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Portland Energy Recovery Facility



Powerfuel Portland Limited

Abnormal Emissions Assessment

Document approval

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1 Introduction

Powerfuel Portland Limited (Powerfuel) is proposing to build the Portland Energy Recovery Facility (the Facility) at a site within Portland Port on the Isle of Portland, Dorset. The Facility will incinerate refuse derived fuel (RDF) produced from domestic (municipal solid waste) and commercial & industrial (C&I) non-hazardous waste.

A detailed description of the activities to be undertaken at the Facility is included within the Supporting Information within the Environmental Permit (EP) application.

Powerfuel is applying to the Environment Agency (EA) under the Environmental Permitting Regulations (EP Regulations) for an EP to operate the Facility.

The EP Regulations require that abnormal event scenarios are considered.

Article 46(6) of the Industrial Emissions Directive (IED) states that:

“... the waste 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 or operation in such conditions over 1 year shall not exceed 60 hours.”

Article 47 continues with:

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

The conditions detailed in Article 46(6) are considered to be “abnormal operating conditions” for the purpose of this assessment apply to the Facility.

2 Identification of Abnormal Operating Conditions

The following are considered to be examples of abnormal operating conditions which may lead to 'abnormal emission levels' of pollutants:

1. Reduced efficiency of lime injection system such as through blockages or failure of fans leading to elevated acid gas emissions (with the exception of hydrogen chloride);
2. Complete failure of the lime injection system leading to unabated emissions of hydrogen chloride. (Note: this would require the plant to have complete failure of the bag filter system. As a plant of modern design, it would have shut down before reaching these operating conditions);
3. Reduced efficiency of particulate filtration system due to bag failure and inadequate isolation, leading to elevated particulate emissions and metals in the particulate phase;
4. Reduced efficiency of the Selective Non-Catalytic Reduction (SNCR) system as a result of blockages or failure of ammonia injection system, leading to elevated oxides of nitrogen emissions; and
5. Complete failure of the activated carbon injection system and loss of temperature control leading to high levels of dioxin reformation and their unabated release.

As a modern design, it is anticipated that the Facility will be operated to a high degree of compliance. Therefore, the identification of plausible abnormal emission levels has been based primarily on the data obtained from modern plants. Where actual data is not available, worst case conservative assumptions have been made.

2.1 Plant start-up and shutdown

Start-up of the Facility from cold will be conducted with an auxiliary fuel (low sulphur fuel oil). Waste will not be introduced into the furnace unless the temperature is above the minimum requirement (850°C) and other operating parameters (for example, air flow and oxygen levels) are within the range proposed within the EP application. During the warming up period the flue gas treatment plant will be operational as will be the control systems and monitoring equipment.

The same is true during plant shutdown. The waste remaining in the furnace will be allowed to burn out, the temperature not being permitted to drop below 850°C by the simultaneous introduction of the auxiliary fuel. After complete burnout of the waste, the auxiliary fuel burners are turned off and the system will be allowed to cool. During this period, the combustion control systems, flue gas cleaning equipment, and the monitoring equipment will be fully operational.

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

In relation to the magnitude of dioxin emissions during plant start-up and shutdown, research has been undertaken by AEA Technology on behalf of the EA. Whilst elevated emissions of dioxins (within one order of magnitude) were found during shutdown and start-up phases where the waste was not fully established on the grate, the report concluded that:

"The mass of dioxin emitted during start-up and shutdown for a 4-5 day planned outage was similar to the emission which would have occurred during normal operation in the same period. The emission during the shutdown and restart is equivalent to less than 1% of the estimated annual emission (if operating normally all year)."

Therefore, there is no reason why start-up and shutdown operations will affect the long-term impact of the Facility.

3 Plausible Abnormal Emission Levels

The following plausible abnormal emission levels for the Facility have been identified based on the performance of similar plants in the UK. The plausible abnormal emissions concentrations are presented in Table 1, where available, these have been based on measured data from comparable Facilities.

