Energy from Waste, Combined Heat and Power Facility
North Yard, Devonport

Environmental Permit Application (Application EPR/WP3833FT/A001)

Emissions Management
June 2011

Prepared for

MVV Environment Devonport Ltd

Revision Schedule

Emissions Management Report
June 2011

Rev	Date	Details	Prepared by	Reviewed by	Approved by
01	Feb 2011	Initial Draft	**Andrew Oliver** Consultant	**Angela Graham** Principal	**Mike Nutting** Associate
02	May 2011	Final Draft	**Andrew Oliver** Consultant	**Angela Graham** Principal	**Mike Nutting** Associate
03	June 2011	Final	**Andrew Oliver** Consultant	**Angela Graham** Principal	**Mike Nutting** Associate

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The methodology adopted and the sources of information used by URS Scott Wilson in providing its services are outlined in this Report. The work described in this Report was undertaken between May 2009 and April 2011 and is based on the conditions encountered and the information available during the said period of time. The scope of this Report and the services are accordingly factually limited by these circumstances.

Where field investigations are carried out, these have been restricted to a level of detail required to meet the stated objectives of the services. The results of any measurements taken may vary spatially or with time and further confirmatory measurements might need to be made after any significant delay in issuing this Report.

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1 Report Context

Scott Wilson Ltd has been commissioned by MVV Environment Devonport Ltd (MVV hereafter) to prepare an application for an environmental permit for an Energy from Waste, Combined Heat and Power Facility located at Devonport Dockyard, Plymouth (Devonport EfW/CHP hereafter).

Within the Site, as defined in planning terms, and the Installation, as defined in permitting terms, the proposed facility will comprise:

- Tipping Hall;
- Waste Bunker Hall with Waste Handling Cranes;
- Bale Store/Baling System;
- Turbine Hall with Steam Turbine Generator;
- Boiler House with Grate, Boiler and Ancillary Systems;
- Flue Gas Cleaning System and Chimney;
- Air Cooled Condensers;
- Water Treatment Plant;
- Bottom Ash Handling System.
- Administration Block; and
- Workshop and Stores

This report has been prepared to support an application for an environmental permit and details the emissions management systems proposed for the site. The report should be read in conjunction with the other supporting application reports and risk assessments.

2 Summary

2.1 Introduction

This section of the application provides an overview of installation emissions management techniques and defines overall BAT with respect to:

- Emissions monitoring and control; and
- Management of nuisance issues, such as noise, vibration and odour.

The information in the following sections outlines the various management and control techniques employed at the installation.

2.2 Regulatory Context

The main regulations governing waste management activities at the site are the Environmental Permitting Regulations (EPR) 2010. These regulations provide the structure on which the site is licensed and operated including the requirements in relation to emissions monitoring, control and management

2.3 Overall Assessment of Best Available Technique

The Sector Guidance Notes SGN 5.01 "*Guidance for the Incineration of Waste and Fuel Manufactured From or Including Waste*" provides BAT guidance for:

- Emissions monitoring and abatement; and
- Management of nuisance issues such as noise, vibration and odour.

This document assesses installation operations and provides evidence for:

Table 2.1: Emission Considerations

Emission Consideration	BAT Requirement	Site Justification
Air Point Sources	NOx Control	• Grate air cooling mechanism will be used • In-leak prevention using appropriate sealing and maintenance of negative pressure in furnace • Control of combustion air during incineration using multiple injection points with independent control • Flue gas recirculation • SNCR using urea
	Acid Gas Control	• Acid scrubbing using sodium bicarbonate and activated carbon • Variable feed control
	Particulate Control	• Bag filter
	Metals Control	• Melting point of some metals not exceeded • Dry scrubber using activated carbon • Removal of metals that have adhered to the surface of particulate matter by the filtration action of the bag filter.
	Dioxin & Furan Control	• Dry scrubbing of flue-gas using activated carbon

Emission Consideration	BAT Requirement	Site Justification
		resulting in direct adsorption of dioxins and furans; • Boiler design is aimed a preventing build-up of a boundary layer of slow moving gases along the boiler surface and specifically maintain the critical surface temperature below the desorption temperature thus minimising dioxin/furan reformation; and • Removal of dioxins and furans that have adhered to the surface of particulate matter by the filtration action of the bag filter
Water Point Sources	Surface Water	• No direct discharges to surface water at the site • Use of collected surface water as 'grey water'
	Ground Water	• No direct discharges to groundwater at the site
	Sewer	• Recirculation of process water in the process means that, under normal operations, there will be no discharge of process wastewater to sewer • During periods of shutdown if process water cannot be used on site, the monitoring of the effluent will be completed and discharge will be via tanker or to sewer in line with agreed discharge limits
Fugitive Emissions	To Air	• Covering of all loads on waste received/ removed and on raw material deliveries • Bag filters on sodium bicarbonate, urea, PAC and ash silos • Maintenance of high standards of housekeeping • Effective plant maintenance to minimise leaks
	To Water	• Provision of containment on fuel tanks • Interceptor on site drainage system • Maintenance of high standards of housekeeping • Effective plant maintenance to minimise leaks
Nuisance Issues	Odour	• Maintenance of negative pressure within the reception building • Fast-acting roller doors on the reception building • Carbon and dust filter for air extracted from bale store during shutdown periods
	Noise & Vibration	• Use of acoustic enclosures where required • Use of cladding with appropriate attenuation properties • Switching plant off when not in use • Maintenance of plant to minimise the risk for vibration & increased noise due to deterioration • Enclosure of main plant processes inside enclosed treatment building
Monitoring	Continuous	• MCERTS registered CEM in line with WID monitoring requirements

Emission Consideration	BAT Requirement	Site Justification
	Spot	• Extractive monitoring by certified monitoring firms in line with WID requirements
	Environmental	• Site inspections

A combination of the techniques described above is deemed to meet the BAT requirements defined in the relevant guidance.

