Air Quality Abnormal Operations Assessment: Bridgwater Resource Recovery Facility

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1 Introduction

1.1 This report provides the air quality modelling assessment relating to 'abnormal operations' to support the Environmental Permit application for the Resource Recovery Facility off Showground Road in Bridgwater.

1.2 The Environmental Permitting Regulations (2016) set the legislative background for environmental permitting in England and Wales. The Regulations include a commitment to minimise emissions to air from permitted processes, and include obligations for compliance with all legislated emissions limits for permitted processes, including the Industrial Emissions Directive (IED) (2010/75/EU, 2010) emission limits for waste incineration processes.

1.3 The IED sets total emission limit values (ELVs) for a number of pollutants typically emitted during waste incineration. The requirements of the IED were transposed into UK law on 27th February 2013 by the Environmental Permitting (England and Wales) (Amendment) Regulations (2013). These make any new installation seeking a permit after 28th February 2013 subject to the IED. This amendment was consolidated into the Environmental Permitting (England and Wales) Regulations (2016).

1.4 Articles 46(6) and 47 of the IED provide operators with rules under which they can seek 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 pollution control or emissions monitoring equipment. As detailed in Article 46(6) of the IED, 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 reduce or close down operations until normal operations can be restored.

1.5 Emissions under two abnormal operations scenarios have been provided by the Applicant for use in this assessment:

- Scenario 1: failure of individual abatement equipment; and
- Scenario 2: a General Stop of the plant (shut down) in the event of a loss of power.

1.6 The modelling assessment of the above scenarios has been undertaken based on the technical details and methodology presented in the air quality assessment for the Permit Application completed by AQC in March 2020 (AQC Report No. J1983G/1/F1), hereafter referred to as the '2020 Permit Air Quality Assessment'. As such, this report should be read in conjunction with the 2020 Permit Air Quality Assessment. This assessment has assumed that the emissions parameters such as temperature and volume flow rate will not differ significantly during abnormal operations from those under normal operations; as such, only the pollutant emission rates differ

from the model inputs outlined in the 2020 Permit Air Quality Assessment. The abnormal operations assessment has used the same models as submitted alongside the 2020 Permit Air Quality Assessment, which used a unitary emission rate; the abnormal operations emission rates have been applied in post-processing.

1.7 Pollutants modelled in the assessment, as requested by the EA, include:

- dioxins and furans;
- nitrogen dioxide (NO_2);
- fine airborne particulate matter (PM_{10});
- the following trace metals:
  - cadmium (Cd);
  - mercury (Hg);
  - antimony (Sb);
  - arsenic (As);
  - lead (Pb);
  - chromium (Cr);
  - copper (Cu);
  - magnesium (Mn);
  - nickel (Ni); and
  - vanadium (V);
- sulphur dioxide (SO_2);
- polychlorinated biphenyls (PCB); and
- hydrogen chloride (HCl).

1.8 In order to quantify the worst-case potential impact of the abnormal operations, the modelling has assumed continuous operation under abnormal operations for all eight of the meteorological years modelled, and the 100th percentile of hourly mean concentrations (or 24-hour mean concentrations in the case of particulate matter[1]) has been calculated, alongside an annual mean concentration. The approach is especially worst-case in the case of short-term concentrations. In order to determine the annual mean contribution of 60 hours of abnormal operations, the annual mean output has been factored by 60/8760.

[1] This approach conservatively assumes that abnormal operations could take place for a full 24-hour period when, in reality, the IED limits them to a maximum of four concurrent hours.

1.9 To consider the potential impacts of the abnormal operations scenarios, these values have been compared to the annual mean and 100th percentile of hourly mean contributions of the plant under normal operations.

2 Emission Parameters

2.1 The Applicant has provided pollutant emission rates to be used in the assessment for each of the abnormal operation scenarios. For Scenario 1, a description of the equipment failure that would cause the abnormal emissions is also provided, in Table 1. The applicant has advised that these situations would normally be expected to be rectified within 30 minutes, i.e. the emission rates described in Table 1 would typically occur for no longer than 30 minutes. Some pollutants will have elevated emissions under more than one failure scenario; where this occurs only the higher emission rate has been used and is presented in Table 1.