Table 1: Plausible Abnormal Emissions from an EfW

Pollutant	Permitted Emission Limit, (mg/Nm ³) ⁽¹⁾		Plausible Abnormal Emission, (mg/Nm ³) ⁽¹⁾	% Above Max Permitted Emission
	Daily Average	½ hourly max		
Oxides of nitrogen	120	400	500 ⁽²⁾	25
Particulate matter (PM ₁₀)	5	30	150 ⁽³⁾	400
Sulphur dioxide	30	200	450 ⁽⁴⁾	163
Hydrogen chloride	6	60	900 ⁽⁴⁾	2,817
Hydrogen fluoride	1	4	20 ⁽⁵⁾	400
Dioxins and dioxin-like PCBs	0.06 ng/Nm ³		6 ng/Nm ³	9900 ⁽⁶⁾
PCBs	0.005 mg/Nm ³ ⁽⁷⁾		0.5 mg/Nm ³	9900 ⁽⁸⁾

NOTES:

- All emissions expressed as Nm³ based (dry, 0°C, 11% reference oxygen content).
- Taken as the upper end of the range of monitored raw flue gas after the boiler from the Waste Incineration BREF (Table 3.6)
- Taken from the IED maximum permitted level.
- Based on information presented in the Devonport Decision Document (Reference: EPR/WP3833FT).
- Maximum of the range for municipal waste from the Waste Incineration BREF
- Assumes a 99% removal efficiency in lieu of any other information as set out in the Devonport Decision Document (Reference: EPR/WP3833FT).
- The Waste Incineration BREF provides a range of values for PCB emissions to air from European municipal waste incineration plants. This states that the annual average total PCBs is less than 0.005 mg/Nm³ (dry, 11% oxygen, 273K). In lieu of other available data, this has been assumed to be the emission concentration for the Facility.
- In lieu of any publicly available information, the plausible emissions multiplier for PCBs is assumed to be the same as for dioxins.

A number of assumptions have been made with regard to the emissions of individual metals.

- Emission concentration of mercury has been assumed to be 100% of the Best Available Techniques Associated Emission Level (BAT-AEL) concentration of 0.02mg/m³.
- Emission concentration of cadmium has been taken as half the BAT-AEL concentration for cadmium and thallium and compounds of 0.02mg/m³.
- Emission concentration of heavy metals that have a short or long term AQAL have been considered (antimony, arsenic, chromium, copper, lead, manganese, nickel, vanadium) and have been taken from the EA guidance document "Guidance on assessing group 3 metal stack

emissions from incinerators” (version 4). This guidance summarises the existing emissions from 18 Municipal Waste Incinerators (MWIs) and Waste Wood Co-incinerators in the UK over a period between 2007 and 2015. This has been used in lieu of any guidance from the EA.

4. The Predicted Abnormal Emissions are calculated based on 30 times the emission concentration, as it is assumed that metals are in the particulate phase with the exception of mercury where it has been assumed there is a 99% removal efficiency.

The plausible abnormal emissions concentrations for metals are presented in Table 2.

Table 2: Predicted Abnormal Metal Emissions from an EfW

Pollutant	Emission Concentrations ($\mu\text{g}/\text{Nm}^3$)	Predicted Abnormal Emission ($\mu\text{g}/\text{Nm}^3$)	% Above Max Permitted Emission
Antimony	11.5	345	2,900
Arsenic	25	750	2,900
Cadmium	10	300	2,900
Chromium	92	2,760	2,900
Chromium (VI)	0.13	3.9	2,900
Copper	29	870	2,900
Lead	50.3	1,509	2,900
Manganese	60	1,800	2,900
Mercury	20	2,000	9,900
Nickel	220	6,600	2,900
Vanadium	6	180	2,900
NOTES: All emissions expressed as Nm^3 based (dry, 0°C , 11% reference oxygen content).			

The definition of ‘abnormal operating conditions’ also encompasses periods where the continuous emission monitoring equipment is not operating correctly and data relating to the actual emission concentrations are not available. This assessment has only used data where the concentration of continuously monitored pollutants has been quantified. Furthermore, no data on flow characteristics (flow rate, temperature etc.) during these abnormal operating conditions is available, so for the purposes of this assessment the design flow characteristics have been applied to the plausible emission levels to derive an emission rate and assess impact.

In defining abnormal operating conditions Annex VI, Part 3 (2) notes that under no circumstances shall the total dust concentration exceed $150 \text{ mg}/\text{Nm}^3$ expressed as a half hourly average. As such total dust has been included in this analysis. However, Annex VI, Part 3 (2) goes on to state that the limits prescribed for TOC set must not be exceeded. As such there is no potential for the impact of emissions of TOC to be greater than that outlined in Appendix D.2[Process Emissions Modelling] to the EIA; therefore, TOC has not been considered within this abnormal emissions assessment.