3 Point Source Releases to Air

3.1 Introduction

This section provides evidence of the existence of relevant emissions controls and abatement for point source releases to air that have sufficient capacity to allow the effective management and control of the Site to the standard indicated by the Environment Agency SGN 5.01 "*Guidance for the Incineration of Waste and Fuel Manufactured From or Including Waste*" (Section 2.2.1)

3.2 Source Characterisation

Point source releases from the EfW/CHP facility are identified in Table 3.1 below:

Table 3.1: Point Source Releases to Air

Point Reference	Plant Source	Emissions
A1 Main Chimney	• Incineration of mixed wastes	• Oxides of nitrogen • Sulphur dioxide • Carbon monoxide • Ammonia • Particulate matter • Volatile organic carbons • Hydrogen chloride • Hydrogen fluoride • Metals • Dioxins and furans

Emissions, the associated control and monitoring arrangements are discussed in Sections 3.3 to 3.5, to follow.

3.3 Abatement System

The facility will meet the WID emission standards through a combination of the following measures;

- High-quality combustion process ensures low Carbon Monoxide and total organic carbon concentrations;
- Low NO & NO_2 concentrations achieved as a result of SNCR scrubbing and flue gas recirculation; and a
- Dry absorption APC system using sodium bicarbonate and activated lignite coke (PAC).

A copy of the proposed specification of the APC control system is provided in Appendix A – the detail will be finalised as the design is finalised for construction.

3.3.1 Selective Non-Catalytic Reduction (SNCR)

Urea will be delivered to site as pellets, and dissolved in softened water for injection and use as required. Each of the pellet and solution storage capacities is 50m^3, enough for more than 14 days supply.

NO_x reduction is realised in the 1st boiler pass using several injection nozzles in the furnace, corresponding to the optimum reaction temperatures at various load conditions while avoiding excessive ammonia slip. To ensure the optimum function of the SNCR, and to monitor the combustion closely, an acoustic measurement of the flue gas temperature will be provided.

The use of urea within the SNCR system will facilitate improved heat recovery, with lower levels of pollution being generated.

3.3.2 Sodium Bicarbonate Scrubbing System

Sodium bicarbonate will be used as a reagent for control of acid gases such as SO_2, HCl and HF. The use of sodium bicarbonate ensures a quick response to changes in the inlet conditions, and as such it may be considered superior to the use of lime as a reagent. Sodium bicarbonate also reduces the amount of air pollution control residues created.

Sodium bicarbonate will be delivered to the facility by bulk powder tanker, and will be conveyed pneumatically into the storage silo (150m^3 capacity, equivalent to 10 days supply). Each silo will be equipped with its own local dust filter to remove bicarbonate particulates from the vented conveying air.

Sodium bicarbonate will be removed from the silo, and transported using pneumatic conveyors, before being injected directly into the flue gas duct. The reagent is injected via a radial fan, which produces the required volume and flow rate to ensure the appropriate mix.

Injection into the flue gas occurs upstream, i.e. before the economiser, where the flue gas temperature corresponds with the optimum condition for reactions to occur. The optimal temperature range for injection is between 200^{o}C and 240^{o}C. Injection promotes the separation of acid pollutants like HCl, SOx and HF, through the reaction of the sodium bicarbonate, thus creating the relevant reaction salts which occur as a dry powder.

3.3.3 Powdered Activated Carbon Scrubbing System

Powdered Activated Carbon (PAC) will primarily be used to absorb mercury, dioxins and furans. As these species are not monitored continuously, it will not be practicable to vary the feed rate by real-time control during normal operation. As such, the optimum rate of activated carbon injection will be determined during plant commissioning, and the system set to provide excess carbon during plant operation. The results of periodic extractive testing for these emissions species will be used to confirm the dosing rate.

PAC will be delivered by bulk powder tanker, and will be conveyed into a carbon silo (80m^3 capacity, equivalent to 80 days supply). The silo will be equipped with its own local dust filter to remove PAC particulate from the vented conveying air.

PAC will be conveyed from the silo by a screw feed, and will then be pneumatically conveyed to the flue gas duct, where it will be injected into the flue gases via a radial fan.

Injection into the flue gas occurs downstream of the economiser where the flue gas temperature corresponds with the optimum condition for reactions to occur. The optimal temperature for injection is around 160^{o}C. Injection promotes major separation of the volatile heavy metals (eg mercury) and pollutant organic species (e.g. PCDD/F) through adsorption on the PAC, prior to the flue gas being directed into the fabric bag filter.

3.3.4 Bag Filter System

The final component of the flue gas cleaning system will be a fabric filter that will be located downstream of the urea, sodium bicarbonate and PAC injection systems. The flue gases will be drawn into the bag-house inlet, where the inlet design facilitates even distribution of the incoming flue gas. The flue gases will then be directed upwards into the filter media by baffles in the duct and hopper.

As the flue gas is drawn through the filter bag, a cake of particulate matter will form on the outer surface of the bag, and this assists with the filtration and scrubbing processes. Cleaned gases that have passed through the bag filter will be drawn upward into an outlet plenum chamber, and are then ducted to the flue gas fan for discharge via the main chimney. The flue gas fan will be connected to a pressure sensor and variable speed controller that helps to maintain a constant negative pressure in the furnace system, thus drawing the flue gas from the furnace through the Heat Recovery Steam Generator (HRSG) and abatement system.

The filter bags act as a foundation for the formation of a filter cake, which serves both as a reaction medium for the acid gas neutralisation, and for the adsorption of heavy metals and organic compounds, as well as providing particulate filtration.

The filter bags will be cleaned by a standard 'reverse-jet' technique, whereby a pulse of compressed air will be introduced down each filter bag. This pulse of compressed air causes the collected dust cake on the outer surface of the bag to break loose and fall into the hopper of the filter chamber. The solid material, known as air pollution control residue (APC residue), which collects in the filter hoppers, is transferred using mechanical conveying to one of two storage silos. A proportion of the APC residue is recirculated and re-injected into the flue gas to optimise the use of fresh reagent.

3.4 Emissions Control

3.4.1 Oxides of Nitrogen (NO_x)

The potential options for reduction of NO_X identified in SGN S5.01 "*Guidance for the Incineration of Waste and Fuel Manufactured From or Including Waste"* are summarised in Table 3.2 below coupled with a statement on their applicability to emissions control at the installation.

