Attachment G.1: Raw Materials

G.1.1 Raw Material Use

A list of all raw and ancillary materials requirements for the Meath waste-to-energy facility is provided in Table G.1.a. The quantities given are based on the measured consumptions over the first 6 months of operation of the plant.

All chemicals are stored and handled in accordance with relevant health, safety and environmental guidelines.

Table G.1.a: Raw, Product and Ancillary Materials, Substances, Preparations, Fuels and Energy Used or Produced by Activity

Ref. Nº or Code	Material/ Substance(1)	CAS Number	Danger(2) Category	Amount Stored (tonnes)	Annual Usage (tonnes)	Nature of Use	R(3) - Phrase	S(3) - Phrase
M1	Ammonia solution (NH_4OH) (24.9%)	1336-21-6	Corrosive, dangerous to the environment	1	30	Boiler feedwater additive	34	(1/2), 26, 36/37/39, 45, 61
M2	Ammonia solution (NH_4OH) (24.9%)[1]	1336-21-6	Corrosive, dangerous to the environment	66	975	SNCR reagent	34	(1/2), 26, 36/37/39, 45, 61
M3	Urea[1]	57-13-6		0	0	Not used		
M4	Activated carbon	7440-44-0	N/a	35	122	Flue gas treatment	N/a	22, 24/25
M5	Expanded clay (Dioxorb)	1305-62-0	Irritant	35	220	Flue gas treatment	38, 41	22, 24, 25
M6	Hydrated lime ($Ca(OH)_2$)	1305-62-0	Irritant	217	128	Flue gas treatment	41	26, 39
M7	Quick lime (CaO) (95%)	1305-78-8	Irritant	432	2,960	Flue gas treatment	41	26,39
M8	Trisodium phosphate (Na_3PO_4)	7601-54-9	Corrosive	0.5	6	Boiler feedwater additive	34	26, 36/37/39, 45
M9	NaOH (50%)	1310-73-2	Corrosive	1.6	27	Demineralisation	35	(1/2),26, 37/39, 45
M10	HCl (30%)	7647-01-0	Corrosive	1	30	Demineralisation	34, 37	(1/2)26, 45
M11	Light Fuel Oil	68334-30-5	Harmful, dangerous to the environment, Flammable	34	300	Auxiliary firing in furnace	10, 51/53, 65, 66, 67	16,24, 29/35, 61, 62
M12	Diesel oil	68334-30-5	Harmful, dangerous to the environment, Flammable	6.8	15	Fuelling onsite vehicles	40, 65, 52/53	24, 36/37, 43, 62
M13	Hydraulic Oil	Mixture	Harmful	0.9	5	Lubrication of moving parts	N/a	N/a

[1] Either Ammonia solution or Urea can be used as a SCNR reagent

Ref. Nº or Code	Material/ Substance(1)	CAS Number	Danger(2) Category	Amount Stored (tonnes)	Annual Usage (tonnes)	Nature of Use	R(3) - Phrase	S(3) - Phrase
M14	Oil free of Polychlorinated biphenyl (PCB)	63148-62-9	N/A	7.3	0	Transformers	N/A	N/A
M15	Electricity import	N/A	N/A	N/A	2,380 MWh[2]	Provide site load in event of shutdown	N/A	N/A
M16	FGT-residues	Mixed, need analysis on a case by case basis	Harmful to aquatic organisms, may cause long term effects in the aquatic environment	126	11,000	Products of flue gas treatment process	R52/53	N/A
M17	Boiler ash	Mixed, need analysis on a case by case basis	Harmful to aquatic organisms, may cause long term effects in the aquatic environment	84	3,300	Products of waste combustion	R52/53	N/A
M18	Bottom ash residue	Mixed, need analysis on a case by case basis	N/A	1,240	55,000	Products of waste combustion	N/A	N/A

Notes: 1. In cases where a material comprises a number of distinct and available dangerous substances, please give details for each component substance.
2. c.f. Article 2(2) of SI Nº 77/94
3. c.f. Schedules 2 and 3 of SI Nº 77/94

[2] Anticipated to be no more than 980 hours per year at 2.48MW

Attachment G.2: Energy Efficiency

G.2.1 Energy Efficiency

G.2.1.a Waste Framework Directive

The revised Waste Framework Directive 2008/98/EC considers energy efficient waste-to-energy facilities to be recovery plants, assigning them a R1 code. To qualify for this recovery code, new plants must have a 0.65 efficiency factor according to the R1 formula used in the Directive. This is calculated as follows:

$$(E_p – (E_f + E_i)) / (0.97 \times (E_w + E_f))$$

Where:

E_p = annual produced and utilised energy from waste (total of heat/steam plus electricity as equivalents) (MWh/h). According to the BREF notes, this includes both exported and circulated energy. Electricity output is multiplied by 2.6 as it is considered to be more valuable[3] than heat. Heat output is multiplied by 1.1.

