REPORT

Boston Alternative Energy Facility

Appendix 14.6 Abnormal Emissions Assessment

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A14.1 Introduction

A14.1.1 An abnormal emissions assessment has been undertaken to support the Development Consent Order (DCO) Examination and Environmental Permit application, to be submitted to the Environment Agency, for the proposed Boston Alternative Energy Facility ('the Facility'). The Facility will only be operational once an Environmental Permit is granted and will be required to adhere to any conditions imposed by the Environmental Permit.

A14.1.2 This Appendix has been produced following receipt of Relevant Representations from Public Health England (RR-023) (document reference 9.2) and discussions at an Air Quality Topic Meeting on 7th September 2021. An abnormal emissions assessment is required by the Environment Agency (EA) in support of the Environmental Permit application. However, this additional information has been provided by the Applicant at this stage to aid both the EA and the Examining Authority in their responses to and evaluation of the DCO Application for the Facility.

A14.1.3 This report provides the results of an assessment of the potential long- and short-term air quality impacts during abnormal operations. Background concentrations used in the assessment are inclusive of emissions from the adjacent permitted Biomass UK No. 3 Ltd facility.

Abnormal Operations

A14.1.4 Article 46 of the Industrial Emissions Directive (IED) allows for operators to have some operational flexibility to resolve problems with plant without initiating a complete shutdown of the Facility. This is known as 'abnormal operations' and includes incidents such as technically unavoidable stoppages, disturbances, or failures of the air pollution control equipment or monitoring equipment.

A14.1.5 The Environmental Permitting Regulations require that abnormal event scenarios are considered. Article 46(6) of the IED states that:

> *"…the waste incineration plant or waste co-incineration plant or individual furnaces being part of a waste incineration plant or waste co-incineration plant shall under no circumstances continue to incinerate waste for a period of more than 4 hours uninterrupted where emission limit values are exceeded.*

The cumulative duration of operation in such conditions over 1 year shall not exceed 60 hours."

A14.1.6 Article 47 states that:

"In the case of a breakdown, the operator shall reduce or close down operations as soon as practicable until normal operations can be restored."

A14.1.7 In this abnormal emissions assessment for the Facility, the conditions detailed above in Article 46(6) are considered to be "abnormal operating conditions".

A14.2 Identification of Abnormal Operating Conditions

A14.2.1 Examples of abnormal operating conditions in the Facility which may lead to 'abnormal emission levels' of pollutants are as follows:

- Failure or reduced efficiency of the Selective Non-Catalytic Reduction (SNCR) system, which is used to abate nitrogen oxides (NOx) levels to below the BAT-AEL daily emission limit of 120 $mg.m^{-3}$, would result in elevated oxides of nitrogen emissions. This may occur as a result of blockages or failure of the ammonia injection system.
- Failure or reduced efficiency of the particulate filtration system, which would lead to elevated particulate and metal emissions. This may occur as a result of bag failure and inadequate isolation.
- Failure or reduced efficiency of the acid gas abatement system (i.e., lime injection system). Reduced efficiency of the lime injection system, as a result of blockages or failure of the fans, would lead to elevated acid gas emissions (excluding hydrogen chloride). Complete failure of the lime injection system would lead to unabated emissions of hydrogen chloride. However, this would require the plant to have complete failure of the bag filter system and, as the Facility will be of modern design, the Facility would have shut down prior to reaching these operating conditions.
- Failure of the activated carbon injection system and loss of temperature control would lead to the reformation of high levels of dioxins and unabated release of these dioxins.

A14.2.2 The Facility will be of modern design, and as such will operate to a high level of compliance with BAT-AELs and therefore instances of abnormal operating conditions would be minimised.

Plant Start-Up and Shutdown

A14.2.3 Clean support fuel (i.e., low sulphur light fuel oil) will be used for start-up of the Facility from cold and waste will not be introduced into the Facility unless the temperature is above the minimum requirement of 850 ºC and other operating parameters (e.g. air flow and oxygen levels) are within the range stipulated in the Environmental Permit. Gas cleaning plant, control systems and monitoring equipment will be operational during the warming-up period.

A14.2.4 Plant shutdown will be similar, the waste remaining on the grate will be allowed to burn out and with the simultaneous introduction of clean support auxiliary fuel, the temperature will not be permitted to drop below 850 ºC. After complete burnout of the waste, the burners will be turned off and the plant will be allowed to cool. Again, the gas cleaning equipment, control system and monitoring equipment will be fully operational during this period.

A14.2.5 It should also be noted that start-up and shutdown are infrequent events; the Facility is designed to operate continuously, and ideally will only close down for its annual maintenance programme.

A14.2.6 A report produced by AEA Technology (AEA Technology, 2012) references research undertaken by AEA Technology on behalf of the Environment Agency (Environment Agency, 2008) in relation to emissions of dioxins during start up and shut down episodes. The research identified that elevated emissions of dioxins occurred during start up and shut down , however the mass emission over a four-day start up and shut down period was no greater than the emission which would occur over normal operations across the same period. As such, it is not expected that there would be any significant impacts on long-term concentrations of dioxins associated with start up and shut down periods.

A14.3 Predicted Abnormal Emission Levels

A14.3.1 Predicted abnormal emissions levels for the Energy from Waste (EfW) and lightweight aggregate (LWA) lines of the Facility are detailed in **Table A14.6-1**. As stated in **Chapter 14 Air Quality** of the ES (document reference 6.2.14(1)), in the absence of site-specific emissions monitoring data for the proposed EfW and LWA stacks, and to undertake a worst case scenario assessment, the relevant Best Available Techniques (BAT)-Associated Emission Levels (AELs) were used as the permitted emission limits. These were obtained from the most recent BAT-conclusion document for waste incineration (European Parliament, 2019). Where BAT-AELs were provided as a range, the upper values were used to provide a conservative assessment. For example, the BAT-AEL for NOx emissions is expressed as a daily average in the range 50-120 mg.Nm^{-3} for new EfW plants, therefore 120 mg.Nm^{-3} was used in the assessment.

