9. EMMISSIONS TO AIR

9.1 General

The air emissions from the Ringaskiddy waste management facility are described in this section.

9.2 Community Recycling Park

There will be no main, minor or boiler emissions from the community recycling park. Containers will be covered as appropriate and putrescible wastes will not be accepted. There will not be odour emissions or fugitive emissions from the community recycling park.

9.3 Waste Transfer Station

9.3.1 General

There will be no boiler emissions from the waste transfer station. There will be no main emissions from the waste transfer station.

9.3.2 Minor Emissions

Sources of minor emissions in the waste transfer station will be:

- the repackaging or cross pumping of drums, which are being repacked, will be done in the repack room
- pumping the contents of drums into the bulk tanks, this will be done in the drum wash and repack building
- drum washing, this will be done in the drum wash room
- breathing losses from the bulk tanks.

The emissions from the repacking operations will be vapour from waste solvent. The room extracts for the drum wash and repack building will be ducted to an abatement system. This will be activated carbon unit, a vapour condenser or a catalytic oxidiser. Refer to section 9.5.9 for a description of the operation of these abatement systems. Refer to figure 9.1 for a plan showing the locations of the emission points in the waste transfer station.

The bulk tanks will be maintained under a nitrogen blanket. The blanket will be kept at a constant pressure. In the event of the pressure increasing, a relief valve will activate, until the pressure returns to the set pressure. The off gases from the relief valves will be collected and ducted to the abatement system. In extreme over pressure, i.e. at pressures greater than 18mbar, the relief valves vent to atmosphere. The emission will be vapour from the waste solvent in the tanks and nitrogen.

There will be various classes of solvent in the drums and bulk tanks. Minor emissions are defined as emissions which are less than 20% of the BATNEEC Guidance Note threshold. For the purposes of this application, the limit value for minor emissions is taken as less than that for TA Luft class I solvent, that is less than 20% of 0.1kg/hr or 20mg/m^3.

9.3.3 Potential Emissions

The emergency generator will only be used if there is a mains power failure. In this infrequent event, there will be emissions from the emergency generator.

9.3.4 Emissions List

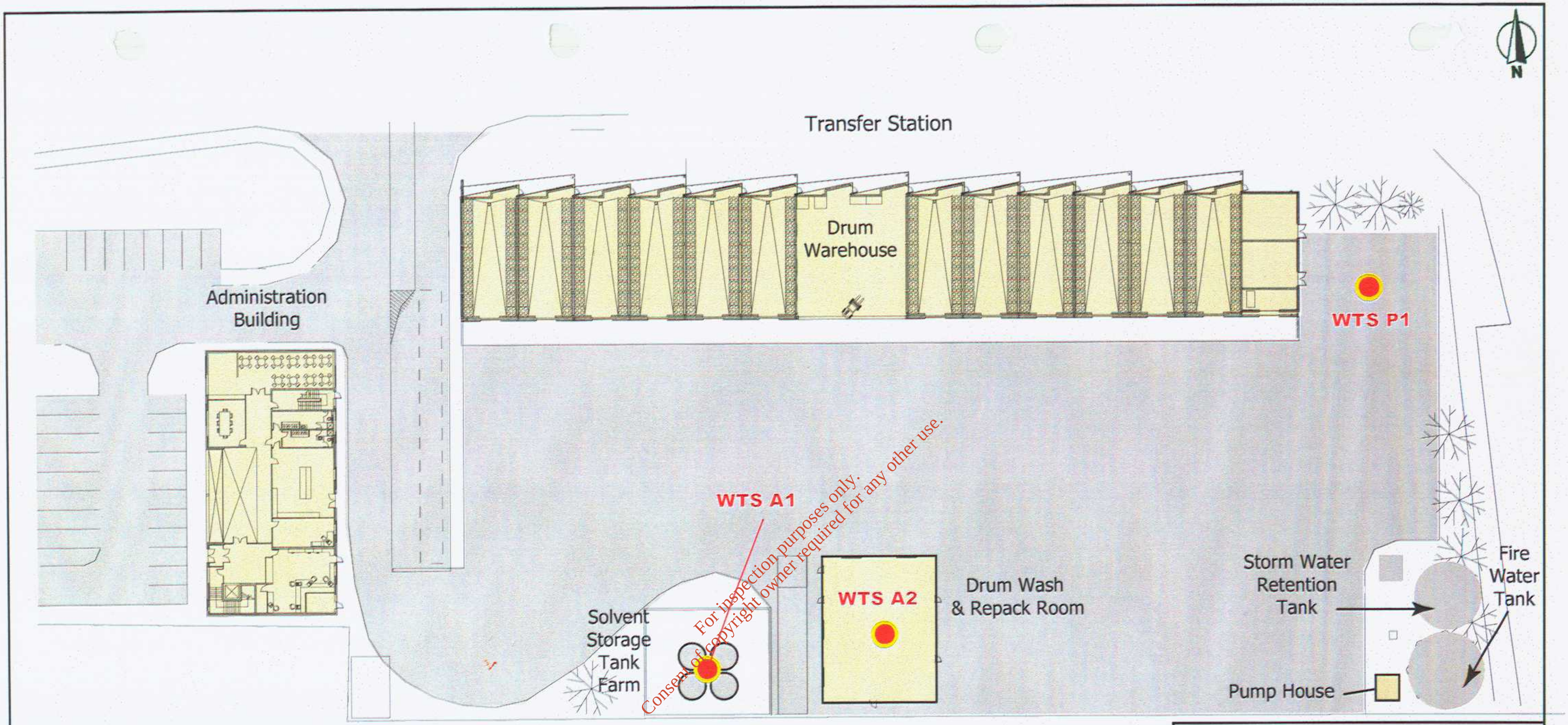
Minor Emissions

WTS A1 Waste transfer station bulk waste tanks abatement unit

WTS A2 Waste transfer station repack room abatement unit

Potential Emission

WTS P1 Emergency generator



Emission Points

MINOR:
WTS A1 Bulk tanks Abatement Unit
WTS A2 Drum Wash/ Repack Room Abatement Unit

POTENTIAL:
WTS P1 Emergency Generator

NOTE: Exact location will be defined when detailed engineering has been completed

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Files Located : J:/jobs/992/graphics/EIS figures
Ordnance Map :

Figure Title : Waste Transfer Station - Location of Air Emission Points
Figure No : 9.1

TABLE 9.1: EMISSIONS TO ATMOSPHERE – Minor and Potential atmospheric emissions from Waste Transfer Station

Emission point Reference Numbers	Description	Emission details[1]				Abatement system employed
		material	mg/Nm$^{3(2)}$ (note 3)	kg/h (note 3)	kg/year (note 3)	
Minor Emission						
WTS A1	Drum wash and repack building	Solvent vapour	<4	<0.02		To be decided, an activated carbon unit, a vapour condenser or a catalytic oxidiser.
WTS A2	Bulk Tanks breathing losses	Solvent vapour and nitrogen	<4	<0.02		To be decided, an activated carbon unit, a vapour condenser or a catalytic oxidiser.
Potential Emission						
WTS P1	Emergency generator - will operate only in power cut	SOx, NOx				

1 The maximum emission should be stated for each material emitted, the concentration should be based on the maximum 30 minute mean.

2 . Concentrations should be based on Normal conditions of temperature and pressure, (i.e. 0°C101.3kPa). Wet/dry should be clearly stated. Include reference oxygen conditions for combustion sources.

3. The emissions are expected to be very minor and well below 20% of the BATNEEC threshold. It would be very difficult to quantify these emissions.

9.4 Waste to Energy Plant Emissions Summary

9.4.1 General

There will be one main stack on site through which atmospheric emissions will be discharged. This will have two flues, one associated with each furnace line of the waste to energy plant. The emission will be the products of combustion after treatment. Air emission limits for the incineration of waste have been specified in EU Directive on the Incineration of Waste (2000/76/EC).

The main air emissions from the waste to energy plant are quantified in the following tables 9.2 to 9.5. The emissions are expected to be well below the EU Directive limits. Emission control parameters and monitoring equipment are tabulated in table 9.6. Minor emissions are detailed in table 9.7 and the potential emissions are tabulated in table 9.8. Refer to figure 9.2 for a plan showing the locations of the emission points in the waste to energy plant.

There will be no boiler emissions from the waste to energy plant.

9.4.2 Minor Emissions

Normally the vents from the bulk tanks will be ducted to the PCC. If the PCC is not operating, the vents will be ducted to an alternative abatement system. Refer to section 9.5.9.

The laboratory will be equipped with fume hoods which will vent to atmosphere.

9.4.3 Potential Emissions

The emergency generator will only be used if there is a mains power failure. In this infrequent event, there will be emissions from the emergency generator.

9.4.4 List of Emission Points

Main Emission Points

WTE A1 Waste to energy plant main stack flue 1 (phase 1 – fluidised bed line)

WTE A2 Waste to energy plant main stack flue 2 (phase 2 – moving grate line)

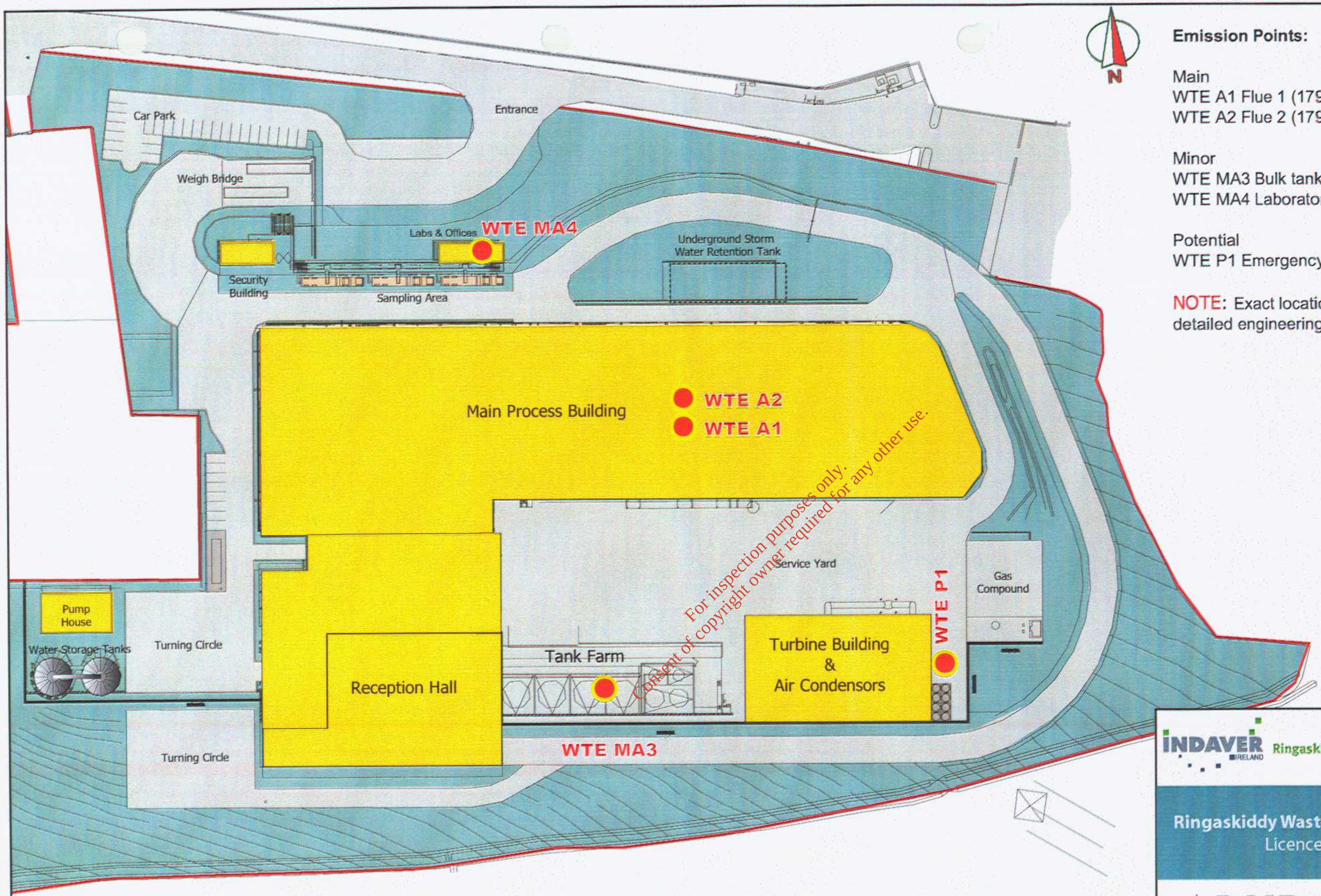
Minor Emissions

WTE MA3 Waste to energy plant bulk waste tanks abatement system

WTE MA4 Waste to energy plant laboratory fume hoods

Potential Emissions

WTE P1 Waste to energy plant emergency generator



Emission Points:

