Air Quality Assessment of Abnormal Operations

Proposed Small Waste Incineration Plant

203 Burcott Road, Avonmouth, Bristol

For Pyrocore

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Quality Management

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Contents

Tables, Figures and Appendices

Tables

1 Introduction

1.1 An air quality impact assessment has been undertaken to accompany the permit application for the proposed small waste incinerator at 203 Burcott Road, Avonmouth, Bristol. The permit application has been prepared to support the application for a change of use of the site to allow the assembly and calibration of a small-scale containerised pyrolysis plant on site. The small-scale containerised plant will pyrolyse waste and is of a scale trod all under the definition of a small waste incineration plant (SWIP).

1.2 This report provides the results of an assessment of the potential long and short-term air quality impacts during abnormal operations. The results during normal operations are presented in the RPS September 2021 Air Quality Assessment Proposed Small Waste Incineration Plant report [1].

2 Abnormal Operations

Background

2.1 Article 46 of the Industrial Emissions Directive (IED) [2] provides operators with some operational flexibility to resolve plant problems without initiating a complete shutdown of the facility. These scenarios are termed 'abnormal operations' and include incidents such as technically unavoidable stoppages, disturbances, or failures of the air pollution control equipment or monitoring equipment.

2.2 The IED requires that such abnormal operations must not exceed a maximum of four hours at any one time and the cumulative duration of these periods must not exceed 60 hours in a year. If the failure cannot be rectified after four hours, then the facility must shutdown.

2.3 The modelling results presented in the Air Quality Assessment were prepared on the basis of continuous operations, with emissions to air for each pollutant considered being at the IED limits for the entire time. In practice, for the majority of plant operating conditions, emissions would be well below the IED limits.

2.4 The potential long-term and short-term air quality impacts during abnormal operations are summarised below.

Failure of the Selective Non-Catalytic Reduction (SNCR) System

2.5 The SNCR air pollution control system is expected to abate nitrogen oxides (NO_x) down to levels well below the IED daily-mean emissions limit value of 200 $mg.m^{-3}$. Unabated concentrations of NO_x are anticipated to be 600 $mg.m^{-3}$, i.e. 1.5 times the daily-mean emissions limit value.

2.6 The IED emission limit applies to NOx emissions. In order to assess the human-health related impacts of abnormal operations NO_x concentrations need to be converted to nitrogen dioxide (NO_2). Total conversion (i.e. 100%) of NO to NO_2 is sometimes used for the estimation of the absolute upper limit of the annual mean NO_2. This technique is based on the assumption that all NO emitted is converted to NO_2 before it reaches ground level. However, in reality the conversion is an equilibrium reaction and even at ambient concentrations a proportion of NO_X remains in the form of NO.

2.7 Historically, the Environment Agency has recommended that for a 'worse case scenario', a 70% conversion of NO to NO_2 should be considered for calculation of annual average concentrations. Following the withdrawal of the Environment Agency's H1 guidance document, there is no longer an explicit recommendation; however, for the purposes of determining the impacts during abnormal operations, a 70% conversion of NO to NO_2 has been assumed for annual average NO_2 concentrations in line with the Environment Agency's historic recommendations and an assumed conversion of 35% follows the Environment Agency's recommendations [3] for the calculation of 'worse case scenario' short-term NO_2 concentrations. This is consistent with the methodology adopted for the Air Quality Assessment.

2.8 The ground-level concentrations under abnormal operations are then compared to the relevant Environmental Assessment Levels (EALs) for ambient NO_2 concentrations set out in Table 2.5 of the Air Quality Assessment but repeated, as appropriate, throughout this report for ease of reference.

2.9 Under abnormal operations, the maximum short-term emission rate has been considered to be 600 mg/m^3 i.e. 1.5 times the normal emission rate and this will have the effect of increasing the modelled Process Contribution (PC) by a factor of 1.5.

2.10 The maximum long-term PC for NO_2 under normal operating conditions is 5.0 $\mu g.m^{-3}$. Under abnormal operations, emissions are expected to be 3 times the normal operating concentration for a maximum of 60 hours out of the year and, as such, the PC can be calculated using the following formula 5.0 x [(3 x 60/3032) + (2972/3032)], based on 18 weeks of operation throughout the year.