2.2 While the data provided by the Applicant suggests a maximum dust emission rate of 20 mg/Nm^3 following the failure of a bag in the bag filter, the Environment Agency has requested that an emission rate of 150 mg/Nm^3 is used for this scenario; the results presented later in this report for Scenario 1 are, therefore, based on this higher emission rate.

2.3 Emission rates have not been provided for TOCs or for PCBs for Scenario 1. However, the Applicant has provided typical pollutant concentrations in the post-boiler exhaust gas stream, prior to the flue gas abatement equipment. These data show TOC concentrations in the unabated exhaust gas to be <10 mg/Nm^3, which also happens to be the 'normal operations' daily average emission rate required by IED. As such, it has been assumed that emission rates for TOCs and PCBs will not be elevated (when compared with those modelled for normal operations[2]) under abnormal operations.

2.4 The emission rate provided for hydrogen fluoride is identical to that modelled for normal operations, thus it is assumed that emissions of this pollutant will not be elevated under abnormal operations.

2.5 On the basis of the above, no results have been presented for Scenario 1 for TOC, PCB or HF.

[2] i.e. in practice, the assumption that under normal operations, emissions will be no lower than the IED emissions limit is likely to be worst-case and this worst-case modelling will thus also cover abnormal operation conditions.

Table 1: Scenario 1 - Emissions Following Failure of Individual Abatement Equipment

Failure	Pollutant	Emissions (mg/Nm^3)
Magnesium Lime or Lime blackout	SO_2	<387
	HCL	<992
	HF	<1
Activated carbon blackout	Heavy metals (Sb + As + Pb + Cr + Cu + Mn + Ni + V)	<5
	Cd and Tl	<3
	Hg	<0.8
SNCR or SCR NH_3 blackout	NOx	<500
Sudden breakage of a bag	Dust	<10-20
Inadequate combustion requiring burner ignition	PCDD/F	0.0000003

2.6 Table 2 presents the assumed emission rates that will occur for 10-20 minutes following loss of power to the facility, in which case the plant will shut down. In such a scenario the bag filter will continue to be operational and there will be residual activated carbon and lime on the sleeves of the bag filters that will continue to be reactive.

Table 2: Scenario 2 – Emissions Following Black Out (lasting 10-20 minutes)

Pollutant	Emissions (mg/Nm^3)
Dust	<10
TOC	<10
PCDD/F	<0.0000001
Hg	<0.05
Cd and Tl	<0.05
Heavy metals (Sb + As + Pb + Cr + Co + Cu + Mn + Ni + V)	<0.5
HCl	<992
SO_2	<380
NOx	<500
HF	<1

2.7 As the TOC concentration in this scenario is again the same as that assumed under normal operations[2], it has again been assumed that TOC and PCB emissions will not be elevated (when compared with those modelled for normal operations) under abnormal operations. The same applies for hydrogen fluoride. On this basis, no results have been presented for Scenario 2 for these pollutants.

3 Impact Assessment

Annual Mean

3.1 Table 3 presents the maximum predicted annual mean process contributions anywhere within the Cartesian grid of receptors (see the 2020 Permit Air Quality Assessment for details of receptors), in any of the meteorological years modelled, for each of the abnormal operation scenarios. The annual mean process contributions under normal operations are also presented, for comparison, assuming continuous operation throughout the year. For abnormal operations Scenario 1 and Scenario 2, the contributions presented are those of 60 hours of abnormal operations alone. This contribution under 60 hours of abnormal operations is then presented as a percentage of the total annual contribution under normal operations, for reference.

Table 3: Maximum Predicted Annual Mean Process Contributions (Assuming 60 hours of Operation for Abnormal Operations)