Main
WTE A1 Flue 1 (179 122E, 064 207N)
WTE A2 Flue 2 (179 127E, 064 209N)

Minor
WTE MA3 Bulk tanks abatement unit
WTE MA4 Laboratory Fume Hood

Potential
WTE P1 Emergency Generator

NOTE: Exact location will be defined when detailed engineering has been completed

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Ordnance Map :

Figure Title : Waste to Energy Plant - Location of Air Emission Points

Figure No : 9.2

TABLE 9.2 MAIN EMISSIONS TO ATMOSPHERE – WTE A1

Emission Point Ref. Nº:	WTE A1
Source of Emission:	Fluidised-bed/post combustion chamber line (phase 1)
Location :	Southerly flue of exhaust stack
Grid Ref. (12 digit, 6E,6N):	179 122E, 064 207N
Vent Details Diameter: Height above Ground(m):	 1.725m 55m
Date of commencement:	To be agreed

Characteristics of Emission :

(i) Volume to be emitted:			
Average rate/hour (at 100% load)	92,661m^3/h	Average/day (at 100% load)	2,223,864m^3/d
Maximum rate/hour (at 110% load)	101,927m^3/h	Maximum/day (at 110% load)	2,446,250 m^3/d
Short-term peak rate/hour (at 120% load)	111,193m^3/h	The duration of the peak flow is very short, a rate/day is not relevant	
Mean efflux velocity (at 100% load)	15.1m/s	Minimum efflux velocity (at 50% load)	7.55m/s
(ii) Other factors			
Temperature	130°C(max)	100°C(min)	100°C(avg)
For Combustion Sources: Volume terms expressed as : ☐ wet. ☑ dry. 11%O_2			

Refer also to section 9.4.2 of EIS.

Period or periods during which emissions are made, or are to be made, including daily or seasonal variations (start-up /shutdown to be included):

Periods of Emission (avg)	60min/hr 24hr/day days/yr: see note 1

Note 1: The plant will be operational for 7500 hours per year.

TABLE 9.3 MAIN EMISSIONS TO ATMOSPHERE – WTE A2

Emission Point Ref. Nº:	WTE A2
Source of Emission:	Moving grate line (phase 2)
Location :	Northerly flue of exhaust stack
Grid Ref. (12 digit, 6E,6N):	179 122E, 064 209N
Vent Details Diameter: Height above Ground(m):	 1.62m 55m
Date of commencement:	To be agreed

Characteristics of Emission :

(i) Volume to be emitted:			
Average rate/hour (at 100% load)	73,139m^3/h	Average/day (at 100% load)	1,755,336m^3/d
Maximum rate/hour (at 110% load)	80,453m^3/h	Maximum/day (at 110% load)	1,930,870 m3/d
Short term peak rate/hour (at 120% load)	87,767m^3/h	The duration of the peak flow is very short, a rate/day is not relevant	
Mean efflux velocity (at 100% load)	13.5m/s	Minimum efflux velocity (at 50% load)	6.75m/s
(ii) Other factors			
Temperature	130°C(max)	100°C(min)	100°C(avg)
For Combustion Sources: Volume terms expressed as :	☐ wet.	☑ dry.	11%O_2

Refer also to section 9.4.2 of EIS.

Period or periods during which emissions are made, or are to be made, including daily or seasonal variations (start-up /shutdown to be included):

Periods of Emission (avg)	60min/hr 24hr/day days/yr: see note 1

Note 1: The plant will be operational for 7500 hours per year.

TABLE 9.4: MAIN EMISSIONS TO ATMOSPHERE - Chemical characteristics of the emission

Emission Point Reference Number: WTE A1 (southerly flue, associated with Phase 1)

Parameter	Prior to treatment (note 1,2)				Brief description of treatment	As discharged (note 1,2)					
	mg/Nm^3		kg/h			mg/Nm^3		kg/h.		kg/year	
	Avg	Max	Avg	Max		Avg	Max (note 9)	Avg	Max (note 9)	Avg	Max (note 9)
Total Dust (note 3)	3000	5000	277.8	509.5	Cyclone/Electrofilter and bag house filters	1	10	0.0926	1.019	694.5	7642.5
Gaseous & vaporous organic substances expressed as total organic carbon (TOC) (note 3)	5	10	0.463	1.019	Activated carbon and lime injection	1	10	0.0926	1.019	694.5	7642.5
Hydrogen Chloride (HCl) (note 3)	2100	3000	194.46	305.7	Scrubbers and activated carbon and lime	1	10	0.0926	1.019	694.5	7642.5
Hydrogen Fluoride (HF) (note 3)	10	59	0.926	6.012	Scrubbers and activated carbon and lime	1	1	0.0926	0.1019	694.5	764.25
Sulphur Dioxide (SO_2) (note 3)	1000	2000	92.6	203.8	Scrubbers and activated carbon and lime	20	50	1.852	5.095	13890	38,212.5
Nitrogen Oxides (as NO_2) (note 3)	350	600	32.41	61.14	Ammonia/urea injection	170	200	15.74	20.38	118065	152,850
Total Cadmium and Thallium and their compounds, expressed as Cd and Tl (note 4)	0.5	2.5	0.0463	0.2548	Activated carbon and lime injection	0.025	0.05	0.00232	0.005095	17.363	38.21
Mercury and its compounds, expressed as Hg (note 4)	0.5	1	0.0463	0.1019	Activated carbon and lime injection	0.025	0.05	0.00232	0.005095	17.363	38.21

TABLE 9.4 cont'd: MAIN EMISSIONS TO ATMOSPHERE - Chemical characteristics of the emission

Emission Point Reference Number: WTE A1 (southerly flue, associated with Phase 1)

Parameter	Prior to treatment (note 1,2)				Brief description of treatment	As discharged (note 1,2)					
	mg/Nm^3		kg/hr			mg/Nm^3		kg/h.		kg/year	
	Avg	Max	Avg	Max		Avg	Max (note 9)	Avg	Max (note 9)	Avg	Max (note 9)
Total of Antimony, Arsenic, Lead, Chromium, Cobalt, Copper, Manganese, Nickel and Vanadium and their compounds, expressed as Sb, As, Pb, Cr, Co, Cu, Mn, Ni and V (note 4)	5	100	0.463	10.19	Activated carbon and lime injection	0.25	0.5	0.0232	0.05095	173.63	382.1
Dioxins and furans (note 5)	2ng/m^3	10ng/m^3	1.85x10^{-7}	1.019x10^{-6}	Activated carbon and lime injection in two stages or in single stage with lignite coke filter	0.01ng/m^3	0.1ng/m^3	9.26x10^{-10}	1.019x10^{-8}	6.945 x10^{-6}	7.64 x10^{-5}
Carbon Monoxide (note 6)	20	50	1.852	5.095	Oxygen addition to furnace	20	50	1.852	5.095	13 890	38,212.5
(note 7)		150		15.285			150		15.285		114,638
(note 8)		100		10.19			100		10.19		

1. Concentrations are based on Normal conditions of temperature and pressure, (i.e. 0°C101.3kPa). 11% O_2 dry gas
2. Mass emission is based on 7500 hours per year.
3. Daily average value
4. Average over the sample period of a minimum of 30 minutes and a maximum of 8 hours
5. Average values measured over a sample period of a minimum of 6 hours and a maximum of 8 hours.
6. As daily average value
7. As maximum of at least 95% of all measurements determined as 10-minute average value.
8. As maximum of all measurements determined as half hourly average values taken in any 24 hour period
9. Based on 110% of nominal load.

TABLE 9.5: MAIN EMISSIONS TO ATMOSPHERE - Chemical characteristics of the mission

Emission Point Reference Number: WTE A2 (northerly flue, associated with Phase 2)

Parameter	Prior to treatment (note 1,2)				Brief description of treatment	As discharged (note 1,2)					
	mg/Nm^3		kg/h			mg/Nm^3		kg/h.		kg/year	
	Avg	Max	Avg	Max		Avg	Max (note 9)	Avg	Max (note 9)	Avg	Max (note 9)
Total Dust (note 3)	3000	5000	219.3	402.5	Bag house filters	1	10	0.0731	0.805	548.3	6037.5
Gaseous & vaporous organic substances expressed as total organic carbon (TOC) (note 3)	5	10	0.3655	0.805	Activated carbon and lime injection	1	10	0.0731	0.805	548.3	6037.5
Hydrogen Chloride (HCl) (note 3)	930	2000	67.98	161	Scrubbers and activated carbon and lime	1	10	0.0731	0.805	548.3	6037.5
Hydrogen Fluoride (HF) (note 3)	10	59	0.731	4.747	Scrubbers and activated carbon and lime	1	1	0.0731	0.0805	548.3	603.75
Sulphur Dioxide (SO_2) (note 3)	730	2000	53.36	161	Scrubbers and activated carbon and lime	20	50	1.462	5.095	10965	30,187.5
Nitrogen Oxides (as NO_2) (note 3)	350	600	32.41	48.3	Ammonia/urea injection	170	200	12.43	16.1	93,225	120,750
Total Cadmium and Thallium and their compounds, expressed as Cd and Tl (note 4)	0.5	2.5	0.0366	0.201	Activated carbon and lime injection	0.025	0.05	0.00183	0.004025	13.7	30.19
Mercury and its compounds, expressed as Hg (note 4)	0.5	1	0.0366	0.0805	Activated carbon and lime injection	0.025	0.05	0.00183	0.004025	13.7	30.19

TABLE 9.5 cont'd: MAIN EMISSIONS TO ATMOSPHERE - Chemical characteristics of the emission

Emission Point Reference Number: WTE A2 (northerly flue, associated with Phase 2)

Parameter	Prior to treatment (note 1,2)				Brief description of treatment	As discharged (note 1,2)					
	mg/Nm^3		Kg/hr			mg/Nm^3		kg/h.		kg/year	
	Avg	Max	Avg	Max		Avg	Max (note 9)	Avg	Max (note 9)	Avg	Max (note 9)
Total of Antimony, Arsenic, Lead, Chromium, Cobalt, Copper, Manganese, Nickel and Vanadium and their compounds, expressed as Sb, As, Pb, Cr, Co, Cu, Mn, Ni and V (note 4)	5	30	0.366	2.413	Activated carbon and lime injection	0.25	0.5	0.0175	0.04023	137.07	301.86
Dioxins and furans (note 5)	2ng/m^3	10ng/m^3	1.462x10^{-7}	8.045x10^{-7}	Activated carbon and lime injection in two stages or in single stage with lignite coke filter	0.01ng/m^3	0.1ng/m^3	7.31x10^{-10}	8.045x10^{-9}	5.483 x10^{-6}	6.03 x10^{-5}
Carbon Monoxide (note 6)	20	50	1.462	4.026	Oxygen addition to furnace	20	50	1462	4.062	10, 980	30,695
(note 7)		150		12.068			150		12.068		90,585
(note 8)		100		8.052			100		8.052		

1. Concentrations are based on Normal conditions of temperature and pressure, (i.e. 0°C101.3kPa). 11% O_2 dry gas
2. Mass emission is based on 7500 hours per year.
3. Daily average value
4. Average over the sample period of a minimum of 30 minutes and a maximum of 8 hours
5. Average values measured over a sample period of a minimum of 6 hours and a maximum of 8 hours.
6. As daily average value
7. As maximum of at least 95% of all measurements determined as 10-minute average value.
8. As maximum of all measurements determined as half hourly average values taken in any 24 hour period
9. Based on 110% of nominal load.