Table 3.2: NO_x Reduction Techniques

Technique	Applicability
Primary Measures	
Fuel Selection	• Limited opportunity to reduce fuel NO_X but no nitrogen rich waste streams such as sewage sludge will be introduced
Combustion Chamber Design	• System designed around optimised incineration and combustion air control thus providing the basis for good NO_X control
Air Control – Primary and Secondary	Furnace design ensures that the : • Primary and secondary air feeds are optimised and individually controllable so that the combustion conditions secure the complete oxidative combustion of the waste stream; and • Multiple air injection ports and directional injection nozzles are provided for optimisation of air control
Temperature Control	• Temperature control to meet the required WID levels of 850^{O}C and 2 seconds residence time will be set with the automatic control system, helping to maintain even, minimum, temperatures
Flue Gas Recirculation	• Flue gas recirculation will be used to replace some of the secondary air requirements, thus reducing flame temperature in the combustion chamber
Secondary Measures	
Selective Non Catalytic Reduction (SNCR)	• This is an established technique used on other EfW plants, which utilises urea to chemically reduce NO_X to nitrogen and water.

In summary NO_X reduction and control will be achieved in the thermal treatment processes at the EfW/CHP facility through the following techniques:

- Uncontrolled air ingress to the combustion chamber will be minimised by the design of the inlet feed hopper, to effectively provide an air-tight seal around it;
- The moving grate system is designed as a completely air-cooled system, which assists with temperature control;
- Optimised primary and secondary air-feeds, to ensure complete combustion of the waste material;
- Suitable temperature control to meet the WID limits (850^{o}C with a minimum 2 seconds residence time after last injection of combustion air);
- Secondary air supply includes flue gas recirculation in the combustion chamber, which assists with temperature control and reduces the flame temperature required, thus reducing NO_X production; and
- SNCR, using urea, will be utilised to chemically remove NO_x; the urea reagent is injected into the furnace system, and chemically reacts with NO_x to reduce it to nitrogen and water via the reactions shown below:
    a. $CO(NH_2)_2$ (aq) + ½O_2 → CO_2 + 2NH_2
    b. $CO(NH_2)_2$ (aq) + H_2O → CO_2 + 2NH_3
    c. 2NO + 2NH_3 + O_2 → 2N_2 + 3H_2O
    d. 2NO_2 + 4NH_3 + O_2 → 3N_2 + 6H_2O

3.4.2 Acid Gases (Hydrogen Chloride, Hydrogen Fluoride and Sulphur Oxides)

The potential options for reduction of acid gases identified in SGN S5.01 "*Guidance for the Incineration of Waste and Fuel Manufactured From or Including Waste"* are summarised in Table 3.3 below along with their applicability to emissions control at the installation.

Table 3.3: Acid Gas Reduction Techniques

Technique	Applicability
Primary Measures	
Fuel Selection	• Auxiliary burner fuel is low sulphur Gas Oil
Secondary Measures	
Scrubbing	• A dry scrubbing process using sodium bicarbonate to react with the acid gases will be utilised

In summary, the treatment of acid gases (HCl and HF) and sulphur oxides (SO_2 and SO_3 collectively SO_x) consists of:

- Use of low sulphur gas oil as a secondary fuel for use in the auxiliary burners; and
- Dry scrubbing of the flue gases through the addition of sodium bicarbonate powder as a reagent; the neutralisation reactions produce sodium chloride, sodium fluoride, sodium sulphate and sodium sulphite and the reactions are:

Hydrogen Chloride

- HCl (g) + $NaHCO_3$ (s) ⟶ NaCl (s) + H_2O (g) + CO_2 (g)

Hydrogen Fluoride   • $HF\ (g) + NaHCO_3\ (s) \longrightarrow NaF\ (s) + H_2O\ (g) + CO2\ (g)$
Sulphur Trioxide   • $SO_3\ (g) + NaHCO_3\ (s) \longrightarrow Na_2SO_4\ (s) + H_2O\ (g) + 2\ CO_2\ (g)$
Sulphur Dioxide   • $SO_2\ (g) + NaHCO_3\ (s) \longrightarrow Na_2SO_3\ (s) + H_2O\ (g) + 2\ CO_2\ (g)$

This neutralisation reaction will occur both in the flue gas ducts and on the surface of the filter bags. Typically >99% of the HCl and HF are removed, and up to 90% of the SO_2, which is less reactive.

3.4.3 Oxides of Carbon

Emissions of oxides of carbon will be controlled through the optimisation of the combustion processes and the air flows within it.

3.4.4 Particulate Matter

Particulate matter comprises the fine fraction of the solid combustion products that become entrained in the flue gas, along with the sodium bicarbonate and PAC injected into the flue gas stream. This mixture of particulate material is removed by the fabric filter..

The efficiency of the bag filter is >99%, and the mechanism of particulate removal by the bag filter will be as follows:

1. The flue gas and PAC/ sodium bicarbonate mixture enters the fabric filter inlet duct;
2. The fabric filetr inlet is designed to uniformly distribute the flue gas, thus avoiding channeling;
3. The gases will be directed upwards into the filter media by guide vanes in the inlet duct; initially a coating of particulate material forms on the outer surface of the bags, and this subsequently acts as the filtering medium;
4. The dust will accumulate on the filter elements while the flue gas passes through the filter bag from the outside to the inside;
5. Accumulated powder will be dislodged from the bags by an intermittent reverse pulse-jet of compressed air. This will be achieved by a jet of compressed air being pulsed down each bag. The pulse of compressed air causes the collected dust cake to break loose and fall into the hopper of the filter chamber;
6. The dislodged powder known as air pollution control residue (APC) will be subsequently transferred by mechanical conveying to an APCR silo;
7. The flue gas will be drawn by the induced draft fan into an outlet plenum chamber and will then be exhausted to atmosphere via the main chimney; and
8. The flue gas fan will be connected to a pressure sensor and a variable speed controller to maintain a constant negative pressure in the furnace system, thus drawing gases from the furnace through the Heat Recovery Steam generator (HRSG) and abatement system.

The filtration of particulate matter also assists with the removal of dioxins, furans and metals as the sodium bicarbonate/ PAC coating on the outer surface of the filter bags provides a final reaction site for these pollutants.

3.4.5 Metals

Metals will be removed by a combination of:

- Adsorption, whereby PAC provides the absorbent surface for the metals, particularly mercury; and
- Formation of metal oxide particles that become associated with other particulate matter, and are subsequently removed by the fabric filter.

3.4.6 Dioxins and Furans

The potential options for reduction of dioxins and furans identified in SGN S5.01 "*Guidance for the Incineration of Waste and Fuel Manufactured From or Including Waste"* are summarised in Table 3.4 below along with their applicability to emissions control at the installation.

