FICHTNER
Consulting Engineers Limited

Lostock Sustainable Energy Plant Ltd

Lostock Sustainable Energy Plant

Schedule 5 Response

1 Introduction

A Schedule 5 Request was issued to the Environment Agency (EA) dated 20 September 2023.

The Schedule 5 Request explains that the from the Habitats Risk Assessment (HRA) undertaken by the EA:

> *"The permission, plan or project (PPP) cannot be ascertained to have no adverse effect on the integrity of the following site(s), either alone or in combination with other plans and projects…":*
>
> - *West Midlands Mosses SAC (UK0013595)^*
> - *Midland Meres and Mosses Phase 2 Ramsar (UK11080)^"*

On this basis the EA has requested that Lostock Sustainable Energy Plant Ltd (LSEP):

> *Provides a proposal to reduce acid deposition resulting from activities at the installation.*

This technical note has been developed in response to the Schedule 5 Request.

2 Proposed solution

LSEP has reviewed the impact of emissions on acid deposition, as requested in the Schedule 5 Request, presented in the air quality assessment submitted with the application. In response to the request to reduce impacts of acid deposition on ecological features, LSEP would propose to implement the following additional amendments to the operation of the Facility:

- implemented an interlock on the DCS to prevent more than 685,000 tpa of waste from being fed into the waste feed hopper for the two lines (combined), whilst retaining the maximum hourly throughput of 45.5 tonnes per hour as allowed within the constraints of the firing diagram; and
- the emission limit for NOx will be reduced to 150 mg/Nm^3.

Taking this into consideration, the consequences to these changes have been considered in relation to the following:

1. Non-technical summary, updated to qualify the proposed change to the capacity and emission limits – Appendix A.
2. Air quality impacts, refer to the Air Quality Addendum – Appendix B.
3. Operating Techniques, updated to be consistent with the proposed change in capacity – Appendix C.

LSEP can confirm that the proposed changes will not result in any additional changes/amendments to the environmental assessments, or BAT assessments, submitted with the EP application as it will not require any changes to the installed waste processing equipment, abatement systems, or any of the associated management systems.

We trust that the information contained within this response is acceptable to the EA.

Yours sincerely

FICHTNER Consulting Engineers Limited

James Sturman
Lead Consultant

Paul Harrison
Lead Consultant

A Revised Non-technical summary

Lostock Sustainable Energy Plant Limited (LSEP Ltd) was granted an Environmental Permit (EP) for a waste incineration facility (LSEP or the 'Facility') on 16 December 2013. The EP has been subject to one variation since it was granted.

LSEP Ltd is applying for the following changes to the EP:

1. Increase the capacity of the Facility from 600,000 tonnes per annum (based on a throughput of 72.2 tonnes per hour and an availability of around 8,000 hours) to 685,000 tonnes per annum with a maximum hourly throughput of 45.5 tonnes per hour per line as per the Firing Diagram provided in Appendix A.

   [It should be noted that the original application was for 728,000 tonnes per annum; however, through the EP determination process LSEP Ltd has reduced the proposed maximum capacity to 685,000 tonnes per annum]
2. Reducing the daily average emissions limit for NOx to 150 mg/Nm^3, all other emission limits will be in accordance with the upper end of the BAT-AELs.
3. Amend the Site Layout/Installation Boundary to align with the design of the Facility allowing for its design evolution since the original EP was granted.
4. Amend the Operating Techniques/permit conditions to align with the design of the Facility allowing for its design evolution since the original EP was granted.
5. Introduce two additional EWC codes to the EP.
6. Introduce an additional emission point to allow the discharge of excess process effluents to sewer.

LSEP Ltd considers that this application should be determined as a Substantial Variation, due to the proposed increase in capacity exceeding the relevant threshold of 3 tonnes per hour as set out in Part 2 of Schedule 1 of the Environmental Permitting Regulations (EPRs).

Air quality assessments for the proposed increase in capacity have been undertaken (refer to Appendix E). The conclusions of the Air Quality Assessments, and associated Addendums, are as follows:

- The significance of the impact of process emissions from the Facility would be negligible and not significant on human health.
- In relation to European designated ecological features, impacts have been screened out as insignificant.
- In relation to UK designated ecological features, impacts can be screened out as insignificant, with the exception of Plumley Lime Beds SSSI. However, these impacts are not considered to have a significant effect on the integrity of this feature.
- In relation to local wildlife sites, impacts will not be significant.

B Air Quality Addendum

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Air Quality Addendum

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Document approval

	Name	Signature	Position	Date
Prepared by:	Rosalind Flavell	RFlavell	Senior Consultant	16/11/2023
Checked by:	James Sturman		Lead Consultant	16/11/2023

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Contents

1 Introduction

1.1 Background

This Air Quality Assessment Addendum has been produced to present the results of the updated analysis of air quality impacts associated with the following additional amendments to the operation of the Lostock Sustainable Energy Plant (LSEP) (the Facility):

- implemented an interlock on the DCS to prevent more than 685,000 tpa of waste from being fed into the waste feed hopper for the two lines (combined), whilst retaining the maximum hourly throughput of 45.5 tonnes per hour as allowed within the constraints of the firing diagram; and
- the emission limit for NOx will be reduced to 150 mg/Nm^3.

The primary aim of the additional amendments is to reduce the impact of acid deposition below the levels presented within the EP application currently being determined by the Environment Agency, herein referred to as the 'original EP application'.

This Air Quality Assessment Addendum has been produced to update the Process Emissions Modelling Report submitted with the original EP application (S3291-0200-0004HKL dated 04 November 2021) and the AQA for Permit Application (S3291-0320-004HKL, dated 26 January 2023) (the EP Submission Documents). Where appropriate replacement tables and analysis has been produced.

2 Discussion

2.1 Model Inputs

The MCR point of the Facility is 45.5 tonnes per hour (tph) per line. Assuming an annual availability of 8,000 hours this equates to an annual throughput of 728,000 tpa at maximum continuous rating shown in the Firing Diagram, presented in Appendix A of the EP Application Pack. However, the dispersion model is run for the whole year, i.e. 8,760 hours. Therefore, the modelled impacts presented in the original EP application are actually based on an annual throughput of 797,160 tpa (i.e. 45.5 x 2 x 8,760) and are an overestimation of likely long term impacts of the Facility.

As stated previously, it is proposed to implement an interlock on the DCS to prevent more than 685,000 tpa or waste from being fed into the feed hopper on the two lines combined. Therefore, the dispersion model has been re-run with an average hourly volumetric flow rate to reflect typical long-term operation of the Facility on an annual basis. This results in a lower release rate of pollutants, but as the stack diameter is fixed the velocity it will also reduce dispersion of pollutants.

The following table presents the model inputs used within this analysis. This is an update to Table 7 and Table 8 of Process Emissions Modelling Report.

Updated Table 7: Stack Source Data – Per Line

Item	Unit	MCR factored to 685,000 tpa	MCR - 45.5 tph per line
Stack data			
Height	m	90	
Internal diameter	m	2.4 (per line) (1)	
Stack 1 location	m, m	368321, 373942	
Stack 2 location	m, m	368327, 373941	
Flue gas conditions			
Temperature	°C	135	
Exit moisture content	% v/v	18.2%	
	kg/kg	0.133	
Exit oxygen content	% v/v dry	6.1%	
Reference oxygen content	% v/v dry	11.0%	
Volume at reference conditions (dry, ref O_2)	Nm^3/s	63.2	73.6
Volume at actual conditions	Am^3/s	77.4	90.4
Exit velocity	m/s	17.1	19.9

Notes:

1. the May 2011 ES was modelled using a single effective stack location and stack diameter. For the updated modelling in this report, two stack locations at their actual diameters have been used in accordance with the latest design details.

It has been assumed that emissions from the Facility will comply with the BAT-AELs for an existing plant, or the emission limits from Annex VI Part 3 of the IED for waste incineration plants where BAT-AELs are not applicable, with the exception of NOx where an annual mean ELV of 150 mg/Nm^3 is being applied for.

Updated Table 8: Stack Emissions Data – Per Line – 45.5 tph per line

Pollutant	**Conc. (mg/Nm³, unless stated)**		**Release rate (g/s, unless stated)**	
	Daily or periodic	**Half-hourly**	**Daily or periodic**	**Half-hourly**
Oxides of nitrogen (as NO_2)	150	400	11.034	29.425
Sulphur dioxide	40	200	2.943	14.713
Carbon monoxide	50	100	3.678	7.356
Fine Particulate Matter (PM)$^{(2)}$	5	30	0.368	2.207
Hydrogen chloride	8	60	0.589	4.414
Volatile organic compounds (as TOC)	10	20	0.736	1.471
Hydrogen fluoride	1	4	0.074	0.294
Ammonia	10	-	0.736	-
Cadmium and thallium	0.02	-	1.471 µg/s	-
Mercury	0.02	-	1.471 µg/s	-
Other metals$^{(3)}$	0.3	-	22.069 µg/s	-
Dioxins and furans	0.08 ng/Nm^3	-	5.885 ng/s	-
Benzo(a)pyrene (PaHs)$^{(4)}$	0.2 µg/Nm^3	-	14.713 µg/s	-
PCBs$^{(5)}$	0.005	-	0.368 µg/s	-

Notes:

All emissions are expressed at reference conditions of dry gas, 11% oxygen, 273.15K.

(1) Averaging period for carbon monoxide is 95% of all 10-minute averages in any 24-hour period.

(2) As a worst-case it has been assumed that the entire PM emissions consist of either PM_{10} or $PM_{2.5}$ for comparison with the relevant AQALs.

(3) Other metals consist of antimony (Sb), arsenic (As), lead (Pb), chromium (Cr), cobalt (Co), copper (Cu), manganese (Mn), nickel (Ni) and vanadium (V).

(4) The maximum concentration of BaP recorded at a UK plant is 0.2 µg/Nm³ (2019 Waste Incineration BREF, Figure 8.121). This is assumed to be the emission concentration for the Facility.

(5) Table 3.8 of the 2006 Waste Incineration BREF states that the annual average total PCBs is less than 0.005 mg/Nm³ (dry, 11% oxygen, 273K). In lieu of other available operational data, this has been assumed to be the emission concentration for the Facility.

Table 8A: Stack Emissions Data – Per Line – 685,000 tonnes per annum

Pollutant	**Conc. (mg/Nm^3, unless stated)**		**Release rate (g/s, unless stated)**	
	Daily or periodic	**Half-hourly**	**Daily or periodic**	**Half-hourly**
Oxides of nitrogen (as NO_2)	150	-	9.482	-
Sulphur dioxide	40	-	2.528	-
Carbon monoxide	50	-	3.161	-
Fine Particulate Matter (PM)(2)	5	-	0.316	-
Hydrogen chloride	8	-	0.506	-
Volatile organic compounds (as TOC)	10	-	0.632	-
Hydrogen fluoride	1	-	0.063	-
Ammonia	10	-	0.632	-
Cadmium and thallium	0.02	-	1.264 µg/s	-
Mercury	0.02	-	1.264 µg/s	-
Other metals(3)	0.3	-	18.964 µg/s	-
Dioxins and furans	0.08 ng/Nm^3	-	5.057 ng/s	-
Benzo(a)pyrene (PaHs)(4)	0.2 $\mu g/Nm^3$	-	12.642 µg/s	-
PCBs(5)	0.005	-	0.316 µg/s	-

Notes:

All emissions are expressed at reference conditions of dry gas, 11% oxygen, 273.15K.

(1) Averaging period for carbon monoxide is 95% of all 10-minute averages in any 24-hour period.

(2) As a worst-case it has been assumed that the entire PM emissions consist of either PM_{10} or $PM_{2.5}$ for comparison with the relevant AQALs.

(3) Other metals consist of antimony (Sb), arsenic (As), lead (Pb), chromium (Cr), cobalt (Co), copper (Cu), manganese (Mn), nickel (Ni) and vanadium (V).

(4) The maximum concentration of BaP recorded at a UK plant is 0.2 $\mu g/Nm^3$ (2019 Waste Incineration BREF, Figure 8.121). This is assumed to be the emission concentration for the Facility.

(5) Table 3.8 of the 2006 Waste Incineration BREF states that the annual average total PCBs is less than 0.005 mg/Nm^3 (dry, 11% oxygen, 273K). In lieu of other available operational data, this has been assumed to be the emission concentration for the Facility.

All other model inputs are as set out in Section 4 of the Process Emissions Modelling Report.

2.2 Results - impacts on human health

The detailed results tables set out in the Process Emissions Modelling Report are based on the operation at point MCR (i.e. 45.5 tph per line).

The proposed reduction in the NOx emission limit will affect the predicted nitrogen dioxide impacts set out in the EP Submission Documents. Appendix A includes a table which presents the revised impact of nitrogen dioxide emissions from the Facility operating at MCR with the proposed NOx ELV of 150 mg/Nm^3.

As shown at the point of maximum impact the short-term PC can be screened out as 'insignificant as the contribution is less than 10% of the AQAL. Although the long term impact is greater than 1% of the AQAL and cannot be screened out as 'insignificant' the PEC is predicted to be well below 70% of the AQAL and the total impact can be screened out as 'not significant'. This is in accordance with the conclusions of the original EP application.

This analysis assumes that the Facility continually operates at MCR. As detailed it is proposed to implement an interlock on the DCS to limit the throughput of waste to 685,000 tpa. As such the predicted impacts set out the original EP application and discussed above are an overestimation of likely impacts long term impacts of the Facility. Therefore, the dispersion model has been re-run with an average hourly volumetric flow rate to reflect the proposed maximum capacity.

The detailed results tables in Appendix A have been produced which present the results based on an annual throughput of 685,000 tpa.

As shown, the peak impact is similar to when operating at MCR. The lower release rate of pollutants is offset by the reduced dispersion.

This analysis shows that at the point of maximum impact the long term impact operating at 685,000 tpa is less than 1% of the AQAL for all pollutants other than nitrogen dioxide, VOCs (as 1,3-butadiene), and cadmium. However, in all instances the PEC is well below 70% of the AQAL and the total impact of the Facility is not significant.

2.3 Results - impact at ecological receptors

Detailed results tables showing the impact of emissions from the Facility operating with the proposed reduced annual throughput and reduced NOx ELV at each of the identified ecological receptors are presented in Appendix B. These are updates of Tables 28, and the tables set out in Appendix C of the Process Emissions Modelling Report.

2.3.1 Impacts at European designated sites

As shown, the impact is less than 1% of the long term Critical Level and less than 10% of the short-term Critical Level. As such the impact can be screened out as 'insignificant'.

With reference to nitrogen and acid deposition the impact of the Facility is less than 1% of the minimum Critical Load. As such the impact can be screened out as 'insignificant'.

It is also important to note that the peak impact is driven by an outliner. Table 1 presents the impacts at receptor E3 (Midland Meres and Mosses – Oak Mere SAC) for the 5-years of weather data. As shown using 2018 weather data results in the greatest impact. The average over the 5-years is only 73% of the maximum year. As such actual long-term impacts are expected to be significantly lower than predicted. This receptor has been chosen as this is the point to represent a European designated site for which the greatest impact occurs with reference to the Critical Load for acid deposition.

Table 1: Interannual variability at receptor E3

Weather data	Annual mean NOx impact (µg/m³)	Annual mean acid deposition impact (as % of Critical Load)
2016	0.05	0.8%
2017	0.02	0.4%
2018	0.06	0.9%
2019	0.03	0.5%
2020	0.05	0.8%
Average as % of maximum	73%	73%

2.3.2 Impacts at UK designated sites

As shown in Appendix B, the impact is less than 1% of the long term Critical Level and less than 10% of the short-term Critical Level, with the exception of the following at Plumley Lime Bed SSSI:

- Impacts of ammonia emissions in relation to the Critcal Level for lichen sensitive communities;
- Nitrogen deposition impacts on woodland habitats; and
- Acid deposition impacts on grassland habitats.

Table 2 provides a summary of the impacts at Plumley Lime Beds SSSI.

Table 2: Plumley Lime Beds SSSI – Breakdown of Impacts

Weather data	NOx (as % of Critical Level)	NH_3 (as % of Critical Level)	Acid Dep (as % of Critical Load)	Acid Dep (as % of Critical Load)
Critical Level / Load	10	1	15	1.886
2016	0.74%	1.48%	1.1%	2.0%
2017	0.85%	1.69%	1.2%	2.3%
2018	0.85%	1.70%	1.2%	2.3%
2019	0.87%	1.74%	1.3%	2.4%
2020	0.97%	1.94%	1.4%	2.6%
Average as % of maximum	88%	88%	88%	88%
Notes: N deposition calculated for woodland habitats. Impacts at grassland habitats insignificant.				

As shown, there is a great deal of interannual variability. The average is only 88% of the maximum over the 5-years of weather data. These predicted impacts are lower than those set out in the Ecological Interpretation of Air Quality Assessment which was submitted with the original EP application. Therefore, the conclusions of the Ecological Interpretation of Air Quality Assessment remain valid that:

- Ammonia – “*In this context the continued contribution from the LSEP with the Proposal is likely to be inconsequential in terms of either adding to the effects of baseline, or preventing recovery following implementation of wider-scale abatement measures*”

- Nitrogen deposition – *“the process contribution will be inconsequential to the effects of the baseline and would not significantly impede recovery following wider-scale abatement measures”*
- Acid deposition – *“the site-specific critical load for acid deposition of 1.886keq/ha/yr (minCLmaxN) is certainly over-precautionary” … “no significant harm is therefore likely as a consequence of acid deposition”.*

2.3.3 Impacts at local designated sites

At all local sites the impact of the Facility is less than the Critical Level and Critical Load and therefore can be screened out as ‘insignificant’.

3 Summary

The impact of the proposed amendments to the Facility will not result on a significant impact on air quality. The Facility will have an insignificant impact on air quality and deposition of pollutants at European designated ecological receptors.

A Detailed modelling results tables

Updated Table 19 - Dispersion Modelling Results – Point of Maximum Impact - Daily ELVs – MCR – 150 mg/Nm^3 NOx

Pollutant	Quantity	Units	AQAL	Bg conc.	PC at point of maximum impact						Max as % of AQAL	PEC (PC +Bg)	PEC as % of AQAL
					2016	2017	2018	2019	2020	Max			
Nitrogen dioxide	Annual mean	µg/m^3	40	17.05	0.44	0.41	0.32	0.40	0.33	0.44	1.10%	17.49	43.72%
	99.79th%ile of hourly means	µg/m^3	200	34.10	6.56	6.14	6.20	6.58	6.20	6.58	3.29%	40.68	20.34%
Sulphur dioxide	99.18th%ile of daily means	µg/m^3	125	29.40	1.93	1.47	1.48	1.28	1.31	1.93	1.54%	31.33	25.06%
	99.73rd%ile of hourly means	µg/m^3	350	29.40	4.88	4.43	4.53	4.83	4.47	4.88	1.40%	34.28	9.80%
	99.9th%ile of 15 min. means	µg/m^3	266	29.40	5.73	5.75	5.67	5.83	5.79	5.83	2.19%	35.23	13.24%
PM$_{10}$	Annual mean	µg/m^3	40	12.98	0.02	0.02	0.02	0.02	0.02	0.02	0.05%	13.00	32.50%
	90.41st%ile of daily means	µg/m^3	50	25.96	0.08	0.07	0.06	0.08	0.06	0.08	0.17%	26.04	52.09%
PM$_{2.5}$	Annual mean	µg/m^3	20	8.79	0.02	0.02	0.02	0.02	0.02	0.02	0.10%	8.81	44.05%
Carbon monoxide	8 hour running mean	µg/m^3	10,000	690.00	5.81	7.60	8.23	6.98	8.61	8.61	0.09%	698.61	6.99%
	Hourly mean	µg/m^3	30,000	690.00	10.36	9.04	9.36	9.73	8.61	10.36	0.03%	700.36	2.33%
Hydrogen chloride	Hourly mean	µg/m^3	750	1.42	1.66	1.45	1.50	1.56	1.38	1.66	0.22%	3.08	0.41%
Hydrogen fluoride	Annual mean	µg/m^3	16	2.35	0.004	0.004	0.003	0.004	0.003	0.004	0.03%	2.35	14.71%
	Hourly mean	µg/m^3	160	4.70	0.21	0.18	0.19	0.19	0.17	0.21	0.13%	4.91	3.07%
Ammonia	Annual mean	µg/m^3	180	4.23	0.04	0.04	0.03	0.04	0.03	0.04	0.02%	4.27	2.37%
	Hourly mean	µg/m^3	2,500	8.46	2.07	1.81	1.87	1.95	1.72	2.07	0.08%	10.53	0.42%

Pollutant	Quantity	Units	AQAL	Bg conc.	PC at point of maximum impact						Max as % of AQAL	PEC (PC +Bg)	PEC as % of AQAL
					2016	2017	2018	2019	2020	Max			
VOCs (as benzene)	Annual mean	µg/m^3	5	0.56	0.04	0.04	0.03	0.04	0.03	0.04	0.84%	0.60	12.04%
	Daily mean	µg/m^3	30	1.12	0.86	0.47	0.72	0.64	0.63	0.86	2.88%	1.98	6.62%
VOCs (as 1,3-butadiene)	Annual mean	µg/m^3	2.25	0.25	0.04	0.04	0.03	0.04	0.03	0.04	1.86%	0.29	12.97%
Mercury	Annual mean	ng/m^3	250	0.57	0.08	0.08	0.06	0.08	0.06	0.08	0.03%	2.88	1.15%
	Hourly mean	ng/m^3	7,500	1.14	4.15	3.62	3.74	3.89	3.45	4.15	0.06%	9.75	0.13%
Cadmium	Annual mean	ng/m^3	5	-	0.08	0.08	0.06	0.08	0.06	0.08	1.67%	0.65	13.07%
	Hourly mean	ng/m^3	-		4.15	3.62	3.74	3.89	3.45	4.15	-	5.29	-
PAHs	Annual mean	pg/m^3	250	0.98	0.84	0.79	0.61	0.76	0.63	0.84	0.33%	1.82	0.73%
Dioxins	Annual mean	fg/m^3	-	32.99	0.33	0.32	0.24	0.30	0.25	0.33	-	33.32	-
PCBs	Annual mean	ng/m^3	200	128.93	0.02	0.02	0.02	0.02	0.02	0.02	0.01%	128.95	64.48%
	Hourly mean	ng/m^3	6,000	257.86	1.04	0.90	0.94	0.97	0.86	1.04	0.02%	258.90	4.31%

Note:

All assessment is based on the maximum PC using all 5 years of weather data.

