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Indaver

Rivenhall

Air Quality Issues

1 Introduction

This briefing note has been produced by Fichtner Consulting Engineers (Fichtner) to provide a non-technical summary of air quality questions frequently raised by members of the public on energy from waste (EfW) projects with reference to the Rivenhall Integrated Waste Management Facility (IWMF)

2 Air quality assessment levels

Air quality assessment levels have been set to protect human health and ecosystems. These are a mixture of limits and targets set in legislation (such as the Air Quality Standards regulations), air quality objectives (set within the Air Quality Strategy), and environmental assessment levels which have been set by the Environment Agency based on World Health Organisation (WHO) air quality guidelines and workplace exposure limits.

3 Ambient air quality data

Monitoring is carried out by local authorities of key pollutants (typically nitrogen dioxide and particulate matter) as part of their commitment to local air quality management. This is carried out with a combination of continuous analysers and diffusion tubes.

Diffusion tubes passively monitor the concentration of a pollutant, and are typically used by local authorities for monitoring of nitrogen dioxide. These are a low cost method of analysing concentration in the air and therefore can be deployed at many locations to investigate spatial differences in concentrations. The tube includes a chemical reagent to absorb nitrogen dioxide from the air. The diffusion tube is exposed for a period of a month and then sent off to a laboratory for analysis. Therefore, the concentration determined from the laboratory is the average concentration over the exposure period. The site of the diffusion tubes typically remains the same for many years and can be used to determine if there are any trends in air pollution levels as well as confirming if the levels comply with legislative requirements.

Continuous analysers are the other option and these sample and record the concentrations of pollutants in air continuously. Nitrogen dioxide is typically monitored for using a chemiluminescent analyser and is subject to rigorous quality assurance and quality control procedures, to ensure the reliability of the data. These are costly to install and maintain and as such are not as widespread as diffusion tubes, However, using a combination of these two methods ensures that both spatial and temporal variations in concentrations can be determined.

4 Modelling of emissions

In order to determine what the impact of the IWMF would be on the local environment, modelling was carried out using an industry standard model in line with the Environment Agency's (EA's) guidance on modelling.

The model uses hourly sequential weather data to predict the dispersion of pollutants from an emission source on an hour-by-hour basis. The model can be used to determine the impact across a grid and at nominated receptor locations to represent areas of potential exposure for a range of averaging times in line with the air quality assessment levels, such as an annual mean, 1-hour mean, 15-minute mean.

To do so the model was set up to assume that each item of plant within the IMWF operated continuously and at the proposed emission limits values (ELVs). Weather data was taken from the closest representative site (Stansted Airport) for a period of 5 years. The weather data needs to include a range of parameters including temperature, wind speed and direction, relative humidity, and cloud cover on an hour by basis, have a high level of data capture and be broadly representative of conditions at the emission source modelled.

Five years of data was used in the model to account for interannual variability in weather conditions. The impacts were calculated as the maximum impact predicted using all five years of weather data.

In the modelling, it was assumed that each item of plant continually operated at the proposed ELVs. This is a very conservative assumption as plant will be offline for maintenance and would be operated to not exceed the ELVs. Emissions of many of the pollutants released would be significantly below the ELVs. However, this conservative approach means that the impact of the worst-case operation of the IWMF occurring at the same time as the worst-case weather conditions for the dispersion of the emissions is accounted for.

5 Results

The air quality assessment for the Rivenhall IWMF compared the predicted impact of emissions from the IWMF determined from the dispersion modelling to the environmental assessment levels appropriate for the pollutants released from the IWMF. This assumed that:

- The plant within the IWMF continually operated at the ELVs during the worst-case weather conditions for dispersion;
- Impacts are based on the maximum predicted impact using 5-years of weather data;
- The entire dust emissions consist of only PM_{10} or $PM_{2.5}$ for comparison with the relevant environmental assessment levels;
- The entire VOC emissions consist of only benzene or 1,3-butaidene; and
- The entire cadmium and thallium emissions consist of only cadmium.

These assumptions means that predicted impacts are worst-case, for the following reasons:

- The plant will be offline for periods for maintenance and hence would not necessarily operate for the full year.
- The plant would need to operate below the ELVs to ensure that these are not exceeded as a condition of the Environmental Permit, therefore actual emissions would be lower than assumed.
- Emissions of dust would consist of a range of sizes, but it was assumed that the entire dust emissions consists of only PM_{10} (smaller than 10 µm) or $PM_{2.5}$ (smaller than 2.5 µm) for

comparison with the assessment level. By definition PM_{10} includes $PM_{2.5}$'s but $PM_{2.5}$s do not include those particles sized between 2.5 µm and 10 µm.

- Emissions of VOCs would include a range and are unlikely to consist of a single species.
- The plant has an ELV for combined cadmium and thallium emissions. Monitoring from existing plants has shown that this is highly conservative.

The permitting and planning regime are slightly different. For permitting, the impacts were compared to guidance from the EA, whilst to support the planning application, reference was made to guidance on determining the significance of impacts from the Institute of Air Quality Management (IAQM).