E_f = annual energy input to the system by imported energy (fuels) with steam production (MWh/h), e.g. auxiliary fuels. Only the energy contributing to normal operations is included here.

E_i = annual imported energy without steam production (MWh/h) e.g. for start up and shut down

E_w = annual energy input to the system by waste (MWh/h)

0.97 = factor accounting for energy losses in bottom ash and by radiation

As per the Waste Framework Directive, the formula has been applied in accordance with the reference document on the Best Available Techniques for waste incineration (Annex 10.4). The parameters used are listed in Table G.2.a below.

[3] The range of potential uses for electricity is greater than that for heat.

Table G.2.a: Parameters used in R1 calculation

Parameter	Value used[1]	Comment
E_p	= (2227MJ x 2.6) + (57MJ x 1.1) = 5,853MJ	From operational data, the typical electricity production from the turbine is approx. 2227MJ/t. This is scaled up using the equivalence factor of 2.6 for electricity. The internal consumption of produced steam for soot blowers and ejectors (57MJ/t) is also counted in E_p. This is also multiplied by the equivalence factor for steam (1.1).
E_f	(37.5MJ x 1.1 x 50%) = 20.5MJ	Approx. 37.35MJ fuel is used in the plant per tonne waste, of which 50% is used in startup and contributes to steam production. This is multiplied by the equivalence factor 1.1 to give E_f.
E_i	(37.3MJ x 1.1 x 50%) + (13.1MJ x 2.6) = 54.6MJ	The remaining 50% of fuel used in startup does not contribute to steam production. This is multiplied by the equivalence factor 1.1. Electricity is also used during startup and shutdown. This is multiplied by the equivalence factor 2.6.
E_w	8,700MJ	The approx. calorific input of the fuel is 8,700MJ/t.

[1] Units are 1 MJ/t

$(E_p - (E_f + E_i)) / (0.97 \times (E_w + E_f))$

(5,853-(20.5+54.6))/ (0.97 x (8,700 + 20.5)

5,777.9/(0.97 x 8,720.5) = 0.683

From this calculation, the Meath waste-to-energy facility will have an efficiency of 0.683 and therefore qualifies for the R1 code.

G.2.1.b Energy Efficiency in Design

The facility has been designed with energy efficiency as a priority in order to maximise electricity production.

Heat from the combustion of waste is converted to electricity at a gross efficiency of 25% and a net efficiency of 21% (when in-house consumption is netted off). The energy efficiency of a waste-to-energy plant is lower than that of a typical power plant because of the requirement to maintain temperatures and pressures below levels at which corrosive flue gases attack boiler components. This reduces the potential for steam output from the boiler and limits electricity generation. Waste-to-energy plants must also operate with a higher quantity of excess air, compared with power plants, to meet lower emissions limits. This also reduces the energy efficiency of the plant because heat is lost to the additional combustion air.

Some of the Best Available Techniques selected for the plant to optimise energy efficiency include:

- Minimising flue gas heat losses by:
  - optimising primary and secondary air distribution to minimise excess air requirements
  - minimising the boiler exit temperature to ensure the maximum transfer of energy from the flue gases to steam
  - selecting a flue gas treatment technique that does not require re-heating at any stage (i.e. where the temperature decreases from the boiler exit to the stack)
- Ensuring the thermal conversion efficiency of the boiler will be greater than 80%
- Selecting a turbine suited to high energy efficiency and maximum expansion of steam to very low pressure (0.1 bar, in vacuum)

The overall energy demand on the site has been minimised by:

- Selecting low energy systems, such as the SNCR system for NO_x abatement
- Minimising the use of primary fuels by using energy produced onsite
- Sourcing secondary combustion air from the main process building where it is effectively pre-heated
- Installing variable speed drives on fans and pumps

As well as factoring efficiency into design considerations, the efficient use of energy and resources is an ongoing concern at all Indaver facilities. It is one of the 11 key objectives in the Indaver Improvement Plan. Targets set out under this objective include items such as:

- Reviewing in-house energy and resource usage by:
  - conducting electrical inspections
  - conducting regular energy efficiency audits
  - establishing Key Performance Indicators (KPIs) for these resources
- Developing energy reduction initiatives including:
  - awareness campaigns
  - energy management systems
  - installing motion detectors for lighting

An example of an awareness campaign run at existing Indaver facilities in Ireland is attached in Appendix G1.