TABLE 9.6 EMISSIONS TO ATMOSPHERE

Atmospheric emissions abatement / treatment control

Emission point reference number : WTE A1 and WTE A2

Control[1] parameter	Equipment[2]	Equipment maintenance	Equipment calibration	Equipment back-up
Dust	Cyclone/ electrofilter (WTE A1 only) Bag house filter	As per supplier's recommendations	As per supplier's recommendations	Cyclone/electrofilter spares Bag house filter in modules, spares
TOC	Furnace/ activated carbon and lime injection, bag house filter	As per supplier's recommendations	As per supplier's recommendations	Appropriate spares
HCL	Wet scrubbers	As per supplier's recommendations	As per supplier's recommendations	2 scrubbers, standby pumps
HF	Wet scrubbers	As per supplier's recommendations	As per supplier's recommendations	2 scrubbers, standby pumps
SO_2	Wet scrubbers	As per supplier's recommendations	As per supplier's recommendations	2 scrubbers, standby pumps
NO_x as NO_2	Furnace and Ammonia or Urea injection	As per supplier's recommendations	As per supplier's recommendations	Appropriate spares
Heavy metals	Activated carbon and lime injection and bag house filters	As per supplier's recommendations	As per supplier's recommendations	Bag house filter in modules, spares
PCDD/PCDF	Activated carbon and lime injection in two stages or single stage activated carbon and lime plus a lignite coke filter	As per supplier's recommendations	As per supplier's recommendations	2 stage PCDD/PCDF removal, Bag house filter in modules, spares,
CO	Furnace	As per supplier's recommendations	As per supplier's recommendations	Spares

[1] List the operating parameters of the treatment / abatement system which control its function.
[2] List the equipment necessary for the proper function of the abatement / treatment system.
[3] List the monitoring of the control parameter to be carried out.

TABLE 9.6 cont'd EMISSIONS TO ATMOSPHERE

Atmospheric emissions abatement / treatment control

Emission point reference number : WTE A1 and WTE A2

Control[1] parameter	Monitoring to be carried out[3]	Monitoring equipment	Monitoring equipment calibration
Dust	Continuous	SIGRIST photometer or similar	As per supplier's recommendations
TOC	Continuous	Flame ionisation detector	As per supplier's recommendations
HCL	Continuous	Individual monitor or multi-component analyser	As per supplier's recommendations
HF	Proposed quarterly for first year, twice per year in subsequent years	Multi-component analyser or sampling and analysis in accredited laboratory	As per supplier's recommendations
SO_2	Continuous	Individual monitor or multi-component analyser	As per supplier's recommendations
NO_x as NO_2	Continuous	Individual monitor or multi-component analyser	As per supplier's recommendations
Heavy metals	Quarterly for first year, twice per year in subsequent years	Sampling and analysis in accredited laboratory	As per supplier's recommendations
PCDD/PCDF	Continuous sampling with approximately 20 samples analysed per year; and twice yearly analysis of sample taken over 6 to 8 hour period	AMESA dioxin monitoring system or similar Sampling and analysis in accredited laboratory	As per supplier's recommendations
CO	Continuous	Individual monitor or multi-component analyser	As per supplier's recommendations

[1] List the operating parameters of the treatment / abatement system which control its function.
[2] List the equipment necessary for the proper function of the abatement / treatment system.
[3] List the monitoring of the control parameter to be carried out.

TABLE 9.7: EMISSIONS TO ATMOSPHERE - Minor atmospheric emissions from Waste to Energy Plant

Emission point Reference Numbers	Description	Emission details[1]				Abatement system employed
		material	mg/Nm$^{3(2)}$ (note 3)	kg/h (note 3)	kg/year (note 3)	
WTE MA3	Bulk waste tanks	Solvent vapour and nitrogen	<4	<0.02		either an activated carbon unit, a vapour condenser or a catalytic oxidiser abatement system *(in the event the post combustion* chamber is shut down)
WTE MA4	Laboratory fume hoods	Solvent vapour	<4	<0.02		No abatement required

1 The maximum emission should be stated for each material emitted, the concentration should be based on the maximum 30 minute mean.

2 . Concentrations should be based on Normal conditions of temperature and pressure, (i.e. 0°C101.3kPa). Wet/dry should be clearly stated. Include reference oxygen conditions for combustion sources.

3. The emissions are expected to be very minor and well below 20% of the BATNEEC threshold. It would be very difficult to quantify these emissions.

TABLE 9.8: EMISSIONS TO ATMOSPHERE - Potential atmospheric emissions Waste to Energy Plant

Emission point ref. no. (as per flow diagram)	Description	Malfunction which could cause an emission	Emission details (Potential max. emissions)[1]		
			Material	mg/Nm^3	kg/hour
WTE A1 or WTE A2 or from vents in bunker roof		Fire in bunker	NO_2, SO_2, HCl, HF, PM_{10}, heavy metals	Note 2	
			CO	500	
			VOCs	1000	
			PCDD/PCDF	12.1 ng/m^3	
WTE A1 or WTE A2	In an emergency shut down the lime/limestone addition to the scrubbers may stop HCL, HF, SO_2 removal not as efficient	Emergency shut down	NO_2, SO_2, CO, VOCs, HCl, HF, PCDD/PCDFs, heavy metals	Note 3	Note 3
WTE A1 or WTE A2	Accidental release of untreated flue gases	Malfunction of flue gas cleaning equipment	NO_2, SO_2, PM_{10}, CO, VOCs, HCl, HF, PCDD/PCDFs, heavy metals	Note 3	Note 3
WTE A1 or WTE A2	Accidental release of partially treated flue gases	Malfunction of flue gas cleaning equipment	NO_2, SO_2, PM_{10}, CO, VOCs, HCl, HF, PCDD/PCDFs, heavy metals	Note 3	Note 3
WTE P1	Emergency generator	Power cut	NO_2 and SO_2		

Note 1: Estimate the potential maximum emission for each malfunction identified.
Note 2: NO_2, SO_2, HCl and HF concentrations would be similar to the untreated flue gases. Refer to tables 9.4 and 9.5. The concentrations of heavy metals and PM_{10} in the emission from a fire in the bunker would be expected to be lower and higher, respectively, than in the untreated flue gases, detailed in tables 9.4 and 9.5, but it would be difficult to predict the values.
Note 3: Similar to untreated flue gases. Refer to tables 9.4 and 9.5

9.5 Waste to Energy Plant Abatement Systems

9.5.1 List of Abatement Systems

The following abatement systems will be used in the waste to energy plant:

- Cyclone/Electrofilter dust collector
- Ammonia/Urea injection for selective non catalytic reduction de-NO_x .
- Activated carbon and lime injection
- Bag house filters
- Wet Scrubbers
- Activated carbon and lime injection or lignite coke filter
- Plume abatement
- Post combustion chamber combustion of vent losses from bulk tanks.

There will be a separate flue gas cleaning line for each furnace line. The main components of the flue gas cleaning system on the two lines will be similar but the detail may different, and there will be a cyclone or electrofilter dust collector on the fluidised bed line which will not be required on the moving grate line.

9.5.2 Cyclone / Electrofilter

There will be a cyclone or electrofilter dust collector installed between the boiler and evaporating spray tower on the fluidised bed line. This will be a relatively course dust collector to collect any sand from the fluidised bed which becomes entrained in the flue gases. The decision on the type of course dust collector will be made at the detailed design stage. Refer to figure 9.3 for process flow diagrams of the cyclone and electrofilter.

9.5.2.1 Cyclone

Description

The cyclone will the remove dust or particles by centrifugal and inertial forces, induced by forcing the particulate-laden gas to change direction.

The cyclone will operate by creating a double vortex inside the cyclone body. The incoming gas will be forced into circular motion down the cyclone near the inner surface of the cyclone tube. At the bottom of the cyclone, the gas will turn and spiral up through the centre of the tube and out of the top of the cyclone. Particles in the gas stream will be forced towards the cyclone walls by the centrifugal force of the spinning gas but will be opposed by the fluid drag force of the gas travelling through and out of the cyclone.

For large particles, the centrifugal force will overcome the force of the upward flue gas flow so the particles will reach the cyclone walls. Gravity will cause these larger particles to travel down into a bottom hopper. Small particles will remain entrained in the flue gases which will pass out of the cyclone.

Process Control

No process control is needed for the cyclone. It is static equipment. Temperature and pressure limitations will be dependent on the materials of construction.

Emissions from the Cyclone

There will be no emissions from the cyclone during normal or abnormal operations.

Inputs and Outputs

Inputs will be the flue gases coming from the boiler. Output will be de-dusted flue gases and dust which will be collected in a hopper under the cyclone.

Abnormal Situations

If the pressure drop over the cyclone becomes too high (e.g. due to a very high flue gas flow), it is possible that the load of the furnace would have to be reduced in order to maintain the under pressure in the installation.

The cyclone could become plugged with dust. The blockage would prevent the ID fan maintaining the furnace at under pressure. The furnace pressure will be monitored with a pre-alarm and an alarm. If the under pressure is not restored following the pre-alarm the plant will be automatically shut down.

Physical abrasion from dust particles could cause damage to the wall of the cyclone causing to a leak, with air being sucked into the cyclone. This would lead to a drop in the flue gas temperature, which will be monitored. The damage to the cyclone walls would be noticed in the normal preventative maintenance inspections during a shut down.

There will be no emissions during abnormal operations.

9.5.2.2 Electrostatic Precipitator

Description

The flue gases, cooled down to approx. 230°C when leaving the boiler may be pre-cleaned in an electrostatic precipitator. The dust, which will not be removed in the electrostatic precipitator, will enter the spray dryer.

The electrofilter will be an electrostatic precipitator. In the electrostatic precipitator the dust laden flue gases will pass through an electrostatic field. Electrons from the discharge electrodes, which will be wires in a frame, with a high negative voltage, will collide with the dust particles giving them a negative charge. The negatively charged dust particles will be attracted by the positively charged collecting electrodes, which will comprise a number of plates. On their track to the collecting electrodes the charged dust particles will further collide with other dust particles to agglomerate and settle on the collecting electrodes.

The dust will be removed from the collecting electrodes by a rapping mechanism. This will comprise shafts, which will be arranged across the direction of the gas flow, at the end of each electrostatic field. The shafts will carry hammers for rapping each row of plates. Each electrostatic field will be rapped separately. The tapping cycles can be adjusted by the rapping cycle control to suit the gas and dust conditions.

The dust will fall into hoppers and will be transferred by means of enclosed conveyors from the hoppers to the boiler ash silo.

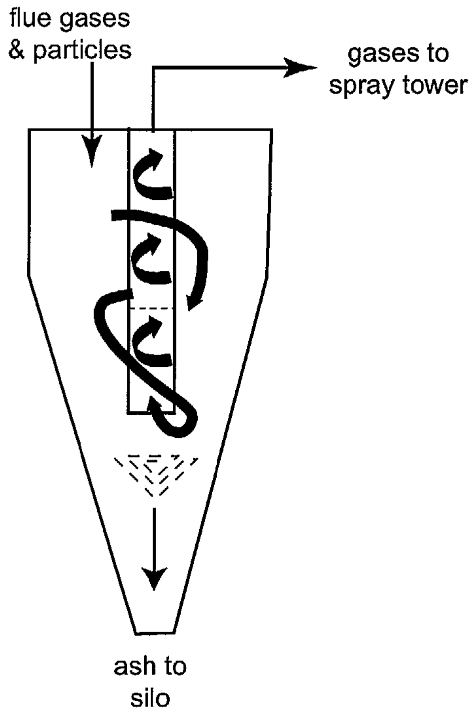
The electrofilter requires a high voltage power supply, which is not required for the cyclone.