2.11 The predicted NO_2 PCs under normal and abnormal operations are set out in Table 2.1.

Table 2.1 Predicted Concentrations ($\mu g.m^{-3}$) During Normal and Abnormal Operations

			Normal			Abnormal				
Pollutant	**Averaging Period**	**EAL**	**Max PC**	**Max PC as % of EAL**	**Max PC**	**PC as % of EAL**	**Is PC Potentially Significant ?**	**AC**	**PEC**	**PEC as % of EAL**
NO_2	99.79th Percentile Hourly mean	200	45.1	23	67.6	34	Yes	67.2	134.8	67
	Annual mean	40	5.0	13	5.2	13	Yes	33.6	38.9	97

PCs drawn from Table 5.1 of the Air Quality Assessment

2.12 Under abnormal operations, the maximum NO_2 PC is predicted to be 5.2 µg.m^{-3}. This equates to 13% of the EAL of 40 µg.m^{-3} and cannot therefore be screened out without considering the PEC. The PEC during abnormal operations is 38.9 µg.m^{-3}, which is 97% of the EAL. The headroom between the PEC and the EAL of 40 µg.m^{-3} is considered to provide sufficient headroom to avoid significant adverse effects to human health and the environment.

Failure of the Acid Gas Abatement System

Short-term Impacts

2.13 Failure of the acid gas abatement system has been considered as follows. The unabated emission of each acid gas is expected to be HCl 115 mg.m^{-3}, HF 3.9 mg.m^{-3} and SO_2 754 mg.m^{-3}. The abnormal PC has been calculated based on the ratio of unabated emissions to IED short-term emission limits and reported in Table 2.2.

Table 2.2: Predicted Short-term Concentrations (µg.m^{-3}) During Normal and Abnormal Operations

Pollutant	Averaging Period	EAL	Normal		Abnormal					
			Max PC	PC as % of EAL	Max PC	PC as % of EAL	Is PC Potentially Significant ?	AC	PEC	PEC as % of EAL
HCl	1 hour (max)	750	20.7	3	39.6	5	No	-	-	-
HF	1 hour (max)	160	1.4	1	1.3	1	No	-	-	-
	1 hour (monthly mean)	16	0.1	1	0.5	3	Yes	2.46	2.96	19
SO_2	15 min (99.9th %ile)	266	69.2	26	260.7	98	Yes	3.05	263.75	99
	1 hr (99.73th %ile)	350	63.4	18	239.1	68	Yes	3.05	242.12	69
	Daily-mean (99.18th %ile)	125	45.0	36	169.8	136	Yes	3.05	172.87	138

PCs drawn from Table 5.1 of the Air Quality Assessment

2.14 Short-term emissions of HCl and HF (1 hour mean) can be screened out as insignificant based on the PC being less than 10% of the EAL. The PECs for 15 minute and 1 hour SO_2 and HF (monthly mean) are below the EALs over the relevant averaging periods and as such will have no significant adverse effect. The PEC for daily-mean SO_2 is predicted to be 138% of the EAL and is potentially significant.

2.15 The results presented in this report are based on the maximum across the modelled grid. When considering the results at the modelled sensitive receptors, the predicted abnormal concentrations are lower. The daily-mean would apply at residential receptors (receptors 8 to 10) and not at the industrial receptors (1 to 7). The maximum abnormal PC at residential receptors has been calculated based on the ratio of unabated emissions to IED short-term emission limits and reported in Table 2.3.

Table 2.3: Predicted Short-term Concentrations (µg.m^{-3}) During Normal and Abnormal Operations at Residential Receptors

Pollutant	Averaging Period	EAL	Normal		Abnormal		
			Max PC	PC as % of EAL	Max PC	PC as % of EAL	Is PC Potentially Significant?
SO_2	Daily-mean (99.18th %ile)	125	0.55	0	2.1	2	No

2.16 The PC is less than 10% of the EAL at residential receptors and therefore can be screened out as insignificant.

Failure of the Activated Carbon Injection System (Vapour phase heavy metal control)

2.17 It has been conservatively assumed that in the event of a failure of the activated carbon system all emissions will increase by an order of 100 times.

Metals

Short-term Impacts

2.18 Based on the assumption above it has been assumed that heavy metals are emitted at 100 times the mass emitted under normal operations. Table 2.4 sets out the PC under abnormal operations.

Table 2.4: Predicted Short-term Concentrations (µg.m^{-3}) During Normal and Abnormal Operations

Pollutant	EAL	Normal		Abnormal					
		Max PC	PC as % of EAL	Max PC	PC as % of EAL	Is PC Potentially Significant?	AC	PEC	PEC as % of EAL
Tl	30	0.017	0	1.72	6	No	-	-	-
Hg	7.5	0.017	0	1.72	23	Yes	0.017	1.74	23
Sb	150	0.172	0	17.24	11	Yes	0.001	17.24	12
Cr	150	0.172	0	17.24	11	Yes	0.006	17.25	12
Cu	200	0.172	0	17.24	9	No	-	-	-
Mn	1500	0.172	0	17.24	1	No	-	-	-
V	1	0.172	17	17.24	1724	Yes	0.001	17.24	1724

PCs drawn from Table 5.1 of the Air Quality Assessment

2.19 The PEC for all short-term emissions, with the exception of vanadium are below the EAL and can be screened out as insignificant.