A14.3.2 The predicted abnormal emission levels presented in **Table A14.6-*1* Predicted abnormal emissions from each of the EfW stacks (x3) and LWA stacks (x2)Table A14.6-1** have been assumed to be five times the permitted emission limit, which is in line with industry standard approaches. The assumptions used in this assessment will form part of the discussion with the Environment Agency during the Environmental Permit application and will be reviewed and updated as necessary during Permitting.

Table A14.6-1 Predicted abnormal emissions from each of the EfW stacks (x3) and LWA stacks (x2)

Pollutant	Units	Permitted Emission Limit (1)	Averaging Period	Predicted Abnormal Emission	Factor Applied to Increase Pro-Rata
Oxides of nitrogen (NOx)	mg.Nm^{-3}	120	Daily average	600	5
Particulate matter (PM_{10})	mg.Nm^{-3}	5	Daily average	25	
Sulphur dioxide (SO_2)	mg.Nm^{-3}	30	Daily average	150	
Hydrogen chloride (HCl)	mg.Nm^{-3}	6	Daily average	30	
Hydrogen fluoride (HF)	mg.Nm^{-3}	1	Daily average or average over sampling period	5	

Pollutant	Units	Permitted Emission Limit (1)	Averaging Period	Predicted Abnormal Emission	Factor Applied to Increase Pro-Rata
(1) All emissions expressed as Nm^3 based (dry, 0 °C, 11% reference oxygen content)					

A14.3.3 The following assumptions have been taken into consideration with regard to the emission of individual metals, in line with industry standard approaches:

- The emission concentration of cadmium, thallium and mercury have assumed to be 100% of the BAT-AEL concentration of 0.02 $mg.m^{-3}$.
- The Environment Agency published it's guidance document *'Guidance on assessing group 3 metal stack emissions from incinerators'* (version 4) in 2016 (Environment Agency, 2016, regarding the consideration of Group III metals in dispersion modelling. Group III metals are subject to an aggregated emission limit for nine metals (antimony, arsenic, chromium, cobalt, copper, lead, manganese, nickel, vanadium and their components) and therefore impacts can be overstated. Table A1 of the Environment Agency guidance (2016) provides a summary of 34 measured values for each Group III metal recorded from municipal waste and waste wood co-incinerators in the UK over a period between 2007 and 2015, which can be used to adjust Group III emissions. The maximum percentages were applied to the long term BAT-AEL for the purposes of this assessment. Short-term emissions were assumed to be at the aggregate emission limit of 0.3 $mg.m^{-3}$.
- For the abnormal emissions assessment, Group I and II metals have been assumed to be 100 times the BAT-AEL emission concentration of 0.02 $mg.m^{-3}$. Group III metals have been assumed to be five times the BAT-AEL emission concentration.

A14.3.4 The predicted abnormal emission levels for metals are presented in **Table A14.6-2**.

Table A14.6-2 Predicted abnormal metal emissions from each of the EfW and LWA stacks

Pollutant	Emission Concentration(1,2,3)	Predicted Abnormal Emission	Factor Applied to Increase Pro-Rata
Group I Metals ($mg.Nm^{-3}$)			
Cadmium	0.02	2.0	100
Thallium			
Group II Metals ($mg.Nm^{-3}$)			
Mercury	0.02	2.0	100
Group III Metals ($\mu g.Nm^{-3}$)(4)			
Arsenic	25	125	5

Pollutant	Emission Concentration[1,2,3]	Predicted Abnormal Emission	Factor Applied to Increase Pro-Rata
Cobalt	5.6	28	5
Copper	29	145	5
Chromium	92	460	5
Chromium (VI)	0.13	0.65	5
Manganese	60	300	5
Nickel	53	265	5
Lead	50.3	251.5	5
Antimony	11.5	57.5	5
Vanadium	6	30	5

(1) Reference Conditions: 273K, 11% O2 and 101.3 kPa, dry gas
(2) Average over the sampling period, with exception of mercury which has an averaging period of a daily average or average over the sampling period
(3) Factored based on the maximum measured concentrations, reported in the Environment Agency's *'Guidance on assessing group 3 metal stack emissions from incinerators'* (version 4) as a proportion of the BAT-AELs for group 3 metals, with the exception of nickel where the two highest outliers were discounted
(4) Group III metal short term emission concentrations were assumed to be the aggregate emission limit of 0.3 $mg.m^{-3}$, and therefore the predicted abnormal emission was 1.5 $mg.m^{-3}$ for short term Group III metals.

A14.3.5 This assessment has assumed that abnormal operating conditions would not affect the exhaust gas characteristics (e.g. flow rate, temperature etc.) and therefore the exhaust flow characteristics as used in the assessment presented within **Chapter 14 Air Quality** of the ES (document reference 6.2.14(1)) have been applied to the abnormal emission levels to assess the impact.

A14.4 Predicted Abnormal Emissions Impact

A14.4.1 For the abnormal emissions assessment, it has been assumed as a worst case that the three Energy from Waste (EfW) lines could operate under abnormal operating conditions at the same time and the two lightweight aggregate (LWA) lines could operate under abnormal operating conditions at the same time. It is considered highly unlikely, however, that the three EfW lines and two LWA lines would operate under abnormal operating conditions at the same time, therefore this scenario has not been assessed.

A14.4.2 The calculated receptor breathing height (1.5 m) concentrations have been increased pro-rata based on the predicted abnormal emission concentrations in **Table A14.6-1** and **Table A14.6-2**. In order to capture the full process

contribution (PC) from the Facility at the worst case receptor during abnormal operating conditions, the relevant PC from the EfW or LWA under normal conditions (i.e., what is reported in the ES chapter) have been added to the abnormal PCs for the LWA and EfW respectively.