Process Control

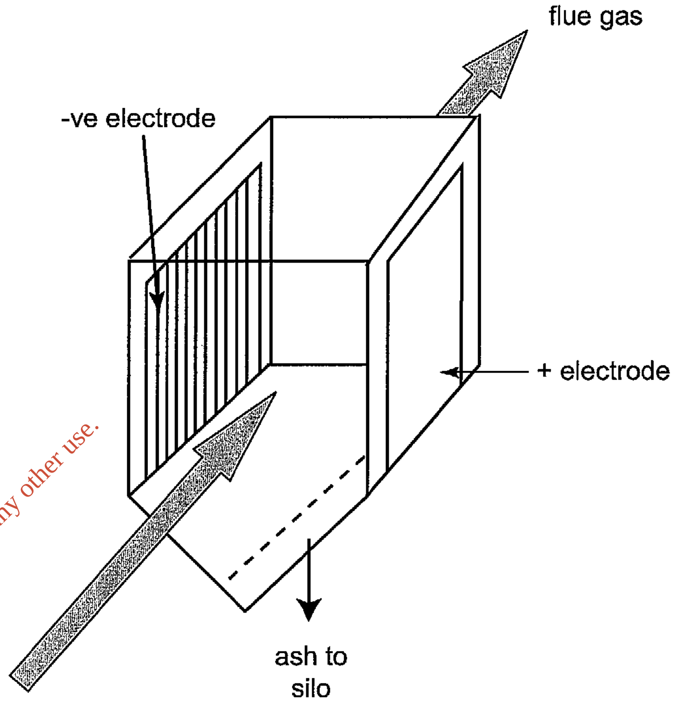
The voltage and current in the precipitator will be monitored and maintained within a preset range.

Emissions from the Electrofilter

There will be no emissions from the electrofilter during normal or abnormal operations.



Cyclone



Electrostatic
Precipitator

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Ordnance Map :

Figure Title : Process Flow Diagram - Cyclone and Electrostatic Precipitator

Figure No : 9.3

Inputs and Outputs

Inputs will be the flue gases coming from the boiler. Output will be dedusted flue gases and dust which will be collected in a hopper under the electrofilter.

Abnormal Operations

The accumulation of dust in the hopper could form a bridge to the electrode causing a short circuit, preventing the flow of current. There will be high level alarms in the hoppers to signal the built up of dust.

The collecting electrode could become fouled with an excessive accumulation of dust. This would reduce the efficiency of the electrostatic precipitator. Any fouling on the collecting electrode will be cleaned as part of the normal preventative maintenance during a shut down.

A wire in the negative electrode could rupture. This would cause a short circuit if it touched the positive electrode. If this happened it would be necessary to initiate a shut down.

There will be no emissions during abnormal operations.

9.5.2.3 Ammonia/Urea Injection for Selective Non Catalytic Reduction of Nitrogen Oxides

Description

All combustion processes lead to the formation of nitrogen oxides (NO_x). These substances are formed partly from combustion of the nitrogen fraction in the waste feed and partly from the oxidation of nitrogen in the combustion air. The optimised combustion conditions in the furnace will minimise the oxidation of nitrogen in the combustion air. However, to meet the strict NO_x emission values set by the EU, 'DeNO_x' technology will be used.

This technology uses the reaction of ammonia and nitrogen oxides at high temperature to convert the nitrogen oxides to nitrogen and water vapour. This reaction will be achieved by the injection of either an ammonia solution or urea into the first section of the boiler. The ammonia will react with the Nitrogen Oxides (NO_x) to form nitrogen and water, thus reducing the NO_x concentrations in the flue gases. This technology is known as selective non-catalytic de-NO_x.

The reactions that will take place are as follows:

$$6NO + 4NH_3 \rightarrow 5N_2 + 6H_2O$$

$$4NO + 4NH_3 + O_2 \rightarrow 4N_2 + 6H_2O$$

$$2NO_2 + 4NH_3 + O_2 \rightarrow 3N_2 + 6H_2O$$

$$NO + NO_2 + 2NH_3 \rightarrow 2N_2 + 3H_2O$$

The concentration of NO_x in the combustion gases will be continuously monitored and the rate of ammonia or urea injection will be set to ensure that the NO_x concentration will be well below the concentration limits in the Directive, while minimising the injection of ammonia/urea.

It has not been decided yet whether ammonia or urea will be adopted. The decision will be based on local availability, cost and process parameters.

Process Control for the Urea/Ammonia Injection

The ammonia solution or urea will be injected into the first section of the boiler at a controlled rate, which will be based on the NO_x concentration measured continuously in the stack.

Emissions from the Urea/Ammonia Injection

There will be no emissions from the Urea/Ammonia injection system.

Inputs and Outputs

The inputs to the system will be combustion gases and ammonia solution or urea. The output will be water vapour and nitrogen.

Abnormal situations

An abnormal situation would be a dosage system malfunction, resulting in the injection of too much ammonia or urea, which would register as a drop in the NO_x measured in the stack emissions, or too little ammonia or urea, which would result in a rapid rise in the NO_x measured in the stack emissions. Injection of too much ammonia or urea would give an ammonia-like odour to the boiler ash. Upper and lower alarm levels will be set, to alert the plant operator to take corrective action.

9.5.3 Evaporating Spray Tower

The combustion gases leaving the boilers will still be relatively hot at approximately 230 °C. They will be cooled in the evaporating spray towers to a temperature of 140°C to 180 °C. The evaporating spray tower is described in section 3.10.

9.5.4 Activated Carbon and Lime Injection

Activated carbon and lime will be injected into the flue gases leaving the spray tower. The activated carbon and lime may be injected separately or may be pre-mixed prior to injection. The activated carbon and lime will form a cake on the sleeves of the filter. Heavy metals, trace levels of organics and dioxins in the flue gases will be removed by means of adsorption onto the surface of the granules of the activated carbon and lime. The activated carbon and lime and any other particulates will then be removed from the flue gases by filtration in the bag house filter.

The activated carbon and lime will also remove Hydrochloric Acid (HCl) and Sulphur dioxide (SO_2) in the flue gases although this is not their primary function. HCl and SO_2 will also be removed in the wet scrubber system, described in detail in section 9.5.6.

Process Control

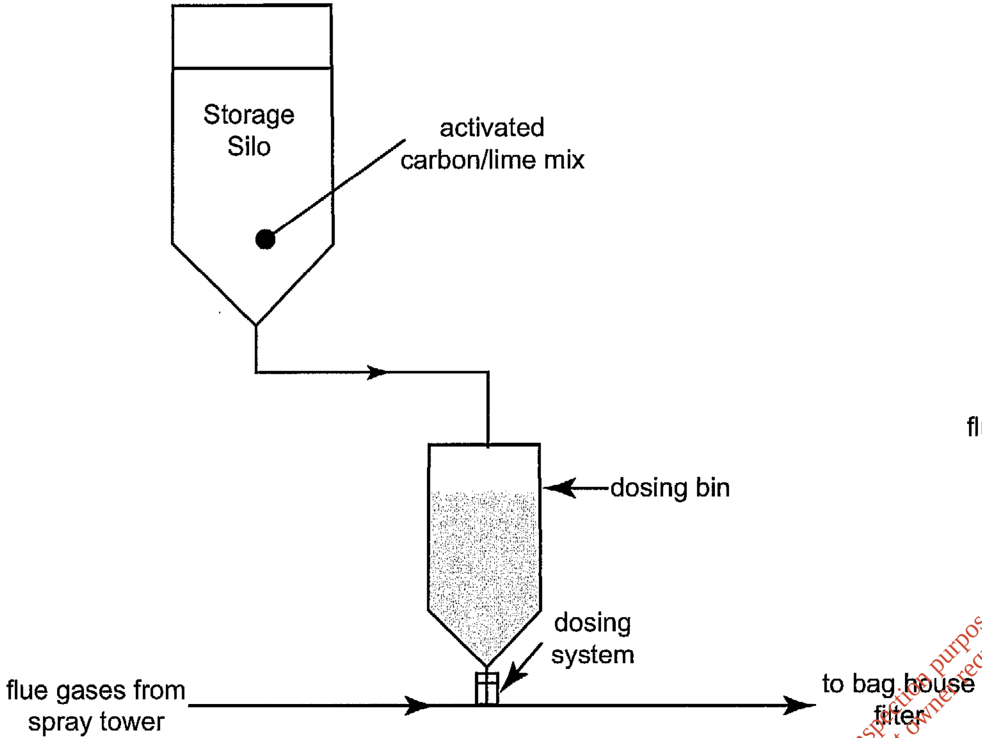
The activated carbon and lime will be loaded from the storage silo (or silos) to dosing bins on each line. The silo(s) and dosing bins will be fitted with low level alarms. From the dosing bins the activated carbon and lime will be injected at a fixed rate, which will be controlled by a volumetric dosing screw. This fixed rate will be based on the operating experience of the incineration plants in Belgium. The rate of dosing of activated carbon is expected to be circa 15kg/hour per line. This will ensure the maximum reduction in emissions.

The weight of the dosing bin, containing the activated carbon and/or lime, will be monitored continuously to ensure that dosing is continual. The rate at which the dosing bin is filled and the dust levels in the bag house filter will also be monitored. There will be flow detection instruments on the feed from the dosing bins to the flue gas line. If the re-fill rate or the flow drops below a preset level, an alarm will be triggered to alert the plant operator to take corrective action. As an additional control, the dust in the dosing line will be measured.

Refer to figure 9.4 for a process flow diagram of the activated carbon and lime injection.

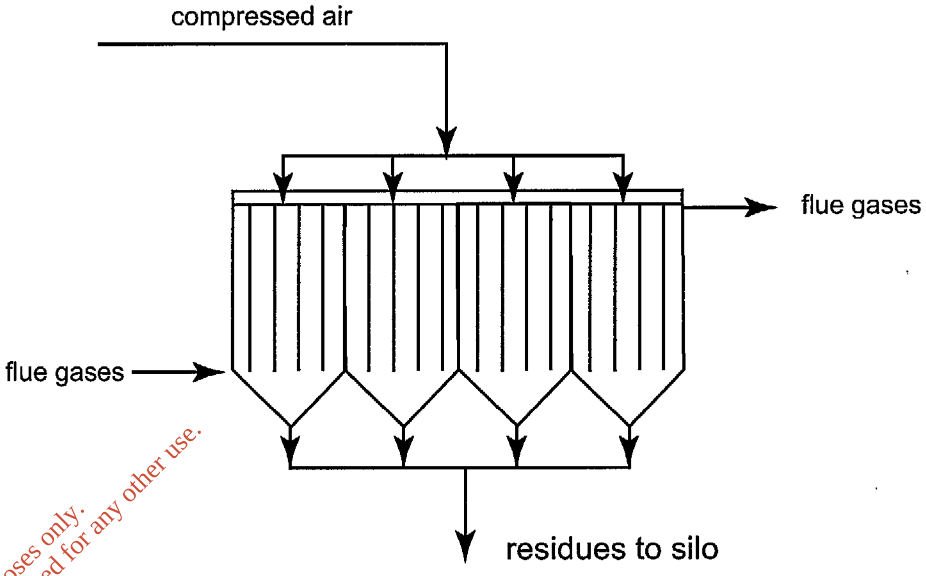
Emissions during Normal Operations

There will be no emissions to the atmosphere from the activated carbon and lime injection stage. The equipment is located within the main process building, the air from which is extracted and used for secondary combustion air in the furnace.



Activated Carbon/Lime Injection

NOTE: activated carbon and lime may be dosed separately



Bag House Filter

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Ordnance Map :

Figure Title : Process Flow Diagram - Activated Carbon/Lime Injection and Bag House Filter

Figure No : 9.4

Inputs and Outputs

The inputs and outputs from carbon and lime injection process will be the activated carbon and lime and flue gas cleaning residues.

Abnormal situations

An abnormal situation would be the failure of the injection of the activated carbon and lime. The second stage dioxin removal system would still be in operation and the emission limits for dioxins and heavy metals would not be exceeded.

9.5.5 Bag house filters

The particulates in the flue gases will consist primarily of fly ash carried over from the boiler and also of dry residues from the evaporation of process effluent in the evaporating spray towers. These will be removed in the bag house filter.

Each line will be equipped with a bag house filter, containing circa 1000 filter sleeves in separate compartments. Particulates in the flue gases following activated carbon and lime injection will be collected in the bag house filter. The separate compartments in the filter will allow the cake that accumulates on the filter sleeves to be removed, without compromising the efficiency of the filter. The dust cake, which will accumulate on the sleeves, will be blown off periodically using compressed air. The cake will then fall into hoppers at the bottom of the filter.