2.20 For vanadium, the predicted PC is more than 1% of the EAL and the PEC is above the EAL. These predictions assume that vanadium individually comprise the total of the group 3 metals emissions. In reality, the IED emission limit applies to all nine of the group 3 metals. The Environment Agency '*Releases from waste incinerators – Guidance on assessing group 3 metal stack emissions from incinerators'* version 4 (undated), provides a summary of 34 measured values for each metal recorded at 18 municipal waste and waste wood co-incinerators between 2007 and 2015. For vanadium, the measured concentration varies from <0.05% to 1.2% of the IED emission concentration limit. Table 2.5 shows the predicted PCs if vanadium is 1.2% of the emission limit. In this case, the predicted abnormal PC remains more than 1% of the EAL; however, the PEC is below the EAL. The vanadium impacts are therefore not considered to be significant.

Table 2.5: Predicted Long-term Concentrations (µg.m^{-3}) During Normal and Abnormal Operations – Step 2

Pollutant	EAL	Normal		Abnormal					
		Max PC	PC as % of EAL	Max PC	PC as % of EAL	Is PC Potentially Significant?	AC	PEC	PEC as % of EAL
V	1	0.002	0.21	0.21	21	Yes	0.001	0.21	21

2.21 It should be noted that the Activated Carbon injection system is used to control vapour phase emissions of metals. Most metals will be in the particulate phase, with only Hg and a limited amount of Cd emitted as vapour. As such failure of the Activated Carbon injection system is unlikely to lead to any significant short-term emissions of metals. No significant adverse effect on human health is anticipated

Long-term Impacts

2.22 Based on the assumption used above that heavy metals are emitted at 100 times the normal emission concentration for a maximum of 60 hours then under abnormal operations the impact can be calculated using the following formula: PC (normal) x [(100 x 60/3032) + (2972/3032)]. Table 2.6 sets out the PC under abnormal operations.

Table 2.6: Predicted Long-term Concentrations (µg.m^{-3}) During Normal and Abnormal Operations

Pollutant	EAL	Normal		Abnormal					
		Max PC	PC as % of EAL	Max PC	PC as % of EAL	Is PC Potentially Significant?	AC	PEC	PEC as % of EAL
Cd	0.005	0.002	36	0.005	106	Yes	0.000	0.006	115
Tl	1	0.002	0	0.005	1	No	-	-	-
Hg	0.25	0.002	1	0.005	2	Yes	0.017	0.022	9
Sb	5	0.172	3	0.510	10	Yes	0.001	0.511	10
As	0.003	0.018	599	0.053	1773	Yes	0.001	0.054	1801
Cr	5	0.018	0	0.053	1	Yes	0.006	0.059	1
Cr(VI)	0.0002	0.000	3	0.000	8	Yes	0.000	0.000	9
Co	0.2	0.018	9	0.053	27	Yes	0.024	0.077	39
Pb	0.25	0.018	7	0.053	21	Yes	0.008	0.062	25
Mn	0.15	0.018	12	0.053	35	Yes	0.008	0.062	41
Ni	0.02	0.018	90	0.053	266	Yes	0.001	0.054	271
V	5	0.018	0	0.053	1	Yes	0.000	0.053	1

PCs drawn from Table 5.1 of the Air Quality Assessment

2.23 The PEC for all long-term emissions, with the exception of Cd, As and Ni are below the EAL and can be screened out as insignificant.

2.24 The results presented in this report are based on the maximum across the modelled grid. When considering the results at the modelled sensitive receptors, the predicted abnormal concentrations are lower. The annual-mean would apply at residential receptors (receptors 8 to 10) and not at the industrial receptors (1 to 7). The maximum abnormal PC at residential receptors has been calculated based on the ratio of unabated emissions to IED short-term emission limits and reported in Table 2.7.

Table 2.7: Predicted Long-term Concentrations (µg.m^{-3}) During Normal and Abnormal Operations – Residential Receptors

Pollutant	EAL	Normal		Abnormal					
		Max PC	PC as % of EAL	Max PC	PC as % of EAL	Is PC Potentially Significant?	AC	PEC	PEC as % of EAL
Cd	0.005	0.00001	0.11	0.00002	0	No	0.00130	0.0013	26
As	0.003	0.00005	1.79	0.00016	5	Yes	0.00082	0.0010	33
Ni	0.020	0.00005	0.27	0.00016	1	No	0.00100	0.0012	6

2.25 The PEC is less than the EAL at residential receptors and therefore can be screened out as insignificant.

2.26 It should be noted that the Activated Carbon injection system is used to control vapour phase emissions of metals. Most metals will be in the particulate phase, with only Hg and a limited amount of Cd emitted as vapour at the stack temperature of around 140^{0}C. As such failure of the Activated Carbon injection system is unlikely to lead to any significant short-term impact.

