FICHTNER

SOFIDEL INTERTISSUE

BAGLAN

ABNORMAL EMISSIONS ASSESSMENT

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Document Production & Approval Record				
ISSUE NO. 1	**NAME**	**SIGNATURE**	**POSITION**	**DATE**
Prepared by:	Rosalind Flavell	RFlavell	Consultant	09/11/2015
Checked by:	Stephen Othen	[signature]	Technical Director	09/11/2015

Document Revision Record		
ISSUE NO.	**DATE**	**DETAILS OF REVISIONS**
1	09/11/2015	First draft for client review.
2		
3		
4		

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1.1 Introduction

Sofidel is proposing to construct a wood-fuelled boiler ("the Facility") at the existing Intertissue paper manufacturing site off Brunell Way, Neath Port Talbot. The Facility will process pre-processed waste wood biomass fuels. Due to the recycled nature of some of the fuel, the limits on emissions to air will be based on those outlined in Annex VI of the Industrial Emissions Directive (IED) (Special Provisions for Waste Incineration Plants and Waste Co-Incineration Plants) (2010/75/EU). This will include limits on emissions of oxides of nitrogen, sulphur dioxide, heavy metals and dioxins and furans.

The Environmental Permitting Regulations require that abnormal event scenarios are considered. This report addresses this issue in further detail than the detailed air quality assessment submitted in support of the Environmental Permit application.

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 Facility to have complete failure of the bag filter system. As a facility of modern design the Facility 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 proposed Facility would 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 clean support fuel (liquid petroleum gas or low sulphur light fuel oil). Waste wood fuel is not introduced into the plant unless the temperature is above the minimum requirement (850ºC) and other operating parameters (for example, air flow and oxygen levels) are within the range stipulated in the permit. During the warming up period, the gas cleaning plant will be operational as will be the control systems and monitoring equipment.

The same is true during plant shutdown. The wood remaining on the grate is allowed to burn out, the temperature being maintained above 850ºC by the simultaneous introduction of clean support auxiliary fuel. After complete burnout of the wood, the burners are turned off and the plant is allowed to cool. During this period the gas cleaning equipment is fully operational, as will be the control systems and monitoring equipment.

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 Environment Agency[1]. 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)."*

There is therefore no reason why such start-up and shutdown operations will affect the long term impact of the facility.

[1] Investigation of Waste Incinerator Dioxins During start-up and shutdown operating phases. EAT/ENV/R/2563 – Issue 1, AEA Technology on behalf of the Environment Agency, November 2008.

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 a comparable facility. It should be noted that the Facility is to be classified as a co-incinerator. As such emission limits are referenced to 6% oxygen content.

Table 1: Plausible Abnormal Emissions

Pollutant	Permitted Emission, (mg/m^3)	Plausible Abnormal Emission, (mg/m^3)	% Above Max Permitted Emission
Oxides of nitrogen	300	825	175
Particulate matter (PM_{10}s)	15	225 (1)	1400
Sulphur dioxide	75	675	800
Hydrogen chloride	15	104 (2)	593
Hydrogen fluoride	2	135	8,900
TOC (VOCs)	15	15 (1)	0
Carbon monoxide	15	15 (1)	0
Dioxins	0.1 ng/m^3	10 ng/m^3 (3)	9900

NOTES:

All emissions are expressed at reference conditions dry, 6% oxygen, 273K

(1) Taken from the Chapter IV of the Industrial Emissions Directive corrected to 6% reference oxygen content.

(2) Based on chlorine content of the fuel, as discussed below.

(3) As previously requested by the Environment Agency, corrected to 6% oxygen content.

The chlorine content of the fuel anticipated to be is less than 0.1 % dry ash free. A simple combustion calculation based on the plant operating processing 2.25 tph shows that the maximum unabated hydrogen chloride emissions would be 0.450 g/s or 104 mg/Nm^3, assuming that all of the chlorine in the fuel is converted to hydrogen chloride.