Predicted Short Term Impacts

A14.4.3 Under abnormal operations, pollutants with 15 minute and 1 hour mean averaging period EALs have had predicted impacts calculated by increasing pro-rata the predicted PC using BAT-AEL limits according to the factors details in **Table A14.6-1** and **Table A14.6-2**.

A14.4.4 PM_{10} and SO_2 EALs all make provisions for a daily mean (i.e., 24 hour) EAL. Under the IED, abnormal emissions must not occur for longer than four hours, after which time the Facility must cease operating. Therefore, in order to calculate the effect of abnormal emissions in relation to these EALs it was assumed that the plant operates abnormally for a maximum of four hours during any 24 hour period. The 24 hour average PCs under abnormal conditions for PM_{10} and SO_2 have therefore been calculated using the following formula:

$$Predicted\ Abnormal\ Emission\ Daily\ PC = Max\ 24\ hour\ PC\ * \left(\left(Factor * \frac{4}{24}\right) + \frac{20}{24}\right)$$

EfW Lines

A14.4.5 The short term PC associated with the three EfW lines of the Facility operating under abnormal conditions concurrently are detailed below in **Table A14.6-3** and **Table A14.6-4**.

Table A14.6-3 Short-term Impacts Resulting from Predicted Abnormal Emissions from the three EfW Lines of the Facility (Concurrently) – Non-Metals

Pollutant	Averaging Period	Objective/ EAL ($\mu g.m^{-3}$)	Worst Case Receptor	Predicted Impact – BAT-AEL Limits		Predicted Impact – Abnormal Emission	
				Max PC	% of EAL	Max PC*	% of EAL
Nitrogen dioxide (NO_2)	1 hour mean (99.79th Percentile)	200	R10	17.6	9%	109.5	55%
Particulate matter (PM_{10})	24 hour mean (90.41st Percentile)	50	R5	0.4	1%	0.9	2%
Sulphur dioxide (SO_2)	15 minute mean (99.90th Percentile)	266	R10	14.1	5%	76.3	29%
	1 hour mean (99.73rd Percentile)	350	R10	12.3	4%	66.7	19%

Pollutant	Averaging Period	Objective/ EAL ($\mu g.m^{-3}$)	Worst Case Receptor	Predicted Impact – BAT-AEL Limits		Predicted Impact – Abnormal Emission	
				Max PC	% of EAL	Max PC*	% of EAL
	24 hour mean (99.18th Percentile)	125	R10	6.4	5%	13.4	11%
Hydrogen chloride (HCl)	1 hour mean	750	R10	2.9	0%	15.8	2%
Hydrogen fluoride (HF)	1 hour mean	160	R10	0.5	0%	2.6	2%
*Inclusive of non-abnormal PC at receptor from the LWA stacks							

Table A14.6-4 Short-term Impacts Resulting from Predicted Abnormal Emissions from the three EfW Lines of the Facility (Concurrently) – Metals

Pollutant	Averaging Period	EAL ($ng.m^{-3}$)	Worst Case Receptor	Predicted Impact – BAT-AEL Limits		Predicted Impact – Abnormal Emission	
				Max PC	% of EAL	Max PC*	% of EAL
Group I Metals							
Thallium	1 hour mean	30,000	R10	9.5	0%	956.5	3%
Group II Metals							
Mercury	1 hour mean	7,500	R10	9.5	0%	956.5	13%
Group III Metals							
Cobalt	1 hour mean	6,000	R10	143.4	2%	791.4	13%
Copper	1 hour mean	200,000	R10	143.4	0%	791.4	0%
Chromium	1 hour mean	150,000	R10	143.4	0%	791.4	1%
Manganese	1 hour mean	1,500,000	R10	143.4	0%	791.4	0%
Antimony	1 hour mean	150,000	R10	143.4	0%	791.4	1%
Vanadium	1 hour mean	1,000	R10	143.4	14%	791.4	79%
*Inclusive of non-abnormal PC at receptor from the LWA stacks							

A14.4.6 This assessment is considered to be highly conservative as it assumes that the predicted abnormal emissions coincide with the worst case meteorological conditions of the worst case year at the worst case receptor. No exceedances of any of the short term Objectives or EALs are predicted, even taking into account the conservative nature of the assessment. The maximum predicted abnormal

PC is vanadium, at 79% of the hourly mean Objective. The maximum predicted abnormal non-metal PC is nitrogen dioxide, at 55% of the EAL.

LWA Lines

A14.4.7 The short term PC associated with the two LWA lines of the Facility operating under abnormal conditions concurrently are detailed below in **Table A14.6-5** and **Table A14.6-6**.

Table A14.6-5 Short-term Impacts Resulting from Predicted Abnormal Emissions from the two LWA Lines of the Facility (Concurrently) – Non-Metals

Pollutant	Averaging Period	Objective/ EAL ($\mu g.m^{-3}$)	Worst Case Receptor	Predicted Impact – BAT-AEL Limits		Predicted Impact – Abnormal Emission	
				Max PC	% of EAL	Max PC*	% of EAL
Nitrogen dioxide (NO_2)	1 hour mean (99.79th Percentile)	200	R35	15.2	8%	113.6	57%
Particulate matter (PM_{10})	24 hour mean (90.41st Percentile)	50	R35	0.4	1%	1.0	2%
Sulphur dioxide (SO_2)	15 minute mean (99.90th Percentile)	266	R35	11.9	4%	69.8	26%
	1 hour mean (99.73rd Percentile)	350	R35	10.7	3%	63.0	18%
	24 hour mean (99.18th Percentile)	125	R35	4.9	4%	13.2	11%
Hydrogen chloride (HCl)	1 hour mean	750	R35	2.4	0%	13.9	2%
Hydrogen fluoride (HF)	1 hour mean	160	R35	0.4	0%	2.3	1%
*Inclusive of non-abnormal PC at receptor from the EfW stacks							