PCBs

2.27 As for heavy metals, it has been assumed that PCBs are emitted at 100 times the mass emitted under normal operations. Table 2.8 sets out the PC under abnormal operations.

Table 2.8: Predicted Short-term Concentrations (µg.m^{-3}) During Normal and Abnormal Operations

Pollutant	EAL	Normal		Abnormal		
		Max PC	PC as % of EAL	Max PC	PC as % of EAL	Is PC Potentially Significant?
PCBs	6	2.88E-09	0	2.88E-07	0	No

PCs drawn from Table 5.1 of the Air Quality Assessment

2.28 The PC for PCBs is less than 10% of the EAL and can be screened out as insignificant.

Failure of the Bag Filters (Control of Particulates and Heavy Metals)

Particulate Matter

2.29 The EAL makes provisions for a daily-mean PM_{10} concentration of 50 $\mu g.m^{-3}$, not to be exceeded more than 35 times a year. Under the IED, abnormal emissions must not last longer than four hours, after which time the facility must cease operating.

2.30 As the EAL for PM_{10} is based on a daily-average, emissions during the abnormal operation have been calculated assuming that the plant operates abnormally for four hours during any 24 hour period. Part 3 to the IED specifies a maximum emission concentration during abnormal operations of 150 $mg.Nm^{-3}$ for total dust. This is five times greater than the maximum emission concentration of 30 $mg.Nm^{-3}$ specified in the IED for normal operations for short-term emissions. The 24-hour average PC for PM_{10} under abnormal operations has been calculated using the following formula: PC (normal) x [(5 x 4/24) + (20/24)].

2.31 For long-term emissions the maximum emission concentration of 150 $\mu g.m^{-3}$ is 15 times greater than the maximum emission concentration of 10 $\mu g.m^{-3}$ specified in the IED for normal operations. The annual-mean PC for PM_{10} has been calculated using the following formula: [PC (normal) x ((15 x 60/3032) + (2972/3032)].

2.32 The maximum abnormal PCs are reported in Table 2.9.

Table 2.9: Predicted PM_{10} Concentrations ($\mu g.m^{-3}$) During Normal and Abnormal Operations

Pollutant	Averaging Period	EAL	Normal		Abnormal					
			Max PC	Max PC as % of EAL	Max PC	PC as % of EAL	Is PC Potentially Significant?	AC	PEC	PEC as % of EAL
PM_{10}	90.41st Percentile Daily mean	50	5.4	11	9.0	18	Yes	43.8	52.8	106
	Annual mean	40	0.4	1	0.5	1	Yes	21.9	22.4	56

PCs drawn from Table 5.1 of the Air Quality Assessment

2.33 The annual-mean abnormal impacts can be screened out as insignificant as the PECs is less than the EAL. The PEC for the daily-mean abnormal emissions is 106% of the EAL and is potentially significant.

2.34 The results presented in this report are based on the maximum across the modelled grid. When considering the results at the modelled sensitive receptors, the predicted abnormal concentrations are lower. The daily-mean would apply at residential receptors (receptors 8 to 10) and not at the industrial receptors (1 to 7). The maximum abnormal PC at residential receptors has been calculated based on the ratio of unabated emissions to IED short-term emission limits and reported in Table 2.10.

Table 2.10: Predicted Short-term Concentrations (µg.m^{-3}) During Normal and Abnormal Operations at Residential Receptors

Pollutant	Averaging Period	EAL	Normal		Abnormal		
			Max PC	PC as % of EAL	Max PC	PC as % of EAL	Is PC Potentially Significant?
PM_{10}	90.41st Percentile Daily mean	50	0.03	0	0.06	0	No

2.35 The PC is less than 10% of the EAL at residential receptors and therefore can be screened out as insignificant.

Metals

2.36 If it assumed that the metals concentrations increase by the same ratio as total dust i.e 5 times the normal emissions for failure of the bag filters, the results presented in paragraphs 2.18 to 2.26 will be highly conservative.

3 Summary of Conclusions

3.1 Under abnormal operations, all air quality impacts are considered to have an insignificant effect.

References

1 RPS (2021) Air Quality Assessment Proposed Small Waste Incineration Plant, 203 Burcott Road, Avonmouth, Bristol, For Pyrocore.

2 Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) (Recast)

3 Environment Agency (undated) Conversion Ratios for NOx and NO_2

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