Pollutant	Maximum PC in Cartesian Grid (µg/m^3)			Max Abnormal Operations PC as a % of Normal Operation PC	EAL
	Normal Operation	Scenario 1	Scenario 2		
Dioxins and furans	0.0000000007	0.000000000025	0.000000000008	3.4%	**0.0000003[a]**
NO_2	1.03	0.029	0.029	2.9%	**40**
PM_{10}	0.059	0.0121	0.00081	20.5%	**40**
Cd	0.00025	0.00025	0.0000042	102.7%	**0.005**
Hg	0.00012	0.000067	0.0000042	54.8%	**0.25**
Sb	0.0037	0.00042	0.000042	11.4%	**5**
As	0.0037	0.00042	0.000042	11.4%	**0.003**
Pb	0.0037	0.00042	0.000042	11.4%	**0.25**
Cr III	0.0037	0.00042	0.000042	11.4%	**5**
Cr VI	0.0037	0.00042	0.000042	11.4%	**0.0002**
Cu	0.0037	0.00042	0.000042	11.4%	**10**
Mn	0.0037	0.00042	0.000042	11.4%	**0.15**
Ni	0.0037	0.00042	0.000042	11.4%	**0.02**
V	0.0037	0.00042	0.000042	11.4%	**5**
PCBs	0.0000000010	0.000000000007	0.000000000007	0.7%	**0.2**

3.2 Table 4 sums the PC under normal operations and the maximum PC under either of the abnormal operations scenarios (these will always be at the same receptor due to being based on the same

models, just with emission rates edited in post-processing), and presents this as a percentage of the EAL. Where this is greater than 1% of the EAL, the PEC is then also calculated, using the baseline concentrations outlined in the 2020 Permit Air Quality Assessment. No PEC is presented for Chromium VI as a robust baseline concentration could not be determined.

Table 4: Maximum Predicted Annual Mean PCs and PECs (µg/m³)

Pollutant	Combined Total PC	% of EAL	PEC	% of EAL	EAL
Dioxins and furans	0.00000000076	0.3%	-	-	**0.0000003[a]**
NO_2	**1.06**	**2.7%**	27.06	67.7%	**40**
PM_{10}	0.071	0.2%	-	-	**40**
Cd	**0.00050**	**10.0%**	0.00061	12.3%	**0.005**
Hg	0.00019	0.1%	-	-	**0.25**
Sb	0.0041	0.1%	-	-	**5**
As	**0.0041**	**137.0%**	**0.0049**	**164.0%**	**0.003**
Pb	**0.0041**	**1.6%**	0.0096	3.8%	**0.25**
Cr III	0.0041	0.1%	-	-	**5**
Cr VI	**0.0041**	**2055.6%**	-	-	**0.0002**
Cu	0.0041	<0.1%	-	-	**10**
Mn	**0.0041**	**2.7%**	0.0065	4.4%	**0.15**
Ni	**0.0041**	**20.6%**	0.0048	24.1%	**0.02**
V	0.0041	0.1%	-	-	**5**
PCBs	0.00000000099	<0.1%	-	-	**0.2**

3.3 The calculated PEC for Arsenic is above the EAL, as is the PC for Chromium VI, but these have been calculated assuming all of the group 3 metals emission to be composed of that individual metal. This is unrealistic, but the same situation occurred in the 2020 Permit Air Quality Assessment. Environment Agency guidance (Environment Agency, 2016) was used to determine more realistic emission rates for these metals. This guidance suggests that arsenic is unlikely to constitute more than 5% of the total group 3 metals emission, and Chromium VI is unlikely to constitute more than 0.03%. The results and analysis in Table 4 are reproduced in Table 5 for these two pollutants with these ratios applied to the total group 3 metals emission. Again, no PEC is presented for Chromium VI as a robust baseline concentration could not be determined.

Table 5: Maximum Predicted Annual Mean PCs and PECs (µg/m³)

Pollutant	Combined Total PC	% of EAL	PEC	% of EAL	EAL
As	**0.00021**	**6.9%**	0.00102	33.9%	**0.003**
Cr VI	0.0000012	0.6%	-	-	**0.0002**

3.4 The calculated PEC of arsenic is well below the EAL, and the PC of Chromium VI is less than 1% of the EAL. Overall, it is judged that abnormal operations will not contribute significantly to annual mean pollutant concentrations in the vicinity of the facility, and will not affect achievement of the EALs.

Short-Term

3.5 Table 6 presents the maximum predicted 100th percentile process contributions anywhere within the Cartesian grid, in any of the meteorological years modelled, for each of the abnormal operation scenarios. Again the 100th percentile process contributions under normal operations are also presented, for comparison. These are the maximum 100th percentile of 1-hour concentrations for all pollutants other than particulate matter, for which the 100th percentile of 24-hour mean concentrations is presented; this is highly conservative given that the IED only allows abnormal operations for a maximum of four hours for any one instance.