Table 3.4: Dioxin and Furan Reduction Techniques

Technique	Applicability
Combustion control	• Combustion conditions will be optimised in respect of residence time, temperature and oxygen
Avoiding Conditions for Dioxin and Furan reformation	• Dioxin and furan reformation occurs in the temperature range 200^{O}C to 450^{O}C, and the process is designed to minimise the time the flue gases remain in this temperature range
Bag filtration	• Dioxins and furans adhere to the surface of particulate matter and will be removed by the bag filter system
Carbon Impregnated fabric filter	• PAC material forms a coating on the outer surface of the bag filter providing a similar adsorbent effect

In summary, the treatment of dioxins and furans consists of:

- Furnace system design, which has been developed to provide good combustion control by balancing the air requirements and its subsequent distribution; primary and secondary air control will be provided into individual zones by separately controlled fans;
- Reformation of dioxins and furans will be minimised by ensuring that the flue gas temperature drop from >850^{O}C to bag filter temperature of around 150^{O}C occurs as quickly as possible, which will be achieved by:
    a. Preventing the build-up of a boundary layer of slow moving gases along the boiler surface; and
    b. The design of the boiler arrangement, specifically to maintain the critical surface temperature below the desorption temperature;
- Removal of dioxins and furans that have adhered to the surface of particulate matter by the filtration action of the fabric filter; and
- Direct adsorption of dioxins and furans also occurs primarily onto the PAC.

3.4.7 Chimney Height

Dispersion modelling using ADMS, Version 4.2 has been used to determine the chimney height required to disperse emissions to atmosphere in order to deliver the required air quality mitigation benefit without giving rise to other undesirable effects.

The results of the dispersion modelling are provided in Appendix B of the Impact Assessment report (see Application Volume 2, part 2) and confirms the following chimney height parameters at the operational design load:

Table 3.5: Chimney Height at Operational Design Load

Parameter	Unit	Value	Parameter	Unit	Value
Chimney Height	m	95	Efflux Temperature	^{O}C	120
Flue Diameter	m	2.3	Volumetric Flow	Nm^3/s	45.14
Efflux Velocity	m/s	15.64	Oxygen content	% wet	7.5
Moisture Content			% Volume	16.92	

* ***at reference conditions (ie 1 atm, 0^{O}C, dry, 11% oxygen)***

3.4.8 Plume Visibility

No routinely visible plumes are expected from the main chimney, and although a 'steam' plume may occasionally be visible in cold, wet weather, this is minimised by use of the dry scrubbing system

3.5 Plant Performance and Emissions Benchmarks

3.5.1 Emissions Inventory

Table 3.6 summarises the actual performance of MVV's Leuna facility located in Germany, which is similar to the Devonport Design. This table indicates the nature and quantities of the emissions to atmosphere from the chimney. The performance levels are provided for illustrative purposes of the typical emissions expected from the plant:

Table 3.6: Typical Emission Levels

Parameter	Average Emissions			WID ELV
	mg/m^3	g/sec	Te/yr	mg/m^3
Oxides of Nitrogen	172.67	7.804684	221.52	200
Sulphur Dioxide	37.67	1.702684	48.33	50
Carbon Monoxide	12.25	0.5537	15.72	50
Particulate Matter	0.66	0.029832	0.85	10
Ammonia	8	0.3616	10.26	10
Volatile Organic Compounds	0.75	122	0.0339	10
Hydrogen Chloride	3.85	0.17402	4.94	10
Hydrogen Fluoride	0.06	0.002712	0.08	1
Dioxins and Furans	0.00000015	6.78E-09	0.00000019	0.0000001
Heavy Metals				
Mercury	0.0025	0.000113	0.0032	0.05
Cadmium	0.0011	4.97E-05	0.0014	**Cd + Tl**
Thallium	0.0011	4.97E-05	0.0014	0.05
Antimony	0.00022244	1.01E-05	0.0003	-
Arsenic	0.00022244	1.01E-05	0.0003	-
Chromium	0.00635548	0.000287	0.0082	-
Chromium (VI)	4.4488E-05	2.01E-06	0.0001	
Cobalt	0.00022244	1.01E-05	0.0003	-
Copper	0.00158887	7.18E-05	0.0020	-
Manganese	0.00022244	1.01E-05	0.0003	-
Nickel	0.00317774	0.000144	0.0041	-
Lead	0.00178	1.64E-05	0.000461	-
Vanadium	0.00022244	1.01E-05	0.0003	-
Total Group III Metals				0.5

<u>**Notes**</u>

- Annual release (Te) determined on an operating basis of 7,884 hours

3.5.2 Proposed Emissions Benchmarks

Proposed emissions benchmarks for the EfW/CHP facility have been drawn from SGN 5.01 *“Guidance for the Incineration of Waste and Fuel Manufactured From or Including Waste”* and are based on the current WID emission limit values. The proposed Emission Limit Value (ELV) benchmarks are shown in Table 3.7 below.

Table 3.7: Proposed Emission Benchmarks

Emission Parameter	Unit	Based on Continuous Monitoring	
		½ Hour Average – 100% compliance	Average of ½ hour averages over 24hr day (100% compliance)
Oxides of Nitrogen	mg/m^3	400	200
Sulphur Dioxide	mg/m^3	200	50
Carbon Monoxide	mg/m^3	100	50
Particulate Matter	mg/m^3	30	10
Volatile Organic Compounds (as TOC)	mg/m^3	20	10
Hydrogen Chloride	mg/m^3	60	10
		Based on Extractive Monitoring	
Hydrogen Fluoride	mg/m^3	4	1
Dioxins and Furans	ng/m^3	0.1	
Mercury	mg/m^3	0.05	
Cadmium & Thallium	mg/m^3	0.05	
Other Metals	mg/m^3	0.5	
Note:			
• Reference conditions = temperature 273K, pressure 101.3 kPa, 11% oxygen, dry gas			

As a worst case assumption, both the air dispersion modelling and the impact assessment from the installation have been based on WID emission limit values and the maximum capacity of the plant. However, it should be noted that, based on previous plant performance at similar facilities, the EfW/CHP facility will be perform better than WID. The expected performance in relation to the WID emission limit values is shown in Table 3.8 below.