G.2.1.c Energy Balance

In summary, for a 69,3MW waste thermal input per incineration line the following heat balance is expected:

- Heat loss by radiation from the hot equipment (furnace, boiler, steam cycle) is approximately 1.5 MW (2% for the boiler furnace, 1% for the remainder). This heat is not recovered but does heat the building before being evacuated through the natural draft building ventilation to atmosphere,

- 61.3MW is converted into steam. The remaining 9.7 MW of heat is released from the boiler to the flue gas treatment system,
- Steam at 40 bar / 400^{o}C enters the turbine and steam at 0.15 bar / 46^{o}C leaves the turbine The 61.26 MW steam is converted to 17.2 MW electricity. The vacuum steam leaving the turbine is condensed in a closed loop in the air cooled condensers. The excess heat is released into the atmosphere,
- Because of the power of the ID-fan, 0.5 MW is added to flue gas going to the stack,
- 1.2 MW is lost over the wet deslagger,
- 0.04 MW is lost over the flue gas residue silo.

A guideline heat balance for the site is shown in Figure G.2.a below to provide an overview of heat transfer. As per condition 7.3 of WL0167-02, Indaver will conduct an audit of the energy efficiency of the site, and this will be repeated annually and included in the Annual Environmental Report.

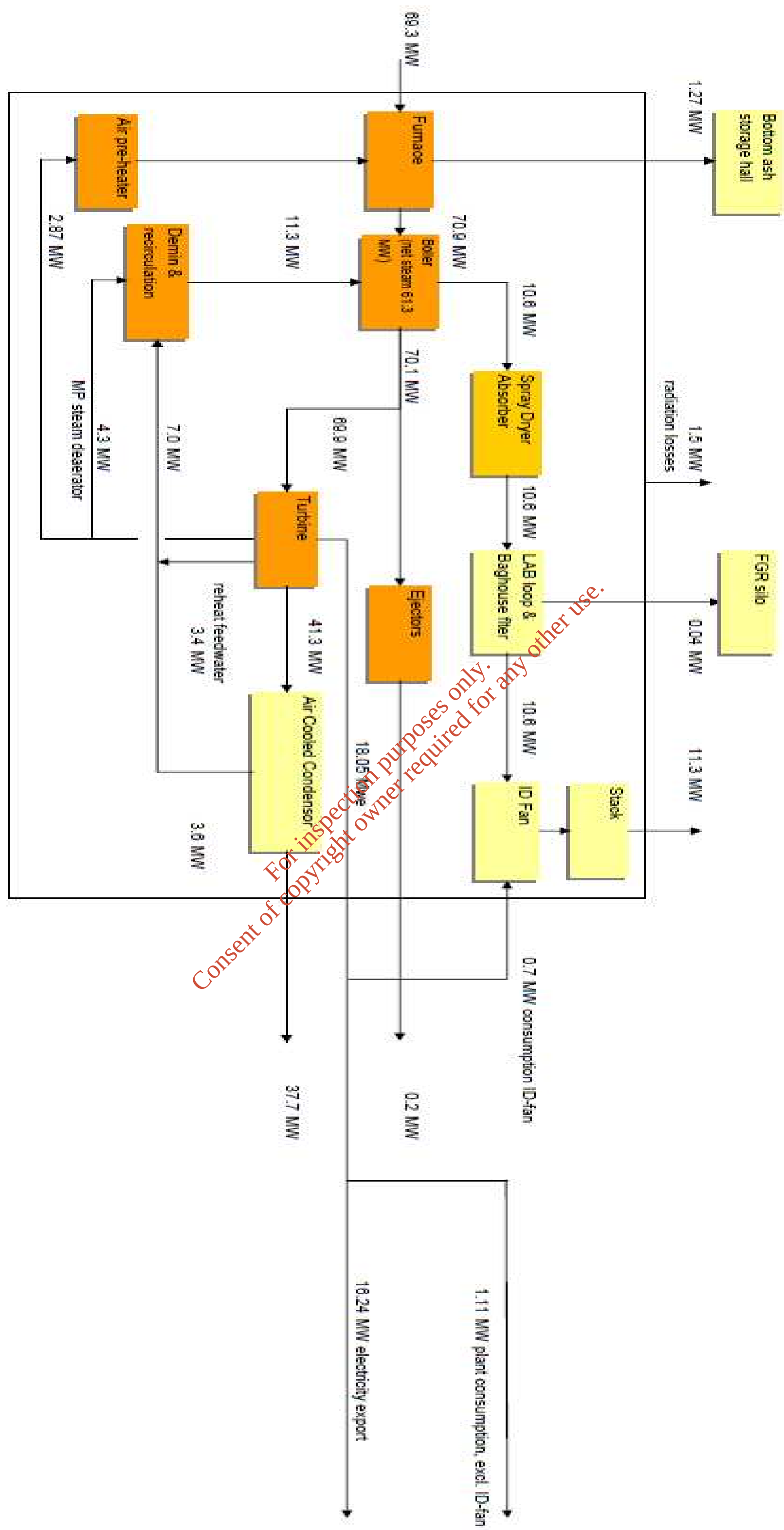

Figure G.2.a: Heat Balance for Meath Waste-to-Energy Plant

Appendix G1

INDAVER IRELAND

Energy Efficiency

LIGHTING TIPS

Did you know lighting accounts for about 45% of the electricity usage in a commercial building:

Flex your Power

Lighting an empty office overnight wastes enough energy to heat water for 1,000 cups of coffee.

What can you do?

1 The Off Switch

Turn lights off when leaving a room or area. When leaving for lunch or meetings switch off desk lamps and office lights.

2 Good Housekeeping

Dirty reflectors and louvers reduce light output by 20%. To ensure optimum efficiency, clean reflectors, windows and roof-lights.

3 Hours of Use

Make sure that full lighting is not being used unnecessarily outside of normal business hours.

4 Office Set Up

Is the office layout making the most of natural light?

5 Task Lighting

Where possible use individual task lighting in preference to increasing illumination over a large area.

6 Light Bulbs

Make sure that the light bulbs in your office are the most energy efficient with longer lifespans and lower maintenance costs.

Contact us if you have any new ideas

- Talk to your manager
- Take your idea to the next Sphere Meeting
- Use the QESH suggestion box
- E-mail info@indaver.ie

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INDAVER IRELAND