Dispersion Modelling Results – Point of Maximum Impact - Daily ELVs – Annual throughput of 685,000 tpa

Pollutant	**Quantity**	**Units**	**AQAL**	**Bg conc.**	**PC at point of maximum impact**						**Max as % of AQAL**	**PEC (PC +Bg)**	**PEC as % of AQAL**
					2016	**2017**	**2018**	**2019**	**2020**	**Max**			
Nitrogen dioxide	Annual mean	µg/m^3	40	17.05	0.44	0.40	0.31	0.38	0.32	0.44	1.09%	17.49	43.72%
	99.79th%ile of hourly means	µg/m^3	200	34.10	6.33	5.90	5.99	6.39	6.24	6.39	3.20%	40.49	20.25%
Sulphur dioxide	99.18th%ile of daily means	µg/m^3	125	29.40	2.00	1.39	1.44	1.24	1.27	2.00	1.60%	31.40	25.12%
	99.73rd%ile of hourly means	µg/m^3	350	29.40	4.73	4.21	4.35	4.68	4.40	4.73	1.35%	34.13	9.75%
	99.9th%ile of 15 min. means	µg/m^3	266	29.40	5.58	5.61	5.55	5.94	5.75	5.94	2.23%	35.34	13.28%
PM$_{10}$	Annual mean	µg/m^3	40	12.98	0.02	0.02	0.01	0.02	0.02	0.02	0.05%	13.00	32.50%
	90.41th%ile of daily means	µg/m^3	50	25.96	0.08	0.07	0.06	0.08	0.06	0.08	0.16%	26.04	52.08%
PM$_{2.5}$	Annual mean	µg/m^3	20	8.79	0.02	0.02	0.01	0.02	0.02	0.02	0.10%	8.81	44.05%
Carbon monoxide	8 hour running mean	µg/m^3	10,000	690.00	5.61	7.55	8.01	6.69	8.40	8.40	0.08%	698.40	6.98%
	Hourly mean	µg/m^3	30,000	690.00	10.24	9.01	9.44	11.10	8.53	11.10	0.04%	701.10	2.34%
Hydrogen chloride	Hourly mean	µg/m^3	750	1.42	1.64	1.44	1.51	1.78	1.37	1.78	0.24%	3.20	0.43%
Hydrogen fluoride	Annual mean	µg/m^3	16	2.35	0.004	0.004	0.003	0.004	0.003	0.004	0.03%	2.35	14.71%
	Hourly mean	µg/m^3	160	4.70	0.20	0.18	0.19	0.22	0.17	0.22	0.14%	4.92	3.08%
Ammonia	Annual mean	µg/m^3	180	4.23	0.04	0.04	0.03	0.04	0.03	0.04	0.02%	4.27	2.37%
	Hourly mean	µg/m^3	2,500	8.46	2.05	1.80	1.89	2.22	1.71	2.22	0.09%	10.68	0.43%
	Annual mean	µg/m^3	5	0.56	0.04	0.04	0.03	0.04	0.03	0.04	0.83%	0.60	12.03%

Pollutant	Quantity	Units	AQAL	Bg conc.	PC at point of maximum impact						Max as % of AQAL	PEC (PC +Bg)	PEC as % of AQAL
					2016	2017	2018	2019	2020	Max			
VOCs (as benzene)	Daily mean	µg/m^3	30	1.12	0.89	0.44	0.72	0.63	0.59	0.89	2.96%	2.01	6.70%
VOCs (as 1,3-butadiene)	Annual mean	µg/m^3	2.25	0.25	0.04	0.04	0.03	0.04	0.03	0.04	1.85%	0.29	12.96%
Mercury	Annual mean	ng/m^3	250	0.57	0.08	0.08	0.06	0.07	0.06	0.08	0.03%	2.88	1.15%
	Hourly mean	ng/m^3	7,500	1.14	4.10	3.60	3.78	4.44	3.41	4.44	0.06%	10.04	0.13%
Cadmium	Annual mean	ng/m^3	5	-	0.08	0.08	0.06	0.07	0.06	0.08	1.67%	0.65	13.07%
	Hourly mean	ng/m^3	-		4.10	3.60	3.78	4.44	3.41	4.44	-	5.58	-
PAHs	Annual mean	pg/m^3	250	0.98	0.83	0.76	0.59	0.72	0.61	0.83	0.33%	1.81	0.73%
Dioxins	Annual mean	fg/m^3	-	32.99	0.33	0.30	0.24	0.29	0.25	0.33	-	33.32	-
PCBs	Annual mean	ng/m^3	200	128.93	0.02	0.02	0.01	0.02	0.02	0.02	0.01%	128.95	64.48%
	Hourly mean	ng/m^3	6,000	257.86	1.02	0.90	0.94	1.11	0.85	1.11	0.02%	258.97	4.32%
Other metals	Annual mean	ng/m^3	-	-	1.25	1.14	0.89	1.09	0.92	1.25	See metals assessment – table 22 and 23		
	Daily	ng/m^3	-	-	26.68	13.21	21.70	18.89	17.80	26.68			
	Hourly mean	ng/m^3	-	-	61.46	54.04	56.63	66.58	51.16	66.58			

Note:

All assessment is based on the maximum PC using all 5 years of weather data.

Updated Table 22: Long-Term Metals Results – Point of Maximum Impact – Annual throughput of 685,000 tpa

Metal	AQAL	Background conc.	Metals emitted at combined metal limit				Metal as % of ELV (1)	Metals emitted as per EA maximum			
			PC		PEC			PC		PEC	
	ng/m^3	ng/m^3	ng/m^3	as % AQAL	ng/m^3	as % AQAL		ng/m^3	as % AQAL	ng/m^3	as % AQAL
Arsenic	3	1.10	1.25	20.83%	2.35	39.17%	8.3%	0.10	1.74%	1.20	20.07%
Antimony	5,000	-	1.25	0.02%	-	-	3.8%	0.05	0.00%	-	-
Chromium	5,000	39.00	1.25	0.02%	40.25	0.80%	30.7%	0.38	0.01%	39.38	0.79%
Chromium (VI)	0.2	7.80	1.25	500.0%	9.05	3620.0%	0.043%	0.00	0.22%	7.80	3120.22%
Cobalt	-	0.92	1.25	-	2.17	-	1.9%	0.02	-	0.94	-
Copper	10,000	33.00	1.25	0.01%	34.25	0.34%	9.7%	0.12	0.001%	33.12	0.33%
Lead	250	16.00	1.25	0.50%	17.25	6.90%	16.8%	0.21	0.08%	16.21	6.48%
Manganese	150	36.00	1.25	0.83%	37.25	24.83%	20.0%	0.25	0.17%	36.25	24.17%
Nickel	20	14.00	1.25	6.25%	15.25	76.25%	73.3%	0.92	4.58%	14.92	74.58%
Vanadium	5,000	1.70	1.25	-	2.95	-	2.0%	0.02	-	1.72	-

Notes:

(1) Metal as maximum percentage of the group 3 BAT-AEL, as detailed in EA metals guidance document (V.4) Table A1.

Updated Table 23: Short-Term Metals Results – Point of Maximum Impact – Annual throughput of 685,000 tpa

Metal	AQAL	Background conc.	Metals emitted at combined metal limit				Metal as % of ELV (1)	Metals emitted no worse than a currently permitted facility			
			PC		PEC			PC		PEC	
	ng/m^3	ng/m^3	ng/m^3	as % AQAL	ng/m^3	as % AQAL		ng/m^3	as % AQAL	ng/m^3	as % AQAL
Arsenic	-	2.20	66.58	-	68.78	-	8.3%	5.55	-	7.75	-
Antimony	150,000	-	66.58	0.04%	-	-	3.8%	2.55	0.002%	-	-
Chromium	150,000	78.00	66.58	0.04%	144.58	0.10%	30.7%	20.42	0.01%	98.42	0.07%
Chromium (VI)	-	15.60	66.58	-	82.18	-	0.043%	0.03	-	15.63	-
Cobalt	-	1.84	66.58	-	68.42	-	1.9%	1.24	-	3.08	-
Copper	200,000	66.00	66.58	0.03%	132.58	0.07%	9.7%	6.44	0.003%	72.44	0.04%
Lead	-	32.00	66.58	-	98.58	-	16.8%	11.16	-	43.16	-
Manganese	1,500,000	72.00	66.58	0.00%	138.58	0.01%	20.0%	13.32	0.001%	85.32	0.006%
Nickel	-	28.00	66.58	-	94.58	-	73.3%	48.82	-	76.82	-
Vanadium	1,000	3.40	26.68	2.67%	30.08	3.01%	2.0%	0.53	0.053%	3.93	0.39%

Notes:

(1) Metal as maximum percentage of the group 3 BAT-AEL, as detailed in EA metals guidance document (V.4) Table A1.

Updated Table 24: Dispersion Modelling Results – Comparison with May 2011 ES - Daily ELVs

Pollutant	**Quantity**	**Units**	**AQAL**	**PC at point of maximum impact**					
				May 2011 ES		**Facility**		**Change – i.e. the Proposal**	
				Max PC	**as % of AQAL**	**Max PC**	**as % of AQAL**	**PC**	**as % of AQAL**
Nitrogen dioxide	Annual mean	µg/m³	40	0.61	1.52%	0.44	1.09%	-0.17	-0.43%
	99.79th %ile of hourly means	µg/m³	200	10.61	5.30%	6.58	3.29%	-4.03	-2.01%
Sulphur dioxide	99.18th %ile of daily means	µg/m³	125	2.59	2.07%	2.00	1.60%	-0.59	-0.47%
	99.73rd %ile of hourly means	µg/m³	350	7.46	2.13%	4.88	1.40%	-2.58	-0.73%
	99.9th %ile of 15 min. means	µg/m³	266	8.75	3.29%	5.94	2.23%	-2.81	-1.06%
PM_{10}	Annual mean	µg/m³	40	0.04	0.11%	0.02	0.05%	-0.02	-0.06%
	90.41st %ile of daily means	µg/m³	50	0.18	0.36%	0.08	0.17%	-0.10	-0.19%
$PM_{2.5}$	Annual mean	µg/m³	20	0.04	0.22%	0.02	0.10%	-0.02	-0.12%
Carbon monoxide	8 hour running mean	µg/m³	10,000	9.19	0.09%	8.61	0.09%	-0.58	<0.01%
	Hourly mean	µg/m³	30,000	10.86	0.04%	11.10	0.04%	0.24	<0.01%
Hydrogen chloride	Hourly mean	µg/m³	750	2.17	0.29%	1.78	0.24%	-0.39	-0.05%
Hydrogen fluoride	Annual mean	µg/m³	16	0.00	0.03%	0.00	0.03%	<0.01	<0.01%
	Hourly mean	µg/m³	160	0.22	0.14%	0.22	0.14%	<0.01	<0.01%
Ammonia	Annual mean	µg/m³	180	0.04	0.02%	0.04	0.02%	<0.01	<0.01%
	Hourly mean	µg/m³	2,500	2.17	0.09%	2.22	0.09%	0.05	<0.01%
VOCs (as benzene)	Annual mean	µg/m³	5	0.04	0.87%	0.04	0.83%	<0.01	-0.04%
	Daily mean	µg/m³	30	-	-	0.89	2.96%	-	-
VOCs (as 1,3-butadiene)	Annual mean	µg/m³	2.25	0.04	1.93%	0.04	1.85%	<0.01	-0.08%
Mercury	Annual mean	ng/m³	250	0.22	0.09%	0.08	0.03%	-0.14	-0.06%
	Hourly mean	ng/m³	7,500	10.86	0.14%	4.44	0.06%	-6.42	-0.08%

Pollutant	Quantity	Units	AQAL	PC at point of maximum impact					
				May 2011 ES		Facility		Change – i.e. the Proposal	
				Max PC	as % of AQAL	Max PC	as % of AQAL	PC	as % of AQAL
Cadmium	Annual mean	ng/m³	5	0.22	4.34%	0.08	1.67%	-0.14	-2.67%
	Hourly mean	ng/m³	-	10.86	-	4.44	-	-6.42	-
PAHs	Annual mean	pg/m³	250	0.87	0.35%	0.83	0.33%	-0.04	-0.02%
Dioxins	Annual mean	fg/m³	-	0.43	-	0.33	-	-0.10	-
PCBs	Annual mean	ng/m³	200	0.02	0.01%	0.02	0.01%	<0.01	<0.01%
	Hourly mean	ng/m³	6,000	1.09	0.02%	1.11	0.02%	0.02	<0.01%
Other metals	Annual mean	ng/m³	-	2.61	-	0.92	0.00%	-1.69	-
	Hourly mean	ng/m³	-	130.32	-	51.16	0.00%	-79.16	-
Long term impacts of the Facility are based on modelling for 685,000 tpa whilst short term impacts area based on the maximum predicted impact of either operating at MCR or the average flow based on an annual throughput of 685,000 tpa.									

B Ecological impacts based on operation at a Facility throughput of 685,000 tpa

Updated Table 28: Critical Level Summary – European and UK Designated Sites

Site ID	**Site name**	**Site designation**	**Lichen Sensitive**	**Pollutant impacts as a % of CL**					
				Annual mean NOx	**Daily mean NOx**	**Annual mean SO_2**	**Weekly mean HF**	**Daily mean HF**	**Annual mean NH_3**
Critical level (µg/m^3)				**30**	**75***	**10 / 20**	**0.5**	**5**	**1 / 3**
E1	Midland Meres and Mosses – Phase 1 (also the Mere SSSI and Tatton Meres SSSI)	Ramsar	Yes	0.29%	1.08%	0.23%	0.35%	0.11%	0.57%
E2	Midland Meres and Mosses – Phase 1 (also the Mere SSSI and Tatton Meres SSSI) 2	Ramsar	Yes	0.44%	1.45%	0.36%	0.54%	0.14%	0.89%
E3	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC)	Ramsar	Yes	0.20%	1.12%	0.16%	0.60%	0.11%	0.39%
E4	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC) 2	Ramsar	Yes	0.12%	1.16%	0.10%	0.57%	0.12%	0.24%
E5	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC) 3	Ramsar	Yes	0.16%	0.94%	0.13%	0.48%	0.09%	0.33%
E6	Rostherne Mere	Ramsar	No	0.39%	1.15%	0.16%	0.49%	0.11%	0.26%
E7	Witton Lime Beds	SSSI	Yes	0.35%	3.68%	0.28%	1.42%	0.37%	0.69%
E8	Plumley Lime Beds	SSSI	Yes	0.97%	4.35%	0.78%	2.07%	0.44%	1.94%

Note:
Daily mean impacts have been compared to the Critical Level of 75 µg/m^3 as a screening noting that the Critical Level of 200 µg/m^3 is more appropriate.

Updated Table 39: Annual Mean PC used for Deposition Analysis

ID	Site	Annual mean PC (ng/m³)			
		Nitrogen dioxide	Sulphur dioxide	Hydrogen chloride	Ammonia
E1	Midland Meres and Mosses – Phase 1 (also the Mere SSSI and Tatton Meres SSSI)	60.1	22.9	4.6	5.7
E2	Midland Meres and Mosses – Phase 1 (also the Mere SSSI and Tatton Meres SSSI) 2	93.3	35.5	7.1	8.9
E3	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC)	41.2	15.7	3.1	3.9
E4	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC) 2	25.3	9.6	1.9	2.4
E5	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC) 3	34.3	13.1	2.6	3.3
E6	Rostherne Mere	82.5	31.4	6.3	7.9
E7	Witton Lime Beds	72.6	27.6	5.5	6.9
E8	Plumley Lime Beds	203.8	77.6	15.5	19.4
E9	Ashton’s and Neumann’s Flashes	95.2	36.3	7.3	9.1
E10	Gadbrok Valley	72.5	27.6	5.5	6.9
E11	Griffiths Park	131.1	49.9	10.0	12.5
E12	Long Wood	261.5	99.6	19.9	24.9
E13	Marston Flashes	72.0	27.4	5.5	6.9
E14	Wade Brook	270.3	103.0	20.6	25.7
E15	Wincham Brook Valley and Mill Wood	415.9	158.4	31.7	39.6
E16	Winnington Wood	248.2	94.5	18.9	23.6
E17	River Dane	180.5	68.8	13.8	17.2
E18	Marshall's Gorse	67.9	25.9	5.2	6.5

ID	Site	Annual mean PC (ng/m³)			
		Nitrogen dioxide	Sulphur dioxide	Hydrogen chloride	Ammonia
E19	Rudheath Lime Beds	236.7	90.1	18.0	22.5
E20	Lostock House Orchard	254.0	96.8	19.4	24.2

Updated Table 30: Critical Level Summary – Maximum over 5 Years

Site ID	Site name	PC as a % of CL								
		Annual mean					Weekly mean	Daily mean		
		NOx	SO2		NH3		HF	NOx		HF
Critical level (µg/m^3)		**30**	**10***	**20**	**1***	**3**	**0.5**	**75**	**200**	**5**
E9	Ashton’s and Neumann’s Flashes	0.45%	0.36%	0.18%	0.91%	0.30%	1.74%	4.87%	1.83%	0.49%
E10	Gadbrok Valley	0.35%	0.28%	0.14%	0.69%	0.23%	2.87%	8.34%	3.13%	0.83%
E11	Griffiths Park	0.62%	0.50%	0.25%	1.25%	0.42%	2.48%	7.13%	2.67%	0.71%
E12	Long Wood	1.25%	1.00%	0.50%	2.49%	0.83%	2.21%	5.20%	1.95%	0.52%
E13	Marston Flashes	0.34%	0.27%	0.14%	0.69%	0.23%	0.95%	4.37%	1.64%	0.44%
E14	Wade Brook	1.29%	1.03%	0.51%	2.57%	0.86%	2.91%	8.51%	3.19%	0.85%
E15	Wincham Brook Valley and Mill Wood	1.98%	1.58%	0.79%	3.96%	1.32%	3.45%	12.05%	4.52%	1.21%
E16	Winnington Wood	1.18%	0.95%	0.47%	2.36%	0.79%	1.68%	5.20%	1.95%	0.52%
E17	River Dane	0.86%	0.69%	0.34%	1.72%	0.57%	3.03%	7.97%	2.99%	0.80%
E18	Marshall's Gorse	0.32%	0.26%	0.13%	0.65%	0.22%	1.76%	6.11%	2.29%	0.61%
E19	Rudheath Lime Beds	1.13%	0.90%	0.45%	2.25%	0.75%	2.53%	10.33%	3.87%	1.03%
E20	Lostock House Orchard	1.21%	0.97%	0.48%	2.42%	0.81%	2.16%	5.14%	1.93%	0.51%
Note: * CL applicable where lichens are present.										