The bag house filter will ensure that dust emissions from the waste to energy plant will be less than the EU limit of 10 mg/m^3.

Refer to figure 9.4 for a process flow diagram of the bag house filter.

Emissions during normal operations

There will be no emissions to the atmosphere from the bag house filter stage.

Inputs and Outputs

The inputs to the bag house filter will be the activated carbon and lime mixture and flue gas cleaning residues. The output will be cleaner flue gases and flue gas cleaning residues. Refer to section 12.2.8 for the annual quantity of flue gas cleaning residues from each line.

Abnormal situations

At temperatures greater than 180°C, heat may be generated due to oxidation of the carbon granules. The heat generated could cause hot spots in the bag house filter. If the quantity of carbon is relatively low, the probability of a hot spot is reduced. The use of lime mixed with the activated carbon, rather than pure activated carbon, will minimise the possibility of hot spots in the bag house filter.

Operating with the flue gases at high temperatures for the long term could cause damage to the sleeves of the bag house filter. Operating with the flue gases at low temperature may cause wet sleeves in the bag house filter. The flue gases leaving the evaporating spray towers are monitored and maintained at circa 170°C to avoid either situation.

Sleeves will be replaced as required, usually every 3 to 6 years. The rupture of a sleeve will be detected by very small dust peaks in the stack emissions. It will be possible to replace a sleeve on-line by closing off one module.

Dust accumulation in the bag house filter, due to a blockage in the discharge system, could lead to a sudden overpressure failure. Differential pressure indication will be provided on the bag house filter to reduce the risk of dust accumulation on the sleeves. The hopper, in which the dust from the bag house filter will be collected, will be fitted with a high level alarm to indicate either a blockage in the hopper or that the silo for the dust is full and needs to be emptied.

9.5.6 Wet Scrubber System

Description

Following the bag house filters, the flue gases will be treated by wet scrubbing. Different configurations of the wet scrubbing system are under consideration, based on a combination of wet scrubbing and semi-wet scrubbing.

For the wet scrubbing, a scrubbing tower will be used. The scrubber tower will be approximately 15m high and 5m in diameter. Acids such as SO_2, HCl and HF (which will be formed if sulphur, fluorine and chlorine are present in the waste stream) and heavy metals will be removed from the flue gases by absorption in the scrubbing liquid. A good contact between the scrubbing liquid (with reagent) and the gases will be very important. This contact will be enhanced either by a filling material (packed tower) or by spraying nozzles. The absorption will be improved by adding an alkaline reagent that will chemically react with the acids to form salts. Different reagents can be used for wet scrubbing: lime or limestone, which have calcium (Ca^{2+}) as the active component, or caustic, which has (Na^+) as active component. With lime milk or limestone, gypsum ($CaSO_4$) can be recovered because of the reaction of $Ca2^+$ with SO_2.

The following reactions with Ca^{2+} or Na^+ based reagents will occur:

- absorption of HCl:

with lime milk	$Ca(OH)_2 + 2\ HCl \rightarrow CaCl_2 + 2\ H_2O$
with limestone	$CaCO_3 + 2\ HCl \rightarrow CaCl_2 + H_2O + CO_2$
with caustic	$NaOH + HCl \rightarrow NaCl + H_2O$

- absorption of HF:

with lime milk	$Ca(OH)_2 + 2\ HF \rightarrow CaF_2 + 2\ H_2O$
with limestone	$CaCO_3 + 2\ HF \rightarrow CaF_2 + H_2O + CO_2$
with caustic	$NaOH + HF \rightarrow NaF + H_2O$

-absorption of SO_2:

with lime milk	$2\ Ca(OH)_2 + 2\ SO_2 \rightarrow 2\ CaSO_4 + 2\ H_2O$
with limestone	$2\ CaCO_3 + 2\ SO_2 + O_2 + 2\ H_2O \rightarrow 2\ CaSO_4 + 2H_2O + 2CO_2$
with caustic	$4\ NaOH + 2\ SO_2 + O_2 \rightarrow 2\ Na_2SO_4 + H_2O$

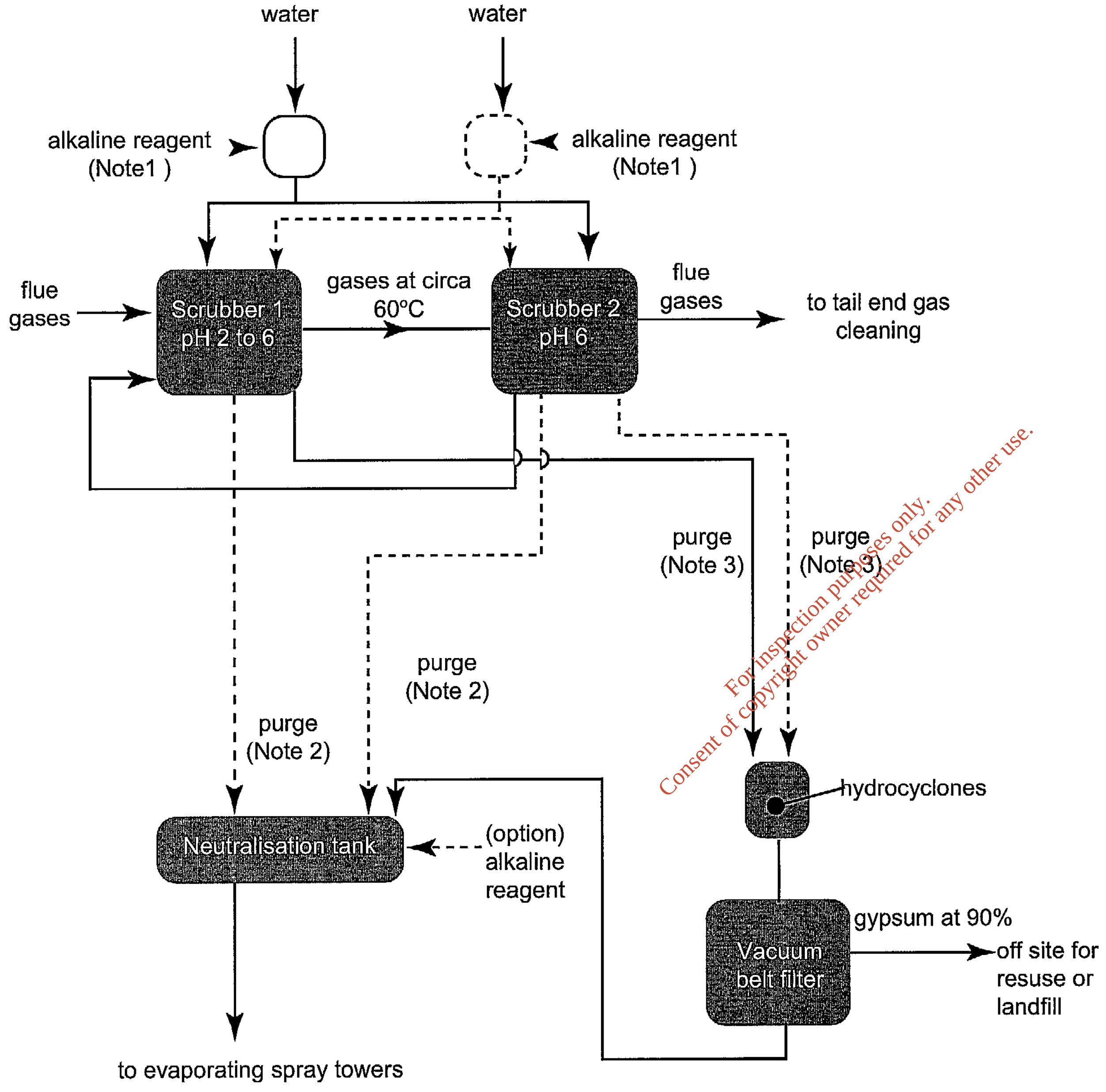
The choice of the reagent depends on the supplier, the price and the load of pollutants. Lime milk is more reactive than limestone. Caustic is even more reactive, but doesn't give the possibility of recovering gypsum.

Absorption of HCl and HF will be very easy and will occur first, and at any pH-value. Only after the absorption of these acids and, at a higher pH value, SO_2 will start to be absorbed.

Configuration 1

The first configuration is to have two wet scrubbers in sequence. Refer to figure 9.5 for a process flow diagram of the wet scrubber system in configuration 1.

The first scrubber will have two functions, to quench the flue gases and to absorb acid gases. The first scrubber will absorb mainly HCl, HF and heavy metals to produce calcium or



Note 1: Alkaline reagent can be lime, limestone or caustic.

Note 2: If caustic used as reagent.

Note 3: If lime or limemilk used as reagent.

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Figure Title : Process Flow Diagram - Scrubbing system Configuration 1

Figure No : 9.5

sodium salts (see reactions above). At the first stage of the first scrubber the flue gases will be quenched, cooling them to about 60°C by saturating them with water. In this process, some of the solution will evaporate off, leading to increased concentration of salts in the circulating liquid. These salts and heavy metals will accumulate in the circulating solution. In order to prevent crystallisation of these salts and fouling of the pipe work, a quantity of the circulating solution will be purged continuously and replaced with fresh make-up. The purge from the first scrubber will be pumped to the neutralisation tank from where it will then be recycled for use in the evaporating spray towers.

The second scrubber will mainly absorb SO_2. The purge of this scrubber will go either to the first scrubber or to the neutralisation tank where it will then be recycled for use in the evaporating spray towers. If a Ca^{2+}-based reagent is used, the purge from the second scrubber will contain gypsum ($CaSO_4.2H_2O$) in suspension. Before going to the neutralisation unit, the purge with gypsum suspension will then pass through a series of hydro cyclones and then to a vacuum belt filter, where gypsum will be filtered out as an approximately 90% solids content cake. The overflow from the hydro cyclones and the recovered water from the vacuum belt filter (after gypsum has been removed) will be pumped to the neutralisation tank.

Should maintenance be required on one of the scrubbers, the plant will be able to continue operating with the other scrubber, assuming that the first scrubber is still quenched. With just one scrubber in operation the plant will meet the EU Directive limits for emissions of the above gases and heavy metals.

Configuration 2

In the second configuration, the absorption of HCl and HF will be done in the semi-wet system. Lime milk will be injected in the evaporating spray towers. The evaporating spray towers will, in effect, become spray reactors in this system. Refer to figure 9.6 for a process flow diagram of the scrubber system in configuration 2.

After the bag house filter there will be only one scrubber where the SO_2 removal will take place. The purge from this scrubber will go to the neutralisation tank (passing through hydro cyclones and a vacuum belt filter to remove gypsum in case of a Ca^{2+}-based reagent) and will then be recycled to the evaporating spray towers.

Process Control

Following parameters are continuously monitored in the circulating liquid of the scrubbers and used to control the wet scrubbing:

- Density or conductivity
- pH

The rate of purge will be controlled by the measurement of the density or the conductivity of the solution in the scrubber (either of which are an indicator of the level of dissolved salts. Density also gives an indication for the amount of suspended gypsum in case of a Ca^{2+}-based reagent). The rate of addition of reagent will be controlled by the pH measurement.

Each scrubber will be equipped with a flow detector on the circulating liquid system and will be provided with back-up circulating capacity or a back-up pump which will automatically be brought on line should a low flow alarm be activated.

For the semi-wet system, lime milk will be added based on the HCl measurement in the flue gases after the bag house filter.

Emissions

The only emission from the scrubbers will be gypsum from the purge of the circulating solution in case of a Ca^{2+}-based reagent. Approximately 2,555 tonnes/annum of gypsum will be produced based on a nominal throughput of 200,000 tonnes/annum with the two phases in operation.

For configuration 2, there will be more residues to be evacuated from the bottom of the spray tower (spray reactor). This material will consist of calcium salts and unreacted lime and will be mixed with the flue gas cleaning residues.

Refer to tables 12.1, 12.2 and 12.3 for the estimates of residue quantities for the different configurations of scrubbing systems.