Table 6: Maximum Predicted 100th Percentile Process Contributions (µg/m³)

Pollutant	Maximum PC in Cartesian Grid			Maximum PC as % of EAL	EAL
	Normal Operation	Scenario 1	Scenario 2		
NO_2	51.32	64.15	64.15	**32.1%**	**200**
PM_{10} (24hr)	0.63	18.87	1.26	**37.7%**	**50**
Hg	0.0033	0.27	0.02	3.6%	**7.5**
Sb	0.11	1.83	0.18	1.2%	**150**
Cr III	0.11	1.83	0.18	1.2%	**150**
Cu	0.11	1.83	0.18	0.9%	**200**
Mn	0.11	1.83	0.18	0.1%	**1,500**
V	0.11	1.83	0.18	**183.3%**	**1**
SO_2	73.32	141.87	139.30	**40.5%**	**350**
PCB	0.000000029	0.000000029	0.000000029	0.00000049%	**6**
HCL	22.00	363.65	363.65	**48.5%**	**750**

3.6 PCs of nitrogen dioxide, PM_{10}, vanadium, sulphur dioxide and hydrogen chloride are greater than 10% of the EAL. In the case of vanadium, it has been assumed that all of the group 3 metals

emission is composed of that individual metal. This is unrealistic; Environment Agency guidance (Environment Agency, 2016) suggests that vanadium is unlikely to constitute more than 1.2% of the total group 3 metals emission. Applying this ratio, the maximum PC for vanadium would be just 0.022 µg/m^3, which is just 2.2% of the EAL, thus the PC for this pollutant can also be screened out as being less than 10% of the EAL.

3.7 In the case of PM_{10}, the maximum PC presented for Scenario 1 is highly unrealistic, as it assumes the abnormal operations to occur for a full calendar day, when in reality the IED only allows abnormal operations for a maximum of four hours for any one instance, and a maximum of 60 hours in any one year. If it is assumed that the abnormal operations will not occur for more than four hours on any given day, the PC would more likely be around 6.3% of the objective (37.7%*4/24), which is below the screening threshold. Given that the 90.4th percentile reflects concentrations on the 36th highest day of the year, it is likely that even assuming four hours of abnormal operation on this 36th highest day is highly unrealistic and thus worst-case.

3.8 Table 7 presents PECs for nitrogen dioxide, sulphur dioxide and hydrogen chloride, calculated by adding the maximum PC to two times the long-term baseline concentration for each pollutant. Baseline concentrations for nitrogen dioxide and sulphur dioxide are presented in the 2020 Permit Air Quality Assessment. For hydrogen chloride, a long-term baseline concentration of 0.71 µg/m^3 has been used, this being the highest annual mean concentration measured across Defra's Acid Deposition Monitoring Network between 2013 and 2015 (monitoring of this pollutant ceased in 2016).

Table 7: Maximum Short-Term PECs (µg/m^3)

Pollutant	Maximum PC in Cartesian Grid	PEC	PEC as % of EAL	EAL
NO_2	64.15	116.15	58.1%	**200**
SO_2	141.87	149.05	42.6%	**350**
HCL	363.65	364.36	48.6%	**750**

3.9 The calculated PECs are all well below the EAL, thus it is judged that abnormal operations will not affect achievement of the short-term EALs.

4 Conclusions

4.1 The abnormal operations assessment has demonstrated that abnormal operations will not contribute significantly to annual mean pollutant concentrations in the vicinity of the facility, and will not affect achievement of the EALs. Abnormal operations will also not cause any short-term EALs to be exceeded. As such, it is concluded that abnormal operations will not significantly affect local air quality.

5 References

2010/75/EU (2010) *Industrial Emissions (Integrated Pollution Prevention and Control) (Recast)*.

Environment Agency (2016) *Guidance on Assessing Group 3 Metal Stack Emissions from Incinerators - V.4*.

Environmental Permitting Regulations (2016) *The Environmental Permitting Regulations in England and Wales*.