Updated Table 40: Deposition Calculation - Grassland

ID	Site	Deposition (kg/ha/yr)				N Deposition (kgN/ha/yr)	Acid Deposition keq/ha/yr	
		Nitrogen dioxide	Sulphur dioxide	Hydrogen chloride	Ammonia		N	S
E1	Midland Meres and Mosses – Phase 1 (also the Mere SSSI and Tatton Meres SSSI)	0.009	0.043	0.070	0.030	0.038	0.003	0.005
E2	Midland Meres and Mosses – Phase 1 (also the Mere SSSI and Tatton Meres SSSI) 2	0.013	0.067	0.109	0.046	0.060	0.004	0.007
E3	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC)	0.006	0.030	0.048	0.020	0.026	0.002	0.003
E4	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC) 2	0.004	0.018	0.030	0.013	0.016	0.001	0.002
E5	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC) 3	0.005	0.025	0.040	0.017	0.022	0.002	0.003
E6	Rostherne Mere	0.012	0.059	0.096	0.041	0.053	0.004	0.006
E7	Witton Lime Beds	0.010	0.052	0.085	0.036	0.046	0.003	0.006
E8	Plumley Lime Beds	0.029	0.147	0.238	0.101	0.130	0.009	0.016
E9	Ashton’s and Neumann’s Flashes	0.014	0.069	0.111	0.047	0.061	0.004	0.007
E10	Gadbrok Valley	0.010	0.052	0.085	0.036	0.046	0.003	0.006
E11	Griffiths Park	0.019	0.094	0.153	0.065	0.084	0.006	0.010
E12	Long Wood	0.038	0.189	0.306	0.129	0.167	0.012	0.020
E13	Marston Flashes	0.010	0.052	0.084	0.036	0.046	0.003	0.006
E14	Wade Brook	0.039	0.195	0.316	0.134	0.173	0.012	0.021
E15	Wincham Brook Valley and Mill Wood	0.060	0.300	0.486	0.206	0.266	0.019	0.032
E16	Winnington Wood	0.036	0.179	0.290	0.123	0.158	0.011	0.019

ID	Site	Deposition (kg/ha/yr)				N Deposition (kgN/ha/yr)	Acid Deposition keq/ha/yr	
		Nitrogen dioxide	Sulphur dioxide	Hydrogen chloride	Ammonia		N	S
E17	River Dane	0.026	0.130	0.211	0.089	0.115	0.008	0.014
E18	Marshall's Gorse	0.010	0.049	0.079	0.034	0.043	0.003	0.005
E19	Rudheath Lime Beds	0.034	0.171	0.276	0.117	0.151	0.011	0.018
E20	Lostock House Orchard	0.037	0.183	0.297	0.126	0.162	0.012	0.020

Updated Table 41: Deposition Calculation - Woodland

	Site	**Deposition (kg/ha/yr)**				**N Deposition (kgN/ha/yr)**	**Acid Deposition keq/ha/yr**	
		Nitrogen dioxide	**Sulphur dioxide**	**Hydrogen chloride**	**Ammonia**		**N**	**S**
E1	Midland Meres and Mosses – Phase 1 (also the Mere SSSI and Tatton Meres SSSI)	0.017	0.087	0.169	0.045	0.062	0.004	0.010
E2	Midland Meres and Mosses – Phase 1 (also the Mere SSSI and Tatton Meres SSSI) 2	0.027	0.134	0.262	0.069	0.096	0.007	0.016
E3	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC)	0.012	0.059	0.115	0.031	0.042	0.003	0.007
E4	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC) 2	0.007	0.036	0.071	0.019	0.026	0.002	0.004
E5	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC) 3	0.010	0.049	0.096	0.025	0.035	0.003	0.006
E6	Rostherne Mere	0.024	0.119	0.231	0.061	0.085	0.006	0.014
E7	Witton Lime Beds	0.021	0.105	0.203	0.054	0.075	0.005	0.012
E8	Plumley Lime Beds	0.059	0.294	0.571	0.151	0.210	0.015	0.034
E9	Ashton’s and Neumann’s Flashes	0.027	0.137	0.267	0.071	0.098	0.007	0.016
E10	Gadbrok Valley	0.021	0.104	0.203	0.054	0.075	0.005	0.012
E11	Griffiths Park	0.038	0.189	0.367	0.097	0.135	0.010	0.022
E12	Long Wood	0.075	0.377	0.733	0.194	0.269	0.019	0.044
E13	Marston Flashes	0.021	0.104	0.202	0.053	0.074	0.005	0.012
E14	Wade Brook	0.078	0.390	0.758	0.201	0.278	0.020	0.046
E15	Wincham Brook Valley and Mill Wood	0.120	0.600	1.166	0.309	0.428	0.031	0.070
E16	Winnington Wood	0.071	0.358	0.696	0.184	0.256	0.018	0.042

	Site	Deposition (kg/ha/yr)				N Deposition (kgN/ha/yr)	Acid Deposition keq/ha/yr	
		Nitrogen dioxide	Sulphur dioxide	Hydrogen chloride	Ammonia		N	S
E17	River Dane	0.052	0.260	0.506	0.134	0.186	0.013	0.031
E18	Marshall's Gorse	0.020	0.098	0.190	0.050	0.070	0.005	0.011
E19	Rudheath Lime Beds	0.068	0.341	0.664	0.176	0.244	0.017	0.040
E20	Lostock House Orchard	0.073	0.366	0.712	0.188	0.262	0.019	0.043

Updated Table 42: Detailed Results – Nitrogen Deposition

ID	Site name	NCL Class	Site designation	Lower CL	Upper CL	Background	PC impacts as a % of CL		PEC	
							% of Lower CL	% of Upper CL	% of Lower CL	% of Upper CL
European designated sites										
E1	Midland Meres and Mosses – Phase 1 (also the Mere SSSI and Tatton Meres SSSI)	Valley mires, poor fens and transition mires	Ramsar	10	15	23.66	0.4%	0.3%	237.0%	158.0%
E2	Midland Meres and Mosses – Phase 1 (also the Mere SSSI and Tatton Meres SSSI) 2	Valley mires, poor fens and transition mires	Ramsar	10	15	23.80	0.6%	0.4%	238.6%	159.1%
E3	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC)	Permanent oligotrophic waters: Softwater lakes	Ramsar	5	10	15.60	0.5%	0.3%	312.5%	156.3%
E4	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC) 2	Permanent oligotrophic waters: Softwater lakes	Ramsar	5	10	15.60	0.3%	0.2%	312.3%	156.2%
E5	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC) 3	Permanent oligotrophic waters: Softwater lakes	Ramsar	5	10	15.60	0.4%	0.2%	312.4%	156.2%
E6	Rostherne Mere	Pioneer, low-mid, mid-upper saltmarshes	Ramsar	20	30	14.20	0.3%	0.2%	71.3%	47.5%
UK designated sites										
E7	Witton Lime Beds	Sub-Atlantic semi-dry calcareous grassland	SSSI	15	25	26.40	0.3%	0.2%	176.3%	105.8%

ID	Site name	NCL Class	Site designation	Lower CL	Upper CL	Background	PC impacts as a % of CL		PEC	
							% of Lower CL	% of Upper CL	% of Lower CL	% of Upper CL
E8	Plumley Lime Beds	Broadleaved deciduous woodland	SSSI	10	20	52.80	2.1%	1.0%	530.1%	265.0%
E8	Plumley Lime Beds	Sub-Atlantic semi-dry calcareous grassland	SSSI	15	25	30.50	0.9%	0.5%	204.2%	122.5%
Locally Designated Sites										
E9	Ashton's and Neumann's Flashes	Valley mires, poor fens and transition mires	LWS	10	15	26.46	0.6%	0.4%	265.2%	176.8%
E10	Gadbrok Valley	Broadleaved deciduous woodland	LWS	10	20	45.50	0.7%	0.4%	455.7%	227.9%
E10	Gadbrok Valley	Low and medium altitude hay meadows	LWS	20	30	26.46	0.2%	0.2%	132.5%	88.4%
E11	Griffiths Park	Broadleaved deciduous woodland	LWS	10	20	45.50	1.3%	0.7%	456.3%	228.2%
E11	Griffiths Park	Low and medium altitude hay meadows	LWS	20	30	26.46	0.4%	0.3%	132.7%	88.5%
E12	Long Wood	Broadleaved deciduous woodland	LWS	10	20	45.50	2.7%	1.3%	457.7%	228.8%
E13	Marston Flashes	Valley mires, poor fens and transition mires	LWS	10	15	25.76	0.5%	0.3%	258.1%	172.0%
E14	Wade Brook	Low and medium altitude hay meadows	LWS	20	30	26.46	0.9%	0.6%	133.2%	88.8%
E15	Wincham Brook Valley and Mill Wood	Valley mires, poor fens and transition mires	LWS	10	15	26.46	2.7%	1.8%	267.3%	178.2%

ID	Site name	NCL Class	Site designation	Lower CL	Upper CL	Background	PC impacts as a % of CL		PEC	
							% of Lower CL	% of Upper CL	% of Lower CL	% of Upper CL
E16	Winnington Wood	Broadleaved deciduous woodland	AW	10	20	43.40	2.6%	1.3%	436.6%	218.3%
E17	River Dane	Broadleaved deciduous woodland	pLWS	10	20	45.50	1.9%	0.9%	456.9%	228.4%
E18	Marshall's Gorse	Broadleaved deciduous woodland	pLWS	10	20	45.50	0.7%	0.3%	455.7%	227.8%
E19	Rudheath Lime Beds	Valley mires, poor fens and transition mires	pLWS	10	15	26.46	1.5%	1.0%	266.1%	177.4%
E20	Lostock House Orchard	Low and medium altitude hay meadows	pLWS	20	30	30.52	0.8%	0.5%	153.4%	102.3%
E20	Lostock House Orchard	Broadleaved deciduous woodland	pLWS	10	20	52.92	2.6%	1.3%	531.8%	265.9%

Updated Table 43: Detailed Results – Acid Deposition

Site ID	Site name	Acidity Class	Site designation	Background		PC impacts as a % of Min CL Function	PEC as a % of Min CL Function
				N	S		
E1	Midland Meres and Mosses – Phase 1 (also the Mere SSSI and Tatton Meres SSSI)	Not sensitive to acidity	Ramsar	1.69	0.21	-	-
E2	Midland Meres and Mosses – Phase 1 (also the Mere SSSI and Tatton Meres SSSI) 2	Not sensitive to acidity	Ramsar	1.70	0.22	-	-
E3	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC)	Bogs	Ramsar	1.80	0.20	0.94%	371.3%
E4	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC) 2	Bogs	Ramsar	1.80	0.20	0.6%	370.9%
E5	Midland Meres and Mosses – Phase 2 (also Oak Mere SAC and West Midlands Mosses SAC) 3	Bogs	Ramsar	1.80	0.20	0.8%	371.2%
E6	Rostherne Mere	Not sensitive to acidity	Ramsar	1.00	0.20	-	-
E7	Witton Lime Beds	Calcareous grassland	SSSI	1.90	0.20	0.2%	41.6%
E8	Plumley Lime Beds	Unmanaged Broadleaf Coniferous Woodland	SSSI	3.80	0.20	2.6%	214.7%
E8	Plumley Lime Beds	Calcareous grassland	SSSI	2.20	0.20	0.5%	47.8%
E9	Ashton’s and Neumann’s Flashes	Not sensitive to acidity	LWS	1.89	0.21	-	-
E9	Ashton’s and Neumann’s Flashes	Calcareous grassland	LWS	1.89	0.21	0.2%	41.6%

Site ID	Site name	Acidity Class	Site designation	Background		PC impacts as a % of Min CL Function	PEC as a % of Min CL Function
				N	S		
E10	Gadbrok Valley	Unmanaged Broadleaf Coniferous Woodland	LWS	3.25	0.25	0.6%	116.6%
E10	Gadbrok Valley	Calcareous grassland	LWS	1.89	0.21	0.2%	41.6%
E11	Griffiths Park	Unmanaged Broadleaf Coniferous Woodland	LWS	3.25	0.25	1.7%	186.2%
E11	Griffiths Park	Calcareous grassland	LWS	1.89	0.21	0.3%	41.7%
E12	Long Wood	Unmanaged Broadleaf Coniferous Woodland	LWS	3.25	0.25	3.3%	187.8%
E13	Marston Flashes	Calcareous grassland	LWS	1.84	0.22	0.2%	40.8%
E14	Wade Brook	Calcareous grassland	LWS	1.89	0.21	0.7%	42.1%
E15	Wincham Brook Valley and Mill Wood	Calcareous grassland	LWS	1.89	0.21	1.0%	42.4%
E16	Winnington Wood	Unmanaged Broadleaf Coniferous Woodland	AW	3.10	0.26	3.2%	182.8%
E17	River Dane	Unmanaged Broadleaf Coniferous Woodland	pLWS	3.25	0.25	2.3%	186.8%
E18	Marshall's Gorse	Unmanaged Broadleaf Coniferous Woodland	pLWS	3.25	0.25	0.5%	116.6%
E19	Rudheath Lime Beds	Calcareous grassland	pLWS	1.89	0.21	0.6%	42.0%

Site ID	Site name	Acidity Class	Site designation	Background		PC impacts as a % of Min CL Function	PEC as a % of Min CL Function
				N	S		
E20	Lostock House Orchard	Calcareous grassland	pLWS	2.18	0.21	0.6%	47.7%
E20	Lostock House Orchard	Unmanaged Broadleaf Coniferous Woodland	pLWS	3.78	0.25	3.3%	217.1%

ENGINEERING + CONSULTING

FICHTNER
Consulting Engineers Limited

Kingsgate (Floor 3), Wellington Road North,
Stockport, Cheshire, SK4 1LW,
United Kingdom

t: +44 (0)161 476 0032
f: +44 (0)161 474 0618

www.fichtner.co.uk

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Document approval

	Name	Signature	Position	Date
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Contents

1 Non-technical summary

Introduction

This document forms the application to permit the operation of a Sustainable Energy Plant (SEP) under the Environmental Permitting Regulations 2010 (as amended). The applicant and operator of the SEP is Lostock Sustainable Energy Plant Ltd.

The SEP will burn up to 685,000 tonnes of waste fuels per annum, with a maximum hourly capacity of 45.5 tonnes per hour, consisting of Solid Recovered Fuel (SRF), commercial and industrial waste (C&I) and municipal solid waste (MSW); and consequently will be subject to the requirements of the Waste Incineration Directive, 2000 as recast within the Industrial Emissions Directive (IED). The SEP has been designed and will be operated to ensure compliance with all relevant requirements of this Directive.

The SEP will comprise a twin line waste incineration facility.

This Non Technical Summary provides a brief overview of the proposals subject to this application.

Site Location

The SEP will be located within the Tata Chemicals Europe soda ash works at Lostock. A location plan is provided in Figure 2 [of the original EP application].

Process Description

The soda ash process at Lostock site has a significant steam demand as well as requiring electricity to power the process. The process uses up to 160 tonnes of intermediate pressure (IP) steam per hour .Of this 60 tonnes per hour is used to provide heat for bicarbonate decomposition and product drying. The remaining 100 tonnes per hour is processed through a turbine and alternator generating additional electrical power and low pressure steam which is subsequently used in the ammonia recovery step (distillation).

Currently steam and electricity is provided from a gas fired combined heat and power (CHP) plant at Winnington. The SEP will comprise 2 no. 120MW thermal boilers and is assumed to generate approximately 76.9 MW of electricity, with the potential to export up to 25 tonnes of steam (which would reduce the electrical output of the Facility).

Security of power supply is a major concern to energy intensive industries. With conventional fossil fuel supplies in decline, Operators are seeking to secure future energy supply from alternative means through fuel diversification. The proposals for the Lostock SEP are being developed for this specific purpose.

The operation of the proposed SEP will achieve a net reduction in greenhouse gas emissions. These savings are achieved through:

- Exporting electricity from the SEP to the grid – displacing fossil fuel derived electricity from older inefficient power plant.
- Avoiding the generation of methane by diverting waste away from landfill to the SEP.
- Recycling of residues from the SEP avoiding the need for processing of virgin materials (e.g. aggregates).

It is estimated that the proposed SEP will provide greenhouse gas savings of approximately 159,989 tonnes of carbon dioxide equivalent emissions per annum in the base case.

The SEP comprises two processing lines each with a boiler with a capacity of 120 MWth that will generate steam. Electricity will be exported to the grid.

It is intended that waste will be delivered by road. If the potential for delivery by rail is realised during the development of the project, this will be further assessed. The waste will either have been pre-weighed or will be weighed upon entry to the site. Waste acceptance procedures will be in place to ensure that it conforms to those materials which the SEP is designed to accept. Inside the plant building, waste will be discharged directly into the waste bunker. The capacity of the waste bunker will be approximately 4,500 tonnes of waste.

Waste material is transferred from the stacking area via two overhead gantry cranes into the waste charging hoppers. The charging hopper connects into a feed chute from where hydraulically driven ram feeders are used to deliver waste to the furnace and ensure even distribution across the width of the grate.

Moving grate technology will be used for burning the waste material. The grate is designed as a multi-line sliding grate and is longitudinally inclined. The grate bars are cooled by primary air.

The combustion stage will be automatically controlled to manage fuel flow, combustion air flow and to monitor temperature and oxygen to ensure optimum destruction of pollutants and minimum waste generation.

Primary combustion air will be fed into the furnace through the underside of the grate by a primary air fan. Secondary air will also be injected at high velocity through nozzles positioned in the walls at the end of the combustion chamber. This will create turbulence, which assists mixing of secondary air and combustion gases to achieve complete combustion of the gases. The volume/flow rate of both primary and secondary air will be regulated by the combustion control system.

Selective Non-Catalytic Reduction involving the injection of ammonia above the furnace is used to control nitrogen oxide releases in the exhaust gases. This system of controlling nitrogen oxides is widely applied at other similar facilities and it is considered well proven in controlling emissions below the levels within the Waste Incineration Directive.

Hot gases from the combustion chamber will pass into the boiler section where steam will be raised. The boiler design has been selected to minimise the synthesis of dioxins and furans.

Steam raised in the boilers will be passed to a single turbine to generate electricity, with the potential to export heat to local users should this become commercially and technically viable.

The SEP includes abatement to ensure that releases to air are controlled below the limits specified within the Waste Incineration Directive. In addition to the use of selective noncatalytic reduction (see above), the following flue gas treatment plant is provided:

- Dry sorption reactor including sodium bicarbonate and activated carbon injection; and
- Fabric bag filter.

The residues of the bag filters and the reactors are collected and directed to the residue silos. The residue silos are designed to discharge product via an enclosed loading chute into trucks.

Clean flue gases exiting the abatement system for each line will be discharged through two 90m flue stacks, one serving each line. This height has been selected to give optimum dispersion for the proposed plant configuration.

The abatement plant cannot be bypassed and will be in operation at all times, including startup and shutdown.

A fundamental requirement of the WID (Article 6 (3)) is that incineration facilities have in place an automatic system which prevents waste material feed (other than auxiliary fuel) in the following situations:

- at start up until a temperature of 850°C has been reached;

- whenever the temperature of 850°C is not maintained;
- whenever the continuous emission monitors show that any emission limit value is exceeded due to disturbance or failure of the purification devices.

For the proposed SEP back up burners fuelled by light fuel oil are located above the grate. The burners will be automatically triggered to ensure that the minimum temperature of 850°C is maintained.

The detailed plant design process will include computational fluid dynamic modelling of the furnace to demonstrate that the temperature and residence time requirements specified in the Waste Incineration Directive will be met.

The SEP has been designed to minimise fresh water consumption. This is achieved by maximising the re-use of process waters. Under normal operations, there will be no process water discharges. Furthermore, rainwater would be collected and used e.g. in welfare facilities. During periods of heavy rainfall where the rate of generation exceeds the capacities of storage facilities, excess rainwater will be discharged to surface water.

All plant areas will be surfaced to an appropriate standard for the activities within that area. All liquid tanks and drums will be provided within impermeable bunding in line with industry best practice standards (i.e. sized to contain 110% of the tank contents and including blind drains). Materials selected for surfacing of process areas and bunds will be resistant to the materials they may come into contact with.

There will be no direct discharges to groundwater from the SEP.

Odour problems are not expected from the SEP. Any potential odours from storage of the waste materials will be extracted from above the storage bunker and used as combustion air within the furnace, thereby destroying any potentially odorous compounds. The plant will be of a two-stream design, with maintenance of each line undertaken in succession. Therefore, it is very unlikely for both lines to be shut down at the same time. Odour will be controlled during shutdown periods by minimising the amount of waste in storage. Waste will be run-down prior to periods of planned maintenance. In addition, doors to the tipping hall will be kept shut during periods of shutdown.

Management of Activities

An environmental management system will be established in accordance with the requirements of the ISO14001 standard. The environmental management system will be combined with both the quality and health and safety management system to form an integrated management system.

The Plant Operator has established integrated management systems at existing operational plants and it is anticipated that a similar system will be adopted (and modified as necessary) at the SEP.

Raw Materials

An inventory of raw materials will be implemented and maintained throughout the operational life of the SEP. The principal raw materials will be the incoming waste material, in addition the following reagents will be used for flue gas cleaning:

- ammonium hydroxide;
- sodium bicarbonate; and
- activated carbon.

Use of reagents will be optimised during commissioning and controlled during operation.

Waste

The main solid residues produced by the SEP will be:

- bottom ash; and
- air pollution control residues

Bottom ash will be stored at the site prior to transfer off-site for processing. Unburned waste would be recovered from the bottom ash if identified, with any unburned material returned to the waste bunker and combusted.

The air pollution control residues will either be sent to landfill or to a suitably licensed processing facility for recycling. The Operator will regularly review the disposal options for this residue and if a recycle route becomes viable then the residue will be diverted for recycling.

Energy Efficiency

The SEP design includes combined heat and power technology and minimises the use of fossil fuels by combusting materials derived from wastes. The SEP is designed to minimise internal energy demand thereby maximising the amount of heat and power available for export.

Accidents

The SEP has been designed for safe operation under normal, abnormal and emergency conditions. The design process will be subject to a hazard study process designed to remove hazards through the plant design wherever possible. Prior to operation an accident management plan will be in place and this system will be reviewed and maintained as a live management system.

Noise

A noise assessment has been carried out for the proposed SEP. The results of the assessment indicate that significant adverse noise or vibration effects would not be expected as a result of operating the SEP.

Monitoring

Discharges to air will be monitored and reported by the SEP using continuous monitoring equipment supported by periodic stack monitoring. All monitoring will meet the requirements of the Waste Incineration Directive.

Process control systems will be included to provide process monitoring to ensure that the SEP is controlled within the design parameters.

The quantity of wastes generated from the SEP will be monitored. Further monitoring and reporting of bottom ash and air pollution control residues will be carried out in accordance with the requirements of the environmental permit.

Where available for monitoring parameters, equipment certified to the Environment Agency monitoring standard will be used to carry out monitoring at the SEP.

Site Condition and Closure

A full description of the site conditions at the time of the original EP application are provided in the Application Site Condition Report, which provides a coherent record of the site.

A site closure plan will be developed in order to demonstrate that the SEP will be decommissioned when it has reached the end of its operational lifetime to avoid any pollution risk and return the site of operation to its original condition at the time of commencing operation, in accordance with the requirements of the Environmental Permitting regime. A range of appropriate measures will be adopted during operation to ensure that the requirements for site restoration following decommissioning will be minimised.

Impacts

Assessments of air quality effects and human health risk have been undertaken and concluded that no significant effects will arise as a result of operation of the proposed SEP. A separate air quality assessment considered effects at sensitive ecological sites and also concluded that no significant effects would occur.

These assessments have considered the effects from operation of both lines of the SEP development.

Summary

In summary the proposed SEP will be designed and operated to ensure that significant impacts will not arise as a result of its operation. The main plant will operate techniques that are proven and reliable and for the selected site are concluded to represent Best Available Techniques.

2 Management of activities

2.1 General

An environmental management system will be established in accordance with the requirements of the ISO14001 standard. The EMS will be combined with both the quality and health and safety management system to form an Integrated Management System (IMS).

The Operator has established integrated management systems at existing operational plant and it is anticipated that a similar system will be adopted (and modified as necessary) at the SEP. However, the system will be designed to be complementary to other management systems within the Lostock site.