Table A14.6-6 Short-term Impacts Resulting from Predicted Abnormal Emissions from the two LWA Lines of the Facility (Concurrently) – Metals

Pollutant	Averaging Period	EAL ($ng.m^{-3}$)	Worst Case Receptor	Predicted Impact – BAT-AEL Limits		Predicted Impact – Abnormal Emission	
				Max PC	% of EAL	Max PC*	% of EAL
Group I Metals							
Thallium	1 hour mean	30,000	R35	7.9	0%	799.4	3%

Pollutant	Averaging Period	EAL ($ng.m^{-3}$)	Worst Case Receptor	Predicted Impact – BAT-AEL Limits		Predicted Impact – Abnormal Emission	
				Max PC	% of EAL	Max PC*	% of EAL
Group II Metals							
Mercury	1 hour mean	7,500	R35	7.9	0%	799.4	11%
Group III Metals							
Cobalt	1 hour mean	6,000	R35	118.9	2%	695.3	12%
Copper	1 hour mean	200,000	R35	118.9	0%	695.3	0%
Chromium	1 hour mean	150,000	R35	118.9	0%	695.3	0%
Manganese	1 hour mean	1,500,000	R35	118.9	0%	695.3	0%
Antimony	1 hour mean	150,000	R35	118.9	0%	695.3	0%
Vanadium	1 hour mean	1,000	R35	118.9	12%	695.3	70%
*Inclusive of non-abnormal PC at receptor from the EfW stacks							

A14.4.8 Similar to the EfW stacks, no exceedances of any of the short term Objectives or EALs are predicted, even taking into account the conservative nature of the assessment. The maximum predicted abnormal PC is vanadium, at 70% of the hourly mean Objective. The maximum predicted abnormal metal PC is mercury, at 70% of the EAL.

Predicted Long Term Impacts

A14.4.9 The effect on long term PCs associated with the Facility operating at the identified abnormal emission levels (for both the EfW and LWA lines) has been calculated by increasing pro-rata (see **Table A14.6-1** and **Table A14.6-2** for factors applied) the predicted long-term PCs.

A14.4.10 The annual operating hours of the EfW and LWA lines will be approximately 8,000 hours (91% of the year), due to scheduled plant downtime (e.g., planned maintenance). Therefore, this assessment assumed that the Facility is operating at the BAT-AEL emission limits for 7,940 hours per year and at the predicted

abnormal emission levels (detailed in **Table A14.6-1** and **Table A14.6-2**) for 60 hours per year, as considered using the formula below.

$$Predicted\ Abnormal\ Emission\ LT\ PC\ = Max\ LT\ PC\ * (\left(Factor * \frac{60}{8{,}000}\right) + \frac{7{,}940}{8{,}000})$$

EfW Lines

A14.4.11 The long term PCs associated with the three EfW lines of the Facility operating under abnormal conditions concurrently are detailed below in **Table A14.6-7** and **Table A14.6-8**.

Table A14.6-7 Long-term Impacts Resulting from Predicted Abnormal Emissions from the three EfW Lines of the Facility (Concurrently) – Non-Metals

Pollutant	Objective/EAL ($\mu g.m^{-3}$)	Worst Case Receptor	Predicted Impact – BAT-AEL Limits		Predicted Impact – Abnormal Emission	
			Max PC	% of EAL	Max PC*	% of EAL
Nitrogen dioxide (NO_2)	40	R5	2.0	5%	2.8	7%
Particulate matter (PM_{10})	40	R5	0.1	0%	0.2	0%
Particulate matter ($PM_{2.5}$)	25	R5	0.1	0%	0.2	1%
Hydrogen chloride (HCl)	20	R5	0.1	1%	0.2	1%
Hydrogen fluoride (HF)	16	R5	0.0	0%	0.0	0%
*Inclusive of non-abnormal PC at receptor from the LWA stacks						

Table A14.6-8 Long-term Impacts Resulting from Predicted Abnormal Emissions from the three EfW Lines of the Facility (Concurrently) – Metals

Pollutant	EAL ($ng.m^{-3}$)	Worst Case Receptor	Predicted Impact – BAT-AEL Limits		Predicted Impact – Abnormal Emission	
			Max PC	% of EAL	Max PC*	% of EAL
Group I Metals						
Cadmium	5	R5	0.5	10%	1.0	20%
Thallium	1,000	R5	0.5	0%	1.0	0%
Group II Metals						
Mercury	250	R5	0.5	0%	1.0	0%
Group III Metals						
Arsenic	6	R5	0.6	10%	0.8	14%
Cobalt	200	R5	0.1	0%	0.2	0%

Pollutant	EAL ($ng.m^{-3}$)	Worst Case Receptor	Predicted Impact – BAT-AEL Limits		Predicted Impact – Abnormal Emission	
			Max PC	% of EAL	Max PC*	% of EAL
Copper	10,000	R5	0.7	0%	1.0	0%
Chromium	5,000	R5	2.2	0%	3.1	0%
Chromium (VI)	0.25	R5	0.0	1%	0.0	2%
Manganese	150	R5	1.5	1%	2.0	1%
Nickel	20	R5	1.3	6%	1.8	9%
Lead	250	R5	1.2	0%	1.7	1%
Antimony	5,000	R5	0.3	0%	0.4	0%
Vanadium	5,000	R5	0.1	0%	0.2	0%
*Inclusive of non-abnormal PC at receptor from the LWA stacks						

A14.4.12 The long term PCs from abnormal emissions for a maximum of 60 hours per year from the three EfW lines are not predicted to exceed any of the long term Objectives or EALs. The maximum predicted abnormal PC is cadmium, at 20% of the EAL. The maximum predicted abnormal non-metal PC is nitrogen dioxide, at 7% of the annual mean Objective.

LWA Lines

A14.4.13 The long term PCs associated with the two LWA lines of the Facility operating under abnormal conditions concurrently are detailed below in **Table A14.6-9** and **Table A14.6-10**.