Table 3.8: Typical Emissions

Substance	Unit	Daily Limit	
		WID Average	Expected
Dust	mg/Nm^3	10	1.5
Hydrogen Chloride	mg/Nm^3	10	8
Sulphur Dioxide	mg/Nm^3	50	40
Oxides of Nitrogen	mg/Nm^3	200	160
Cadmium and Thallium	mg/Nm^3	0.05	0.015
Mercury	mg/Nm^3	0.05	0.0025
Dioxins and Furans	$ngTEQ/Nm^3$	0.1	<0.005
Carbon Monoxide	mg/Nm^3	50	15

3.6 Emissions Monitoring

This section provides evidence of the existence of relevant emissions monitoring for point source releases to air to the standard indicated by the Environment Agency SGN 5.01 “*Guidance for the Incineration of Waste and Fuel Manufactured From or Including Waste*” (Sections 2.10.1 and 2.10.4).

3.6.1 Demonstration of BAT

Table 3.9: Demonstration of BAT

BAT Consideration	Site Justification
1. WID Requirement	• Continuous/extractive monitoring requirements to comply with Articles 7, 10 and 11 of WID will be employed
2. Gas flow	• Will be measured in relation to concentrations and mass releases
3. Reference Conditions	• Temperature, pressure, oxygen and water vapour will be measured to facilitate correction of monitoring results to the relevant standard reference condition

3.6.2 Plume Monitoring

The top of the main chimney will be subject to continuous CCTV monitoring of the plume.

3.6.3 Emission Monitoring Techniques

The facility will be equipped with an advanced Continuous Emission Monitoring System (CEMS), which will continuously display and record the concentration of the flue gas parameters which are required to be continuously monitored in accordance with the requirements of a satisfactory permit as issued by the Environment Agency.

The CEMS will be subject to controlled testing by means of an annual sampling and laboratory testing of flue gas for a calibration check. This will be undertaken by an approved organisation accredited to BS EN ISO 17025 and BS EN 45013.

As a minimum, and subject to the permit, CEMS will be capable of continuously monitoring and recording the following parameters;

- Oxygen;
- Carbon Monoxide;
- Oxides of Nitrogen;
- Volatile Organic Compounds (VOC's);
- Particles;
- Hydrogen Chloride; and
- Sulphur Dioxide.

These parameters will be continuously monitored to ensure the optimum operation of the facility.

Continuous emission monitors will be located down stream of the exhaust fan to monitor the various emission parameters. Standard BSP connections and safe access will also be provided for periodic, manual check-monitoring.

In addition to the main CEMS system, the plant will be equipped with a back-up CEMS monitoring system to provide redundancy in the event of CEMS failure.

Proposed monitoring for the site is identified in Table 3.10 below.

Table 3.10: Proposed Monitoring Techniques

Parameter	Frequency	Method	WID Reference
NO_x (NO and NO_2 as NO_2)	• Continuous and • Extractive – 6 monthly	• ISO 10849: 1996 Note 1 • BS ISO 11564: 1998/Corr 2000	Article 11.2(a) Annex III & V
CO	• Continuous	• ISO 12039: 2001	Article 11.2(a) Annex III & V
Total Dust	• Continuous and • Extractive – 6 monthly	• BS ISO 10155: 1995/Corr 2002 • BS EN 13284-1	Article 11.2(a) Annex III & V
VOC (expressed as TOC)	• Continuous and • Extractive – 6 monthly	• BS EN 12619: 1999	Article 11.2(a) Annex III & V
HCL	• Continuous and • Extractive – 6 monthly	• MCERTS performance standards for CEMS • BS EN 1911: 1998, parts 1 - 3	Article 11.2(a) Article 11.6 Annex III & V
HF	• Extractive – 6 monthly	• CERAM special publication – Draft Std ISO-CD 15713 • US EPA Method 26A	Article 11.2(a) Article 11.4 Article 11.6 Annex III & V
SO_2	• Continuous and • Extractive – 6 monthly	• BS 6069-4: 1992 (ISO 7935)	Article 11.2(a) Annex III & V
Cd, Tl and other trace metals	• Extractive – 6 monthly	• US EPA method 29	Article 11.2(c) Article 11.7 Annex III & V
Hg	• Extractive – 6 monthly	• BS EN 13211: 2001	Article 11.2(c) Article 11.7 Annex III & V
Dioxins and Furans	• Extractive – 6 monthly	• BS EN1948: 1997, parts 1 - 3	Article 11.2(c) Article 11.7 Annex II, III & V
PAHs	• Extractive – 6 monthly	• ISO 11338, parts 1 & 2	Article 11.2(c)
Gas Flow	• Continuous	• BS ISO 14164: 1999	-
Combustion Chamber Gas Temperature	• Continuous	• MCERTs performance std for CEMS	Article 11.2(b)
Exhaust gas oxygen	• Continuous	• ISO 12039: 2001 • MCERTs performance std for CEMS	Article 11.2(b) Article 11.3
Exhaust gas pressure	• Continuous	• MCERTs performance std for CEMS.	Article 11.2(b)
Exhaust gas temperature	• Continuous	• MCERTs performance std for CEMS	-
Exhaust gas water	• Continuous and • Extractive – 6 monthly	• MCERTs performance std for CEMS • US EPA Method 4	Article 11.2(b) Article 11.5
Gas velocity	• Extractive – 6 monthly	• BS 1042 Part 2,1: 1977 or • ISO 10780 Note 3	-

3.6.4 Reference Standards

The following activities will be undertaken:

- Chimney monitoring facilities will be designed to comply with monitoring guidance M1 and M2;
- Continuous emissions monitoring equipment will be undertaken using equipment certified to MCERTs standard;
- Extractive monitoring will be undertaken by independent testing organisations that are accredited to MCERTs;and
- All monitoring of air emissions will be corrected to standard reference conditions, namely:
    a. Temperature = 273K or $0^{O}C$

b. Pressure	=	101.3 kPa (1 atmosphere)
c. Oxygen	=	11%
d. Dry Gas	=	true

4 Point Source Releases to Water

4.1 Introduction

This section provides evidence of the existence of relevant emissions controls and abatement for point source releases to water that have sufficient capacity to allow the effective management and control to the standard indicated by the Environment Agency SGN 5.01 "*Guidance for the Incineration of Waste and Fuel Manufactured From or Including Waste*" (Sections 2.2.2, 2.2.3 and 2.10).