The scope of the EMS element of the IMS will cover those elements required by ISO14001 and environmental permitting. The Operator will implement an environmental policy that will be in place prior to commissioning the plant. All staff and contractors will be made aware of the environmental policy as part of the induction training and a copy will made available on site.

A system for keeping of all relevant records including but not limited to the following, will be developed and implemented prior to commissioning:

- waste transfer/duty of care documentation;
- records of incidents, accidents and emergencies including details of follow-up; and
- any other records required to be kept by the permit.

This procedure will be expanded to cover all aspects for record keeping required by a formal EMS within the timescale set for achievement of certification to ISO 14001.

As part of the formal EMS, systems will be developed and implemented for undertaking audits, setting and reporting of environmental performance, objectives, targets and programmes for future improvements.

Prior to commencing commissioning on waste, all key procedures will be in place as detailed below.

Operations and Maintenance

Procedures will be put in place to ensure that those operations which have the potential to give rise to significant environmental effects are controlled. Procedures will not only cover normal operation but will also address abnormal operation, including start-up and shutdown. Planned maintenance routines will be established to ensure all key plant which have the potential to affect the environmental performance of the plant remain in good working order. Maintenance routines will draw on manufacturers' recommendations, unless operational experience during the lifetime of the plant would indicate the need for variance.

In particular procedures will be developed in relation to the following:

- waste fuel reception and handling, including waste acceptance procedures;
- control of the combustion process, to ensure good combustion is achieved and compliance with WID requirements;
- operation of the flue gas cleaning systems;
- reagent stock management; and
- storage, handling and removal of wastes from the site.

Competence and Training

The Operator will provide operator training to ensure that the plant will be operated by a fully trained workforce. Operator training will be undertaken prior to commencing commissioning of the plant. Training will not only address normal operations but will also include those actions required in the event of abnormal operations and emergencies.

Job specifications will be defined and will include details on relevant qualifications and training (including where relevant on the job training) required for that role. Records of training will be stored and maintained. Records as a minimum will include details relating to the date, type of training and training provider.

All relevant staff (including contractors forming part of the commissioning team) will be made aware of the requirements of the permit, in particular those conditions in relation to emission limits and notification procedures. A copy of the permit will be available for reference within the Control Room.

Procedures will also be in place to ensure that contractors undertaking work at the installation are qualified for the task they are undertaking.

Organisation

An indicative organisation chart for the SEP is provided in Figure 11 [of the original EP application] and indicates the main lines of responsibility. Roles and responsibilities will be clearly defined within the management system.

Further details on specific aspects of the management systems for the SEP are provided in the following sections.

2.2 Accident Management

An accident management plan (AMP) will be established prior to commencing operation of the proposed plant. Procedures to follow in the event of an emergency or accident/incident will be in place prior to burning waste. This will include small incidents such as minor spills and leaks and complaints as well as major incidents such as a fire. There will be a specific procedure for recording and allocating appropriate follow-up for accidents, incidents and nonconformances.

The AMP will be consistent with similar plans already in place for the existing permitted activities within the Lostock site and where relevant will include any actions required in the event of an incident, accident or emergency including communication with the existing plant.

To support the application an initial environmental risk assessment is provided as Appendix H [of the original EP application]. This will be reviewed prior to commencing operation and maintained as part of the AMP throughout the operational life of the plant.

As part of the design process, the proposals will be subject to detailed HAZOP/HAZID with a view to designing out safety, health and environmental risks.

Abnormal Operation

Article 13 of the WID sets out specific requirements covering abnormal operating conditions. The Operator will ensure that the plant will not exceed the maximum permissible period of any technically unavoidable stoppages, disturbances or failures of the abatement plant or monitoring systems. In particular, unless stricter timescales are set within the permit, the SEP shall not continue operation for more than four hours uninterrupted where emission limit values are exceeded and moreover, the cumulative duration of operation under such conditions shall not exceed 60 hours over 1 year.

Systems will be established for recording the duration of any such event and calculating the cumulative duration such that compliance with the permit can be demonstrated. Where any incident or cumulative duration will exceed the maximum permitted time period the plant will be shut down as soon as practicable.

The plant has been designed and will be operated to ensure that at all times when waste is being burned a temperature in excess of 850°C will be achieved for at least 2 seconds after the last injection of combustion air (see further detail in section 3.4 and 3.5). Further, the furnace will be equipped with an automatic system which prevents waste material feed in the following situations:

- at start up until a temperature of 850°C has been reached;
- whenever the temperature of 850°C is not maintained, including shutdown;
- whenever the continuous emission monitors show that any emission limit value is exceeded due to disturbance or failure of the purification devices.

In the event that the automatic system is triggered, the Operator will be alerted via alarms.

Site Security

The main project site is bounded to the east by the Trent and Mersey Canal, which runs north/south. It is used by pleasure craft only and for no current commercial uses. The canal footpath is a public right of way. For security purposes that footpath is fully fenced preventing access to the site.

The main site is bounded to the north by the Tata Chemicals soda ash process and the brine purification plant owned by Ineos. The works extend approximately 800 m to the west with residential land beyond. Access to the site is from Griffiths Road to the east of the site beyond the canal. Further to the east of the site there is an extensive network of historic, elevated waste lime beds.

2.3 Energy Efficiency

General Energy Efficiency Issues

The plant has been designed and will be operated and maintained to minimise internal energy demand. An energy flow diagram is attached to the main application document as Figure 10 [of the original EP application] which indicates the energy flows for the nominal design point.

The plant has been designed to generate energy from waste, however the process itself will require energy to operate. The parasitic load will be supplied in the form of electricity to drive pumps, motors etc. Auxiliary firing will use fuel oil. A breakdown of delivered and primary energy consumption for the SEP is provided in Table 1 below:

Table 1: Expected Breakdown of Delivered and Primary Energy Consumption

Energy source	Energy Consumption		
	Delivered MWh	Primary MWh	% of Total
SEP Energy Demand			
Electricity	48,960[1]	94,233[2]	88.8
Light fuel oil	11,836	11,836[3]	11.2

1. *Based on 8,000 hours operation*

2. *Electricity is assumed to be provided from the SEP. A site specific conversion factor of 1.92 is used to convert delivered to primary energy, this factor is based on the energy losses as per Figure 10 [of the original EP*

application], Appendix C [of the original EP application], which indicates that total energy input = 206MW and total energy output = 107.03 MW (38.40.+68.63); 206/107.03 = 1.92.

3. *Assumes annual light fuel oil consumption of 1,000m3, density 991 kg/m3 and CV of 43MJ/kg. Delivery to primary energy = 1 as per H2 Guidance on Energy Efficiency [7]*

The plant will generate 38 MW of electricity and 100 tonnes per hour of steam for export to the soda ash process at Lostock site. The plant is designed to operate in a fully condensing mode thus avoiding any boiler disruption even if the Tata Chemicals steam demand varied significantly. In the event that the soda ash process is not operating at capacity, steam would be diverted to power generation and excess electricity exported to the grid. 2.29 Specific energy efficiency measures which will be incorporated include the following:

- the plant has been designed to produce both electrical and heat power;
- air pre-heat is minimised from extracting secondary air from the highest (which is also the warmest) point in the building, making use of natural warming of the air;
- heat recovery from flue gas by condensate preheat;
- the furnace section will be effectively insulated and lined to ensure heat is retained;
- design and construction of the plant to avoid uncontrolled air ingress;
- optimisation of the plant layout to avoid excessive transfer of materials, where possible; and
- effective plant maintenance regime to ensure plant efficiency is maintained over time and to reduce down time or prolonged outages.

In the event of an unplanned reduction in steam demand from the soda ash process, the steam generated will be diverted to electrical power generation. This can be achieved rapidly which minimises the potential for any loss of steam by venting.

Operating, maintenance and housekeeping measures

Where relevant, operating procedures will include details of techniques to ensure that the plant is operated efficiently. Maintenance and housekeeping measures will be developed as part of the preventative maintenance system. This will include details of the measures specifically aimed at maintaining the efficiency of the plant during its operational life. In particular procedures will cover the following items:

- operation of motors and drives – daily/shift checks on operations and conditions;
- compressed air systems – daily walk round checks for leaks, procedures for use of pneumatic tools;
- steam systems – walk round checks for leaks and insulation inspection; and
- lubrication systems – schedule for routine lubrication.

Physical Techniques

Insulation will be provided to avoid heat losses from relevant plant items such as the main furnace, steam systems etc. The plant will be housed within buildings and doors will be kept shut other than for access.

Building Services

Energy requirements for building services will be low. Energy efficient lighting will be employed where feasible and lights will be turned off in unoccupied buildings where they are not required for safety or security reasons.

Space heating will be limited to manned areas such as the control room and administration areas, heating of other process buildings will not be required.

Energy Management Techniques

During the operational life of the plant energy use will be monitored and recorded. Periodically usage will be reviewed to identify areas for improvement and ensure that any abnormal increase in energy use is investigated and appropriate action taken to resolve the issue.

Any areas where improvements are identified will be incorporated within the energy efficiency plan for the Site. This plan will be incorporated within the EMS to ensure that it is regularly reviewed and maintained up to date in the light of technology developments.

Consideration of Energy Efficiency with other Environmental Effects

Whilst maximising energy efficiency is important it is noted that other environmental issues need to be considered alongside maximising energy efficiency. Sector guidance notes the following BAT considerations and requires justification of how the proposals represent BAT:

- The choice of fuel impacts upon emissions other than carbon e.g. sulphur in fuel.
- Where the potential minimisation of waste emissions by recovery of energy from waste conflicts with energy efficiency requirements.
- Where the nature of the waste is such that the primary concern of safe waste disposal may be jeopardised by additional energy recovery.

The selected fuel comprises non-hazardous wastes and will replace energy currently generated from natural gas. Given that the primary driver for the plant is to provide future power security through fuel diversification by moving away from burning fossil fuels consideration of fossil fuels other than comparison with natural gas (as the current fuel) is not appropriate. The choice of fuel and effect upon emissions is discussed separately within section 2.4.

The proposals will affect the emissions profile for releases air compared to those from the existing gas-fired CHP. However as demonstrated from the air quality assessment the proposals will not give rise to significant environmental effects (see section 5.1 [of the original EP application]). The emissions to air also need to be considered in the context of a primary driver for the SEP which aims to provide greenhouse gas savings when compare to the existing gas-fired CHP plant.

Energy Efficiency – Sub-Sector specific Issues for Municipal Waste Incineration

The key requirements relevant to the SEP are:

- Steam should be generated either for direct use or for electricity generation.
- Waste heat should be recovered unless to do so can be demonstrated not to represent BAT. All opportunities for CHP and district heating should be explored.
- The siting of plant near to potential or actual energy users will aid maximisation of recovery potential. Consideration of joint venture projects wherever possible.

Energy is recovered from the hot flue gases within the steam boiler. The resulting high pressure steam is directed to the turbine, generating electricity which is exported to the grid. The Facility will also have the potential to export heat to local users should this become commercially and technically viable. The proposals therefore are considered to be BAT for energy efficiency for facilities burning waste achieving a high overall energy efficiency.

A fully condensing turbine has been selected to maximise flexibility in operation between heat and electricity output. In the event that the Tata Chemicals steam demand is reduced or not required the SEP can divert this steam to electricity generation without the need to vent steam.

2.4 Efficient Use of Raw Materials and Water

The principal raw materials used by the plant will include the following:

- In-coming waste / fuel.
- Ammonium hydroxide.
- Activated carbon.
- Sodium bicarbonate.
- Light fuel oil.
- Water.

In addition, smaller volumes of water treatment chemicals and maintenance oils and greases will also be required.

The selection of raw materials is justified below.

In-coming Waste

The primary driver for the plant is to ensure future power security by moving away from the existing reliance on fossil fuel generation. The proposals therefore intend to accept the following waste materials:

- Solid Recovered Fuel (SRF);
- Municipal Solid Waste (MSW); and
- Commercial and Industrial (C&I) Waste.

The European Waste codes (EWC) applicable to the wastes to be accepted at the plant are as follows:

EWC Code	Description
02	**Wastes from agriculture, horticulture, aquaculture, forestry, hunting and fishing, food preparation and processing**
02 01	**wastes from agriculture, horticulture, aquaculture, forestry, hunting and fishing**
02 01 03	plant-tissue waste
02 01 04	waste plastics (except packaging)
02 01 07	wastes from forestry
02 03	**wastes from fruit, vegetables, cereals, edible oils, cocoa, coffee, tea and tobacco preparation and processing; conserve production; yeast and yeast extract production, molasses preparation and fermentation**
02 03 01	sludges from washing, cleaning, peeling, centrifuging and separation
02 03 02	wastes from preserving agents
02 03 03	wastes from solvent extraction
02 03 04	materials unsuitable for consumption or processing
02 03 05	sludges from on-site effluent treatment
02 05	**wastes from the dairy products industry**
02 05 01	materials unsuitable for consumption or processing

EWC Code	Description
02 05 02	sludges from on-site effluent treatment
02 06	**wastes from the baking and confectionery industry**
02 06 01	materials unsuitable for consumption or processing
02 06 02	wastes from preserving agents
02 06 03	sludges from on-site effluent treatment
02 07	**wastes from the production of alcoholic and non-alcoholic beverages (except coffee, tea and cocoa)**
02 07 01	wastes from washing, cleaning and mechanical reduction of raw materials
02 07 02	wastes from spirits distillation
02 07 03	wastes from chemical treatment
02 07 04	materials unsuitable for consumption or processing
02 07 05	sludges from on-site effluent treatment
03	**Wastes from wood processing and the production of panels and furniture, pulp, paper and cardboard**
03 01	**wastes from wood processing and the production of panels and furniture**
03 01 01	waste bark and wood
03 01 05	sawdust, shavings, cuttings, wood, particle board and veneer other than those mentioned in 03 01 04
03 03	**wastes from pulp, paper and cardboard production and processing**
03 03 01	waste bark and wood
03 03 02	green liquor sludge (from recovery of cooking liquor)
03 03 05	de-inking sludges from paper recycling
03 03 07	mechanically separated rejects from pulping of waste paper and cardboard
03 03 08	wastes from sorting of paper and cardboard destined for recycling
03 03 10	fibre rejects, fibre-, filler-and coating sludges from mechanical separation
03 03 11	sludges from on-site effluent treatment other than those mentioned in 03 03 10
04	**Wastes from the leather, fur and textile industries**
04 02	**wastes from the textile industry**
04 02 15	wastes from finishing other than those mentioned in 04 02 14
04 02 21	wastes from unprocessed textile fibres
04 02 22	wastes from processed textile fibres
15	**Waste packaging, absorbents, wiping cloths, filter materials and protective clothing not otherwise specified**

EWC Code	Description
15 01	**packaging (including separately collected municipal packaging waste) packaging (including separately collected municipal packaging waste)**
15 01 01	paper and cardboard packaging
15 01 02	plastic packaging
15 01 03	wooden packaging
15 01 06	mixed packaging
15 01 09	textile packaging
15 02	**absorbents, filter materials, wiping cloths and protective clothing**
15 02 03	absorbents, filter materials, wiping cloths and protective clothing other than those mentioned in 15 02 02
16	**Wastes not otherwise specified in the list**
16 01	**end-of-life vehicles from different means of transport (including off-road machinery) and wastes from dismantling of end-of-life vehicles and vehicle maintenance (except 13, 14, 16 06 and 16 08)**
16 01 03	end-of-life tyres
16 01 19	plastic
17	**Construction and demolition wastes (including excavated soil from contaminated sites)**
17 02	**wood, glass and plastic**
17 02 01	wood
17 02 03	plastic
17 09	**other construction and demolition wastes**
17 09 04	mixed construction and demolition wastes other than those mentioned in 17 09 01, 17 09 02 and 17 09 03
18	**WASTES FROM HUMAN OR ANIMAL HEALTH CARE AND/OR RELATED RESEARCH (except kitchen and restaurant wastes not arising from immediate health care)**
18 01	**wastes from natal care, diagnosis, treatment or prevention of disease in humans**
18 01 04	wastes whose collection and disposal is not subject to special requirements in order to prevent infection (for example dressings, plaster casts, linen, disposable clothing, diapers)
18 01 09	medicines other than those mentioned in 18 01 08 (excluding sharps or infectious waste)
19	**Wastes from waste management facilities, off-site waste water treatment plants and the preparation of water intended for human consumption and water for industrial use**

EWC Code	Description
19 02	**wastes from physico/chemical treatments of waste (including dechromatation, decyanidation, neutralisation)**
19 02 03	premixed wastes composed only of non-hazardous wastes
19 02 10	combustible wastes other than those mentioned in 19 02 08 and 19 02 09
19 05	**wastes from aerobic treatment of solid wastes**
19 05 01	non-composted fraction of municipal and similar wastes
19 05 02	non-composted fraction of animal and vegetable waste
19 05 03	off-specification compost
19 06	**wastes from anaerobic treatment of waste**
19 06 04	digestate from anaerobic treatment of municipal waste
19 06 06	digestate from anaerobic treatment of animal and vegetable waste
19 12	**wastes from the mechanical treatment of waste (for example sorting, crushing, compacting, pelletising) not otherwise specified**
19 12 01	paper and cardboard
19 12 04	plastic and rubber
19 12 07	wood other than that mentioned in 19 12 06
19 12 08	textiles
19 12 10	combustible waste (refuse derived fuel)
19 12 12	other wastes (including mixtures of materials) from mechanical treatment of wastes other than those mentioned in 19 12 11
20	**Municipal wastes (household waste and similar commercial, industrial and institutional wastes) including separately collected fractions**
20 01	**separately collected fractions (except 15 01)**
20 01 01	paper and cardboard
20 01 08	biodegradable kitchen and canteen waste
20 01 10	clothes
20 01 11	textiles
20 01 25	edible oil and fat
20 01 28	paint, inks, adhesives and resins other than those mentioned in 20 01 27
20 01 38	wood other than that mentioned in 20 01 37
20 01 39	Plastics
20 02	garden and park wastes (including cemetery waste)
20 02 01	biodegradable waste
20 03	**other municipal wastes**

EWC Code	Description
20 03 01	mixed municipal waste
20 03 02	waste from markets
20 03 03	street-cleaning residues
20 03 06	waste from sewage cleaning
20 03 07	bulky waste

Given the primary driver for the plant, consideration of fossil fuel alternatives is not within the scope of this project. It is not proposed to handle hazardous waste material.

The plant has been designed on the basis of the above fuels and the design envelope (see Figure 12 [of the original EP application]) will handle a wide variation in operating conditions. In summary the nominal design point for the plant is 10.3 MJ/kg however the range of CVs that will be accommodated is between 8 – 16.5 MJ/kg: Similarly the design throughput of the plant is 36.1 tonnes per hour (tphr) although the plant will accommodate waste throughputs between 22.5 tphr and 39.7 tphr.

Ammonium Hydroxide

NOx control will utilise ammonium hydroxide as the reagent. The main alternative to this reagent is urea. Whilst urea presents lower handling and storage hazards compared to ammonium hydroxide, the reduction reaction of urea gives rise to higher releases of nitrous oxides with corresponding global warming potential (GWP) impacts. Nitrous oxide has a GWP of 310, compared to carbon dioxide with a GWP of 1. Consequently the decision is a balance between the inherent risks associated with ammonium hydroxide versus the increased GWP impacts associated with urea.

Ammonium hydroxide is a fundamental raw material for the soda ash process at the Lostock site and its use in the SEP does not constitute bringing a new chemical onto the site. The Operator utilises ammonium hydroxide as a NOx reagent at other facilities within Europe and are therefore familiar with the risks associated with this reagent and have adopted practices to successfully manage this activity. For this reason, combined with the additional benefits from reduced GWP compared to urea, ammonia solution is proposed for controlling NOx.

Usage of ammonia solution will be monitored and controlled to minimise ammonia slippage whilst also effectively controlling NOx emissions. Dosing will be linked to exhaust gas NOx levels and will be alarmed to alert the Operator in the event of a problem with the dosing of the reagent.

Sodium bicarbonate

There are a number of common alternative reagents which can be used for acid gas control; however, not all are suited for use within a dry system. Justification for the selection of the acid gas system is provided within section 6 and is therefore not discussed further here. Those reagents which can be used within the type of system proposed are sodium bicarbonate, lime or hydrated lime.

Sodium bicarbonate removes acid gases very effectively resulting in cleaner flue gases from combustion processes. The lower consumption of sodium bicarbonate in flue gases makes it a more cost effective option for FGT. Typically, a stoichiometric ratio of 1.25 is achieved, and this is substantially lower than other reagents. Sodium bicarbonate is also effective over a wide range of temperatures and its consumption is the same regardless of gas temperature, and as such is compatible with use in a flue gas cleaning system which combines bag filters, whilst remaining at efficient temperature ranges. (Note bag filters are considered BAT for particulate control). Sodium bicarbonate is suitable for direct injection and for use within the dry sorption reactor. It also has easier handling properties compared to hydrated lime which is corrosive. Sodium bicarbonate gives opportunity to recover heat from the flue gas instead of quenching it in a lime based process.

Less FGT residues are generated with sodium bicarbonate, compared to lime thus resulting in lower disposal costs. Based on 100% reaction, sodium bicarbonate generates approximately half of the residues associated with lime treatment.

In summary the Operator have selected sodium bicarbonate as it is a proven, effective and efficient reagent for neutralising acid gases, and is well suited to operation with bag filters. It can be easily handled as it is non-hazardous and non-irritant.

Dosage rates of sodium bicarbonate will be controlled and monitored to ensure usage is optimised and to avoid overdosage resulting in increased quantities of unreacted material within the APC residues. Dosage will be controlled against raw gas concentrations of SO2 and HCl. Flow of reagent will be monitored and alarmed to indicate a failure.

Powdered Activated Carbon

Powdered activated carbon (PAC) is the most commonly used reagent for dioxin, furan and mercury control. The main alternative to the injection of PAC would be a catalytic system, however, whilst these systems destroy dioxins and furans they do not provide control of mercury and therefore activated carbon injection would still be required.