Table A14.6-9 Long-term Impacts Resulting from Predicted Abnormal Emissions from the two LWA Lines of the Facility (Concurrently) – Non-Metals

Pollutant	Objective/EAL ($\mu g.m^{-3}$)	Worst Case Receptor	Predicted Impact – BAT-AEL Limits		Predicted Impact – Abnormal Emission	
			Max PC	% of EAL	Max PC**	% of EAL
Nitrogen dioxide (NO_2)	40	R35	1.9	5%	3.9	10%
Particulate matter (PM_{10})	40	R35	0.1	0%	0.2	1%
Particulate matter ($PM_{2.5}$)	25	R35	0.1	0%	0.2	1%
Hydrogen chloride (HCl)	20	R35	0.1	1%	0.3	1%
Hydrogen fluoride (HF)	16*	R35	0.0	0%	0.0	0%

Pollutant	Objective/EAL ($\mu g.m^{-3}$)	Worst Case Receptor	Predicted Impact – BAT-AEL Limits		Predicted Impact – Abnormal Emission	
			Max PC	% of EAL	Max PC**	% of EAL
*The long term HF EAL is a monthly mean; however monthly averaging periods cannot be run in the ADMS 5 model. Therefore, the predicted annual average concentration has been used in the assessment as the monthly average concentration. **Inclusive of non-abnormal PC at receptor from the EfW stacks						

Table A14.6-10 Long-term Impacts Resulting from Predicted Abnormal Emissions from the two LWA Lines of the Facility (Concurrently) – Metals

Pollutant	EAL ($ng.m^{-3}$)	Worst Case Receptor	Predicted Impact – BAT-AEL Limits		Predicted Impact – Abnormal Emission	
			Max PC	% of EAL	Max PC*	% of EAL
Group I Metals						
Cadmium	5	R35	0.5	9%	1.3	25%
Thallium	1,000	R35	0.5	0%	1.3	0%
Group II Metals						
Mercury	250	R35	0.5	0%	1.3	1%
Group III Metals						
Arsenic	6	R35	0.6	10%	1.2	19%
Cobalt	200	R35	0.1	0%	0.3	0%
Copper	10,000	R35	0.7	0%	1.4	0%
Chromium	5,000	R35	2.1	0%	4.3	0%
Chromium (VI)	0.25	R35	0.0	1%	0.0	2%
Manganese	150	R35	1.4	1%	2.8	2%
Nickel	20	R35	1.2	6%	2.5	12%
Lead	250	R35	1.2	0%	2.3	1%
Antimony	5,000	R35	0.3	0%	0.5	0%
Vanadium	5,000	R35	0.1	0%	0.3	0%
*Inclusive of non-abnormal PC at receptor from the EfW stacks						

A14.4.14 The long term PCs from abnormal emissions for a maximum of 60 hours per year of the two LWA lines are not predicted to exceed any of the long term Objectives or EALs. The maximum predicted abnormal PC is cadmium, at 25% of the EAL.

The maximum predicted abnormal non-metal PC is nitrogen dioxide, at 10% of the annual mean Objective.

A14.5 Abnormal Operations – Predicted Environmental Concentrations (PECs)

A14.5.1 In accordance with Environment Agency (2021) guidance, PCs are considered to be insignificant if they are below the following criteria:

- 10% of a short-term environmental standard; and
- 1% of a long-term environmental standard.

A14.5.2 Where the impact of abnormal emissions is greater than the above, consideration of the background concentration has been made to ensure that the Objective or EAL is not exceeded as a result of abnormal operating conditions.

Background Concentrations

A14.5.3 The annual average background concentrations that have been used to assess the impact of the Facility are detailed in **Appendix A**. The PC from the Biomass UK No. 3 facility, which is currently being commissioned, were added to the background concentrations, as the PCs from this facility would not be included in the background pollutant concentrations.

A14.5.4 For the consideration of short-term averaging periods, the background has been doubled, in accordance with Environment Agency (2021) guidance.

Predicted Short Term Impacts

EfW Lines

A14.5.5 **Table A14.6-11** and **Table A14.6-12** present the impacts of predicted abnormal operations of the three EfW lines (concurrently) in the short term at the worst

case receptor and the Predicted Environmental Concentration (PEC) (i.e., PC plus 'total background concentration').

Table A14.6-11 Short Term PEC Resulting from Predicted Abnormal Emissions of the three EfW Lines - Non-Metals

Pollutant	Averaging Period	Objective/ EAL ($\mu g.m^{-3}$)	Total Background Conc. ($\mu g.m^{-3}$)	Max PC Abnormal Emissions		PEC Abnormal Emissions	
				($\mu g.m^{-3}$)	% of EAL	($\mu g.m^{-3}$)	% of EAL
Nitrogen dioxide (NO_2)	1 hour mean (99.79th Percentile)	200	22.1	109.5	55%	131.6	66%
Sulphur dioxide (SO_2)	15 minute mean (99.90th Percentile)	266	16.5	76.3	29%	92.9	35%
	1 hour mean (99.73rd Percentile)	350	12.7	66.7	19%	79.4	23%
	24 hour mean (99.18th Percentile)	125	5.6	13.4	11%	19.0	15%

Table A14.6-12 Short Term PEC Resulting from Predicted Abnormal Emissions of the three EfW Lines - Metals

Pollutant	Averaging Period	EAL ($ng.m^{-3}$)	Total Background Conc. ($ng.m^{-3}$)	Max PC Abnormal Emissions		PEC Abnormal Emissions	
				($ng.m^{-3}$)	% of EAL	($ng.m^{-3}$)	% of EAL
Group II Metals							
Mercury	1 hour mean	7,500	5.6	956.5	13%	962.1	13%
Cobalt	1 hour mean	6,000	30.1	791.4	13%	821.5	14%
Vanadium	1 hour mean	1,000	19.8	791.4	79%	811.2	81%

A14.5.6 As shown in the above tables, the PEC is not predicted to exceed the short term Objective/EAL at the point of maximum impact (i.e., worst receptor) for any pollutant whose PC exceeds 10% of the short term Objective/EAL during

abnormal operations of the three EfW lines, and as such will have **no significant impact**.