4.2 Assessment of Best Available Techniques

Environment Agency SGN 5.01 "*Guidance for the Incineration of Waste and Fuel Manufactured From or Including Waste*" (Sections 2.2.2, 2.2.3 and 2.10) identifies BAT in respect of point source releases to water.

Table 4.1: Demonstration of BAT

BAT Consideration	Site Justification
1. WID Requirement	• Monitoring will be completed in line with Article 11 (14) to (17)
2. Emissions Control	• Water use will be minimised where possible, and mechanisms will be put in place to reuse grey water • Process water will be reused in the process and for housekeeping measures • Storage capacity will be provided that will enable potentially contaminated waters/process water to be sampled and tested to confirm suitability for discharge. Provision for removal to an offsite treatment facility by tanker will be in place in the event that the discharge limits cannot be met • Specified emission limit values set by the Sewerage Undertaker will be met

4.3 Source Characterisation

4.3.1 Discharge to Ground Water

There will be no point source releases to groundwater from the site operations.

4.3.2 Discharge to Surface Water

Uncontaminated surface water will comprise run-off from the hard standing/paved areas of the site and roof drainage, which will pass through a Class 1 by-pass interceptor prior to discharge.

4.3.3 Discharge to Sewer

During normal operational running of the EfW/CHP facility there will be no continuous discharge to foul sewer from the process part of the facility, since all the waste water generated will be reused to make up the water lost in the bottom ash quenching system. However, foul water from site welfare arrangements will discharge via the foul sewer as described in section 4.4.2 below.

During periods of facility shutdown, or when periods of increased steam off-take with high condensate losses by the MOD leads to increased waste water from the water treatment plant, there may be a need to arrange for disposal of process water from the facility to foul sewer. .

4.4 Emissions Control

4.4.1 Surface Water Management

Grey Water Management

It is proposed to provide a drainage system to drain the run-off roof and wall rain water to an infiltration system. It is intended that the main building roof and wall surfaces will be drained to an infiltration basin whereas the workshop building, due to its size, will be drained to an infiltration trench.

Surface Water Drainage

The proposed drainage strategy provided below has been developed by GHA Livigunn and a copy of the proposed drainage scheme is provided in Drawing D123356/EP/004 (Application Volume 1, Section 12).

Positive drainage will be provided to all hardstanding areas through the use of a combination of gullies, linear drains or channels and hard pipe. The surface water will pass through a Class 1 bypass petrol interceptor (estimated size at this stage NSB20 - to be confirmed at detailed design stage) prior to being discharged to the tidal estuary of the river Tamar. An outfall structure complete with adequate flow calming measures and scour protection will be provided at the point of discharge. This new outfall structure will be located within the foot print of the site, the invert level of the outfall pipe at the point of discharge will be set such that it is above the maximum tidal water level for a 1 in 200 years return period (i.e 4.48 m AOD - note that this level already includes an allowance for climate change and a 300 mm freeboard). Consequently the design of the surface water system will be based on free discharge flow conditions.

Please note that it is intended to provide an emergency cut-off valve immediately upstream of the outfall such as to prevent any water discharging to the environment in the event of an accidental spill on site.

The EA has confirmed that a flood defence consent and discharge consent will not be required.

4.4.2 Foul Water, Trade Effluent and Contaminated Water Management

Foul Water Drainage

The foul sewer connection for the management of foul water from the site will be made to a rising main section of the existing internal dockyard network. The route of the foul connection is approximately 275 metres, and will include a new 20,000 litre package pumping station with valve chamber and type D access chamber.

Process Water Drainage

There will be no routine discharge of process water from the site during normal plant operations. During periods of plant shutdown, or when periods of increased steam off-take with high condensate losses by the MOD leads to increased waste water from the water treatment plant, there may be a need to arrange for disposal of process water from the facility. To facilitate the management of process water during these periods, a neutralization tank will be provided which will enable water quality testing to ensure that any discharge would comply with the requirements of the foul sewer discharge consent for the site. Arrangements to remove water would then be either via sewer discharge or by tanker.

Fire Water Management

Any firewater generated will be retained within any building and sampled prior to manual discharge to the foul sewer, if found acceptable.

4.5 Plant Performance and Emissions Benchmarks

4.5.1 Proposed Monitoring

There will be no routine discharge of wastewater from the facility during normal operations, and as such no monitoring is proposed at this time.

During periods of equipment or plant shutdown, periods of increased steam off-take or following the accumulation of fire waters at the facility, provision will be made to facilitate the sampling of potentially contaminated waters prior to the discharge point to sewer. Analysis will be undertaken for parameters agreed with the Environment Agency and the Sewerage Undertaker at the time of the required discharge, using analytical techniques in accordance with the current EA guidance.

4.5.2 Reference Standards

In the event that sampling and analysis is required, then the following reference standards will be employed:

- Continuous emissions monitoring equipment will be undertaken using equipment certified to MCERTs standard; and
- Extractive monitoring will be undertaken by independent testing organisations that are accredited to MCERTs.

5 Fugitive Emissions

5.1 Introduction

This section provides evidence of the existence of relevant emissions controls and abatement for fugitive releases that have sufficient capacity to allow the effective management and control of the Site to the standard indicated by the Environment Agency SGN 5.01 "*Guidance for the Incineration of Waste and Fuel Manufactured From or Including Waste*"

5.2 Assessment of Best Available Techniques

Environment Agency SGN 5.01 "*Guidance for the Incineration of Waste and Fuel Manufactured From or Including Waste*" details BAT in respect of fugitive emission control.