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

(1) The emission concentration of mercury has been assumed to be 100% of the IED emission concentration of 0.05 mg/Nm^3.

(2) The emission concentration of cadmium has been taken as half the relevant emission concentration for cadmium and thallium and compounds of 0.05 mg/Nm^3.

(3) Heavy metals which have a short or long term EAL have been considered (antimony, arsenic, chromium, copper, lead, manganese, nickel, vanadium) and the emission concentrations for these metals have been taken as the maximum measured concentration at Wilton 10 biomass plant which processes a similar fuel as the proposed facility. The measured concentration has then been split between the different metals using the proportion of each metal in the APC residues. This monitoring data is summarised in Table 3.

(4) Monitoring of antimony is not undertaken at Wilton 10. In lieu of any monitoring, antinomy emissions have been assumed to be $1/9^{th}$ of the total group 3 emissions limit of 0.5 mg/Nm^3.

(5) The emission concentration of chromium (VI) is based on the ratio of the effective chromium (VI) emission concentration to total metals emissions, as presented in the "Environment Agency Guidance to Applicants on Metals Impact Assessment for Stack Emissions (September 2012 Version 3) guidance note. The analysis of the monitoring of chromium (VI) by the Environment Agency has shown that the mean concentration as a proportion of the ELV is 2.2%. This is similar to the Wilton 10 biomass facility mean analysis. The combustion mechanism for chromium and chromium (VI) are similar; therefore, since the chromium concentrations are similar we would anticipate that the chromium (VI) contribution would also be similar.

(6) The Predicted Abnormal Emissions for each metal are calculated based on 15 times the standard emission concentration, as it is assumed that metals are in the particulate phase and so that the metal emissions during normal emissions will increase in proportion to the increase in particulate emissions.

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

Table 2: Predicted Abnormal Metal Emissions

Pollutant	Emission Concentrations (µg/m³)	Predicted Abnormal Emission (µg/m³)	% Above Max Permitted Emission
Antimony	55.6	833.3	1400
Arsenic	8.0	119.6	1400
Cadmium	25.0	375.0	1400
Chromium	17.9	267.9	1400
Chromium (VI)	0.000130	0.00195	1400
Copper	25.1	376.4	1400
Lead	95.7	1436.0	1400
Manganese	141.7	2125.3	1400
Mercury	50.0	750.0	1400
Nickel	35.5	532.3	1400
Vanadium	0.9	13.2	1400

Table 3: Metals Monitoring Data Analysis						
Pollutant	Measured Concentration as % of IED Group 3 ELV – Environment Agency Guidance			Metals Data from Wilton 10 Biomass Facility Based on APC Residue Analysis – 2008 to 2010 as % of IED Group 3 ELV		
	Mean	Max	Min	Mean	Max	Min
Antimony	0.66%	2.30%	0.02%	-	-	-
Arsenic	0.14%	0.60%	0.06%	0.82%	1.60%	0.12%
Chromium	2.18%	10.42%	0.08%	1.87%	3.57%	0.64%
Cobalt	0.08%	0.78%	0.04%	0.25%	0.53%	0.08%
Copper	1.54%	3.26%	0.50%	2.88%	5.02%	0.43%
Lead	3.16%	7.36%	0.06%	10.65%	19.15%	1.40%
Manganese	3.44%	7.30%	0.30%	15.93%	28.34%	6.08%
Nickel	4.40%	27.24%	0.00%	3.63%	7.10%	0.83%
Tin	0.48%	0.48%	0.48%	-	-	-
Vanadium	0.06%	0.20%	0.04%	0.10%	0.18%	0.05%
Total (calculated)	**16.14%**	**59.94%**	**1.58%**	**16.61%**	**46.39%**	**4.24%**

NOTES:

The measured nickel concentration from the MWIs is greater than 11% due to one single measurement outlier. The average is around 4% of the Group ELV.

Antimony and tin are not monitored in the APC residues at Wilton 10.

It should be noted that 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.