Predicted Short Term Impacts

LWA Lines

A14.5.7 **Table A14.6-13** and **Table A14.6-14** present the predicted impacts of predicted abnormal operations of the two LWA lines (concurrently) in the short term at the worst case receptor and the PEC.

Table A14.6-13 Short Term PEC Resulting from Predicted Abnormal Emissions of the two LWA Lines - Non-Metals

Pollutant	Averaging Period	Objective/ EAL ($\mu g.m^{-3}$)	Total Background Conc. ($\mu g.m^{-3}$)	Max PC Abnormal Emissions		PEC Abnormal Emissions	
				($\mu g.m^{-3}$)	% of EAL	($\mu g.m^{-3}$)	% of EAL
Nitrogen dioxide (NO_2)	1 hour mean (99.79th Percentile)	200	25.3	113.6	57%	138.9	69%
Sulphur dioxide (SO_2)	15 minute mean (99.90th Percentile)	266	18.4	69.8	26%	88.2	33%
	1 hour mean (99.73rd Percentile)	350	14.5	63.0	18%	77.5	22%
	24 hour mean (99.18th Percentile)	125	6.6	13.2	11%	19.8	16%

Table A14.6-14 Short Term PEC Resulting from Predicted Abnormal Emissions of the two LWA Lines - Metals

Pollutant	Averaging Period	EAL ($ng.m^{-3}$)	Total Background Conc. ($ng.m^{-3}$)	Max PC Abnormal Emissions		PEC Abnormal Emissions	
				($ng.m^{-3}$)	% of EAL	($ng.m^{-3}$)	% of EAL
Group II Metals							
Mercury	1 hour mean	7,500	5.6	799.4	11%	805.1	11%
Cobalt	1 hour mean	6,000	30.1	695.3	12%	725.4	12%
Vanadium	1 hour mean	1,000	19.8	695.3	70%	715.2	72%

A14.5.8 As shown in the above tables, the PEC is not predicted to exceed the short term Objective/EAL at the point of maximum impact (i.e., worst receptor) for any pollutant whose PC exceeds 10% of the short term Objective/EAL during abnormal operations of the two LWA lines, and as such will have **no significant impact**.

Predicted Long Term Impacts

A14.5.9 As stated in **Section 0**, the assessment assumed that the Facility is operational at the BAT-AEL emission limits for 7,940 hours per year and at the predicted abnormal emission level for 60 hours per year (assuming the Facility is operational for 8,000 hours per year).

EfW Lines

A14.5.10 **Table A14.6-15** and **Table A14.6-16** present the predicted impacts of predicted abnormal operations of the three EfW lines (concurrently) in the long term at the worst case receptor and the PEC.

Table A14.6-15 Long Term PEC Resulting from Predicted Abnormal Emissions of the three EfW Lines - Non-Metals

Pollutant	Objective/ EAL ($\mu g.m^{-3}$)	Total Background Conc. ($\mu g.m^{-3}$)	Max PC Abnormal Emissions		PEC Abnormal Emissions	
			($\mu g.m^{-3}$)	% of EAL	($\mu g.m^{-3}$)	% of EAL
Nitrogen dioxide (NO_2)	40	9.6	2.8	7%	12.5	31%
Particulate matter ($PM_{2.5}$)	25	8.4	0.2	1%	8.6	34%
Hydrogen chloride (HCl)	20	0.2	0.2	1%	0.4	2%

Table A14.6-16 Long Term PEC Resulting from Predicted Abnormal Emissions of the three EfW Lines - Metals

Pollutant	EAL ($ng.m^{-3}$)	Total Background Conc. ($ng.m^{-3}$)	Max PC Abnormal Emissions		PEC Abnormal Emissions	
			($ng.m^{-3}$)	% of EAL	($ng.m^{-3}$)	% of EAL
Group I Metals						
Cadmium	5	0.3	1.0	20%	1.3	26%
Group III Metals						

Pollutant	EAL ($ng.m^{-3}$)	Total Background Conc. ($ng.m^{-3}$)	Max PC Abnormal Emissions		PEC Abnormal Emissions	
			($ng.m^{-3}$)	% of EAL	($ng.m^{-3}$)	% of EAL
Arsenic	6	2.3	0.8	14%	3.1	52%
Chromium (VI)	0.25	0.2	0.0	2%	0.2	88%
Manganese	150	4.6	2.0	1%	6.6	4%
Nickel	20	2.4	1.8	9%	4.2	21%
Lead	250	5.5	1.7	1%	7.2	3%

A14.5.11 As shown in the above tables, the PEC is not predicted to exceed the long term Objective/EAL at the point of maximum impact (i.e., worst receptor) for any pollutant whose PC exceeds 1% of the long term Objective/EAL during abnormal operations of the three EfW lines, and as such will have **no significant impact**.

LWA Lines

A14.5.12 **Table A14.6-17** and **Table A14.6-18** present the predicted impacts of predicted abnormal operations of the three EfW lines (concurrently) in the long term at the worst case receptor and the PEC.

