforms” at various heights in the boiler).

Example of CFD Modelling Output



Modelled ammonia injection heights

The furnace / boiler process control system will include temperature monitoring at the top of the first pass of the boiler. The fixed geometry of the boiler and the modelled gas flows, in conjunction with the measured temperature at the top of the boiler first pass, will allow the control system to calculate and actuate the optimum level of the boiler to inject ammonia so as to capture the most effective reaction window for the reduction of NO_x, based on the predicted temperature profile of the raw gas passing up the boiler. This is a critical control system functionality because the reaction temperature window for optimum NO_x reduction is relatively narrow, typically between 900^0C and 1100^0C for ammonia reagent.

Ammonia slippage will be continuously monitored by the stack-mounted CEMS. The results will provide a feedback control input to the adjustment of process conditions, in particular, the injection rate of ammonia.

The performance of the SNCR system will be optimised during commissioning of the EfW.

Having determined the heights of the banks of injection ports within the boiler via CFD, the manufacturer will also determine the specific lance and nozzle design for optimised injection of ammonia through each of the banks of ports. A consistent and controlled addition of ammonia is achieved by maintaining a constant flowrate through the injection nozzles whilst varying the composition of the aqueous ammonia by adjusting the quantity of dilution water. This allows the droplet size generated by the nozzle to remain constant according to the optimised design requirement. The spray pattern generated by the nozzles is arranged to cover the full cross section of the boiler from each bank of nozzles.

The supplier will provide a NO_x emission performance guarantee for the SNCR system which will be based on the required emission limits specified by IED Chapter IV and Annex VI, Part 3 (see Table 2.19 on page 118 of the original application).

The gas residence time predicted by the CFD modelling will be independently confirmed by a Notified Body (NOBO) during the commissioning stage.

(v) What precautions have been taken to ensure that "ammonia slip" from the SNCR reagent (ammonia 25% w/w) has been reduced to as low as reasonably practicable? Will ammonia determinant be monitored via the CEMS?

Section 2.11.1.1.2 on page 191 of the original application confirms that ammonia will be continuously monitored by the stack-mounted CEMS. The results will provide a feedback control input to the adjustment of process conditions, in particular, the injection rate of ammonia for SNCR.

The response provided above to point 3.0 (iv) explains the measures which will be taken to minimise ammonia slippage from the operation of the SNCR system. These measures include:

- CFD-based optimisation of the range of ammonia injection heights within the boiler;
- Multiple banks of ammonia injection nozzles for optimised selective injection height, determined in operation by real-time feed forward and feedback monitoring and control systems;
- Optimised design of injection lance and nozzles;
- Consistent and controlled addition of ammonia via constant flowrate and variable aqueous ammonia composition;
- Constant droplet size generation in accordance with optimised design requirement;
- Full cross sectional coverage of the boiler by the spray pattern from each bank of nozzles.

(vi) Where do the solids of the bag house filter "de-dusting" get collected and how are these disposed of?

The management of Air Pollution Control Residue (APCr) is conducted as widely described in the original application, in particular in sections 1.1.4.4 (page 13), 2.2.2.10.11 (page 65), 2.3.2.1.3 (page 121), 2.3.2.4.2 (page 138) and 2.6.1.5 (page 160).

Essentially, APCr is separated from the flue gas stream in the fabric filter and collected in the enclosed hoppers at the base of the unit whereas boiler fly ash residues are collected in various hoppers under the boiler passes. Both are transferred to the APCr storage silo (290 m^3) by enclosed mechanical and / or pneumatic conveyor systems which are designed to prevent fugitive escape of dust.

The APCr storage silo is equipped with a fabric filter on the vent to prevent dust emissions during filling. The air is filtered to a dust concentration of < 5 mg/m^3 prior to emission to air.

Loading of road tankers for APCr despatch is conducted under enclosed conditions. Displaced air from the tanker is vented back into the storage silo. No air will be vented directly from the tanker.

In summary, all APCr handling and storage activities are conducted within fully enclosed systems which prevent any fugitive release of dust.

During initial operation, the only viable option currently available for APCr is disposal to a suitably licensed hazardous landfill via licensed carriers. Whilst there are no such landfills currently operating commercially in Northern Ireland, the Consortium is satisfied that an assured disposal route for APCr from the Hightown facility will be available. However, it must be emphasised that disposal is considered to be the option of last resort and economically and technically feasible options for reuse / recycle / recovery of this material are currently under investigation. The outcome of these investigations will be reported to NIEA prior to start-up of the Hightown Quarry RWMF.