Inputs and Outputs

The inputs into the wet flue gas cleaning system will be flue gases and an alkaline reagent. The exact quantity of reagent used in any year will depend on the sulphur and chlorine content of the waste input. Refer to tables 3.14 and 3.15 in chapter 3 for the estimate of quantities of lime, limestone or caustic which will be used.

Outputs will include wet combustion gases, gypsum (discussed above) and the recovered water from the neutralisation tank that will be recycled back into the process for use in the evaporating spray towers.

The output for the semi-wet system will be calcium salts and un-reacted lime.

Abnormal Operations

In the event of loss of the scrubbing liquid to either scrubber, melting of the lining material in the scrubber would occur. Both low flow and no flow alarms will be provided on the scrubbing liquid supply and a back-up water injection system from the fire ring main will be interlocked to the loss of scrubbing liquid. In the event of loss of either scrubber in Configuration 1, the other scrubber could continue to operate to remove HCl, HF and SO_2 assuming that the first scrubber is still quenched. If the required emission levels cannot be reached, an automatic shut down will be initiated. In the event of loss of the single scrubber in Configuration 2, an emergency shut down will be initiated, if the emission levels of HCL, HF or SO_2 in the stack rise above a preset level, which will be below the licensed limit.

There will also be a dedicated emergency water supply to the scrubbing system. This may be fed from a tank at high level under the roof, which would supply the scrubbers by gravity, or a dedicated diesel powered pump. In the event of an interruption to the normal water supply due to an emergency shut down initiated by a power failure, there may be a brief interval before the diesel pump set of the fire main system cuts in. The emergency water supply will ensure that there will be a continuous water supply to the scrubbers in the interval.

9.5.7 Activated Carbon and Lime Injection or Lignite Coke Filter

Description

The wet combustion gases from the wet flue gas cleaning will pass through the final tail end flue gas cleaning system prior to discharge. The tail end flue gas cleaning system will consist either of a second stage of activated carbon/lime mixture injection and a second bag house filter, or a lignite coke bed. The activated carbon/lime mixture injection and bag house filter system would be similar to that described in sections 9.5.4 and 9.5.5. The carbon bed would consist of a fixed bed of activated lignite cokes. The flue gases will pass upwards through the bed of cokes (approximately 2m in depth) that will absorb remaining trace dioxins, heavy metals and hydrocarbons. The flue gas temperature leaving the tail end flue gas cleaning system will be approximately 60 °C.

Either the bag house filter system or carbon bed system will be based on a modular design, containing separate modules, allowing one modules to be shut off at any time. The flue gases must still pass through the remaining modules and therefore will be treated.

Note 1: Alkaline reagent can be lime, limestone or caustic.

Note 2: If caustic used as reagent.

Note 3: If lime or limestone used as reagent.

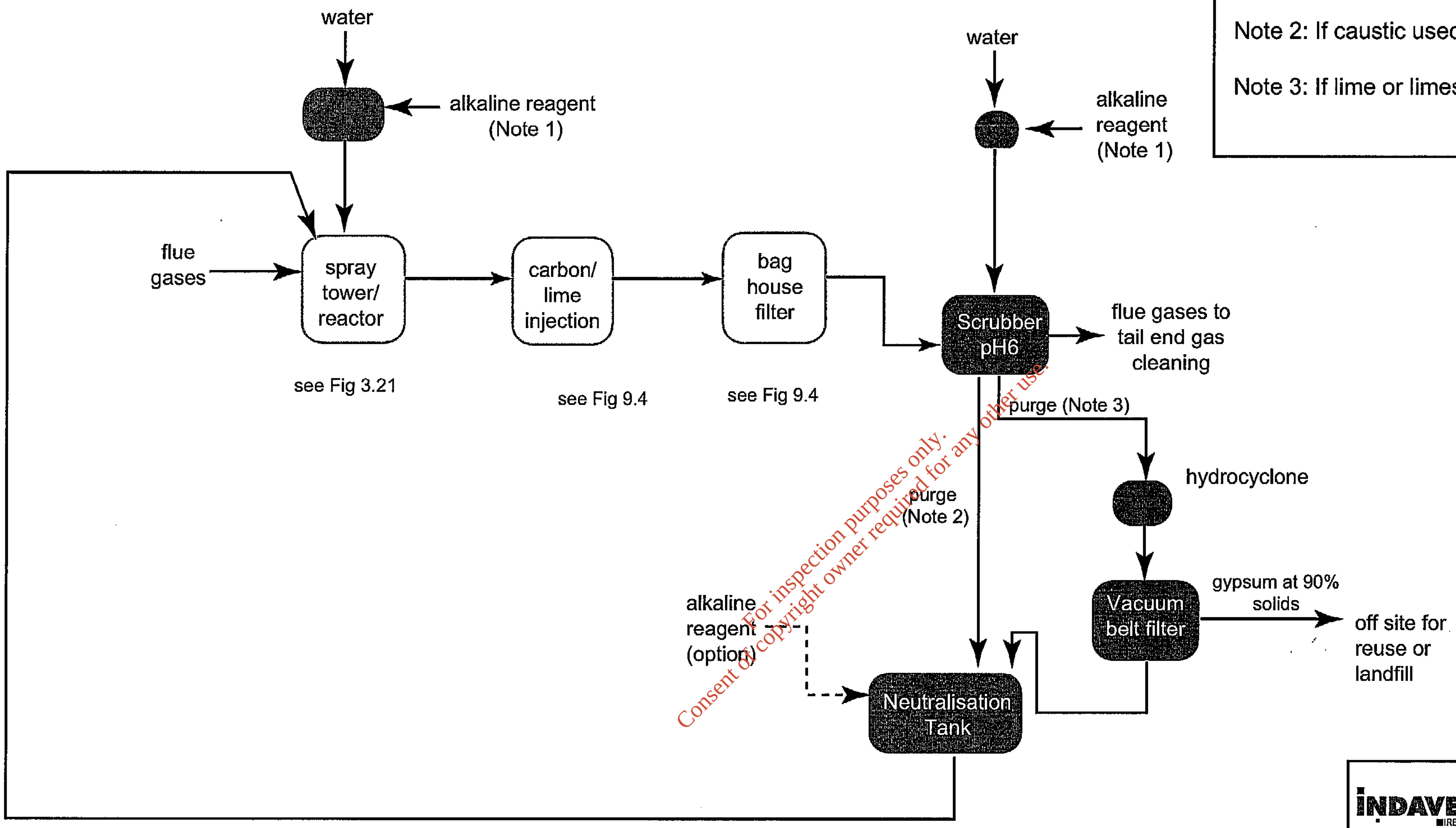

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Figure Title : Process Flow Diagram - Scrubbing System Configuration 2

Figure No : 9.6

Refer to figure 9.7 for a process flow diagram of the two options for the tail end flue gas cleaning system.

Carbon Bed

Approximately once a week a small fixed amount of cokes will be extracted from the bottom of the filter. The removal will be effected by adding water into the coke bed and opening a valve at the bottom through which the cokes can be extracted. The lignite cokes and water removed will be recovered for incineration in the furnace. During maintenance, a depth of 0.5m of lignite cokes will be added to the top of the carbon bed to replace any carbon removed during weekly extractions.

An induced draught (ID) fan will draw the combustion gases through the flue gas cleaning plant and maintain the plant in under pressure. This will ensure that no combustion gases escape from the process without going through the flue gas cleaning plant.

In the case of the carbon bed, the fan will be located between the wet scrubbers and the tail end flue gas cleaning system, as the carbon bed operates more effectively in overpressure. In the case of the bag house filter, the fan will be located downstream of the tail end flue gas cleaning system so that the bag house filter will operate at under pressure.

Refer to figure 9.7 for process flow diagrams for both options for this unit operation.

Process Control

Process control of the activated carbon/lime mixture injection and bag house filter system would be similar to that described in sections 9.5.4 and 9.5.5.

The removal of a small amount cokes from the bottom of the filter will ensure that the cokes, which will get the most exposure to the flue gases, will be removed. The rate of extraction of the cokes will be fixed at a set amount. This amount will be determined during the initial operating stages of the plant, by gradually decreasing the amount of cokes extracted. The point where a decrease in the rate of extraction leads to an increase in emission concentrations will be determined and the rate of extraction will be set at about 150% of this rate. This will ensure that the bed operates to its maximum effectiveness.

Emissions

There will be no emissions from either the activated carbon/lime mixture injection and bag house filter system or carbon bed system.

Inputs and Outputs

Inputs will include combustion gases and the activated carbon/lime mixture or lignite cokes, depending on the system employed. Based on the experience of similar plants it is expected that approximately 185 tonnes/annum of activated carbon/lime mixture or 185 tonnes/annum of lignite cokes will be used, based on a throughput of 200,000 tonnes/annum of waste. Refer to tables 3.14 and 3.15 in chapter 3 for the estimated quantities of utility materials. Outputs will be cleaner combustion gases, and spent cokes or solid residues as appropriate.

Abnormal Situations

The activated carbon/lime mixture injection and bag house filter system would have similar potential problems to those described in sections 9.5.4 and 9.5.5.

Blockages could occur in sections of the carbon bed if the lignite cokes are not changed at the required frequency. The flue gases must pass through the entire carbon bed and therefore dioxins will still be removed. As the carbon bed will be at over pressure, a leak in the container of the bed would result in a leak into the main process building. The carbon bed will be a polishing step and such a leak would be of treated flue gas. A leak would be detected by routine visual inspection.

In the event of ID fan failure, overpressure would be generated in the waste to energy plant and an emergency shutdown sequence, described in detail in section 15.2.7, would be automatically initiated. An emergency motor will be provided on the ID fan to keep it running in the event of failure of the main motor. The fan will be a critical item of plant and therefore will be inspected regularly. Vibration detection and thermocouples will also be provided on the ID fan.

9.5.8 Plume Suppression

Description

The wet scrubbers will cool the flue gases and saturate them with water. The lower temperature and high water content of the flue gases would lead to the formation of a visible plume from the stack in some weather conditions, if discharged directly. In order to reduce the formation of a visible plume, the wet flue gases at 60°C will pass through a re-heater prior to discharge.

This re-heater will use steam from the turbine to reheat the flue gases after the scrubbers. The flue gases will heated from about 60°C to 100°C.

Refer to figure 9.7 for a process flow diagram for the re-heater.

The type of second stage dioxin treatment system will determine the location of the re-heater in the flue gas cleaning lines. In the case of the carbon bed, the re-heater will be located between the carbon bed and the stack. In the case of the bag house filter, the re-heater will be located between the wet flue gas cleaning system and the bag house filter, to ensure that the bag house filter will operate in dry conditions.

Process Control

The operation of the reheater will be controlled by temperature measurement of the flue gases before and after the reheater.

Emissions

The only emission from the plume suppression will be water vapour.

Inputs and Outputs

The input to the re-heater will be steam from the turbine and flue gases at approximately 60°C. The output will be steam/condensate and flue gases at 100°C.

Abnormal Situations

An abnormal situation would be a leak in the heat exchanger. This would result in an increase in the water vapour in the flue gases being emitted from the stack.