PAC is therefore considered BAT for this purpose.

The dosage rate of powdered activated carbon will be set based on operational experience. The performance of the PAC dosage will be confirmed via monitoring of dioxins, furans and mercury during commissioning. In addition, mercury emissions will be continuously monitored and the activated carbon addition rate adjusted to maintain the required level. Dosage of activated carbon will also be alarmed to indicate a failure.

Fuel Oil

Light fuel oil will be used for auxiliary firing. The fuel oil will contain less than 0.1% sulphur. An alternative to the low sulphur fuel oil would be natural gas which does present environmental advantages in lower emissions. However, fuel oil was selected for auxiliary firing as the onsite storage provides guaranteed availability. There is no natural gas connection on the site.

Water

The plant has been designed to minimise use of fresh water. A water flow diagram is indicated in Figure 9 [of the original EP application]. The key use of fresh water is within the boiler water treatment plant supplying top-up water to the boilers and supply to the process water tank. Although condensate is collected and returned to the SEP from the soda ash process at Lostock site, some losses occur and fresh water top-up is needed.

Freshwater input to the process water tank will be minimised through the following:

- Collection of process waste waters for re-use; and
- Collection of rainwater for use within the process.

Freshwater will be supplied from the mains supply and will primarily be used within the sanitary facilities but will also top up the process tank when required.

Waste process water will be stored in a tank with a capacity of approximately 400 m3, fresh process water storage will be approximately 700 m3, and demineralised water storage will be approximately 300 m3. The following waste waters will be collected for re-use within the process water tank:

- Boiler blowdown; and

- Cleaning waters from process areas (except boiler house which is directly re-used in the slag extractor)

The process water will be used primarily within the ash quench.

The rainwater collection system will harvest rain water from the roofs and external hard standing areas (roads etc). The rain water storage reservoir will have a capacity of 14m3 and this water will generally be used within the administration building. A connection from the rainwater storage reservoir will be made to the main process water treatment tank (c. 400 m3 total capacity) in case there is a high demand of recycled process water and high rainfall. Excess rain water during heavy rain fall will overflow to surface water, see Figure 7 [of the original EP application].

In the event of a fire, fire water would be supplied from a dedicated firewater tank with duty/standby diesel driven fire pumps. The firewater tank will have a capacity of approximately 1400 m3. Wastewaters generated from fire fighting will be retained within the SEP. Procedures will be in place for sampling and testing of the water and appropriate disposal arrangements will be in place. The procedure for handling, testing and disposal of fire waters will form part of the operational AMP.

Sufficient firewater containment will be provided – the site will be designed to collect fire water during a fire on site so that it can be tested prior to disposal.

Expected usage and storage volumes for the main raw materials are summarised in Table 2 below.

Table 2: Main Raw Materials Usage

Raw Material	**Nature**	**Expected Usage (approx.)**	**Storage including capacity**	**Fate**	**Environmental Effects**	**Alternatives**
Incoming Waste	Non-hazardous pre-treated waste	578,000 tpa (capacity 600,000 tpa)	4.1 days (c. 9000 tonnes)	Combusted, approximately 70% to air as exhaust gases; 25% solid residues for reuse/recycling, 5% disposed to landfill	The fuel is derived from MSW which has the potential to contain List I and List II substances. Potentially toxic although this is through leachate rather than the solid waste.	Other waste likely to have similar or increased environmental effects (e.g. hazardous waste). Change in composition.
Ammonium Hydroxide	25% ammonia solution	3,280 tpa	76 m3	Reacted and reduced to nitrogen and water and released to air	Not significantly bioaccumulative. Environmental toxicity: 24hr LC50 rainbow trout 0.008mg/l, 96 hr LC50 fathead minnow 8.2 mg/l, 48 hour LC50 bluegill 0.024mg/l, 48 hour EC50 water flea 0.66mg/l	Urea, has lower hazards in storage and handling but increase GWP.
Powder Activated Carbon	Carbon powdered	480 tpa	80 m3	Collected with APC residues	Low toxicity to mammals, low	Alternatives have similar effects

Raw Material	**Nature**	**Expected Usage (approx.)**	**Storage including capacity**	**Fate**	**Environmental Effects**	**Alternatives**
					bioaccumulation potential, highly insoluble and immobile.	
Light Fuel Oil	<0.1% sulphur light fuel oil	1,000 tpa	2 x 90 m3 bunded tanks	Combusted and released as combustion gases	Not readily biodegradable. Persists under anaerobic conditions. Has the potential to bioaccumulate. Harmful, 10 < LC/EC50 < 100 mg/l, to aquatic organisms (estimated). (LC/EC50 expressed as the nominal amount of product required to prepare aqueous test extract). Low acute toxicity to mammals. May cause physical fouling of aquatic organisms.	Natural Gas (see discussion above)
Sodium bicarbonate		20,100tpa	2 x 111 m3	Reacted with acid gases to form salts and collected with APC residues.	Non hazardous and non irritant.	

Raw Material	**Nature**	**Expected Usage (approx.)**	**Storage including capacity**	**Fate**	**Environmental Effects**	**Alternatives**
Water		35,200 tpa	Raw water: 700 m3, demineralised water: 300 m3, Fire water: c. 1400 m3	Re-used or evaporated	-	Recycled water – see discussion above

In addition to the main raw materials, smaller quantities of boiler water treatment chemicals and maintenance oils and greases will be used within the plant.

All liquid reagent storage tanks will be bunded to 110% of the capacity of the storage tank. Bunds will be constructed to appropriate standards and lined with materials that are impervious to the content of the material which they hold.

2.5 Avoidance, Recovery and Disposal of Wastes

The plant will generate three main process wastes/residues, namely bottom ash, boiler ash and air pollution control (APC) residues. Boiler ash and bottom ash will be combined prior to transfer off-site for processing. Expected amounts of each of these wastes is summarised in Table 3 below:

Table 3: Waste Generation, Storage and Disposal/Recovery

Waste	Expected Amount	Storage	Disposal/Recovery Route
Bottom Ash (including boiler ash but excluding metals, see below)	126,450 tpa	Ash handling area	Exported for re-use
Air Pollution Control Residues	23,000 tpa	2 x 440 m3 silos	Disposal to landfill, following treatment.

In addition to the above main wastes, smaller quantities of waste oils and used drums and containers will be generated. Where possible empty drums and containers will be returned to the manufacturers. Waste oils will be sent for recovery.

Bottom Ash

Bottom ash is generated from the furnace grate. The bottom ash is collected at the end of the grate in the water filled bottom ash extractor located beneath the grate, where this material is quenched. From here the ash is moved via an inclined steel plate conveyor, which permits water to drain from the ash back into the quench bath for reuse. The bottom ash will be collected and stored within the bottom ash storage facility.

Bottom ash will be stored in a dedicated ash storage building. Here, any unburned waste that is identified will be recovered. Any unburned material would be returned to the waste bunker and combusted.

Boiler Ash

Boiler Ash is generated from deposits of particulates from the flue gases as they pass through the boilers. This comprises lighter ash particulates carried over from the furnace. The boiler ash is of a similar nature to bottom ash and will be combined with this waste stream for onsite processing.

Air Pollution Control (APC) Residues

APC residues are handled within a fully enclosed system. The residues will be stored in silos and discharged via sealed connections into fully contained disposal vehicles. These measures will avoid the release of dust from handling and transfer of this material.

There is currently no mechanism by which APC residue can be eliminated completely, however, the monitoring control of reagent injection rates is designed to minimise the quantity of the residue formed.

The current status of alternative management facilities for the APC residues has indicated this to be a developing area and whilst there is limited capacity at this time; this will be kept under review as the SEP proposal progresses.

At this stage, the Operator will seek to permit the flexibility to landfill this material initially and until such time as an alternative solution is secured. This approach is proposed on the basis that alternatives are not sufficiently developed at this stage.

The Operator is fully supportive of seeking an alternative to landfilling of the APC residues where this is commercially feasible and environmental benefits can be demonstrated. The Operator will continue to review potential alternatives for the APC residues and where a viable alternative is secured will seek to divert some (in the event of continued capacity limitations) or all the residues away from landfill.

3 Operations

3.1 Incoming Waste and Raw Material Management

The plant will receive waste by road. If the potential for delivery by rail is realised during the development of the project, this will be further assessed.

On arrival at site, waste consignment paperwork will be inspected to ensure that the material being delivered is acceptable in accordance with the waste material supply contract specification and those waste codes as consented within the Environmental Permit. In addition, a visual inspection of the incoming waste material will be undertaken periodically or in all cases where a consignment is suspected to contain non-conforming waste materials. If found to be non-conforming the waste material will be rejected from the site.

Non-conforming materials which enter the bunker will be removed by the crane into a skip and will be returned to the producer.

A procedure will be in place as part of the EMS documenting the waste acceptance and rejection requirements.

Incoming waste materials delivered by road will access the site via the weighbridge. The vehicles will be re-weighed on exit to establish the weight of material delivered. These vehicles will be enclosed to prevent loss of incoming waste material during transportation to the site.

Waste Reception and Storage

All tipping operations will take place within the waste reception hall which is housed within a building. The tipping hall door will be fitted with self closing doors.

The incoming waste material will be emptied directly from the delivery vehicles or rail containers into the waste material storage bunker. The waste bunker itself is contained within the main waste reception hall. The fuel bunker is accessed from seven access gates, which are manually controlled by the crane driver or by a member of staff in the tipping hall to ensure they only open when discharge from a container is to take place. This isolates the bunker from the reception hall and minimises air exchange when the gates are open. It also helps to ensure that the reception hall is kept clean and tidy. The bunker will take the form of a rectangular pit set down in to the floor of the reception area. It will have a depth of up to 12 metres below the general floor level of the plant. The capacity of the bunker will be approximately 9,000 tonnes of waste.

Waste Bunker Management

Two overhead cranes will be provided for transferring fuel from and carrying out mixing of waste within the bunker including transfer of the waste from the collection area of the bunker into the stacking bunker area. Cranes will operate in either manual or semi-manual operating mode. Mixing and transfer activities will be manually controlled; waste feed operations will be semi-automatic.

The crane operator island will be strategically located overlooking both bunker areas and the tipping bays, with CCTV feedback from the charging hopper. The crane operator will visually inspect the material within the bunker and will use the overhead crane to remove any unacceptable material to the end of the first bunker. Unacceptable material will then be removed from the bunker by a mobile crane and returned to the producer.

A closed circuit camera will be set over the charging hoppers to view the hopper conditions and the grab when it is unloading.

The crane grab size has been selected at approximately 20m3 capacity.

A bunker management scheme will be operated to ensure that waste is systematically removed and that prolonged storage of materials does not occur. This scheme will also ensure that areas of the bunker are emptied to permit visual inspection of the bunker wall integrity at least annually.

Odour control within the bunker area is achieved by maintaining a negative pressure with air being drawn from this area through the furnace and combusted (see section 3.4) for further information. A complete shutdown of both lines is expected to be a rare event as planned maintenance will be carried out on only one line at a time. In the unlikely event of a full plant shutdown, all doors/louvres will be kept closed to minimise the potential for fugitive odour emissions. Furthermore, odour will be controlled during shutdown periods by minimising the amount of waste in storage. Waste will be run-down prior to periods of planned maintenance.

Fuels and Treatment Chemicals/Reagents

Auxiliary fuel for the proposed plant will be low sulphur light fuel oil (or equivalent) and will be stored in 2 x 90 m3 tanks. The tanks will be single skinned tanks which are bunded and comply with the requirements of CIRIA C736.

Other reagents will be delivered by road and discharged into dedicated bulk storage tanks. The duty member of staff will be responsible for checking that the material to be delivered is discharged into the appropriate storage vessel and for ensuring that there is sufficient capacity within the storage vessel prior to commencing unloading operations. Level alarms will be installed in storage tanks to avoid overfilling.

Activated carbon and sodium bicarbonate will be used within the flue gas cleaning plant. These reagents are potentially dusty. Deliveries will minimise the potential for dust releases through the use of sealed connections. Air displaced during deliveries will vent via a filter unit installed on the storage vessel. The unit will be equipped with a dust detection system, which will monitor emissions during unloading operations to ensure the filter is operating effectively. In the event of dust emissions, the filter will be replaced. Filter replacement will be included as part of the preventative maintenance plan.

During a delivery of ammonium hydroxide displaced air will be vented back to the delivery vehicle.

In the event of a spillage, any spilt material will be cleaned up immediately and disposed of appropriately.

3.2 Waste Charging

To ensure continuous steady state operation of the combustion stage and boiler sections, it is important to ensure that the waste materials are adequately mixed. Mixing of the incoming waste materials will occur within the bunker, as described above.

The crane transfers the waste materials from the bunker stacking area into a feed hopper. The hopper can be isolated from the feed chute by using a shutdown flap located towards the base. The flap is driven by a hydraulic cylinder and can be operated by remote control. This type of shut-off plant has been successfully operated in a wide number of facilities operating in Europe, including facilities using the proposed technology for the SEP. Experience has proven the shut-off flap to be more reliable and less prone to fouling or damage compared to alternatives.

From the feed hopper the waste material will be deposited onto the feed grate via a water cooled feed chute. The feed chute has been designed to hold a relatively large amount of fuel thereby creating a good air lock between the bunker and the furnace. The feed chute opening widens in a downwards direction thus avoiding blockages as the waste material travels through the chute. The connection between the hopper and the feed chute is designed to be as air tight as possible to prevent the potential escape of fumes or excess air flows into the boiler. A double hydraulic ram system pushes waste material off the feed table and onto the grate.

The combination of the hopper shutdown flap and a water cooled feed chute minimise the risk of a fire.

Level detection is provided in the feed chute. A low level alarm will alert the crane operator that more waste material needs to be transferred from the bunker.

The feed grate is located at the bottom of the feeding chute and is designed to be the same width as the grate thereby providing equal feeding of the waste materials across the entire width of the combustion grate. The grate has been designed as a multi-line sliding grate/feed stoker and longitudinally consists of four separate grate zones providing the following functions:

- drying;
- ignition;
- combustion; and
- burnout.

The movement of the sliding grate transports the waste along its length. The proposed design permits operational control specific to the needs of each zone, i.e. both grate movement and combustion air supply (see detail in Section 3.4) can be separately controlled within each zone of the grate.

The interlocks for the waste charging and feed systems will include the following controls:

- Waste charging cannot take place when:
  - the temperatures drop below 850°C during operation, or during start-up prior to the temperature being raised to 850°C within the furnaces; or
  - when the Facility has processed up to 685,000 tonnes of waste in a calendar year.
- In the event that emissions to atmosphere are in excess of an emission limit value, other than under abnormal operating conditions, the waste charging system (i.e. waste into the hopper) will be prohibited. If a period of abnormal operation exceeds 4 hours, the operators will be required to prohibit the waste charging system.

3.3 Furnace Types

The plant will employ moving grate technology which is a well proven, reliable and highly effective technique for combustion of waste materials comprising or derived from MSW. Demonstrable and well understood performance is a key objective in the selection of the chosen techniques for the proposed plant. However, it is recognised that there are a number of alternative furnace types available for combustion of waste materials. Consideration of these techniques is summarised in Table 4 below:

Table 4: Comparison of Furnace Types

Furnace Type	Suitability for large scale waste application
Fixed Hearth	• Considered suitable for the incineration of consistent feed with relatively low pollution potential. • There are no large scale operational applications of this technology for SRF in the UK. • Not considered suitable at the throughput capacity proposed for this plant

Furnace Type	Suitability for large scale waste application
Fixed Stepped Hearth	• Has not been applied to SRF but typically applied to clinical waste and some MSW applications. • Typically used for plants with a throughput of <1 tonne/hour. Therefore, not considered suitable at the throughput capacity proposed for this plant.
Moving Grate	• Has been applied to SRF within the UK. • Technically proven, reliable and well understood at large scale.
Pulsed Hearth	• No known applications to SRF and not considered suitable.
Rotary Kiln	• Although considered suitable for SRF applications, there are no UK plants operating this technology, although there is one oscillating kiln plant (Grimsby) at a smaller scale using MSW and a further plant proposed. • Achievable energy conversion efficiency is considered lower than that achieved by moving grate due to the large areas of refractory lined combustion chamber relative to scale.
Fluidised Bed	• Has been applied at a similar scale to RDF within the UK (including Allington), albeit reported to have experienced operational difficulties. • Some large scale plants operating in Europe but have had poor reliability. • Has the advantage of lower achievable NOx levels and slightly higher combustion efficiency than moving grate technology. • Produces higher quantities of APC residues which has to be disposed of as a hazardous waste.
Gasification	• Feedstock needs to be homogenous with high organic content however, additional treatment will be necessary for burning the pre-treated waste fractions which will be accepted at the plant. • Flue gases produced can be highly corrosive, such that the boilers/ APC must be built to withstand these. • Although small plant are now coming into operation in the UK, this technology is considered to be unproven commercially at the scale proposed for this plant.
Pyrolysis	• Although small plant are now coming into operation in the UK, this technology is considered as not proven commercially at large scale. • Requires fuel pre-treatment to produce a homogeneous size and type of fuel which will require additional treatment for the pre-treated waste fractions which will be accepted at the plant. • Gas produced tends to be highly corrosive, such that the boilers/APC must be built to withstand these.

Furnace Type	**Suitability for large scale waste application**
	• Lower energy efficiency for stand alone pyrolysis plants, to achieve the greater efficiencies quoted for some facilities combustion of the solid residues is required with additional processes.
Starved-air/semi pyrolytic	• Can achieve lower NOx, VOCs, CO and PM. • Supplementary firing required to achieve the required combustion conditions. • Possibly suitable although no facilities currently exist which operate these systems, therefore, not proven at this scale.
Cyclonic Combustors	• An emerging technology, there are no known applications within the UK, consequently it is not considered to be technically proven at this time.
Gas Incinerators	• Considered unsuitable for proposed fuels.
Drum Incinerators	• Typically only used for hazardous waste fuels. This technology is not considered suitable at the scale of the proposed plant.

Note: Modified and developed from Environment Agency Incineration Sector Guidance Note (S5.01) and BREF[8].

Whilst there are several furnace options identified above, in respect of applications for energy generation from the waste materials proposed for the SEP, moving grate and fluidised bed are currently considered the only technically proven options at large scale. It is also recognised that pyrolysis and gasification are amongst a number of emerging advanced thermal treatment (ATT) options which in the future may provide commercially proven alternative technologies at large scale. But these are not currently commercially robust for this application which requires high guaranteed reliability, efficiency and which has space constraints.

A more detailed assessment of the furnace selection is provided within Section 6.

3.4 Furnace Requirements

Each furnace will be designed to achieve good combustion control with the aim of minimising emissions and maximising burnout of the waste material. In particular the furnace will be designed, validated and operated to meet the requirements within the Waste Incineration Directive (WID), 2000. For the combustion of the proposed waste materials the main WID requirements are as follows:

- a minimum temperature of 850°C for at least 2 seconds, after the last injection of combustion air whenever waste material is being burnt;
- validation that temperature and residence time, and selected oxygen content are achieved, under the most unfavourable conditions;
- minimisation of the amount and harmfulness of residues;
- achievement of less than 5% loss on ignition (dry weight) in bottom ash or 3% total organic carbon (TOC); and
- to ensure that emissions to air do not give rise to significant ground level air pollution.

The combustion control system to be installed at the plant is designed to control the process to ensure operations meet WID requirements, minimise emissions that can be influenced by operating conditions on the grate (CO, NOx and VOC), achieve a constant level of steam production and maintain operation within the range of the firing diagram (see Figure 12 [of the original EP application]). Central to achieving this aim is controlling the combustion process to ensure an even and sufficiently high combustion temperature profile along and across the grate. A number of pyro electric sensors will be installed to provide continuous feed back on the temperature profile.

The control system includes a number of interrelated control loops which adjust different operating parameters to maintain good combustion. Key variables include:

- Ram feeder speed
- Primary air flow
- Grate bar speed (adjustable for each zone)
- Grate bar travel distance (adjustable for each zone)
- Secondary air flow

Pyro-electric sensors are used to monitor moisture content and monitor heat radiation from the entire grate and provide fast feed back to the control system of changes in waste CV thus permitting a quick reaction to automatically adjust grate movement and primary air to maintain optimal combustion.

The furnace design has been sized to ensure that the WID requirements for 2 seconds residence time after the last injection of combustion air can be met. This has been demonstrated at other similar facilities operating the same technology. This will be validated during commissioning.

Although not specifically required by WID for co-incineration plant, each furnace will be equipped with auxiliary low NOx burners fuelled by light fuel oil. The burners will be installed above the secondary air injection and will operate automatically to fulfil the following functions:

- to heat up the furnace during start-up in order to reach a temperature of at least 850ºC before waste derived material is introduced onto the grate;
- to ensure gas combustion for at least 2 seconds at 850ºC is maintained at any point where waste derived material is being burnt. An alarm will signal when there is a risk of not meeting that requirement and the burners will start automatically; and
- to ensure complete combustion of waste during shutdown.

The furnace design and operation aims to maximise burn out of the waste, minimising residue quantity. As a minimum the furnace will achieve a loss on ignition of 5% (dry weight) in bottom ash.

The furnace will typically operate with an excess oxygen level of 6 – 8%. The excess oxygen level is controlled automatically by the combustion control system to ensure that effective burn out of the waste fuel is achieved whilst avoiding adverse effects on energy efficiency by operating at too high excess.

In the event that excess oxygen levels fall below the set range the carbon monoxide (CO) control system will be manually adjusted to bring operations back within the desired range.

A staged combustion air system will be employed. The injection system for the combustion air has been designed to provide effective distribution of combustion air to avoid hot zones and minimise the amount of inorganic material volatised. This is supported by the Operator operational experience at a number of similar facilities which has demonstrated that hot zones and volatisation of inorganic material has never been a problem.