(vii) On page 68 can you confirm that the evaporative cooler is used to cool the flue gas prior to the reactor and is not used for neutralisation reaction as stated?

We can confirm that the evaporative cooler delivers flue gas cooling only and is not used for the neutralisation reaction. A revised summary of the operation of the evaporative cooler and the sorption reactor is provided below:

The evaporative cooler (quench) is a vertically orientated, cylindrical vessel through which the acidic flue gases flow downwards from top to bottom, via a "flow rectifier" in the inlet to ensure uniform gas distribution. Cooling is achieved by the injection of water which removes heat by evaporation to cool the gases to the optimum temperature for the dry sorption reactor (typically around 135 - 145°C). The temperature is controlled above the dew point to avoid condensation of water vapour.

There is no injection of reagent to the cooler.

The gases flow directly from the evaporative cooler into the sorption reactor, which is a vertically orientated, cylindrical reaction tower with a central baffle which forces the gas to flow downwards before reversing direction to flow upwards to the reactor outlet. Dry hydrated lime and powdered activated carbon are continuously injected into the flue gas on the downward pass (according to the continuously monitored acid gas concentration at the boiler outlet) and are distributed homogenously through the gas.

Separated solids from the fabric filter, containing unreacted lime and carbon, are recycled to the sorption reactor on the upwards pass by a screw conveying system, which deposits the reagents into the turbulent gas flow. The recycled solids are conditioned prior to injection by the addition of water in a mixing unit in order to optimise surface activation and reactivity. The added water leads to a further reduction in gas temperature of around 5^0C – 10^0C as a result of evaporation.

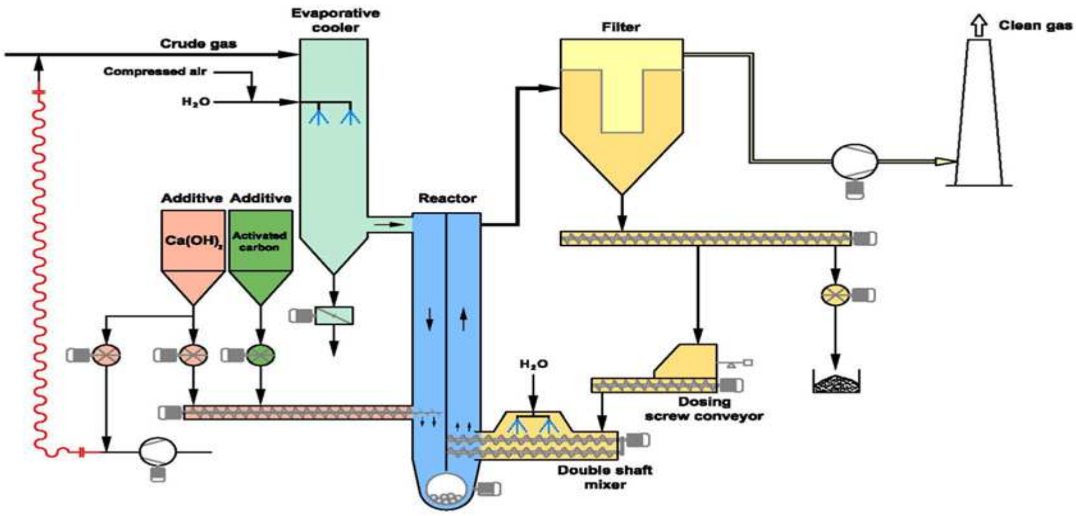
Reagents are injected to the sorption reactor at greater than stoichiometric ratio based on the measured acid gas concentration owing to the relatively slow reaction rate with lime. Continuous recirculation of a substantial proportion of the separated solids from the fabric filter, containing unreacted lime, ensures that enhanced reaction efficiency is achieved which reduces the consumption of fresh hydrated lime.

Details of the reaction chemistry have already been provided in the original application (see pages 69 and 70).

The separation of heavy metals, dioxins and furans is achieved by adsorption (i.e., physical adhesion) onto the surface of the powdered activated carbon, which has a very large surface area to volume ratio and presents a very high level of active surface sites where substances may adsorb. As with the lime, continuous recirculation of a substantial proportion of the separated solids from the fabric filter, containing powdered activated carbon which is not saturated with adsorbed material, ensures that enhanced adsorption efficiency is achieved which reduces the consumption of fresh powdered activated carbon.

The system will therefore operate as represented by the schematic shown in Figure 2.8 of the original application (page 69) and included below.

Schematic of Indicative Semi Dry Flue Gas Treatment



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