4 Impact Resulting from Plausible Abnormal Emissions

4.1 Impact from normal operations

The Appendix D.2 [Process Emissions Modelling] to the EIA has considered the impact of the Facility in isolation and has not identified any local developments that have the potential to cause point source cumulative impacts with the Facility. Therefore, the process contribution used in this assessment is that of the Facility operating in isolation. This data is presented in Appendix B.

4.2 Predicted abnormal short-term impacts

In order to assess the effect on short term ground level concentrations associated with the Facility operating at the identified abnormal emission concentration, the calculated ground level concentration has been increased pro-rata as presented in Table 3.

Table 3: Short-term Impacts Resulting from Plausible Abnormal Emissions

Pollutant	AQAL ($\mu\text{g}/\text{m}^3$)	Predicted Impact – BAT-AELs		Predicted Impact – Abnormal Emission	
		Conc. $\mu\text{g}/\text{m}^3$	% of AQAL	Conc. $\mu\text{g}/\text{m}^3$	% of AQAL
Nitrogen dioxide	200	27.94	13.97%	34.93	17.46%
Particulate matter (PM ₁₀)	50	0.14	0.28%	4.22	8.45%
Sulphur dioxide (24-hour)	125	2.38	1.91%	35.76	28.61%
Sulphur dioxide (1-hour)	350	39.53	11.29%	88.9	25.41%
Sulphur dioxide (15-min)	266	49.16	18.48%	110.6	41.59%
Hydrogen chloride	750	17.53	2.34%	262.9	35.05%
Hydrogen fluoride	160	1.17	0.73%	5.8	3.65%
Pollutant	AQAL (ng/m^3)	Predicted Impact – BAT-AELs		Predicted Impact – Abnormal Emission	
		Conc. ng/m^3	% of AQAL	Conc. ng/m^3	% of AQAL
Antimony	150,000	3.36	0.002%	100.78	0.07%
Chromium	150,000	26.88	0.018%	806.25	0.54%
Copper	200,000	8.47	0.004%	254.14	0.13%
Manganese	1,500,000	17.53	0.001%	525.82	0.04%
Mercury	7,500	5.84	0.078%	584.24	7.79%
Vanadium	1,000	1.75	0.175%	52.58	5.26%
PCBs	6,000	1.46	0.024%	146.06	2.43%

This is considered to be a highly conservative assessment as it assumes that the plausible abnormal emissions coincide with worst case meteorological conditions. Even with this highly conservative

factor, the process contribution is not predicted to exceed any of the short term AQALs. The maximum predicted process contribution (as a % of the applied AQAL) 41.59% for sulphur dioxide (15-min), with all other pollutants lower.

4.3 Predicted abnormal long-term impacts

In order to assess the effect on long term ground level concentrations associated with the Facility operating at the identified abnormal emission levels, the calculated long term ground level concentrations have been increased pro-rata as presented in Table 4.

This assessment assumes that the Facility is operating at the daily average BAT-AELs for 8,700 hours per year and at the plausible abnormal emission levels for 60 hours per year.

Table 4: Long-term Impacts Resulting from Plausible Abnormal Emissions

Pollutant	AQAL ($\mu\text{g}/\text{m}^3$)	Predicted Impact – BAT-AELs		Predicted Impact – Abnormal Emission	
		Conc. ($\mu\text{g}/\text{m}^3$)	% of AQAL	Conc. ($\mu\text{g}/\text{m}^3$)	% of AQAL
Nitrogen dioxide	40	0.77	1.93%	0.79	1.97%
Particulate matter (PM ₁₀)	40	0.05	0.11%	0.05	0.14%
Hydrogen fluoride	16	0.009	0.06%	0.010	0.06%
Pollutant	AQAL (ng/m^3)	Predicted Impact – BAT-AELs		Predicted Impact – Abnormal Emission	
		Conc. (ng/m^3)	% of AQAL	Conc. (ng/m^3)	% of AQAL
Antimony	5,000	0.11	<0.01%	0.13	<0.01%
Arsenic	3	0.23	7.65%	0.27	9.17%
Cadmium	5	0.09	1.84%	0.11	2.20%
Chromium	5,000	0.84	0.02%	1.01	0.02%
Chromium (VI)	0.2	0.00119	0.60%	0.00143	0.71%
Copper	10,000	0.27	<0.01%	0.32	<0.01%
Lead	250	0.46	0.18%	0.55	0.22%
Manganese	150	0.55	0.37%	0.66	0.44%
Mercury	250	0.18	0.07%	0.31	0.12%
Nickel	20	2.02	10.09%	2.42	12.10%
Vanadium	5,000	0.06	<0.01%	0.07	<0.01%
PCBs	200	0.05	0.02%	0.08	0.04%