4 Impact Resulting From Plausible Abnormal Emissions

4.1 Predicted 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 4.

Table 4: Short term Impacts Resulting from Plausible Abnormal Emissions

Pollutant	EAL / AQO (µg/m³)	Predicted Impact –Half Hourly Emission Limit		Predicted Impact – Abnormal Emission	
		Conc. µg/m³	% of AQO/EAL	Conc. µg/m³	% of AQO/EAL
Nitrogen dioxide	200	9.83	4.91%	27.03	13.51%
Particulate matter (PM_{10}s)	50	0.46	0.92%	6.89	13.78%
Sulphur dioxide (daily)	125	4.22	3.38%	37.98	30.38%
Sulphur dioxide (1-hour)	350	6.79	1.94%	61.08	17.45%
Sulphur dioxide (15-min)	266	10.72	4.03%	96.45	36.26%
Hydrogen chloride	750	3.46	0.46%	23.97	3.20%
Hydrogen fluoride	160	0.35	0.22%	31.11	19.44%
Pollutant	**EAL / AQO (ng/m³)**	**Predicted Impact – Emission Limits**		**Predicted Impact – Abnormal Emission**	
		Conc. ng/m³	**% of AQO/EAL**	**Conc. ng/m³**	**% of AQO/EAL**
Mercury	7,500	11.52	0.15%	172.83	2.30%
Antimony	150,000	12.80	0.009%	192.04	0.128%
Chromium	150,000	4.12	0.003%	61.73	0.041%
Copper	200,000	5.78	0.003%	86.74	0.043%
Manganese	1,500,000	32.65	0.002%	489.76	0.033%
Vanadium	1,000	0.20	0.020%	3.05	0.305%

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 these highly conservative factors, there are no exceedances of any of the short term air quality limits. The maximum predicted process contribution (as a % of the applied AQO/EAL) is less than 37%.

4.2 Predicted long term impact

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 5 and Table 6. This assessment assumes that the facility is operating at the daily average emission limits for 8,700 hours per year and at the plausible abnormal emission levels for 60 hours per year.

Table 5: Long Term Impacts Resulting from Plausible Abnormal Emissions

Pollutant	EAL / AQO (µg/m³)	Predicted Impact – Daily Emission Limits		Predicted Impact – Abnormal Emission	
		Conc. (µg/m³)	% of AQO/EAL	Conc. (µg/m³)	% of AQO/EAL
Nitrogen dioxide	40	2.64	6.60%	2.67	6.68%
Particulate matter (PM_{10}s)	40	0.19	0.47%	0.20	0.51%
Particulate matter ($PM_{2.5}$s)	25	0.19	0.75%	0.20	0.82%
Hydrogen fluoride	16	0.02	0.12%	0.03	0.19%
Pollutant	**EAL / AQO (ng/m³)**	**Predicted Impact –Emission Limits**		**Predicted Impact – Abnormal Emission**	
		Conc. (ng/m³)	**% of AQO/EAL**	**Conc. (ng/m³)**	**% of AQO/EAL**
Cadmium	5	0.16	3.12%	0.17	3.41%
Mercury	250	0.62	0.25%	0.68	0.27%
Antimony	5000	0.692	0.014%	0.759	0.015%
Arsenic	3	0.099	3.313%	0.109	3.631%
Chromium	5000	0.223	0.004%	0.244	0.005%
Chromium (VI)	0.2	0.00000162	0.00081%	0.00000178	0.00089%
Copper	10000	0.313	0.003%	0.343	0.003%
Lead	250	1.193	0.477%	1.307	0.523%
Manganese	150	1.766	1.177%	1.935	1.290%
Mercury	20	0.442	2.211%	0.485	2.423%
Nickel	5000	0.011	0.0002%	0.012	0.0002%
Vanadium	5000	0.692	0.014%	0.759	0.015%

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 these highly conservative factors, there are no exceedances of any of the long term air quality limits. The maximum predicted process contribution (as a % of the applied AQO/EAL) is less than 7%.