Table 5.1: Demonstration of BAT

BAT Consideration	Facility Justification
1. Dust	The following control measures will be employed at the site: • All loads being delivered or removed from facility will be covered • All site storage skips will be covered and secured • There will be no outdoor stockpiles • Water sprays will be available for dust suppression if needed • Closed transport systems will be used for PAC, sodium bicarbonate and APC residue • PAC, sodium bicarbonate and APC residue will be stored in purpose designed silos • Bottom ash will be stored in a bunker within the process building • Maintenance of high housekeeping standards • Silos for PAC, sodium bicarbonate and APC residue are equipped with local dust filters • Furnace system designed to operate under negative pressure to prevent gas escape • Waste feed acts as plug in feed chute and seals charging system
2. VOCs	• No volatile or solvent wastes will be accepted for incineration
3. Sub-surface Structures	• Pipe work and drains routing plans will be maintained • Preventative maintenance will include appropriate inspections • Underground storage/sumps will have level monitoring • Drains will have an inspection and cleaning regime in place
4. Surfacing	• Floor, road & hardstandings will all have an impervious surface • All kerbs/construction joints will be sealed • Surfacing will be subject to inspection under maintenance regime
5. Containment	• Secondary containment will be provided for containers of lubricants • 'Chemical safe' will be employed when necessary • Storage areas will be located away from water courses, labelled for material and volume, and inspected daily • All containers will be labelled and have lids secured

5.3 Source Characterisation

5.3.1 Fugitive Releases to Air

The potential for fugitive releases to air at the facility has been evaluated and the following potential sources noted:

- Waste delivery and despatch vehicles;
- Tanker discharge during delivery of PAC and sodium bicarbonate;
- Tanker filling during discharge of APC residue.
- Waste discharge and offloading operations;
- Waste and treatment residue storage;
- Thermal treatment processes;
- Material transport around the processes (e.g. conveyors, screws, etc);
- Plant spillage and leaks;
- Silo overfilling; and
- Surface accumulations of dust.

5.3.2 Litter

The potential for litter releases at the facility has been evaluated and the following potential sources noted:

- Waste delivery and despatch vehicles;
- Waste discharge and offloading operations; and
- Waste storage.

5.3.3 Mud and Debris

The potential for mud has been assessed and is not anticipated to be an issue due to the use of hardstanding around the vehicle routes. The potential for debris at the facility has been evaluated and the following potential sources noted:

- Waste delivery and despatch vehicles;
- Waste discharge and offloading operations;
- Waste and treatment residue storage; and
- Plant spillage and leaks.

5.3.4 Fugitive Releases to Land and Water

The potential for fugitive releases to water (surface water, ground water and sewer) and land at the facility has been evaluated and the following potential sources noted:

- Run-off from waste and treatment residue storage;
- Surface run-off from roads and pavements;

- Process water storage; and
- Firewaters.

5.4 Emissions Control

5.4.1 Dust and Odour

Fugitive releases of dust and odour from the reception hall will be minimised by:

- Maintaining a negative pressure in the tipping hall and waste bunker by extracting air through the furnace during normal operation;
- Maintaining a negative pressure in the tipping hall, waste bunker and bale-store during shutdown periods by extracting air through a dedicated filter system;
- The tipping hall will effectively be a sealed building that uses fast-acting roller doors and staff access door that will be kept closed where practicable thus minimising the potential for fugitive release;
- All waste deliveries to, and despatches from, the facility will be covered or in enclosed containers;
- Water sprays will be available for dust suppression throughout the site, if needed;
- Powdered materials, namely PAC, sodium bicarbonate and APC residue, will be transported by conveying which will be completely enclosed, thus preventing fugitive releases; conveying systems will be included in the planned maintenance regime for the facility, to ensure ongoing effectiveness and integrity thus minimising the potential for fugitive release;
- Silos for powdered materials, namely PAC, sodium bicarbonate and APC residue, will be designed in accordance with industry standards, and will be equipped with level indication, overflow alarms, local dust filtration and over-pressure protection; these measures will minimise the potential for fugitive release;
- Bottom ash will be quenched with water as it is discharged from the combustion chamber, will be transported for storage in a dedicated bunker, and as such the damp material will not be prone to fugitive release until it dries out, but could be a source of release should the dried material become windborne or during loading of wagon; as such, the storage bunker will be housed within the enclosed process building, and all loading of despatch wagons will be undertaken within this building, which will ensure that potential for fugitive releases is minimised at all times;
- The facility's operational control procedures will include requirements in respect of maintaining high housekeeping standards, for which site operators will undertake daily site inspections to identify spillages and sources of leak, repairs will be undertaken promptly and spillages will be removed by vacuum and sweeping as appropriate; water for dust suppression will be available as required during sweeping operations;
- The EfW/CHP process proposed for Devonport has been designed to ensure that the furnace system is kept under negative pressure, thus preventing gas escape, in addition to which, the waste-feed acts as a plug within the feed chute, effectively sealing the charging system;
- Sodium bicarbonate and PAC deliveries will be via bulk-tanker with discharge to the relevant silo, via flexible hoses; deliveries, each of around 20 tonnes, will be blown from the tanker

into the silo once permission to discharge has been given, and, as there may be a danger of leaks from the pipe or its connection during discharge, all off-loading will be supervised;

- The facility's maintenance and inspection programme will be designed for the early detection of leaks through visual checks or physical thickness testing on the tanks and pipelines, while there will also be provision to ensure that tanks and drains are checked for sludge/sediment build-up and cleaning; and
- On-site speed limits will be set, thus minimising the potential for dust to be generated from road surfaces.

5.4.2 Litter

All waste handling operations conducted on-site that have the potential to generate litter will be undertaken within the main process building to minimise any release.

Due to the nature of the permitted wastes, litter is not likely to present a nuisance to any surrounding receptors; however the following measures will be implemented:

- Wastes entering and leaving the facility will be in sheeted/sealed/containerised vehicles;
- Staff will be required to keep the facility and its surrounds tidy; and
- Daily inspections will be carried out; any litter will be retrieved and deposited within the waste reception areas.

5.4.3 Mud and Debris onto the Public Highway

The facility will be constructed to ensure that all vehicle movements are undertaken on paved or concreted surfaces, thus the potential for mud and debris being carried onto the public highway is considered minimal.

To ensure that any emission of mud and debris onto public highways does not become an issue, the following additional controls will be employed:

- The facility will be maintained in a clean condition, with operational surfaces cleared of any potential debris by the use of sweepers if necessary deployed by site management;
- During periods of dry weather, the introduction of water to dampen surfaces may be introduced if necessary, to reduce any potential for dust emissions from vehicular movements;
- Regular daily inspections of operational areas will be carried out by site operational staff, to ensure standards are suitably maintained;
- The facility has a vehicle wash-down area, which will be available for all vehicles to use; and
- In the event that material escapes onto a public road, a sweeper or similar item of equipment will be used to remove any such material as quickly as reasonably possible.