The process contribution is not predicted to exceed any of the long term AQALs. The maximum predicted process contribution (as a % of the applied AQAL) is less than 12.10% for nickel, with all other pollutants lower.

There is no AQAL for dioxins and dioxin-like PCBs against which the impact can be assessed. Therefore, to assess the impact of dioxins and dioxin-like PCBs, the increase in concentration at the

point of maximum impact has been assessed. As can be seen from the results presented in Table 5, the impact of abnormal emissions is to increase in the maximum ground level concentration by 67.81%.

Table 5: Long Term Impacts from Predicted Dioxin Emissions

Pollutant	Predicted Impact – BAT-AELs	Predicted Impact –Abnormal Emission	
	fg/m ³	fg/m ³	% increase
Dioxins	0.55	0.92	67.81%
Dioxin like PCBs	0.084	0.142	67.81%

5 Predicted Environmental Concentration – Abnormal Operations

The EA's Air Emissions Guidance includes the following method for identifying which emissions require further assessment by applying the following criteria:

- the long-term process contribution is <1% of the long term environmental standard; and
- the short-term process contribution is <10% of the short term environmental standard.

Where the impact of abnormal emissions is greater than the above criteria consideration of the background concentration has been made to ensure that the AQAL is not exceeded as a result of abnormal operations.

5.1 Baseline concentrations

The values for the annual average background concentrations that have been used to evaluate the impact of the Facility are presented in Appendix A. These are the baseline concentrations, presented in the Appendix D.1 [Baseline Analysis] and Appendix D.2 [Process Emissions Modelling] of the ES.

5.2 Predicted short term impacts

Table 6 presents the predicted impacts of plausible abnormal operations in the short term at the point of maximum impact and the Predicted Environmental Concentration (PEC) (process contribution plus baseline) for those pollutants for which the impact cannot be screened as insignificant.

Table 6: Short Term PEC Resulting from Plausible Abnormal Emissions

Pollutant	AQAL ($\mu\text{g}/\text{m}^3$)	Baseline Conc.	PC – Abnormal Emissions	PEC – Abnormal Emissions	
		$\mu\text{g}/\text{m}^3$	$\mu\text{g}/\text{m}^3$	$\mu\text{g}/\text{m}^3$	% of AQAL
Nitrogen dioxide	200	44.04	34.93	78.97	39.5%
Sulphur dioxide (24-hour)	125	6.64	35.76	42.40	33.9%
Sulphur dioxide (1-hour)	350	6.64	88.94	95.58	27.3%
Sulphur dioxide (15-min)	266	6.64	110.62	117.26	44.1%
Hydrogen chloride	750	1.42	262.91	264.33	35.2%

As shown, the PEC is not predicted to exceed the AQAL at the point of maximum impact for any pollutant during abnormal operations.

5.3 Predicted long term impacts

Table 7 presents the predicted impacts of plausible abnormal operations in the long term at the point of maximum impact, and the PEC. This assessment assumes that the Facility is operating at the BAT-AELs for 8,700 hours per year and at the plausible abnormal emission levels for 60 hours per year.