Table A14.6-17 Long Term PEC Resulting from Predicted Abnormal Emissions of the two LWA Lines - Non-Metals

Pollutant	Objective/ EAL ($\mu g.m^{-3}$)	Total Background Conc. ($\mu g.m^{-3}$)	Max PC Abnormal Emissions		PEC Abnormal Emissions	
			($\mu g.m^{-3}$)	% of EAL	($\mu g.m^{-3}$)	% of EAL
Nitrogen dioxide (NO_2)	40	9.8	3.9	10%	13.7	34%
Particulate matter (PM_{10})	40	14.9	0.2	1%	15.1	38%
Particulate matter ($PM_{2.5}$)	25	8.4	0.2	1%	8.7	35%
Hydrogen chloride (HCl)	20	0.2	0.3	1%	0.5	2%

Table A14.6-18 Long Term PEC Resulting from Predicted Abnormal Emissions of the two LWA Lines - Metals

Pollutant	EAL ($ng.m^{-3}$)	Total Background Conc. ($ng.m^{-3}$)	Max PC Abnormal Emissions		PEC Abnormal Emissions	
			($ng.m^{-3}$)	% of EAL	($ng.m^{-3}$)	% of EAL
Group I Metals						
Cadmium	5	0.3	1.3	25%	1.5	31%
Group II Metals						
Mercury	250	1.5	1.3	1%	2.7	1%
Group III Metals						
Arsenic	6	2.3	1.2	19%	3.5	58%
Chromium (VI)	0.25	0.2	0.0	2%	0.2	89%
Manganese	150	4.6	2.8	2%	7.4	5%
Nickel	20	2.4	2.5	12%	4.9	24%
Lead	250	5.5	2.3	1%	7.8	3%

A14.5.13 As shown in the above tables, the PEC is not predicted to exceed the long term Objective/EAL at the point of maximum impact (i.e., worst receptor) for any pollutant whose PC exceeds 1% of the long term Objective/EAL during abnormal operations of the two LWA lines, and as such will have **no significant impact**.

A14.6 Summary

A14.6.1 An impact assessment of abnormal operating conditions of the EfW lines and LWA lines has been presented in this report. The predicted impact on air quality associated with the identified predicted abnormal emissions has been calculated by increasing pro-rata the process contribution (PC) associated with normal operations by the ratio between the normal and predicted abnormal emission limit values. This is considered a highly conservative assessment, as it assumes that the predicted abnormal emissions coincide with the worst case meteorological conditions, over a five year period, at a worst case receptor. It has also been conservatively considered that all three lines of the EfW or both

lines of the LWA plant would operate under abnormal conditions at the same time, which is unlikely to ever occur.

A14.6.2 No exceedances of any of the short- or long-term air quality Objectives or Environmental Assessment Levels (EALs) have been predicted during abnormal operating conditions of the EfW or LWA lines.

A14.6.3 The maximum predicted short term PC as a % of the Objective/EAL is 79% (vanadium) and the maximum predicted long term PC as a % of the Objective/EAL is 25% (cadmium). The maximum predicted short term Predicted Environmental Concentration (PEC) (i.e., PC plus 'total background concentration' (see **Appendix A**)) as a % of the Objective/EAL is 81% (vanadium) and the maximum predicted long term PEC as a % of the Objective/EAL is 89% (Chromium VI, note 87% of this is the 'total background concentration' and the abnormal emission PC contributes to only 2% of the EAL).

A14.6.4 It has been concluded that under abnormal operating conditions, all air quality impacts are considered to be **insignificant**.

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Appendix A: Summary of Total Background Concentrations

Background Concentrations

Pollutant		Annual Mean Concentration	Units	Source
Nitrogen Dioxide (NO_2)	R5	9.3	$\mu g.m^{-3}$	2025 concentration from 2018-based Defra (2020a) background maps
	R10	8.2		
	R35	9.3		
Particulates (PM_{10})	R5	14.9	$\mu g.m^{-3}$	
	R35	14.9		
Particulates ($PM_{2.5}$)	R5	8.4	$\mu g.m^{-3}$	
	R35	8.4		
Sulphur Dioxide (SO_2)	R10	2.4	$\mu g.m^{-3}$	2001 Defra background maps (Defra, 2001) (latest available)
	R35	2.7		
Hydrogen Chloride (HCl)		0.2	$\mu g.m^{-3}$	2015 average concentration of gaseous HCl at Stoke Ferry monitoring station (Defra, 2020b) (latest available)
Hydrogen Fluoride (HF)		0.00000246	$\mu g.m^{-3}$	Defra guidance (2006) for reasonable expectation of maximum 1-hour mean HF concentration for a rural site exposed to power station plumes. This value was also used for the annual mean concentration to provide a conservative estimate.
Mercury (Hg)		0.00131	$\mu g.m^{-3}$	2013 annual mean from Heigham Holmes rural background monitoring site (latest data available) (Defra, 2020c)
Cadmium (Cd)		0.0001	$\mu g.m^{-3}$	2019 annual mean from Heigham Holmes rural background monitoring site (Defra, 2020c)
Arsenic (As)		0.00058	$\mu g.m^{-3}$	
Cobalt (Co)		0.000056	$\mu g.m^{-3}$	
Copper (Cu)		0.0022	$\mu g.m^{-3}$	
Chromium (Cr)		0.00108	$\mu g.m^{-3}$	
Manganese (Mn)		0.0029	$\mu g.m^{-3}$	2019 annual mean from Heigham Holmes rural background monitoring site (Defra, 2020c)
Nickel (Ni)		0.0007	$\mu g.m^{-3}$	
Lead (Pb)		0.0038	$\mu g.m^{-3}$	
Vanadium (V)		0.00092	$\mu g.m^{-3}$	
Antimony (Sb)		Assumed 0	$\mu g.m^{-3}$	

Pollutant	Annual Mean Concentration	Units	Source
Thallium (Tl)	Assumed 0	$\mu g.m^{-3}$	No data available for background concentrations of antimony or thallium as they are not measured in the UK, and therefore background concentrations were assumed to be zero