Primary air, extracted from above the waste fuel bunker will be injected beneath the combustion grate. Primary air is preheated using steam. The primary air injection is controlled to minimise NOx production and avoid excessive entrainment of particles.

Secondary air is extracted from the roof area of the boiler house. Extracting the air from this point in the building provides pre-heating of the secondary air.

Turbulence within the combustion chamber is achieved via the injection of the secondary air which utilises a battery of nozzles on each side of the boiler to provide an even distribution. The injection points for the secondary air have been selected to ensure that the flue gas mixture and secondary air injection achieve good distribution of the oxygen.

The furnace design will ensure that plant is as air tight as practicable. In addition the furnace is maintained under negative pressure to prevent the release of gases during charging.

Temperature measurements will be continuously recorded from the following locations:

- Primary combustion zone (using an infra red camera);
- Exit from the secondary combustion zone (using acoustic pyrometers).

In the event that the temperature falls below the minimum temperature (850°C) an audible alarm will be activated to alert operational staff. The auxiliary burners will also fire up, to increase the temperature in the furnace. An automatic interlock will prevent waste feed to the furnace should the temperature fall below the minimum required. This interlock will also be activated at start-up, until the minimum temperature is achieved and whenever the continuous emission monitors show breaches of the emission limit values (over the appropriate averaging period).

3.5 Validation of Combustion Conditions

The WID Article 11(3) requires that combustion temperature and residence time (for incinerators and co-incinerators) are subjected to appropriate validation at least once when the plant is brought into service and under the most unfavourable operating conditions.

The proposed plant will use CFD at the final design stage to demonstrate that the selected design will meet the WID requirements for residence time and temperature for the chosen design envelope. These requirements have been previously validated for other similar facilities operated by the Operator and/or supplied by the technology providers. The output of this study will be reported to the EA and will identify:

- input data for the modelling assessment;
- any assumptions made; and
- confirm the selected model and how this is representative of the proposed plant.

A detailed commissioning plan will be drawn up in advance of the commissioning trials and will describe the methodology which will be applied to ensure that the requirements of WID Article 11(3) will be met.

The commissioning tests will assess the plant performance over a range of operating conditions. Whilst there are some variables which can readily be tested during commissioning (e.g. waste material throughput), the pre-treated waste material being burnt (and its CV) will be determined by that delivered to the site and therefore will introduce some practical limitations on the extent of commissioning trials.

3.6 Combined Incineration of Different Waste Types

The material to be burned within the proposed SEP will comprise treated non hazardous wastes of a similar nature and therefore the requirements under this section of the relevant guidance/WID are not applicable.

3.7 Flue Gas Recirculation (FGR)

FGR is reported as providing a two fold benefit:

- Reduced NOx levels.
- Increased plant energy efficiency.

FGR is often selected where the oxygen content in the flue gases is to be reduced and/or improved mixing of the flue gas in the first boiler pass is required. The recirculated flue gases have a lower oxygen content and when mixed with fresh secondary air the combined larger volume promotes mixing. In practice, good mixing is achieved through appropriate design of the secondary air injection process.

However, despite the reported benefits most energy from waste facilities operate without FGR, and in a number of cases have been reported to retrospectively remove the FGR.

Although FGR can reduce NOx levels, it would still require additional abatement to be installed to achieve the emissions level required by the WID. If the take-off point for the FGR system is installed after the APC plant the ducting will need to be installed with electrical trace heating which would outweigh any energy efficiency benefits in terms of secondary air savings. The requirement for electrical trace heating is primarily to prevent condensation of flue gas constituents in the duct.

The alternative of installing the FGR off-take direct from the boiler is reported as introducing corrosion problems as a result of dew point corrosion due to SOx in the recirculation ducting and abrasion problems due to the fly ash particles in the gas. In practice this leads to operational problems typically requiring replacement of ducting and blower blades after a relatively short time.

Given that the design minimises NOx levels and any energy efficiency benefits reported using FGR are not borne out in practice, the resulting impact on the overall reliability of the plant from FGR is not considered justified and the proposed combination of measures is considered to represent BAT.

3.8 Dump Stacks and Bypasses

There will be no dump stack or bypass included within the design. Under all operating conditions the exhaust gases will pass through the abatement plant prior to discharge from the main stack.

3.9 Cooling Systems

There are three main types of cooling systems commonly employed at facilities generating energy from wastes. These are:

- once through sea or river water;
- evaporative cooling tower; and
- air cooled condenser.

The proposed new SEP will use the latter option of an air cooled condenser. There are advantages and disadvantages in using each of these types of condenser. However for the proposed SEP an air cooled system has been selected for the following reasons:

- air cooled systems do not require the use of chemical treatment or biocides which evaporative systems do;
- there is no visible plume from air cooled system; and
- there is no requirement for water input.

Air cooled condensers have larger energy requirements compared to alternatives and are a potential source of noise (as are cooling towers). An acoustic package will be provided to control noise emissions. The noise assessment in Appendix D [of the original EP application] has considered noise from the air cooled condensers and with the proposed acoustic package significant noise impacts are not predicted. Overall the air cooled condenser is therefore considered BAT for this application.

A total of 10 air cooled condenser units will be provided and located adjacent to the canal.

3.10 Boiler Design

The boiler and furnace are integrated to maximise energy recovery, with a single unit provided for each line. The sides and walls of the furnace are integrated into the membrane walls of the first empty pass. The membrane walls therefore directly extract heat from the furnace. The side walls extend to the level of the grate.

Energy is recovered from the hot flue gases within the steam boiler. The resulting high pressure steam is directed to the turbine, generating electricity which is exported to the grid. The Facility will also have the potential to export heat to local users should this become commercially and technically viable.

The boiler is of a proven design and there are many examples in operation at similar plants. It comprises three vertical radiant passes and a horizontal convective section. The vertical radiant section includes membrane walls whilst the convective section comprises one horizontal flue gas passage with vertical boiler tubes. Super heater and economiser bundles are located at the end of the horizontal pass.

The transition between the different boiler passes and the separation wall between the second and third radiating passes are designed to promote ash separation from the flue gases and provide a uniform flow distribution through each empty pass and at the inlet to the convective section.

Whilst measures to minimise dust carry over are included within the design, some dust will still be present which over time will accumulate as fouling within the boilers. A mechanical rapping system will be installed within the convective section for removal of any deposits.

The selected boilers have been subject to a CFD study. The CFD study was used to determine the exact geometric shape of the boiler sections and ensure that the selected design avoids the formation of pockets of stagnant or low velocity gas.

To maintain the flue gas temperature at the optimal temperature required for the flue gas cleaning plant (190ºC), a feed water preheating system is installed to control the water temperature at the economiser inlet.

To avoid solids build up within the boiler water a continuous bleed of boiler water is removed, known as boiler blowdown. The rate of boiler blowdown is optimised to balance efficient use of treated boiler water whilst avoiding build-up of solids within the boiler water. The residual blowdown is recovered for re-use.

Primary measures for minimisation of Dioxins within the Boilers

The furnace section is designed to operate at high temperature to achieve effective destruction of any dioxins within the waste fuel. However as the gases cool within the boiler section there is the potential for reformation of dioxins whilst in the 'de-novo' synthesis range of approximately 200-450ºC. This section identifies the measures in place to minimise dioxin formation in the boilers and thereby reducing the reliance on downstream abatement plant to remove these pollutants.

The boiler convective section is designed in such a way that the retention time in the temperature range whereby dioxin reformation can take place (200-450ºC) is reduced to a minimum value due to sufficiently high velocities of the flue gases. The units provided are a standard design and have been subject to CFD to ensure that this is achieved.

The steam/metal surface temperature is kept to a minimum where the exhaust gas temperature is within the de novo synthesis range. Whilst the temperature is minimised, this will exceed the BAT value of 170°C although the duration that gases will spend under these conditions would average approximately 1 second.

The boiler passes are successively narrowed increasing the flue gas velocity from approximately 5 m/s up to 10 m/s whilst the flue gas temperature lies within the de novo synthesis range.

Dust can promote the formation of dioxins by acting as a carrier for the catalysts for these reactions. The measures included within the plant and specifically the boiler design to minimise dust carryover and inclusion of a rapping system to remove build-up therefore also contribute to minimising the reformation of dioxins. Further the selection of a horizontal convective section assists in minimising dioxin formation through minimising the contact between exhaust gases and any deposits removed via the inline cleaning.

The above measures are considered to represent BAT for avoiding dioxin formation within the boiler section.

Energy Recovery and Distribution

A single steam turbine will be provided. The turbine will generate electric power which will be exported to the grid and used onsite to power the internal electrical systems.

The turbine will be of non-reheat, pass out condensing design, equipped with a controlled extraction system.

Under normal operating conditions the steam turbine will control the pressure within the boilers. Deviations in actual steam flow arising from changes in input waste material quality, for example, will be levelled out by the inlet pressure control of the turbine. The steam exhaust at the back end of the steam turbine is fed into the air cooled condenser. The vacuum in the condensing section of the turbine is kept to a minimum in order to produce as much energy as possible.

3.11 Start-Up and Shut-Down

The plant has been designed and will be operated to ensure that start-up and shut-down operations, including emergency shut-down scenarios are carried out safely and without significant environmental impact.

The site will document the procedures for start-up and shut-down, these procedures will be in place prior to commissioning of the plant. However, the general sequence of events is summarised below.

Cold Start-up

The boiler furnace and its immediate ancillaries, the condenser and then the steam turbine generator are started.

Preheating is achieved by burning fuel oil in the burners.

At all stages during a cold start-up it is of prime importance to comply with the following conditions when increasing the flue gas temperature:

- controlled temperature rise gradient on the refractory lining in line with supplier recommendations in order to prevent thermal shock.

- the temperature rise is carefully controlled in order to avoid thermal stresses within the plant.

The ash produced by the flue gas treatment is both sticky and corrosive at low temperatures, and combustion of the waste derived materials cannot commence until the flue gas ducts, the scrubber and the bag filter are all at their operating temperature, and until the ash transport systems have been properly warmed by electrical trace heating.

The pre-treated waste is introduced once the flue gas treatment unit is operating in hot condition and the WID temperature requirements within the boiler are also being achieved. Controlled Shutdown

For a controlled shut down, this will require maintaining the burner active in order to sustain the WID 850°C, 2 seconds requirement, until all waste material on the grate has been burned out.

The following summarises the likely sequence of events.

- Cease loading the furnace feed hoppers.
- Close the feed chute dampers, to prevent ingress of air into the boiler.
- Revert the boiler combustion control to manual control and gradually reduce the combustion rate.
- The fuel oil ancillary burner will automatically be triggered to ensure the temperature remains above 850°C for 2 seconds.
- The fuel oil burner setting will be gradually increased in order to sustain 850°C for 2 seconds, until all waste material has been burnt.
- Switch off the flue gas circuits, combustion fans, grate and sodium bicarbonate feed.
- Disengage the steam turbine generator and ensure that an oil pump (either the auxiliary pump the emergency pump) continues running to cool the bearings.
- Allow the pressure to drop by adjusting the HP steam manifold vent such that the steam temperature in the drum does not decrease too fast, to avoid thermal shock.
- Clean the bag filter.
- Keep the ash conveyor system operating for about two hours after extinguishing the furnace.
- Switch off the induced draught fan.

Emergency Shut-down

If any incident endangers or is likely to endanger personnel (e.g. an external steam leak) or cause serious damage to the plant (e.g. loss of water from the drum following a burst tube) or lead to an exceedance of emission limits or other breach of the environmental permit, the emergency shut-down procedure will be used.

In the light of experience, the operator will draw up the relevant operating procedures for the various possible scenarios and taking into account first the safety of personnel and neighbouring populations, then as far as possible, the safety of the plant and environment.

To extinguish combustion in an emergency, operators will use the emergency stop button resulting in immediate stopping of the combustion fan, the grate feed systems and the burner.

A safeguard system is installed, that automatically stops the combustion if critical parameters in the boiler or flue gas treatment operation are breached.

6 BAT assessment

In section 2 of this document a description of the proposed plant has been provided, detailing those techniques that are considered to represent BAT for the proposed plant. This section provides additional supporting information for the selected BAT for the key items of plant as follows:

- Moving grate furnace;
- SNCR;
- Acid gas abatement;
- Injection of activated carbon; and
- Bag filters.

6.1 Selection of Treatment Technology

A brief review of available technologies for thermal treatment of the proposed waste material is provided in section 3.3. This review considered a wide range of technologies, but concluded that moving grate and fluidised bed systems are the only proven systems for the application to the proposed waste material within the UK. Gasification and pyrolysis systems are recognised as emerging techniques; however, they are yet to be proven technologies within the UK at the scale proposed for this plant.

This section provides further discussion on the following alternatives:

- Conventional Thermal Treatment Technologies
  - Option 1: Moving Grate;
  - Option 2: Fluidised Bed;
- Advanced Thermal Treatment
  - Option 3: Gasification;
  - Option 4: Pyrolysis;
  - Option 5: Plasma Arc Gasification;
- Option 6: Biological Treatment (Anaerobic Digestion); and
- Option 7: Landfill.

Conventional Thermal Treatment Technologies

Conventional thermal treatment technologies are based upon the complete combustion of the incoming waste material. The application of conventional thermal treatment technologies to the burning of MSW derived material requires the plant to comply with the WID. Fundamental requirements of the WID include the requirement to achieve a combustion temperature of >850°C with a residence time after the last injection of combustion air of at least 2 seconds. A number of variations exist based on the type of combustion plant. Options 1 and 2 in this assessment represent alternative types of conventional thermal treatment.

Common to Conventional Thermal Treatment Technologies

Conventional thermal treatment processes require flue gas treatment to control NOx emissions, which may give rise as a by-product of the SNCR reaction, to emissions of nitrous oxide, a powerful global warming agent. The nitrous oxide emissions are not a function of the thermal treatment option itself, being related to the selected abatement for NOx and are consequently not included within this section. A separate assessment of the selected NOx abatement is provided later in this section and includes consideration of the global warming impacts associated with the available techniques.

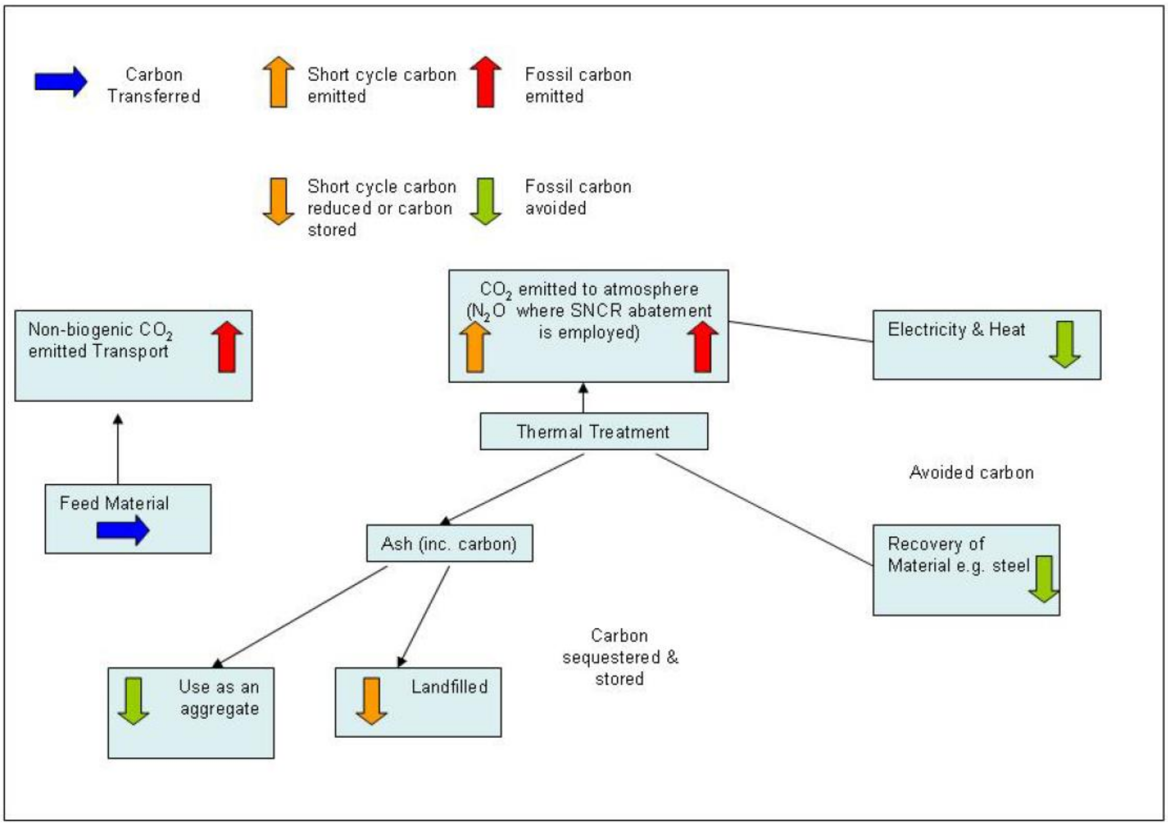

Figure 1: Conventional thermal treatment process

Figure 1 shows a typical flow diagram for Conventional Thermal Treatment Process.

Conventional thermal treatment processes offer a proven technique, able to operate flexibly, to cater for a wide range of waste material inputs.

Option 1: Moving Grate

Moving grate technologies are the most widely adopted system for MSW and MSW derived fuel applications and as such are well proven and reliable. The moving grate system is capable of burning MSW fuel as received as well as processed fuels such as SRF. A variety of designs are available, but typically the grate system will include a mechanism distributing the incoming waste material across the grate and for transporting the combustible material forward, providing mixing as it traverses the length of the grate.

The waste material is burned with an excess of air that is typically drawn from above the storage bunker (as is the case for the proposed SEP), providing a source of odour control, should this be an issue. Primary air is generally fed through the grate with a secondary air supply above the grate to create turbulence.

Exhaust gases from the furnace will require treatment to achieve compliance with the emission limit requirements of the WID.

Moving grate systems will produce two residues, bottom ash and air pollution control (APC) residues. Bottom ash, which is the larger (in quantity) of the two residues has the potential to be reused as an aggregate.

Option 2: Fluidised Bed Furnace

Fluidised bed technology operates by feeding the waste material onto a bed of 'fluidised' sand particles where combustion is thermally more efficient than conventional technologies such as moving grate. The fluidised bed technology requires a homogenous feedstock. In this respect fluidised bed would be suited to the type of waste material proposed for the SEP since further pre-treatment (sorting, crushing, shredding) prior to combustion taking place would possibly not be required.

This technology is capable of achieving somewhat lower NOx emissions in the raw gas than are typically achievable in moving grate systems. This is achieved through lower bed temperatures thus reducing thermal NOx formation. However, additional abatement using either SCR or SNCR will still be required to guarantee WID compliance.

Additional raw materials are required in the form of sand within the fluidised bed system.

Solid waste streams from the process typically include bottom ash, cyclone ash (usually mixed with the bottom ash), and APC residues. Due to the addition of sand for fluidisation waste residues may be higher for fluidised bed systems. As for moving grate plant the bottom ash can be reused as a aggregate.

Fluidised bed technology is employed in Europe and elsewhere, including in the UK, where it is operational both at Allington in Kent and in Scotland at Baldovie, Dundee. The larger Allington plant has three lines with combined capacity of approximately 500,000 tpa. UK experience with fluidised bed plant experience is reported as problematic with both Dundee and Allington experiencing significant downtime.

Advanced Thermal Treatment

Gasification and pyrolysis treatment processes have a long history of application to fossil fuels and certain homogeneous waste streams (although these were not historically governed by the requirements of the Waste Incineration Directive) but their application to MSW and RDF is relatively new in the UK [9]. There is limited experience of plant operating at ‘commercial scale’ in the UK, e.g. the former Compact Power facility at Avonmouth (now owned by Ethos Recycling) and Isle of Wight Energos facility, albeit with commercial scale proposals now coming through the planning and permitting process.

Option 3: Gasification

Gasification is the partial thermal degradation of a substance in the presence of oxygen but with insufficient oxygen to oxidise the waste material completely. This process produces gaseous fractions known as ‘synthesis gas’ or ‘syngas’, primarily a combination of carbon monoxide, hydrogen and methane. The synthesis gas offers the potential to be utilised in a number of ways, including combustion in engines, steam raising boilers or other energy conversion processes, subject to gas quality and legislative requirements.

Gasification is reported by some as offering the opportunity for higher efficiency electrical generation compared to conventional combustion technologies. However, to achieve this, the syngas needs to be burnt in a turbine specifically designed to burn low calorific value syngas. In practice it will be necessary to provide clean up of the syngas and these processes both consume and lose energy. The overall efficiency achieved is therefore lower than for conventional combustion of waste materials [11].

Operationally to obtain consistent gas quality a homogeneous incoming waste stream with a high organic content is required and therefore this technology is better suited to applications where the incoming waste material has been pre-treated and therefore the proposed waste material could be suited to this application.

Gasification requires energy input from supplementary combustion, likely to be using either natural gas or low sulphur oil, to achieve the temperature required for thermal treatment. Typical temperatures for gasification would be above 750°C.

Ash and char are also produced from the gasification process. The ash from some gasification plant is suitable for re-use as an aggregate material. Residues from exhaust gas cleaning, similar to those from conventional combustion plant would be disposed of as hazardous waste.

A typical process flow for a gasification process is shown in Figure 2 below.