Energy Efficiency

HEATING TIPS

Did you know heating and air conditioning accounts for about 25% of the electricity usage in a commercial building:

Reducing the temperature in a room by just 1°C can cut the heating bill by as much as 10%.

What can you do?

1 Optimum settings

Air conditioning and heating controls should not be set so that they conflict with each other. Otherwise, heating and cooling will take place at the same time and waste energy. Ideally, set heating at 19°C and air conditioning at 24°C. Make sure that the two systems cannot work at the same time.

2 Thermostats and Timers (Wall mounted heaters)

Set wall-mounted heaters on timer. Check that timers are set to the minimum period and ensure room thermostats and radiator controls are on minimum settings.

3 The off switch (Office Equipment)

It costs nothing to switch office equipment off. Office equipment generates heat. If possible locate heat-generating equipment such as photocopiers, away from air-conditioned spaces. Where this is not possible, locate them in areas where they are well ventilated and cannot build up heat. Office equipment can add significantly to your electricity bill, not only in running costs, but also in air conditioning.

4 Occupied areas

Ensure that only occupied areas are heated and that heating is reduced during non-working hours, such as bank holidays or weekends.

Contact us if you have any new ideas

- Talk to your manager
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- Use the QESH suggestion box
- E-mail info@indaver.ie

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Energy Efficiency

OFFICE EQUIPMENT TIPS

Did you know that a photocopier left on overnight wastes enough energy to photocopy 5,300 A4 sheets?

A PC monitor left switched on overnight wastes enough energy to laser print 800 A4 copies.

What can you do?

1 Switch off

Make sure all office equipment is switched off overnight. Switch off your screen at lunchtime - the screen on a personal computer uses as much energy as all of its other components.

2 Standby mode

Standby is not switched off!! Even on standby a photocopier consumes as much as 200 watts per day. If you see a light on a machine switch if off.

3 Only switch on when needed

Don't switch on appliances unless you are ready to start using them. Photocopiers and printers don't need to be switched on immediately in the morning. Get into the habit of switching on only when needed.

Contact us if you have any new ideas

- Talk to your manager
- Take your idea to the next Sphere Meeting
- Use the QESH suggestion box
- E-mail info@indaver.ie

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