There is no Air Quality Objective for dioxins against which the impact can be assessed. Therefore to assess the impact of dioxins, the increase for the receptor exposed to the Tolerable Daily Intake has been used to assess whether there will be a significant increase in the impact of dioxins by assessing against the receptor exposed to the Tolerable Daily Intake. As can be seen from the results presented in Table 6 this represents an increase in the maximum ground level concentration of 67.81%.

Table 6: Long Term Impacts from Predicted Dioxin Emissions			
Pollutant	Predicted Impact –Daily Limits	Predicted Impact – Abnormal Emission	
	fg/m^3	fg/m^3	% increase
Dioxins	1.25	2.09	67.81%

Based on the results of the Human Health Risk Assessment, the child residential receptor at the point of maximum impact receiving the highest dose of dioxins from the facility is predicted to be exposed to 1.08 % of the Tolerable Daily Intake (TDI). Assuming the impact of abnormal operations and including the background sources, or the Mean Daily Intake (MDI), it is calculated that the receptor receiving the highest maximum dose will be exposed to (1.08% x 1.6781) + 90% = 91.81 % of the UK TDI for dioxins. It should be noted that the majority of this is attributed to the MDI.

Assuming the conservative factors stated within the modelling, there will be no exceedances of the TDI for dioxins.

5 Predicted Environmental Concentration –Abnormal Operations

Environment Agency guidance note H1 Annex F 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 AQO/EAL is not exceeded as a result of abnormal operations.

5.1 Background concentrations

Appendix A outlines the values for the annual average background concentrations that have been used to evaluate the impact of the Facility. These are as presented in the Air Quality Assessment submitted with the Environmental Permit application.

5.2 Predicted short term impacts

Table 7 below 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 background) for those pollutants for which the impact presented in Table 3 is greater than 10%.

Table 7: Short Term PEC Resulting from Plausible Abnormal Emissions

Pollutant	EAL / AQO (µg/m³)	Background Conc.	PC – Abnormal Emissions	PEC – Abnormal Emission	
		µg/m³	µg/m³	µg/m³	% of EAL
Nitrogen dioxide	200	40.60	27.03	67.63	33.81%
Particulate matter (PM_{10}s)	50	31.80	6.89	38.69	77.38%
Particulate matter (PM_{10}s)(1)	50	15.90	6.89	22.79	45.58%
Sulphur dioxide (24-hour)	125	13.80	37.98	51.78	41.42%
Sulphur dioxide (1-hour)	350	13.80	61.08	74.88	21.39%
Sulphur dioxide (15-min)	266	13.80	96.45	110.25	41.45%
Hydrogen fluoride	160	4.70	31.11	35.81	22.38%

NOTES:

Background assumed to be twice long term background concentration as per Environment Agency guidance not H1.

(1) Background concentration for PM10 assumed to be long term background concentration as per LAQMTG.09.

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

5.3 Predicted long term impact

The following table 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 daily average IED emission limits for 8,700 hours per year and at the plausible abnormal emission levels for 60 hours per year.

Table 8: Long Term PEC Resulting from Plausible Abnormal Emissions

Pollutant	EAL / AQO (µg/m³)	Background Conc.	PC – Abnormal Emissions	PEC – Abnormal Emission	
		µg/m³	µg/m³	µg/m³	% of EAL
Nitrogen dioxide	40	20.3	2.67	22.97	57.43%
Pollutant	**EAL / AQO (ng/m³)**	**Background Conc.**	**PC – Abnormal Emissions (1)**	**PEC – Abnormal Emission**	
		ng/m³	**ng/m³**	**ng/m³**	**% of EAL**
Cadmium	5	0.93	0.17	1.10	22.01%
Arsenic	3	1.20	0.11	1.31	43.63%
Manganese	150	45.95	1.93	47.88	31.92%
Nickel	20	12.45	0.48	12.93	64.67%

(1) The ground level impact has been calculated by apportioning the maximum monitored emission concentration for each metal to the total group 3 metal Process Contribution.