5.4.4 Fugitive Releases to Land and Water

All vehicles, plant and equipment used on-site in connection with the specified waste management operations, will be operated and maintained with the objective of preventing potentially polluting leaks, spillages of wastes or other potentially polluting materials.

Site control measures will include:

- Pavements and roads will be constructed from concrete designed to an appropriate BS; pavements will be laid to falls that facilitate surface water drainage;
- The process buildings have been designed to ensure that firewaters can be retained within them;
- Tanks, pumps and site vehicles will be maintained in line with a defined preventative maintenance schedule to ensure the plant integrity and operational efficiency is maintained;
- All surfacing, containment and drainage has been designed to take into consideration collection capacity, permeability, surface thickness and strength/reinforcement considerations;
- Drain routing plans will be maintained and the drainage system will be subject to an inspection and cleaning regime; and
- All surfaces will be inspected regularly for signs of damage or deterioration and repairs will be scheduled as necessary.

In the unlikely event of a pollution incident occurring on-site:

a) Minor spillages will be managed by the use of appropriate absorbent materials, while used/spent absorbent will be subsequently appropriately disposed of; and

b) In the event of a major spillage, immediate action will be taken to contain the spill. Absorbent materials will be used for spillage control and containment. Absorbents will be stored in waterproof container(s) and all operatives will be made aware of their location. Immediately following clean up and appropriate containment the Environment Agency will be informed and a note to this effect will be made in the site diary.

5.5 Emissions Monitoring

Monitoring of fugitive emissions will be undertaken through:

- Daily site inspections; and
- Preventative maintenance inspections.

6 Odour

6.1 Introduction

This section provides evidence of the existence of relevant emissions controls and abatement for point source releases to air that have sufficient capacity to allow the effective management and control of the Site to the standard indicated by the Environment Agency SGN 5.01 "*Guidance for the Incineration of Waste and Fuel Manufactured From or Including Waste*"

6.2 Assessment of Best Available Techniques

Environment Agency SGN 5.01 "*Guidance for the Incineration of Waste and Fuel Manufactured From or Including Waste*" outlines BAT requirements in respect of odour management. The main considerations for the Devonport EfW/CHP are summarised in Table 6.1 below.

Table 6.1: Demonstration of BAT

BAT Consideration	Site Justification
1. Odour Control	▪ Wastes will be off-loaded, stored and treated in an enclosed processing building. ▪ The processing buildings and waste tipping hall will be maintained under negative pressure. ▪ Process air from the tipping hall, waste bunker and bale store will be used in the combustion process ▪ Waste stored in the Baling area will be wrapped air tight to prevent odours. ▪ In case of shutdown, air from the tipping hall, waste bunker and bale store will be evacuated by a dust and activated carbon filter

6.3 Source Characterisation

Odour releases associated with the Devonport EfW/CHP facility are primarily associated with:

- Waste off-loading
- Waste storage

No odour is anticipated to be generated with the incineration process as the high temperature combustion processes effectively destroy any odour generating pollutant.

The main pollutant sources associated with the site are summarised in Table 6.2 below.

Table 6.2: Point Source Releases to Air

Point Reference	Plant Source	Emissions
Fugitive sources	• Waste storage • Waste off-loading • Waste Bale Store	• Odour

6.4 Emissions Control

In respect of fugitive releases of odour from the site, the following controls will be put in place:

- Waste handling will always take place in the enclosed process building which will be constantly kept at negative pressure. This will avoid any odour escaping from the building.

- Vehicle access to the processing building will be through fast-acting roller shutter doors which will be kept closed where practicable;
- The air removed from the waste tipping hall, waste bunker and bale store will be utilised as process air within the combustion chamber or will be vented through a carbon filter when the combustion process is not available; and
- Wastes stored in the baling area are unlikely to generate odour. The bale store will be kept under negative pressure and the waste will be wrapped in plastic.

6.5 Emissions Monitoring

Monitoring of fugitive emissions will be undertaken through:

- Daily site inspections; and
- Preventative maintenance inspections.

7 Noise

7.1 Introduction

This section provides evidence of the existence of relevant emissions controls and abatement for point source releases to air that have sufficient capacity to allow the effective management and control of the Site to the standard indicated by the Environment Agency SGN 5.01 "*Guidance for the Incineration of Waste and Fuel Manufactured From or Including Waste*"

7.2 Assessment of Best Available Techniques

Environment Agency SGN 5.01 "*Guidance for the Incineration of Waste and Fuel Manufactured From or Including Waste*" outlines BAT requirements in respect of noise management. The main considerations for Devonport EfW/CHP Facility are summarised in Table 7.1 below.

Table 7.1: Demonstration of BAT

BAT Consideration	Site Justification
Noise Control	▪ The preventative maintenance system will include maintenance of bearings, air handling plant, motors or other plant whose deterioration may lead to noise issues. ▪ Cladding on the process buildings will be selected to provide the appropriate level of attenuation.

7.3 Source Characterisation

There are no sources of significant ground borne vibration in the complement of plant items. All internal plant items such as turbines, generators, compressors etc. will be suitably mounted to minimise the transfer of vibration energy to the building structure. Taking this into account, and the distances from the plant to surrounding sensitive receptors, the significance of operational vibration is assessed as negligible.

Potential noise sources from the site are:

- External sources including the ACC fans, the chimney, exhaust steam pipe, transformer, recoolers and HGV vehicle movements; and
- Internal sources including plant within turbine hall, boiler house, tipping hall, ID fan house, water treatment, filter house, and baling area during shutdown...

7.4 Emissions Control

Emissions control at the site will comprise a combination of physical and operational control measures, namely:

- Between the induced draught fan and the chimney an acoustically matched (tuned to the harmonics of the installation) silencer will be installed to prevent noise breakout at the top of the chimney.
- The main transformer is cooled by natural convection and will be housed within a purpose designed enclosure, designed to prevent noise breakout.
- The Air Cooled Condenser is of an ultra low noise design with reduced fan speed to ensure that noise breakout will be minimal and that the system will be very quiet in operation.

- The turbine will be housed in a concrete structure of significant mass in order to ensure that there is no breakout of higher frequency sounds; and
- The building will be predominantly clad in acoustically insulating cladding and all doors will be closed when not in use.

7.5 Emissions Monitoring

- Noise levels will be assessed as part of the routine site inspections.
- Vibration levels will be incorporated into the condition based maintenance checks.