Calculation of 'Total Background Concentrations' Used

Short Term - EfW Lines

Pollutant	Worst Case Receptor	Short Term Background Conc.	Biomass UK No. 3 Ltd PC at Receptor	Total 'Background Concentration'
		($\mu g.m^{-3}$)		
Nitrogen dioxide (NO_2)	R10	16.3	5.8	**22.1**
Particulate matter (PM_{10})	R5	29.7	0.1	**29.8**
Sulphur dioxide (SO_2) – 15 minute	R10	4.8	11.7	**16.5**
Sulphur dioxide (SO_2) – 1 hr	R10	4.8	7.9	**12.7**
Sulphur dioxide (SO_2) – 24hr	R10	4.8	0.7	**5.6**
Hydrogen chloride (HCl)	R10	0.4	3.1	**3.5**
Hydrogen fluoride (HF)	R10	0.0	0.2	**0.2**

Pollutant	Worst Case Receptor	Short Term Background Conc.	Biomass UK No. 3 Ltd PC at Receptor	Total 'Background Concentration'
		($ng.m^{-3}$)		
Thallium	R10	-	3.0	**3.0**
Mercury	R10	2.6	3.0	**5.6**
Cobalt	R10	0.1	30.0	**30.1**
Copper	R10	4.4	30.0	**34.4**
Chromium	R10	1.7	6.0	**7.7**
Manganese	R10	5.7	30.0	**35.7**
Antimony	R10	-	30.0	**30.0**
Vanadium	R10	1.8	18.0	**19.8**

Short Term - LWA Lines

Pollutant	Worst Case Receptor	Short Term Background Conc.	Biomass UK No. 3 Ltd PC at Receptor	Total 'Background Concentration'
		($\mu g.m^{-3}$)		
Nitrogen dioxide (NO_2)	R35	18.7	6.6	**25.3**
Particulate matter (PM_{10})	R35	29.7	0.1	**29.8**
Sulphur dioxide (SO_2) – 15 minute	R35	5.4	13.0	**18.4**
Sulphur dioxide (SO_2) – 1 hr	R35	5.4	9.1	**14.5**
Sulphur dioxide (SO_2) – 24hr	R35	5.4	1.2	**6.6**
Hydrogen chloride (HCl)	R35	0.4	3.2	**3.6**
Hydrogen fluoride (HF)	R35	0.0	0.2	**0.2**

Pollutant	Worst Case Receptor	Short Term Background Conc.	Biomass UK No. 3 Ltd PC at Receptor	Total 'Background Concentration'
		($ng.m^{-3}$)		
Thallium	R35	-	3.0	**3.0**
Mercury	R35	2.6	3.0	**5.6**
Cobalt	R35	0.1	30.0	**30.1**
Copper	R35	4.4	30.0	**34.4**
Chromium	R35	2.2	6.0	**8.2**
Manganese	R35	5.7	30.0	**35.7**
Antimony	R35	-	30.0	**30.0**
Vanadium	R35	1.8	18.0	**19.8**

Long Term - EfW Lines

Pollutant	Worst Case Receptor	Annual Mean Background Conc.	Biomass UK No. 3 Ltd PC at Receptor	Total 'Background Concentration'
		($\mu g.m^{-3}$)		
Nitrogen dioxide (NO_2)	R5	9.3	0.3	**9.6**
Particulate matter (PM_{10})	R5	14.9	0.0	**14.9**
Particulate matter ($PM_{2.5}$)	R5	8.4	0.0	**8.4**
Hydrogen chloride (HCl)	R5	0.2	-	**0.2**

Pollutant	Worst Case Receptor	Annual Mean Background Conc.	Biomass UK No. 3 Ltd PC at Receptor	Total 'Background Concentration'
		($\mu g.m^{-3}$)		
Hydrogen fluoride (HF)	R5	0.0	0.0	**0.0**

Pollutant	Worst Case Receptor	Annual Mean Background Conc.	Biomass UK No. 3 Ltd PC at Receptor	Total 'Background Concentration'
		($ng.m^{-3}$)		
Cadmium	R5	0.1	0.2	**0.3**
Thallium	R5	-	0.2	**0.2**
Mercury	R5	1.3	0.2	**1.5**
Arsenic	R5	0.6	1.7	**2.3**
Cobalt	R5	0.1	1.7	**1.8**
Copper	R5	2.2	1.7	**3.9**
Chromium	R5	0.9	1.3	**2.2**
Chromium (VI)	R5	0.2	0.0	**0.2**
Manganese	R5	2.9	1.7	**4.6**
Nickel	R5	0.7	1.7	**2.4**
Lead	R5	3.8	1.7	**5.5**
Antimony	R5	-	1.7	**1.7**
Vanadium	R5	0.9	1.7	**2.6**

Long Term - LWA Lines

Pollutant	Worst Case Receptor	Annual Mean Background Conc.	Biomass UK No. 3 Ltd PC at Receptor	Total 'Background Concentration'
		($\mu g.m^{-3}$)		
Nitrogen dioxide (NO_2)	R35	9.3	0.5	**9.8**
Particulate matter (PM_{10})	R35	14.9	0.0	**14.9**
Particulate matter ($PM_{2.5}$)	R35	8.4	0.0	**8.4**
Hydrogen chloride (HCl)	R35	0.2	-	**0.2**
Hydrogen fluoride (HF)	R35	0.0	0.0	**0.0**

Pollutant	Worst Case Receptor	Annual Mean Background Conc.	Biomass UK No. 3 Ltd PC at Receptor	Total 'Background Concentration'
		($ng.m^{-3}$)		
Cadmium	R35	0.1	0.2	**0.3**
Thallium	R35	-	0.2	**0.2**
Mercury	R35	1.3	0.2	**1.5**
Arsenic	R35	0.6	1.7	**2.3**
Cobalt	R35	0.1	1.7	**1.8**
Copper	R35	2.2	1.7	**3.9**
Chromium	R35	0.9	1.3	**2.2**
Chromium (VI)	R35	0.2	0.0	**0.2**
Manganese	R35	2.9	1.7	**4.6**
Nickel	R35	0.7	1.7	**2.4**
Lead	R35	3.8	1.7	**5.5**
Antimony	R35	-	1.7	**1.7**
Vanadium	R35	0.9	1.7	**2.6**