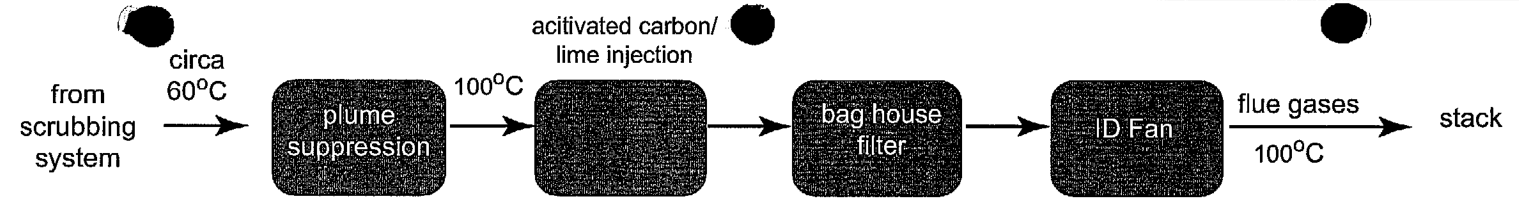
9.5.9 Abatement of Vent Losses from Bulk Waste Tanks

General

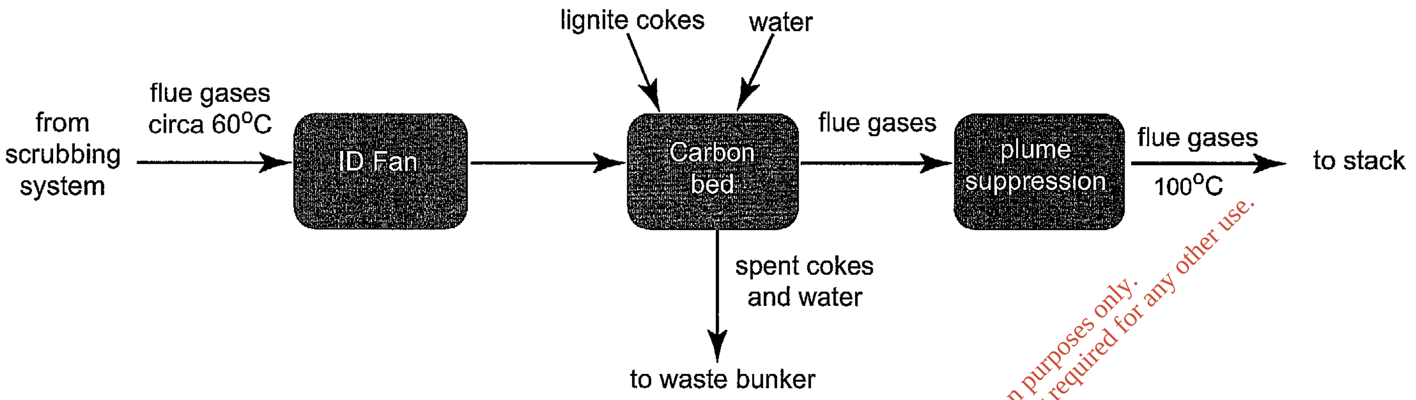
The vents from the bulk waste tanks in the waste to energy plant will be collected in a common header and ducted to the post combustion chamber. In the event that the post combustion chamber is out of service, the vents will be ducted to another treatment system. This will be an activated carbon unit, a vapour condenser or a catalytic oxidiser.

One of these systems will also be used to treat the solvent vapour arising in the operations of the waste transfer station. The breathing losses from emptying the road tankers will be ducted to the tank farm via the sieve.

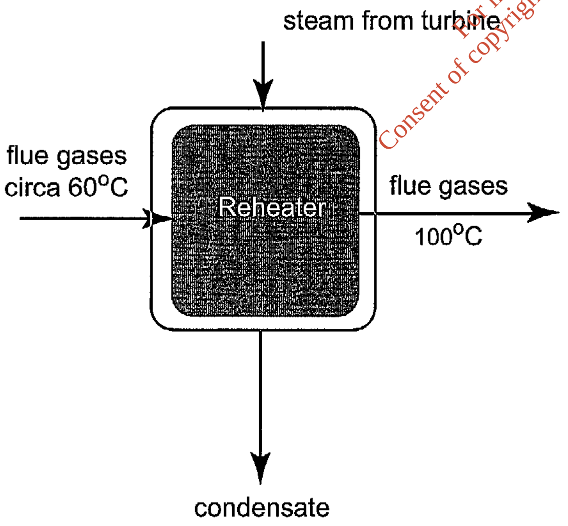
Refer to figure 9.8 for process flow diagrams of the activated carbon unit, the vapour condenser and the catalytic oxidiser.



Tail End Flue Gas Cleaning Option 1



Tail End Flue Gas Cleaning Option 2



Plume Suppression

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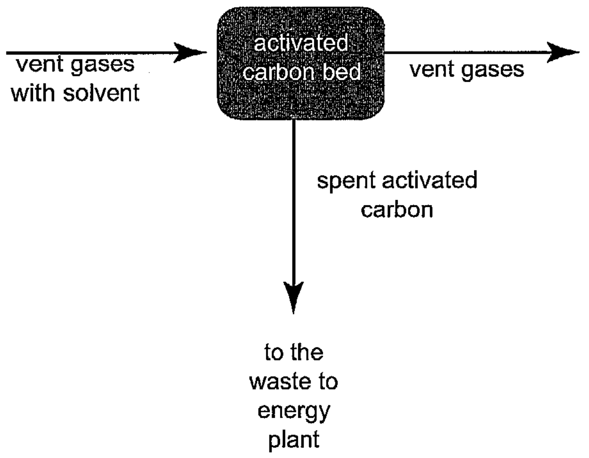
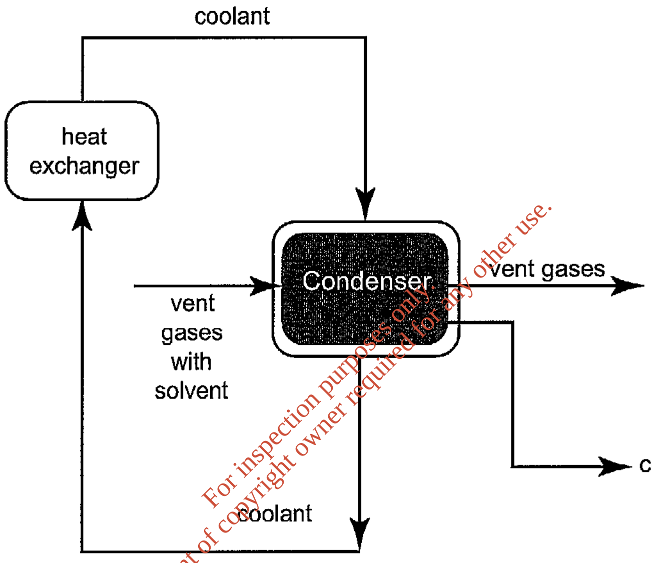
Ordnance Map :

Figure Title : Process Flow Diagram - Tail End Flue Gas Cleaning Options and Plume Suppression

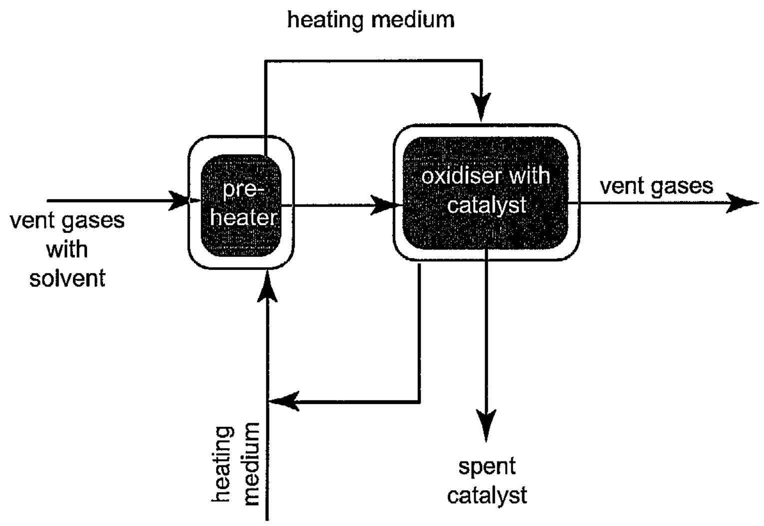
Figure No : 9.7



Activated Carbon Unit



Vapour Condenser



Catalytic Oxidiser

INDAVER IRELAND Ringaskiddy waste management facility

Ringaskiddy Waste Management Facility
Licence Application

ARUP

Files Located : J:/jobs/992/graphics/EIS figures

Ordnance Map :

Figure Title : Process Flow Diagram - Abatement Systems for BulkTank Vents

Figure No : 9.8

Activated Carbon Unit

A unit usually consists of a cylindrical polyethylene or steel container. The size of the container is dependent on the pollutant type, concentration and the influent flow rate. The containers are filled with granular activated carbon. The air stream to be treated is piped to an inlet at the base of the container. As the air stream passes upwards, the activated carbon granules adsorb the pollutants, with the treated air exiting through an outlet at the top of the container. More than one unit can be connected in series or in parallel if required.

Vapour Condenser

Vapour condensation is a simple vapour-liquid equilibrium process. The control parameter is the temperature needed to condense the organic vapours. In a condenser, the gas to be cleaned will be cooled, either directly or indirectly (which is more common) by a coolant below the boiling point of the volatile organic compounds.

The most common type of condenser used is the surface condenser. In this condenser, the coolant does not contact the gas stream. The condensed vapour forms a film on the cooled surface and drains away to a collection tank for storage, reuse, or disposal.

Condensation systems are suitable for low gas flow applications, such as working and breathing losses from tanks and containers.

Catalytic Oxidiser

The catalytic afterburner will use an oxidation process to convert organic compounds to CO_2 and H_2O.

A catalyst will promote the oxidation reaction on the surface of the catalyst (i.e. solid-gas interface) at lower temperatures by providing alternative reaction pathways that have faster rates than the corresponding gas-phase reactions. The catalytic oxidiser will operate typically between 350 and 500 °C.

To save fuel, a heat exchanger may be used to recover the heat generated during oxidisation by preheating the inlet gas.

Catalytic oxidisation is sensitive to pollutant characteristics and process conditions. Design and operating considerations are critical because the catalyst may be adversely affected by high temperatures, high concentrations of organics, fouling from particulate matter or polymers, and deactivation by halogens or certain metals.

The organic-vapour contaminated gas will first be indirectly preheated by the exhaust gas. Supplemental fuel will be used to further preheat the gas, usually in an open flame burner, to the reaction temperature. The gas will then pass over the catalyst, where the organic vapour will be oxidised. The operating temperature required to achieve a particular destruction efficiency will depend on the concentration and composition of the vapour in the emission stream and the type of catalyst used.

Commercial catalysts usually consist of noble metals or metal oxides. The type of catalyst used will depend on the type of organic contaminants to be oxidised. For example, some noble metal catalysts may be poisoned by chlorinated organic vapours, even at the very low concentrations which would be present in the proposed application. In such cases metal oxides, which are more resistant to halogenated compounds, must be used.

Process Control

If the PCC is shut down the vent gases will be diverted to the alternative abatement system.

The temperature of the coolants will be the control parameter for the vapour condenser. The control parameter for the catalytic oxidiser will be temperature. The control parameter for the activated carbon unit will be sampling to determine the degree of saturation of the carbon. This will be undertaken in accordance with standard operating procedures.

Emissions during Normal and Abnormal Operations.

There will be no emissions to the environment if the vapours are ducted to the PCC. If the one of the other systems is used, during normal operations the emission will be treated vapour. An abnormal operation would be a malfunction of the equipment, which could result in an emission of untreated or partially treated solvent vapour.

Inputs and Outputs

The bulk tanks will be under a nitrogen blanket. The input and the output will be solvent vapour and nitrogen. The catalytic oxidiser will produce spent catalyst which will be sent off site for regeneration. The condenser will produce condensate which will be collected and treated in the PCC. The activated carbon unit will produce spent activated carbon which will be treatment in the fluidised bed furnace.

Abnormal Situations

If the tanks are ducted to the PCC, an abnormal situation would be a flame back from the PCC. This would be prevented by the flame arrestors installed in the duct to the PCC.

An abnormal situation for the vapour condenser would be the carry over of water vapour from the head space of the tanks to the ducting of the vapour condenser. The water vapour would freeze and the ice build up could eventually cause a blockage. A flow indicator installed on the vent line would detect the formation of a blockage. The failure of the vapour condenser would lead to an emission. Regular maintenance and periodic monitoring would be undertaken to reduce the risk of a failure.

The poisoning of the catalyst would be an abnormal situation in the catalytic oxidiser which could lead to an emission. Monitoring of the vent line to atmosphere would detect this situation. Another abnormal situation would be too high a concentration of VOCs in the vent from the tank-farm. This could happen if the back-venting to the tanker from a tank failed during a loading/unloading operation. Too high a concentration of VOCs could lead to overheating in the catalyst bed and melting the steel casing of the bed. This would result in an emission. Regular maintenance of the system and a bypass of the bed, based on temperature control, would reduce the risk of this situation occurring.

9.6 Location of Emissions Monitoring Equipment

The stack emissions monitoring equipment will have a series of probes in the stack. The equipment will be housed in a dedicated room located beside the stack, at a level of 22.77 mOD. This room will be readily accessible by stairs from the main part of the waste to energy building.