As shown, the PEC is not predicted to be exceed the AQO/EAL 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.

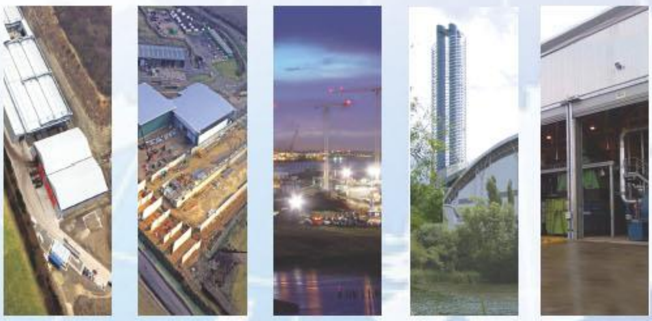
The predicted impact on air quality associated with the identified plausible abnormal emissions has been calculated by pro-rating the impact associated with normal operations by the ratio between the normal and plausible abnormal emission values. This is considered to be a highly conservative assessment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

Even with these highly conservative factors, there are no predicted exceedances of any of the short term or long term air quality limits associated with abnormal operations. The maximum predicted short term process contribution (as % of the applied EAL) is less than 60%; and the maximum predicted long term process contribution (as % of the applied EAL) is less than 15%. Abnormal emissions from the Facility will not cause any exceedances of any Air Quality Objective. In addition, there will not be any exceedances of the TDI for dioxins.

It is concluded that use of the allowance for abnormal operating conditions (as detailed in Article 46 of the IED) is not predicted to give rise to an unacceptable impact on air quality or the environment.

Appendix A – Background Concentrations

Summary of Background Concentrations			
Pollutant	**Annual Mean Concentration**	**Units**	**Justification**
Nitrogen dioxide	20.3	µg/m^3	2011 mapped background dataset maximum grid square within the modelling domain.
Oxides of nitrogen	28.3	µg/m^3	
Sulphur dioxide	6.9	µg/m^3	2001 mapped background dataset maximum grid square within the modelling domain.
Particulate matter (as PM_{10})	15.9	µg/m^3	2011 mapped background dataset maximum grid square within the modelling domain.
Particulate matter (as $PM_{2.5}$)	10.7	µg/m^3	
Carbon monoxide	240	µg/m^3	2001 mapped background dataset maximum grid square within the modelling domain.
Hydrogen chloride	0.72	µg/m^3	Maximum from UK monitoring 2011-2014.
Hydrogen fluoride	2.35	µg/m^3	Maximum measured baseline hydrogen fluoride concentration as presented in the EPAQS report.
Ammonia	1.03	µg/m^3	Maximum mapped background concentration within the modelling domain – 2012 dataset.
Benzene	0.5	µg/m^3	Maximum mapped background concentration within the modelling domain – 2001 dataset.
1,3-butadiene	0.1	µg/m^3	
Mercury	3.00	ng/m^3	The maximum monitored metal concentration from a monitoring site in South Wales over the last 3 full calendar years, with the exception of nickel. For nickel the maximum from a site in South Wales over the last 3 full calendar years excluding Pontardawe Tawe Terrace has been used.
Cadmium	0.93	ng/m^3	
Arsenic	1.20	ng/m^3	
Antimony	1.60	ng/m^3	
Chromium	13.31	ng/m^3	
Cobalt	2.15	ng/m^3	
Copper	23.52	ng/m^3	
Manganese	45.95	ng/m^3	
Lead	16.89	ng/m^3	
Nickel	12.45	ng/m^3	
Vanadium	3.16	ng/m^3	
Dioxins and furans	41.44	fg/m^3	The maximum monitored concentration in the UK between 2008 and 2010.
Polychlorinated biphenyl (PCBs)	317.94	pg/m^3	
Benzo(a)pyrene (PaB)	0.61	ng/m^3	Maximum monitored concentration from the closet 2 sites over the last 5 years.



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