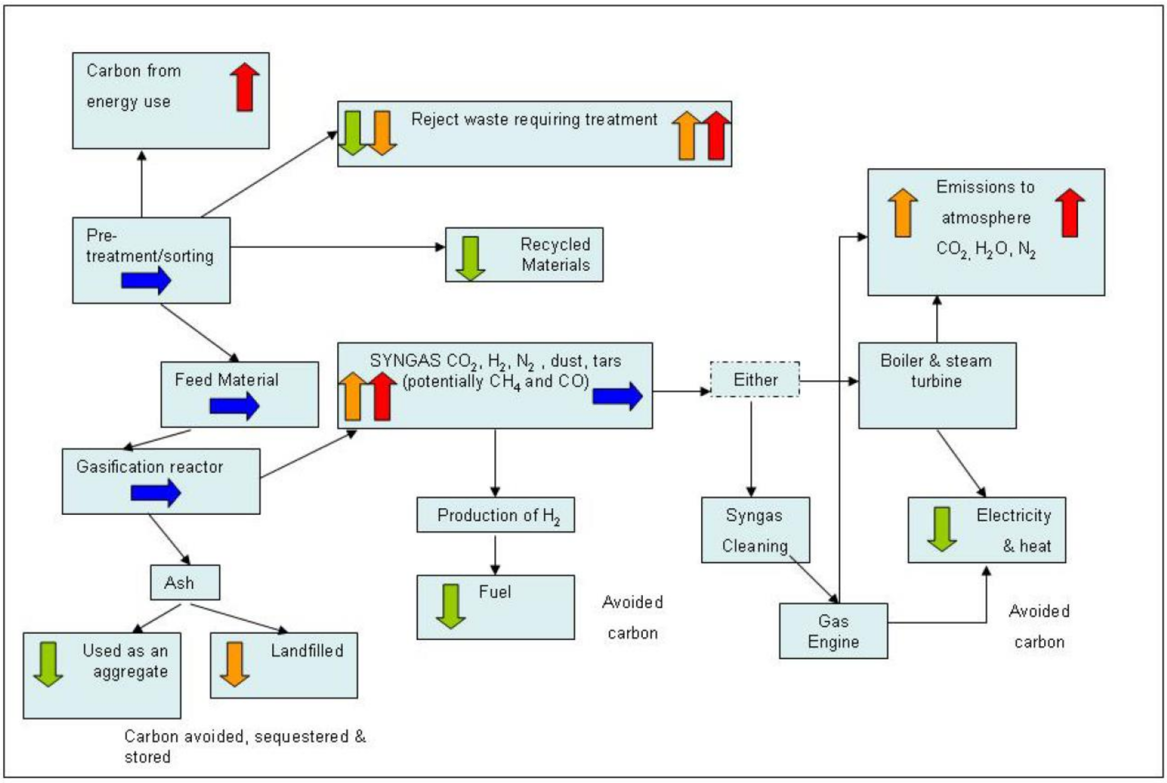

Figure 2: Process flow for Gasification

Combustion of the fuels from the gasification stage, assuming they remain a waste, will be subject to the requirements of the WID. To ensure compliance with emission limits these emissions will require treatment and generally similar abatement to that applied to conventional plant will be required [9].

Currently there is limited experience of gasification technology employed for the treatment of waste materials, with only a few applications in Europe, where experience has proven mixed or is limited. There are a number of planned facilities in the UK, for industrial/commercial waste streams, or pre-treated waste such as the proposed Novera plant in East London (now owned by Biossence) that will treat just over 100,000 tpa of SRF in a single line facility. It may be cost effective at small scale and it may scale on a modular basis, although its presence in the market is not well established.

Although there are plans for larger scale facilities in the UK it remains uncertain as to whether these schemes will be successfully financed and ultimately brought into operation. It is also noted that although larger schemes are proposed, these plant are still less than the capacity of the proposals for the SEP.

Proven availability remains an issue for the technology, which raises questions over the fate of the feedstock during periods of downtime. There is limited alternative for feedstock when the plant is unavailable and it can be assumed that the feed material would be diverted to landfill or an alternative thermal treatment.

Option 4: Pyrolysis

Pyrolysis is the thermal degradation of a substance in the absence of added oxygen. Pyrolysis also offers the potential option of more innovative use of the pyrolysis syngas other than immediate combustion to produce heat, although the Tata Chemicals need for steam precludes this in this case. The process requires energy input from a combination of waste heat from the process and supplementary combustion, likely to be using either natural gas or low sulphur oil, to achieve the temperature required for thermal treatment.

A typical flow chart for a pyrolysis process is shown in Figure 3 below.

Typical temperatures for pyrolysis are between 300-800°C [13].

Similar to gasification, combustion of the fuels will be subject to the requirements of the WID and to ensure compliance with emission limits these emissions will require treatment, generally using similar abatement to that applied to conventional plant will be required [9].

Solid residues from pyrolysis plant have a high carbon content. Unlike combustion bottom ash or the residue from some gasification plant this material will require landfilling or further treatment. Residues from exhaust gas cleaning would require disposal to hazardous landfill.

As with gasification there is limited experience of the application of pyrolysis technology for the treatment of MSW materials, its presence in the market is not well established and its commercial application is limited. It is being tested in a size range of up to 30,000 tpa, with pre-prepared waste material. It therefore cannot be considered to be fully proven at the current time and particularly at the scale proposed for the SEP.

Proven availability remains an issue for the technology, which raises questions over the fate of the feedstock during periods of downtime. There is limited alternative for feedstock when the plant is unavailable and it can be assumed that the feed material would be diverted to landfill or an alternative thermal treatment.

To obtain consistent gas quality a less heterogeneous incoming feed stream is required and some pre-treatment is therefore necessary.

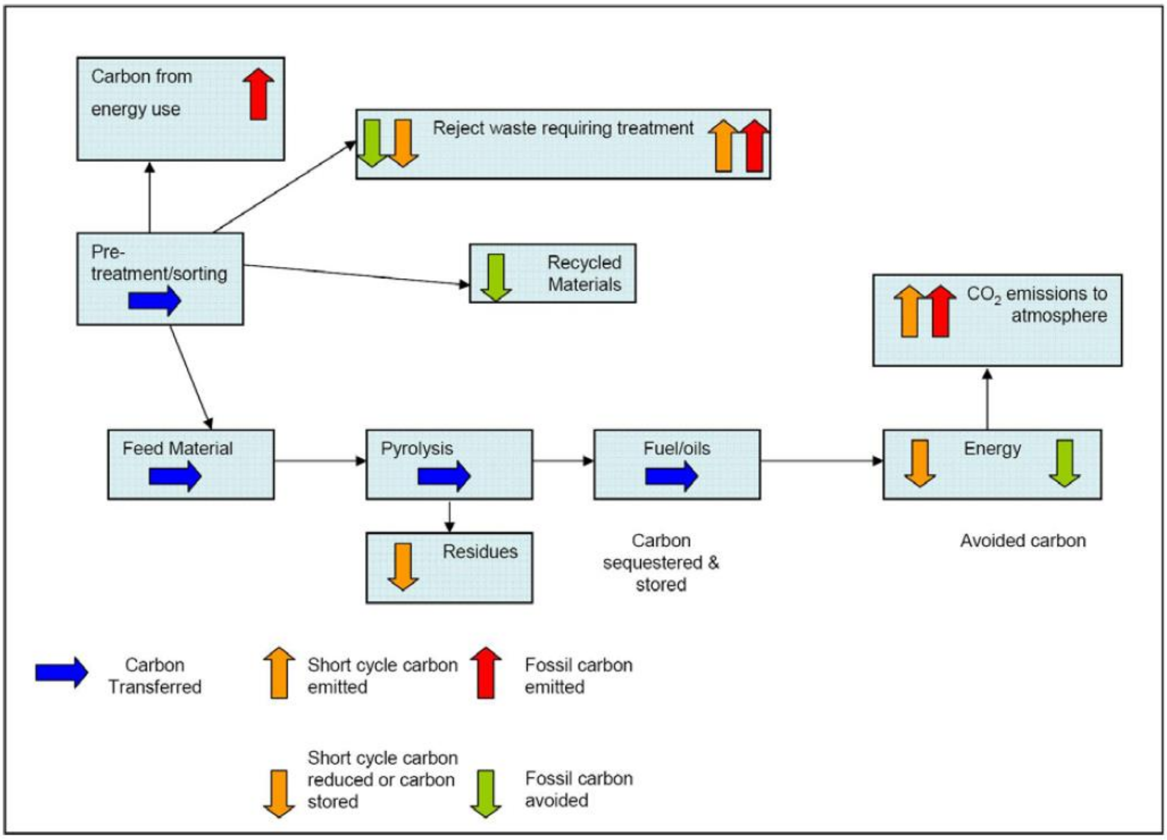

Figure 3: Pyrolysis Process Flow

Other

In addition to the four technologies outlined above, which are subject to further discussion in the remainder of this section, three further alternatives are considered in brief below.

Option 5: Plasma Arc Gasification

Plasma arc gasification technology transforms high calorific waste streams into synthesis gas and a vitrified slag by means of thermal plasma. The plasma is a mixture of electrons, ions and neutral particles (atoms and molecules) often referred to as the fourth state of matter.

It is reported as achieving a greater level of environmental performance in terms of energy production, emissions and residues, although this is disputed. To date the process has been used mainly to treat hazardous wastes including organics, metals, polychlorinated biphenyls (PCBs) (including small-scale equipment) and hexachlorobenzene (HCB).

Plasma Arc technology produces extremely high temperatures to destroy waste materials (5,000 to 15,000 °C). It involves passing a large electric current though an inert gas stream. Under these conditions, hazardous contaminants, such as PCBs, dioxins, furans, pesticides, etc, are broken into their atomic constituents, by injection into the plasma.

The high temperature and oxygen starved environment is used to decompose the feed material into simple molecules i.e. CO, CO2, H2, CH4, etc., and also ash and slag.

Whilst plasma arc gasification is an established technology, the process can be very complex, expensive and operator intensive. There would be significant challenge in achieving the very high temperature throughout a solid waste mass at large scale and this is a practical constraint for scaling the application. To date most applications of Plasma Arc technology for wastes or waste derived fuels have only been carried out on an R & D or demonstration basis at small scale and therefore the technology has not been proven on a commercial basis within the UK. Although there are proposals coming forward through the planning and permitting process all remain well below the scale of the proposed SEP. On this basis plasma arc gasification is not considered proven at the scale of the proposed SEP and is therefore discounted from further consideration.

Option 6: Biological Treatment (Anaerobic Digestion)

Anaerobic digestion (AD) involves biological decomposition of waste in air-tight containers to produce a methane rich biogas. The process requires the control of temperature, pH and moisture to optimise the gas production. Normally the gas is collected and combusted with energy recovered in the form of heat or electricity. Source separated waste is essential if the solid residue (the digestate) is to have value in agricultural or horticultural application as opposed to disposal in landfill sites.

The incoming waste is screened then mixed with previously digested material to achieve the correct consistency. This mixture is then pumped into the air-tight digester vessel where it is held for 2-3 weeks. Inside the digester the material is mixed and biogas formed, taken off and burnt for energy (typical methane content 55-65%). The solid waste digestate is extracted, de-watered and disposed of. Control of temperature is very important in the formation of the biogas. Temperatures must be maintained above 30°C for the gas production to occur at reasonable levels. The use of higher temperature systems is possible and increases the production of biogas, however, the process is faster and requires additional energy input.

Given that the key driver for the proposed plant is to generate energy, the supply of steam to the soda ash process would need to be met by the solution. To achieve the required steam output would require a far larger capacity AD plant (estimated to be approximately 5 times the throughput) than that proposed for the SEP. Further an AD solution would only be suited to the biodegradable faction of the proposed waste streams requiring either further processing on site (increasing the capacity of the plant further) or securing an alternative feed material. On this basis an AD solution at the required scales has been rejected.

Option 7: Landfill

Whilst landfill would be an alternative option for the proposed waste materials, this option would not generate energy from the material and therefore would not meet the fundamental requirements for steam and electricity which is driving the need for the proposed plant. Further, landfill presents a number of environmental issues and for some time has been recognised as an unsustainable option for waste management. Consequently landfill has been discounted as an alternative to the proposed plant.

Assessment of Technology Options

Based on the above overview, this section provides further discussion of the issues and impacts associated with moving grate; fluidised bed; gasification and pyrolysis techniques and describes the basis for concluding that moving grate represents BAT for the SEP.

It has been assumed that all options will involve onsite combustion of any secondary fuels and that all facilities will be required to operate in accordance with the requirements of the IED.

Emissions

All facilities based on combustion, gasification or pyrolysis technologies where they subsequently burn waste materials will be required to comply with the WID. Most technology providers will only provide WID limit guarantees and in most cases options will include similar abatement to ensure that these levels are met. On this basis guaranteed emissions performance is considered similar for all options.

Exhaust gases from all of the options considered (including gasification and pyrolysis) will include trace levels of oxides of nitrogen, acid gases (sulphur oxides, hydrogen chloride, hydrogen fluoride), heavy metals and dioxin and furans.

However, in practice different unabated emissions performance is achieved by the various technologies [11].

Fluidised bed technology is capable of lower NOx emissions and is capable of achieving levels below WID limits for NOx without abatement, although in practice abatement for NOx would be provided to guarantee compliance. Abated NOx emissions would be expected to be dependant on the selected abatement technology and ultimately would be expected to be similar to that achieved for a moving grate system using the same abatement, although noting that lower reagent consumption would be likely. For other pollutants emissions performance would be similar to moving grate.

Reported emissions for gasification and pyrolysis is generally accepted to be based on limited data. As a result, reported performance is variable. Work undertaken for the Environment Agency by AEA Technology indicates that pyrolysis and gasification plant generally achieve similar emissions performance (following abatement) to those for moving grate systems [13]. Other reference documents indicate the potential for improved performance including heavy metals and dioxin and furans, albeit at the expense of increased levels of these pollutants in residues [12, 13].

Global Warming Potential

The GWP of a facility is calculated through assessing all direct releases of greenhouse gases from the process (including the main process, associated abatement and energy related emissions) and indirect emissions of greenhouse gases from the primary source of heat or power imported for use in the process.

All combustion processes will be designed to fully oxidise a waste material and in an energy recovery process to subsequently use the heat energy released through the exothermic reaction of carbon (and hydrogen) with oxygen within a down stream energy conversion stage.

The waste material to be accepted has been fixed during the project planning and contract definition process within the fuel supply contracts, and there will subsequently be a reasonably well defined composition in terms of carbon content. Consequently the quantity of CO2 released from the combustion of the waste material either directly or indirectly will be fixed. For gasification and pyrolysis processes subject to WID, the same carbon in ash requirement applies. The products of gasification/pyrolysis processes (a combination of syngas, liquid fuel and solid residue) will contain the chemical energy associated with the same carbon input stream and will be converted by oxidation to CO2.

It can be noted from the above that the chemistry of the combustion process would be identical for each of the thermal treatment options considered, although the reactions might be optimised under differing conditions, giving rise to the same or similar overall emission of CO2 associated with a given waste material.

In this context, it is necessary to consider the efficiencies related to converting combusted/combustible gases resulting from a process to heat and power, requirement for supplementary combustion of fuel to maintain the thermal treatment process and those measures to maximise internal energy efficiency of the plant itself (including the 'parasitic' load required to drive supporting equipment and plant).

Energy Conversion Efficiencies

The post combustion energy conversion technology for Options 1 and 2 will consist of recovering the energy from the hot combustion gases using a combined heat and power (CHP) unit to generate heat and power simultaneously. In principle, this is independent of the primary combustion process and so it could be considered that the efficiency of this aspect of the SEP should not give rise to any difference between the technologies with respect to overall energy efficiency.

Fuels produced from gasification and pyrolysis (Options 3 and 4) might provide a more flexible option i.e. if treated/ refined to an appropriate specification it could be used on site or piped/transported off-site, although in this case, the fuels would need to be used onsite. The fuel is typically either burned in a boiler to raise steam and electricity, with a lower overall efficiency than an SEP or used as a fuel in an engine or turbine [10]. A summary of energy transfers from each process is given in Table 5.

Table 5: Summary of Technologies and Potential Energy Transfers

Thermal Treatment Process	Output	Transfer of Energy
Conventional thermal treatment (moving grate and fluidised bed)	• Hot exhaust gases	• Pass hot gases through waste heat boiler to produce hot water or steam. • Steam is used in a turbo generator to generate electricity at up to approximately 29% net electrical energy conversion efficiency. • Where steam or hot water are raised for use in an industrial process, efficiency of electrical power generation is reduced but overall energy efficiency can be significantly improved depending on the plant demand.
Pyrolysis	• Syngas • Char • Bio-oil	• Use in steam boiler to drive a steam turbo-generator. • Use pyrolysis oil as an engine fuel.
Gasification	• Syngas • Char	• Use in steam boiler to generate process steam only • Use as a fuel in a steam turbo-generator • Use in a stationary gas engine/turbine to generate electricity at approximately 40% electrical energy conversion efficiency.

Note: Modified from SLR report (2008).

Data for the gross efficiency of ATT technologies using MSW derived fuels are not available on a comparable basis with conventional incineration techniques, due to the limited number of operational plants. Differences in the quoted gross efficiencies of ATT technologies and incineration can arise due to a number of factors which include:

- differences in the assumed CV of the feedstock;
- net power or gross power output (depending on technique used for conversion);
- whether the parasitic load includes any power consumed in the preparation of the feedstock (which does not apply in this case); and
- size of the steam/gas turbine, which influences conversion efficiencies.

A desire to maximise the efficiency of the conversion process is recognised for any thermal treatment technology. The overall efficiency will be dependent on the efficiencies of the steam turbine and heat exchange/boiler design. The principal difference between the overall energy efficiency of each conventional thermal treatment technology option (i.e. fluidised bed or moving grate) is likely to arise from the parasitic load, although there would be only minor variation in parasitic load (relating to internal material flow transfer and flue gas treatment).

Each stage of the conversion process combustion/ gasification/pyrolysis, energy recovery and secondary energy conversion technologies will reduce the overall conversion efficiency and will have space and layout implications. Specifically the syngas cleaning stage can impact on the overall efficiency of the plant and normally requires cooling of the gas, resulting in the loss of sensible heat from the syngas that cannot be fully recovered.

Indirect Energy

Energy requirements related to the indirect energy input (i.e. fuel for auxiliary/support burners) would be similar for conventional thermal treatment options and therefore a similar quantity of CO2 would be produced from each option. Unlike gasification or conventional combustion technologies, pyrolysis also requires supplementary combustion to achieve the temperature required for thermal treatment that is likely to be provided by either natural gas or low sulphur oil.

Plant Energy Requirements

General energy efficiency techniques for the proposed plant were considered earlier in Section 2.3. This includes operational, maintenance and housekeeping energy efficiency measures. There is nothing to prevent similar techniques for energy efficiency being applied to any of the 4 options.

Residue Generation

The residues generated by moving grate systems are either similar or lower in quantity compared to the alternatives, and compared to those for ATT there is the potential for lower hazards associated with the residues due to lower heavy metals, dioxins and furans [11].

Although moving grate and fluidised bed systems generate similar overall quantities of residues, greater volumes of hazardous waste (APC residues) would be generated from a fluidised bed plant compared to a moving grate plant.

Odour

For all options odour management is capable of ensuring that odour nuisance is not an issue and given the nature of the waste material is not considered significant.

Raw Materials

Raw material usage of moving grate systems is less than that required for fluidised bed systems primarily as a result of the requirement for fluidisation sand. ATT options require similar air pollution abatement systems and therefore similar raw materials.

There is the potential for variable usage of raw materials dependant on the raw gas concentrations of pollutants. Given that moving grate systems can present higher raw gas concentrations, the alternatives offer lower reagent usage.

Pyrolysis systems require the addition of supplementary fuel to maintain the treatment process. Whilst all systems will require the use of supplementary fuels during certain operational conditions e.g. start-up/shut-down or occasionally to maintain minimum WID temperatures, their consumption would be much lower than that for pyrolysis.

Noise

Noise emissions from all options are considered similar.

Accidents

All options will handle similar raw materials and reagents and therefore each present similar chemical hazards. ATT systems producing gaseous fuels introduce additional fuel handling hazards.

Costs

Reliable data concerning costs for each of the Options is very difficult to obtain - a fact that has been recognised in published reviews. This is particularly relevant in the case of ATT options where there are no specific examples in the UK and only a few fully commercial worldwide, resulting in very limited cost data. In many instances cost data is only based on estimates and has not been tested commercially, therefore possibly resulting in over optimistic estimates.

In addition to the type of plant proposed, the supply contract type can also have cost implications. For example a turnkey contract can often attract much higher contract costs compared to a supply and install only contract.

That being said, it is generally recognised that moving grate represents the most cost-effective option.

For the advanced thermal treatment options, as already recognised, estimated costs are highly variable and range from lower than moving grate to significantly higher, but with a general consensus that the costs would be higher and the overall efficiency would be lower.

Other

This application is being made to operate a plant to process up to 685,000 tonnes per annum of fuel derived from MSW (or similar). The plant will incorporate 2 lines. Currently there is limited operational experience in the UK of gasification technology applied to waste materials, although a number of facilities are proposed (see discussion above) and only a few applications in Europe, where experience has proven mixed. At this scale the proposed plant is significantly larger than any operational gasification or pyrolysis plants.

There are only two UK facilities operating fluidised bed technologies (Allington in Kent and the Baldovie plant in Dundee, Scotland) with moving grate systems clearly being the most common thermal treatment solutions applied to date in the UK and elsewhere. Although there are operational UK plant utilising fluidised bed systems, the performance has been reported as mixed.

Conclusions

The various options for thermal treatment of the proposed combination of pre-treated waste materials have relative benefits and disadvantages. All four options are capable, subject to appropriate abatement measures being taken, of performing within WID emissions limits (albeit limited emissions performance data are reported in respect of gasification and pyrolysis). Whilst moving grate systems generate higher raw gas pollutant concentrations, the application of abatement, which is still required for all options, enables compliance with WID limits and in many instances performance well below these levels.

The performance of the various options in terms of carbon dioxide releases is recognised as being dependant on the carbon within the waste material which the thermal treatment technology seeks to optimise in the energy conversion process. For the waste materials to be accepted at the plant, carbon dioxide releases from the plant associated with the combustion of the waste material will therefore be limited by the plant capacity of 728,000tpa.