Table 7: Long Term PEC Resulting from Plausible Abnormal Emissions

Pollutant	AQAL ($\mu\text{g}/\text{m}^3$)	Baseline Conc.	PC – Abnormal Emissions	PEC – Abnormal Emission	
		$\mu\text{g}/\text{m}^3$	$\mu\text{g}/\text{m}^3$	$\mu\text{g}/\text{m}^3$	% of AQAL
Nitrogen dioxide	40	22.02	0.79	22.81	57.0%
Pollutant	AQAL (ng/m^3)	Baseline Conc.	PC – Abnormal Emissions (1)	PEC – Abnormal Emission	
		ng/m^3	ng/m^3	ng/m^3	% of AQAL
Arsenic	3	1.1	0.27	1.37	45.8%
Cadmium	5	0.57	0.11	0.68	13.6%
Nickel	20	2.7	2.42	5.12	25.6%

As shown, the PEC is not predicted to exceed the AQAL at the point of maximum impact for any pollutant during abnormal operations.

6 Summary

An assessment of the impact on air quality associated with abnormal operating conditions from the Facility has identified plausible abnormal emissions based on a review of monitoring data from operational facilities of a similar type in the UK. Notwithstanding the low frequency of occurrence of such abnormal operating conditions identified by the review, the potential impact on air quality has been assessed.

The predicted impact on air quality associated with the identified plausible abnormal emissions has been calculated by pro-rating the impact associated with normal operations by the ratio between the normal and plausible abnormal emission values. This is considered to be a highly conservative assessment as it assumes that the plausible abnormal emissions coincide with the worst-case meteorological conditions for dispersion.

Even with these conservative factors, there are no predicted exceedances of any of the short term or long term AQALs associated with abnormal operation. The maximum predicted short term process contribution (as % of the applied AQAL) is 41.59%; and the maximum predicted long term process contribution (as % of the applied AQAL) is 12.10%.

It is concluded that during periods of abnormal operation as permissible under the IED (Article 46) is not predicted to give rise to an unacceptable impact on air quality or the environment.

Appendices

A Baseline Concentrations

Table 8: Summary of Baseline Concentrations

Pollutant	Concentration	Units	Justification
Nitrogen dioxide	22.02	$\mu\text{g}/\text{m}^3$	Maximum mapped background concentration from within 5 km of Site- DEFRA 2018 dataset.
Sulphur dioxide	3.32	$\mu\text{g}/\text{m}^3$	Maximum mapped background concentration from within 5 km of Site- DEFRA 2001 dataset.
Hydrogen chloride	0.71	$\mu\text{g}/\text{m}^3$	Maximum monitored concentration across the UK 2012 to 2015
Cadmium	0.57	ng/m^3	Maximum annual concentration averaged across all urban industrial sites across the UK 2015 to 2019
Arsenic	1.10	ng/m^3	
Mercury	2.80	ng/m^3	

B Process Contribution – Normal Operations

C Process Contribution – Normal Operations

Table 9: Dispersion Modelling Results – Point of Maximum Impact

Pollutant	Quantity	Units	AQAL	Max PC Conc.	Pollutant
					As a % of AQAL
Nitrogen dioxide	Annual mean	µg/m ³	40	0.77	1.93%
	99.79th %ile of hourly means*	µg/m ³	200	79.84	39.92%
Sulphur dioxide	99.18th %ile of daily means	µg/m ³	125	2.38	1.91%
	99.73rd %ile of hourly means*	µg/m ³	350	39.53	11.29%
	99.9th %ile of 15 min. means*	µg/m ³	266	49.16	18.48%
Particulates (PM ₁₀)	Annual mean	µg/m ³	40	0.05	0.11%
	98.4th %ile of daily means	µg/m ³	50	0.14	0.28%
Hydrogen chloride	Hourly mean*	µg/m ³	750	17.53	2.34%
Hydrogen fluoride	Annual mean	µg/m ³	16	0.01	0.06%
	Hourly mean*	µg/m ³	160	1.17	0.73%
Mercury	Annual mean	ng/m ³	250	0.18	0.07%
	Hourly mean	ng/m ³	7500	5.84	0.08%
Cadmium	Annual mean	ng/m ³	5	0.18	3.67%
	Hourly mean	ng/m ³	-	5.84	-
Dioxins and furans and dioxin-like PCBs	Annual mean	fg/m ³	-	0.55	-
PCBs	Annual mean	ng/m ³	250	0.05	0.02%
	Hourly mean	ng/m ³	6000	1.46	0.02%
Group 3 Metals	Annual mean	ng/m ³	-	2.75	-
	Hourly mean	ng/m ³	-	87.64	-

Notes:
 * Assumes operation at the half-hourly ELV.
 All other results based on operation at the daily or period mean ELV.

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