9.7 Fugitive Emissions

9.7.1 General

There are not expected to be any significant fugitive emissions to air from the waste to energy plant and waste transfer station.

The measures which will be in place to prevent fugitive emissions include:

- Making and breaking the connections for the loading and unloading of liquid wastes and for the removal of residues from waste tanks will give rise to minor fugitive emissions. These will be the main sources of fugitive emissions from the site.

- Regular inspections of pipe work to ensure that any leaks are identified and repaired.
- Breathing losses from bulk storage tanks will be ducted to the PCC, and to an alternative abatement system unit if the PCC is down. An over pressure on the breather valve would result in a vent to atmosphere.
- No materials which could give rise to dust will be stored in the open air.
- Waste vehicles will be covered.
- Unloading, handling and storage of solid waste will be undertaken in the enclosed reception hall which will be under negative pressure.
- Residues handling, storage and loading operations will be enclosed. Bottom ash and gypsum will be taken off site in covered trucks. Other residues will be in closed containers. There will be no potential for fugitive emissions from solidified residues.

Refer also to chapter 7, Control of Potential Environmental Nuisances.

9.8 Odour Nuisance

The measures in place to control odour nuisance are described in section 7.6.

9.9 Emissions outside the BATNEEC Guidelines

The appropriate emissions limits for the waste to energy plant are set by the EU Directive on the Incineration of Waste, Council Directive 2000/76/EC. There will be no emissions from the facility at levels which will be outside the limits set in the Directive.

9.10 Assessment of the impact of the emissions to the atmosphere

9.10.1 General

Chapter 9 of the EIS provides a full assessment of the impact of the emissions, from the facility, on the atmosphere. A baseline study of the air quality in the Ringaskiddy area was carried out and the dispersion of emissions from the facility were modelled. The baseline survey and modelling study are summarised below. Refer to chapter 9 of the EIS for the fill details of each.

9.10.2 Baseline Air Quality Review

An extensive baseline survey of air quality was carried out in the region of the site between March and June 2001. The survey focussed on the pollutants likely to be emitted from the facility, and which have been regulated in Council Directive 2000/76/EC, and other potential significant pollutants.

NO_2 concentrations measured over the twelve-week monitoring period were significantly less than the EU limit value with little concentration gradient across the region. PM_{10} concentrations measured over the period averaged 21 $\mu g/m^3$, which is significantly lower than the annual limit value of 40 $\mu g/m^3$. Similarly, levels of SO_2, benzene and HCl were all significantly below the respective limit values.

There are not any internationally accepted ambient air quality concentration or deposition standards, with which to compare the background levels of PCDD/PCDFs. However, levels of dioxins and furans can be compared to existing levels measured sporadically in Ireland and continuously in the UK as part of the TOMPS network. Existing levels in Ringaskiddy are typical of the range of values encountered in rural locations in the UK and Continental Europe and significantly lower than urban locations in the UK and Europe.

Average concentrations of cobalt, chromium, copper, mercury, manganese, lead, antimony, and thallium measured were significantly below their respective annual limit values. Levels of cadmium and arsenic were generally below the detection limit for each of the six weeks in the monitoring period. The monitoring methodology's detection limits could not achieve the stringent limits of the proposed ambient standard for As or Cd. However, no significant local sources of these compounds could be identified and thus, it may be expected that background levels of these compounds are likely to be minor.

Background levels of nickel were detected at above the proposed ambient air quality standard during the monitoring period. Although a source of heavy metals may have been present during the monitoring period, future projections of emissions in the region did not identify any significant local sources of Ni in a detailed cumulative assessment of nearby sources. Thus, it may be expected that background levels of this compound are likely to be minor during operations of Indaver Ireland.

Existing air quality in Ringaskiddy can be compared to levels measured elsewhere in the region. Cork City Centre generally experiences significantly higher levels of NO_2 and PM_{10} whilst recent results from the EPA's mobile monitoring unit indicate that Blackpool, Cork, which is a suburban area, also has significantly higher levels of PM_{10} and NO_2. Thus, the current region is characterised by good air quality and is significantly better than current air quality in suburban locations of Cork.

9.10.3 Emission dispersion modelling

Air emission dispersion modelling was carried out using the United States Environmental Protection Agency's (USEPA) regulatory model ISCST3. The aim of the modelling study was to assess the impact of both typical and maximum emissions from Indaver Ireland in the ambient environment. The study demonstrates that all substances which will be emitted from Indaver Ireland will be at levels that are well below even the most stringent ambient air quality standards and guidelines. The dispersion model study consisted of the following components:

- review of design emission levels and other relevant information needed for the modelling study
- identification of the significant substances which are released from the site
- review of background ambient air quality in the vicinity of the plant
- air dispersion modelling of significant substance concentrations released from the site
- deposition modelling of dioxin and heavy metals released from the site
- identification of predicted ground level concentrations of released substances beyond the site boundary and at sensitive receptors in the immediate environment
- a full cumulative assessment of significant releases from the site taking into account the releases from all other significant industry in the area based on the USEPA's Prevention of Significant Deterioration (PSD) approach
- evaluation of the significance of these predicted concentrations, including consideration of whether these ground level concentrations are likely to exceed the most stringent ambient air quality standards and guidelines.

Modelling and a subsequent impact assessment was undertaken for the following substances released from the site:

- Nitrogen dioxide (NO_2)
- Sulphur Dioxide (SO_2)

- Total Dust (as PM_{10})
- Carbon Monoxide (CO)
- Gaseous and vaporous organic substances expressed as total organic carbon (TOC)
- Hydrogen Chloride (HCl)
- Hydrogen Fluoride (HF)
- PCDD/PCDFs (Dioxins)
- Mercury (Hg)
- Cadmium (Cd) and Thallium (Tl)
- Sum of Antimony (Sb), Arsenic (As), Lead (Pb), Chromium (Cr), Cobalt (Co), Copper (Cu), Manganese (Mn), Nickel (Ni) and Vanadium (V).

Assessment Approach

Emissions from the site were assessed under firstly typical operations and secondly under maximum operating conditions. Maximum operations are based on those outlined in EU Directive 2000/76/EC. Predicted ambient air concentrations have also been identified at the most sensitive residential receptors and in Ringaskiddy and Cobh and the surrounding geographical area as far away as Carrigaline, Monkstown and Crosshaven.

Modelling Under Typical and Maximum Operations

In order to assess the possible impact from Indaver Ireland under typical and maximum operations, a conservative approach was adopted, that is designed to over-predict ground level concentrations. This cautious approach will ensure that an over-estimation of impacts will occur and that the resultant emission standards adopted are protective of ambient air quality. The approach incorporated several conservative assumptions regarding operation conditions at Indaver Ireland. This approach incorporated the following features:

- For the maximum operating scenario, it has been assumed that the two emission points are continuously operating at their maximum operating volume flow. This will over-estimate the actual mass emissions from the site.
- For both scenarios, it has been assumed that both flues are operating simultaneously for 24-hrs/day over the course of the full year.
- Typical emissions are the expected annual average daily emissions from the plant when operating at 100% of its design capacity.

Worst-case meteorological conditions have been used in all assessments. The worst-case year leads to annual average concentrations, which are 30% higher than the five-year average. The year of meteorological data for the years between 1993 and 1997 that gave rise to the highest predicted ground level concentrations of nitrogen dioxide has been reported in this study (Year 1995).

A comparison with a more advanced modelling formulation (AERMOD) has indicated that the current model (ISCST3) is conservative and particularly so for long-term averaging periods.

As a result of these conservative assumptions, there will be an over-estimation of the emissions from the site and the impact of Indaver Ireland in the surrounding environment.

Modelled Locations

In relation to the spatial assessment of emissions from the site, modelling was carried out to cover locations at the boundary of the site and beyond, regardless of whether any sensitive receptors are located in the area. Ambient air quality legislation designed to protect human health is generally based on assessing ambient air quality at locations where the exposure of the population is significant relevant to the averaging time of the pollutant. However, in the current assessment, ambient legislation has been applied to all locations regardless of whether any sensitive receptors (such as residential locations) are present for significant periods of time. Thus, again, this represents a worst-case approach and an examination of the corresponding concentrations at the nearest sensitive receptors relative to the actual quoted maximum concentration indicates that these nearest sensitive receptors generally experience ambient concentrations significantly lower than that reported for the maximum value.

Summary of the Conclusions of Modelling Study

Modelling results indicated that the ambient ground level concentrations will be below the relevant air quality standards or guidelines for all compounds under both typical and maximum operations of the site. The modelling results indicated that this maximum occurs at or near the site's southern boundary. Maximum operations are based on the emission concentrations outlined in EU Directive 2000/76/EC.

Concentrations fall off rapidly away from this maximum and the short-term limit values at the nearest residential receptor will be less than 12% of the worst-case concentration of the pollutants modelled. The annual average concentration has an even more dramatic decrease in maximum concentration away from the site with concentrations from emissions at Indaver Ireland accounting for less than 2% of the limit value (not including background concentrations) at worst case sensitive receptors near the site. Thus, the results indicate that the impact from Indaver Ireland is minor and limited to the immediate environs of the site.

In the surrounding main population centres, Ringaskiddy, Cobh, Monkstown, Carrigaline and Crosshaven, levels are significantly lower than background sources with the concentrations from emissions at Indaver Ireland accounting for less than 2% of the annual limit values for all pollutants.

The emissions will not have a deleterious effect on flora and fauna or damage property or impair or interfere with amenities or with the environment.

9.11 Dioxin and furan uptake model study

There are not any ambient air quality concentration or deposition standards for dioxins and furans, with which the ground level concentration resulting from the emissions from the facility could be compared. Notwithstanding the fact that emissions of these substances will be very significantly below the EU directive limits, to determine the impact on human health from the emissions from the facility, AWN Consulting undertook a study of the uptake of these substances.

The soil sampling, described in section 6.5, the ambient air monitoring data and the dispersion model data was used to establish a baseline for PCDD/F intake for a theoretical Maximum At Risk Individual (MARI) in the Ringaskiddy area. The MARI was assumed to live at the point of maximum PCDD/F deposition and to be a subsistence farmer, who obtained all of their food (vegetables, milk and meat) from a 100m diameter site, upon which the maximum PCDD/F deposition flux impacted.

The baseline (excluding the development) PCDD/F intake for the MARI was modelled following US EPA Methodology and using the Dutch Government Model RISC Human 3.1. The baseline (excluding the development) PCDD/F intake was predicted to be significantly below WHO PCDD/F intake criteria. The modelled results for baseline milk and meat concentrations, when compared with measured data for the Irish and UK environments, indicated that the model gave slightly higher PCDD/F concentrations in milk and meat, which ensures a conservative approach is being taken.

The annual average PCDD/F emissions under maximum operating conditions (worst case emissions) from the proposed waste to energy facility were then used to model average soil concentrations of PCDD/F over the operating life of the facility.

The modelled soil and air values were then added to the existing background values for PCDD/F and input to the RISC HUMAN Model.

The model predicted that the PCDD/F intake for the MARI, with the waste to energy plant operating at maximum emission rates, was still significantly less than recommended WHO Guideline values for PCDD/F intake.

It was therefore concluded that the proposed waste to energy facility will have no significant impact on PCDD/F intake for even the MARI.

Refer to appendix A9.1 for a copy of the report on the dioxin and furan uptake model study.

9.12 Sensitive areas or areas of special interest within a 5km radius of the site

There is a Natural Heritage Area at Monkstown Creek and a Special Protection area and Natural Heritage Area at Loughbeg. Both are with a 5km radius of the site. There are a number of other Natural Heritage Areas in the Lower Cork Harbour Area. Refer to section 10.7 of the EIS.

9.13 Description of Surroundings of the Site

For a description of the habitat, landscape and the topography of the area surrounding the site, highlighting abrupt changes in terrain, refer to chapter 5 of the EIS.

9.14 Appendix 9

Appendix A9.1	Air Modelling Input and Output Files on CD
Appendix A9.2	Dioxin and furan uptake model study
Appendix A9.3	Maps showing emission point locations and building height.