Whilst this addresses the potential for carbon dioxide releases directly associated with the waste material, the efficient use of energy is also important. For the options considered within this assessment the following will effect plant efficiency:

a) the efficiencies of techniques for converting combusted/combustible gases resulting from the process to heat and power;
b) the requirement for supplementary combustion of fuel to maintain the thermal treatment process; and
c) measures to maximise internal energy efficiency of the plant itself (including the ‘parasitic’ load required to drive supporting equipment and plant) are also considered relevant.

The discussions above illustrate that, compared with the other options considered, moving grate systems have similar or improved performance in all three areas.

Moving grate has either a similar or improved performance compared to the other options in relation to electrical efficiency, residue generation, odour, raw material consumption, noise and potential for accidents.

In this context and alongside in particular the fact that its reliability at a commercial scale is proven and that it provides a cost effective option, moving grate has been selected as the thermal treatment technology and is considered BAT for the proposed plant on this basis

Table 6 below provides a summary comparison of the alternatives against moving grate for key BAT requirements.

Table 6: BAT Comparison of Alternatives versus Moving Grate

BAT Criteria	**Option 1 Moving Grate**	**Option 2 Fluidised Bed**	**Option 3 Gasification**	**Option 4 Pyrolysis**
Emissions	Abated emissions meet WID, lower levels are achieved at many plant.	Lower NOx levels than moving grate are achievable, but abatement will still be required to guarantee WID.	Lower emissions of metals as these are transferred to solid residues (see below). Emissions performance is still reported as limited(1), although it is reported that lower emissions	Lower emissions of metals as these are transferred to solid residues (see below). Emissions performance is still reported as limited(1), although it is reported that lower emissions

BAT Criteria	**Option 1 Moving Grate**	**Option 2 Fluidised Bed**	**Option 3 Gasification**	**Option 4 Pyrolysis**
			are achievable(2).	are achievable(2).
Global Warming Potential (GWP)	GWP arises as a result of carbon within the waste material combusting to release CO2 and release of nitrous oxides associated with the NOx abatement (although this is not directly associated with the main technology).	Similar to MG.	Similar to MG.	Higher due to additional burning of support fuel to maintain process temperatures.
Efficiency	20-26% (electricity only)	21% (electricity only)	14-20% (electricity only)	14-20% (electricity only)
Residue Generation	Produces bottom ash (<3% carbon) and APC residues	Produces similar overall quantities of residues for disposal, but a larger proportion of the residue would be hazardous.	Similar to MG, although residues contain higher levels of metals.	Similar to MG, although residues contain higher levels of metals.
Odour	Odour management typically avoids nuisance.	Similar to MG.	Similar to MG.	Similar to MG.
Raw Materials	See Figure 8 [of the original EP application]	Higher due to fluidisation sand requirements.	Variable, depends on flue gas treatment selected	Variable, depends on flue gas treatment selected
Noise	With appropriate abatement noise can be	Similar to MG.	Similar to MG.	Similar to MG.

BAT Criteria	Option 1 Moving Grate	Option 2 Fluidised Bed	Option 3 Gasification	Option 4 Pyrolysis
	successfully be controlled			
Accidents	See section 2.2	Similar to MG.	Fuel-gas handling present additional risks.	Fuel-gas handling and spillages from liquid fuel present additional risks
Costs	Lowest cost per tonne.	Capital can be higher, additional residue collection (typically cyclone and bag filters) and disposal required	Widely variable, but generally higher(1).	Widely variable, but generally higher(1).
Other	Proven technology with a large number of operational facilities.	Some operational experience, with mixed performance.	No large scale UK operational plants.	No large scale UK operational plants.

(1) Review of BAT for New Incineration Issues; Part 1 Waste Pyrolysis and Gasification Activities. P4-100/TR, Environment Agency, 2001 [13].

(2) Advanced Thermal Treatment of Municipal Solid Waste, DEFRA, 2005 [11].

(3) The viability of Advanced Thermal Treatment of Municipal Solid Wastes [12]

(4) Based on WRG Allington performance

(5) Comparison assumes all facilities operate to WID and any intermediate fuels generated are combusted onsite.

6.2 NOx Abatement Selection

Within the EA Sector Guidance for this sector [2], there is a requirement for undertaking a site specific appraisal of the selected abatement plant for NOx control.

As identified in section 6.1 above the selection of the main technology in addition to the selected abatement can affect NOx emissions performance. For the reasons given in section 6.1, gasification and pyrolysis are not considered commercially proven at the scale proposed for this development and therefore are not discussed further. However, fluidised bed provides a proven alternative to the proposed moving grate system and therefore the following options are considered.

- Option 1: Moving grate with Selective Non-Catalytic Reduction (SNCR);
- Option 2: Moving grate with Selective Catalytic Reduction (SCR);
- Option 3: Fluidised bed with SNCR; and
- Option 4: Fluidised bed with SCR.

The assessment has considered the NOx performance in combination with the selected combination as this will vary between moving grate and fluidised bed, other factors such as waste generation, costs etc relate only to the abatement choice as this is the primary purpose of this BAT justification.

For all options, it is assumed that the same primary measures for minimising the formation of NOx are in place (see section 4.1 [of the original EP application] for details). These options are assessed using the H1 Software tool, full details of this assessment are provided in Appendix H [of the original EP application].

Flue gas recirculation is not proposed as part of the design. A justification for not including FGR are discussed in section 3.7 and therefore is not considered further in this section.

In terms of comparing the environmental impacts of SCR and SNCR, the key issues are emissions to air, global warming potential and ozone creation potential (associated with energy use and emissions of NOx). Waste production is also considered a relevant issues for comparing the NOx abatement options in terms of their impact on the environment. All options are assumed to utilise the same reagent, namely ammonia solution and therefore would present similar accident potential, on this basis accidents are excluded from the assessment.

Air Quality Impacts of NOx Emissions

Table 7 provides the long term emission concentrations used in this assessment. Estimated concentrations for each option were provided by the original Applicant. Short term emission concentrations are based on guaranteed values (IED emission limits) and are the same for all abatement options, consequently the effect of short term emissions is not discussed further.

Table 7: Summary of Air Quality Performance Associated with Releases of NOx

Option	**1** **MG SNCR**	**2** **MG SCR**	**3** **FB SNCR**	**4** **FB SCR**
Achievable emissions concentrations (in mg/Nm3)				
NO2	100	70	100	70
N2O	10	0	50	0
NH3	10	5	10	5
Long term % Process Contribution (PC)/Environmental Assessment Level (EAL)				
%PC/EAL NO2	3.28	2.3	3.28	2.3
%PC/EAL NH3	0.08	0.04	0.08	0.04
Long term % Predicted Environmental Concentration (PEC)/Environmental Assessment Level (EAL)				
%PEC/EAL NO2	58	57	58	57

All options demonstrate a performance considerably below WID limits and the predicted environmental concentrations for all options are well below the corresponding EAL.

In terms of NO2 performance SCR can achieve lower NOx concentrations in the exhaust gas releases to atmosphere than SNCR. With any of the options considered the achievable releases are always a balance between pollutant reduction and reagent usage. It should be noted that for the assessment although inherently lower NOx levels are achieved using fluidised bed systems with abatement the achievable releases are the same. However as is discussed below this is achieved in the fluidised bed system with the advantage of reduced reagent usage.

The effect on the predicted environmental concentrations (PEC) shows that the PEC for SCR (Options 2 and 4) is only slightly better than that for SNCR (options 1 and 3) at 22.9µg/m3 compared to 23.3µg/m3 respectively, representing only a 1% improvement.

Deposition of NOx for both SNCR and SCR exceed the insignificance criteria. However, the air quality assessment within Appendix C [of the original EP application] which includes an assessment of deposition demonstrates that no significant impacts are predicted using SNCR. As SCR gives rise to lower releases of NOx, it can be concluded that no significant deposition impacts would be expected for this option.

Releases of ammonia are similar for both technologies assessed and vary only in relation to the abatement considered. SCR is shown to perform better in terms of ammonia releases. Although both are considered insignificant.

The release of nitrous oxides (N2O) does not give rise to localised air quality effects, however it does have global warming effects and therefore the impact of this emission is discussed further below.

Photochemical Ozone Creation Potential (POCP)

Releases of nitrogen dioxide can give rise to photochemical for ozone creation. Given that for this assessment the concentration of NO2 does not alter with technology, the POCP performance is dependant on the abatement choice with SCR achieving a lower POCP than SNCR at 888 compared to 1,269 respectively.

Global Warming Potential

Global warming potential (GWP) has been considered through the discharge of nitrous oxides and carbon dioxide releases associated with the additional energy requirements to operate the abatement plant.

The energy requirements to operate an SCR system are higher than those for SNCR due to the requirement to reheat the exhaust gases to between 300-400°C (the range at which the catalytic process operates). SNCR does not require any reheating and therefore energy input is only required to operate associated plant.

There are also differences in the releases of nitrous oxides between technologies with fluidised bed technologies giving rise to higher release compared to moving grate.

The GWP of the four options considered is summaries in Table 8 below.

Table 8: Summary of GWP Performance

Option	**1**	**2**	**3**	**4**
	MG SNCR	**MG SCR**	**FB SNCR**	**FB SCR**
GWP	14,977	14,682	71,186	16,218

Waste

SNCR produces no wastes requiring disposal whilst SCR uses a catalyst, which periodically requires disposal. The spent catalyst will be replaced every 3-4 years, this averages out to an annual waste disposal of approximately 68 tonnes per annum for the system for the moving grate SCR combination (Option 2) and 58 tonnes per annum for the fluidized bed with SCR (Option 4). The spent catalyst is classified as a hazardous waste and cannot be treated and recovered, therefore the material will require disposal at a hazardous waste landfill.

Summary

To establish BAT for the proposed SEP, the performance of each of the potential options needs to be considered for each of the relevant environmental areas considered. To summarise the assessment above, the performance of SNCR and SCR for each of the relevant issues identified in paragraph 6.91 [of the original EP application] are ranked in Table 9 below.

Table 9: Summary Ranking

	Ranking			
Option	**1 MG SNCR**	**2 MG SCR**	**3 FB SNCR**	**4 FB SCR**
Performance Ranking				
Emissions to air	3	1	3	1
GWP performance	2	1	4	3
POCP performance	3	1	3	1
Sub total	***8***	***3***	***10***	***5***
Waste	1	3	1	3
Sub total	***1***	***3***	***1***	***3***
Environmental performance total	***9***	***6***	***11***	***8***

From the table above the environmental performance of the SCR options overall are better than those for SNCR. However, as discussed above although the performance of SCR is greater for some environmental parameters the actual difference is slight. Given also that SCR is significantly more expensive than SNCR in determining BAT the consideration of costs are relevant. The environmental criteria subject to the cost benefit analysis are those where SCR performs better than SNCR and include NOx emissions, ammonia emissions, POCP performance and GWP. There is little benefit provided by the choice of main technology and section 6.1 provides the justification for the selected moving grate system the cost benefit assessment considers only the combination of NOx abatement with moving grate.

Costs

A breakdown of the costs and relevant assumptions has been provided within the H1 Assessment included as Appendix H [of the original EP application]. Estimated capital and operating costs were provided by the original Applicant for SNCR and SCR abatement systems. Given that the cost benefit analysis is only undertaken for a moving grate system, the costs associated with the moving grate system are excluded. Costs have assumed a 25 year operating life for all options.

Cost Benefit

The cost per tonne of NOx abated for both SNCR and SCR in combination has been calculated and is presented below:

Table 10: Comparison of Costs per Tonne of NOx Abatement

Option	Tonnes of NOx abated per annum	Equivalent annual cost	Equivalent annual cost per tonne of NOx abated per annum
1	1,247	£639,667	£513
2	1,383	£1,426,227	£1,031

**Tonnes abated are calculated based on the following raw gas concentrations (unabated releases) of*

NOx for Moving Grate are 375 mg/Nm3 giving rise to a total of 1700 tpa of NOx

The table above indicates that SNCR provides the most cost-effective method for NOx abatement, with SCR costing almost double that of SNCR whilst providing only slight improvements (1%) in the predicted environmental concentrations of NO2.

It is therefore concluded that overall Option 1 provides the most cost effective solution for the abatement of NOx.

For ammonia releases are associated with operation of the abatement plant and associated ammonia slippage.

Table 11: Comparison of Ammonia Releases

Option	Tonnes of NH3 released	Equivalent annual cost
1	45.34	£639,667
2	22.46	£1,426,227

The additional equivalent annual cost in relation to ammonia to install and operate SCR as opposed to SNCR is £34,377 per tonne of ammonia saved. Given that ammonia process contributions as a percentage of the EAL are less than 1% for all options releases are considered insignificant and consequently the additional cost is not justified.

Global warming effects of the selected NOx abatement vary with SNCR having lower carbon dioxide equivalent emissions associated with energy use than SCR but giving rise to releases of nitrous oxides which are avoided by using SCR. For the two technologies the overall GWP is similar at 14,977 for SNCR and 14,682 for SCR, with SCR providing less than a 2% improvement. Further if the GWP saving is put in the context of the overall GWP for the facility of 249,523 the benefit represents only a 0.1% saving. Therefore in terms of GWP the benefits of SCR over SNCR are not justified.

POCP is a key consideration in the selection of the NOx abatement system. The benefit in terms of POCP avoided SCR compared to SNCR is small, showing a difference of 381 POCP avoided between the two abatement options irrespective of main technology. Again the additional costs which for SCR are almost double those for SNCR are not considered justified for this level of overall benefit.

Table 12: Comparison of Costs per Unit POCP avoided

Option	POCP Avoided	Equivalent annual cost	Equivalent annual cost per unit of POCP avoided*
1	3,491	£639,667	£183
2	3,872	£1,426,227	£368

** POCP avoided is based on a comparison with the raw gas NO2 concentrations (i.e. no abatement) giving*

a POCP of 4,760 for moving grate.

Overall Option 1 provides the most cost effective solution for POCP.

Summary of NOx Appraisal

The assessment of NOx abatement has considered both the environmental performance of the options and the also the relative costs for installation and operation of the abatement plant. Although the environmental performance was considered in combination with both moving grate and fluidised bed technologies the environmental performance in combination with moving grate for both NOx abatement technologies was better than in combination with fluidised bed and on this basis consideration of costs was only taken forward in relation to Options 1 and 2.

It is concluded that although SCR can achieve lower emissions performance overall the benefits offered are only slight and do not justify the additional costs. The POCP of SCR is also lower than that for SNCR, however these savings are achieved at double the equivalent annual cost. The level improved POCP performance achieved by SCR again do not justify a doubling of costs.

SCR also provides a lower GWP effect to that for SNCR, however in terms of the overall reduction in GWP from the facility as a whole, SCR achieves a GWP saving of less than 0.1%. Again this level of saving is not considered to justify the scale of additional costs which SCR incurs.

The selection of moving grate in combination with SNCR (option 1) provides a proven and reliable system for NOx control. The NOx performance of the proposed system is good, achieving levels well below the WID limits. Overall it is concluded that Option 1 is BAT for this installation.

6.3 Acid Gas Abatement Selection

Similar to NOx abatement, the EA sector guidance note requires an options appraisal to be provided for the selected acid gas abatement. The following options have been considered for the proposed SEP:

- Option 1: Wet scrubber, down stream of the bagfilter unit with upstream spray tower;
- Option 2: Semi- dry system; and
- Option 3: Dry system.

Each scenario assumed the SEP is operating at 8,000 hours/600,000 tonnes per annum after routine shutdowns and maintenance. Unlike NOx emissions releases of acid gases are not affected by the main technology therefore all systems are assumed to be used in conjunction with a moving grate plant.

For all options, it is assumed that the same primary measures for minimising the formation of acid gases are in place (see section 4.1 [of the original EP application] for details). These options are assessed using the H1 Software tool, full details of this assessment are provided in Appendix H [of the original EP application].

The options considered for control of acid gases have been assessed on the basis of the following environmental criteria:

- air quality impacts;
- photochemical ozone creation potential (POCP);
- global warming potential (GWP);
- reagent usage; and
- waste hazard.

All options are considered to present similar noise, hazard and visible plume potential. No releases to water are generated from the options considered – for the wet system the scrubber liquor is recycled and therefore does not give rise to an aqueous release. Consideration of these environmental effects has therefore been excluded from this assessment.

Air Quality Impacts

Table 13 provides the long term emission concentrations used in this assessment. Estimated concentrations for each option were sought from the technology supplier. Short term emission concentrations are based on guaranteed values (WID emission limits) and are the same for all abatement options.

Emissions

Table 13: Summary of Air Quality Performance Associated with Releases of Acid Gas

Option	1	2	3
	Wet	Semi-dry	Dry
Achievable emissions concentrations (in mg/Nm3)			
SO2	25	50	25
HCl	5	10	10
HF	0.5	1	1
Long term % Process Contribution (PC)/Environmental Assessment Level (EAL)			
%PC/EAL SO2	2.38	4.76	2.38
%PC/EAL HF	0.156	0.311	0.311
Long term % Predicted Environmental Concentration (PEC)/Environmental Assessment Level (EAL)			
%PEC/EAL SO2	9.38	11.8	9.38

Overall the wet scrubber system provides the lowest release concentrations for acid gas options. HF is screened as insignificant for all options on the basis that the PC/EAL is less than 1. For SO2 the PEC for Options 1 and 3 are 1.88µg/m3 whilst for Option 2 this is higher at 2.36µg/m3 representing a %PEC/EAL of 9.38% (Options 1 and 3) and 11.8% (Option 2) respectively.

Each of the abatement options will achieve process environmental contribution well below relevant EALs.

Given that all options will guarantee WID limits, short term releases for all options are the same and therefore not considered further as part of this assessment.

Photochemical Ozone Creation Potential

Emissions of sulphur dioxide to air are also considered under photochemical ozone creation potential (POCP). Options 1 and 3 both achieve a POCP of 544 whilst the POCP for Option 2 is double this value at 1,088.

Global Warming Potential

In this assessment for acid gas abatement, global warming potential (GWP) is considered through the energy requirements associated with the selected abatement plant options (in terms of CO2). Table 14 below summarises the GWP for each of the options.

Table 14: Summary of GWP performance

Option	**1** **Wet**	**2** **Semi-dry**	**3** **Dry**
GWP	3,827	3,529	3,705

Option 2 provides the best alternative in terms of GWP performance, with Option 1 performing least well.

Reagent Usage

All options require the use of an alkaline reagent and options 1 and 2 also use water. Whilst Option 3 has the largest requirement for reagent, options 1 and 2 also require water with the wet system by virtue of its nature using the greatest amount of water.

Overall it is a balance of the combined inputs. Considering both water and reagents on an equal basis Options 3 performs best in terms of material usage followed by option 2 and with option 1 performing worst.

Waste

All options generate waste streams for disposal as a result of excess reagent and reaction products.

All residues would be hazardous in nature and the disposal route would be the same for each of the abatement options. The overall waste impact scores are as follows Option 1 7,820,000, Option 2 10,518,000 and Option 3 6,900,000. In conclusion Option 3 performs best overall in terms of waste impacts.

Summary

To establish BAT for the proposed SEP the environmental performance of each of the potential options needs to be considered for each of the relevant environmental areas considered. To summarise the assessment above, the performance of each abatement option for each relevant issue are ranked in Table 15.

Table 15: Summary Ranking for Acid Gas Options

	Wet **(Option 1)**	**Ranking** **Semi-dry** **(Option 2)**	**Dry** **(Option 3)**
Emissions to Air	1	3	2
GWP performance	3	1	2
POCP performance	1	3	1
Waste Hazard	2	3	1
Environmental Performance Total	*7*	*10*	*6*

Options 1 and 3 both perform well and overall have a better environmental performance than Option 2. Whilst Option 1 performs marginally better in terms of emissions performance, option 1 offers better GWP savings and performs better in terms of waste hazards.

It is therefore concluded that option 3 is BAT for this installation. Although not reflected in the scope of this assessment Option 3 has the advantage of utilising sodium bicarbonate manufactured by the adjacent Tata Chemicals facility thereby minimizing the effects of transport of the acid gas reagent. The Operator has therefore selected this option 3 for the abatement of acid gases at the SEP.

6.4 Dioxin and Furan Abatement Selection

Activated carbon has been selected for control of dioxins and furans, combined with the primary measures detailed within section 3.10. Dioxin and furans can also be controlled by the use of catalytic abatement systems. These have the advantage of destroying the dioxins and furans rather than removal and transfer into the APC residues. However, activated carbon also controls mercury emissions whilst catalytic systems do not and therefore activated carbon would also be required.

Given that activated carbon is effective for the removal of all three pollutants, this is considered to represent BAT and has been selected for the proposed plant.

6.5 Control of Particulates

There are a range of options available for particulate control including:

- Fabric Filters;
- Ceramic Filters;
- Electro-static Precipitators (ESPs); and
- Wet Scrubbers.

Wet scrubbers and ESPs are not considered to represent BAT on their own as they cannot achieve the emission level performance of other techniques. Ceramic filters can achieve high removal efficiencies of particulates but applications have generally been limited to small scale uses operating at high temperatures. They are also more susceptible to mechanical failures and blinding than fabric filters.

Fabric filters provide reliable abatement of particulates and are generally accepted as BAT for particulate control. The bag filter system will include multiple compartments which permit isolation of a compartment in the event of bag failure (see section 4.1 [of the original EP application] for further information). Dust detection will be provided for each compartment to enable fast detection of a failed bag and isolation of that unit for repair. The proposed system for particulate control at the SEP is therefore considered to be BAT.

ENGINEERING + CONSULTING

FICHTNER
Consulting Engineers Limited

Kingsgate (Floor 3), Wellington Road North,
Stockport, Cheshire, SK4 1LW,
United Kingdom

t: +44 (0)161 476 0032
f: +44 (0)161 474 0618

www.fichtner.co.uk