The EA state that the process contributions can be screened out “insignificant” if:

- *The long term process contribution is less than 1% of the long term environmental standard; and*
- *The short term process contribution is less than 10% of the long term environmental standard”*

Where the process contribution cannot be screened out as “insignificant” further consideration is needed to determine the total impact and whether there is any risk of exceeding the environmental assessment level. Where the total concentration is less than 70% of the long term environmental standard the impact is considered “not significant”.

In this instance the process contribution refers to the contribution from the IWMF, i.e. that predicted using the dispersion model.

Using the IAQM methodology an impact can be described as “negligible” where the long term process contribution is less than 0.5% of the environmental standard, and the short term process contribution is less than 10% of the environmental standard. Where the long term process contribution is greater than 0.5% additional consideration of the baseline concentration is needed to determine the total concentration. Where the total concentration is less than 75% and the process contribution is less than 5% of the environmental standard the impact can also be described as “negligible”.

Applying the EA guidance, the process contribution from the IWMF can be screened out as “insignificant” at the point of maximum impact, with the exception of annual mean impacts of nitrogen dioxide, VOCs and cadmium. However, for these pollutants the total concentration including all other known sources would be well below 70% of the long term environmental standard and the impact is considered “not significant”. The point of maximum impact is located approximately 500m to the north-east of the stack, within the quarry site.

Applying the IAQM guidance, which is appropriate for planning, the process contribution from the IWMF can be screened out as “negligible” at the point of maximum impact with the exception of same pollutants. However, for these pollutants the total concentration including all other known sources would be well below 75% of the long term environmental standard and the impact is also considered “negligible”.

6 Measures to control emissions to air

The CHP Plant includes a range of techniques to control and minimise emissions to air. These include (but are not limited to):

- A modern control system incorporating the latest advance in control and instrumentation technical to control operations and optimise the process.
- Flue gas recirculation to control NOx generation.

- Selective non-catalytic reduction (SNCR) injecting ammonium hydroxide at various points in the combustion chamber, coupled with infra-red pyrometers to allow for precise delivery of reagent to abate NOx generated.
- A controlled dry lime system to neutralise emissions of acid gases, including hydrogen chloride, hydrogen fluoride and sulphur dioxide.
- Injection of activated carbon to adsorb (primarily) dioxins, VOCs, mercury and other trace metals.
- A multi-compartment fabric filter with differential pressure monitoring. This is used to remove the fine ash plus reacted and exceed lime and carbon from the flue gases. The build up of lime and carbon on the surface of the filter bag enhances the performance of the bag filters by producing a “filter cake”. The differential pressure monitoring is used to optimise the performance of the cleaning system and to detect bag failures.

The control measures are all considered Best Available Techniques (BAT) by the EA.

7 Particulate matter emissions from EfWs

Particulate matter is classified according to size, with the smaller particles thought to be more likely to have an impact on health. PM_{10}, for example, is all particles with a diameter of 10 micrometres (µm) or less, and therefore includes smaller particles such as $PM_{2.5}$s and PM_1s etc.

The CHP Plant is required to monitor for total particulate matter, which includes particles of all sizes.

The CHP Plant will include a multi-compartment fabric filter system, within this the following separation principles apply:

- Absolute filtration – particles larger than the holes in the filter obviously cannot pass through.
- Adsorption – a layer of particles called a “filter cake” builds up on the surface of the filter material which consist of reagents (lime and activated carbon) and reaction products.

This filter cake layer is essential to the proper functioning of the flue gas treatment system. Within this layer, the final acid gas neutralisation and the absorption of heavy metals and complex organic compounds takes place. it is this which accounts for the capture of smaller particles which are adsorbed onto the surface of the particles in the filter cake. The smaller the particle, the great the probability it will be adsorbed onto another particle.

The multi-compartment fabric filter system is efficient at removing particulates of all sizes.

A review of data from the International Energy Agency on Fine Particle Emissions of Waste Incineration[1] shows that fabric filter systems can achieve low concentrations of particulates and are very effective at removing particulate matter, including $PM_{2.5}$s and PM_1s. This shows that:

- The abatement of total particulates was between 99.984% and 99.97%;
- The abatement of $PM_{2.5}$s was between 99.971% and 99.990%; and
- The abatement of PM_1s was between 99.864 and 99.991%.

Additional works have been carried out slightly more recently[2] considering the emissions of ultrafine particles which showed that removal efficiency is quite constant across all the

[1] “Fine Particle emissions of Waste Incineration”, Wilen et al, March 2007

[2] Buonanno, G., Scungio, M., Stabile, L. and Tirler, W. “Ultrafine particle emission from incinerators: The role of the fabric filter”, Journal of the Air and Waste Management Association, 62(1):103-111. In Appendix 9.

measurement range, and abatement efficiency for particles between 5 nanometres (nm) (a nm is 1,000 times smaller than a µm) and 40 nm was estimated to be 99.88%.

8 Monitoring of emissions to air

The Environmental Permit for the IWMF includes a series of conditions which must be adhered to these include a requirement to monitor for emissions to air from stack.

In line with the requirements of the Environmental Permit, the CHP will include a Continuous Emissions Monitoring System (CEMS). The purpose of the CEMS is to provide information necessary to efficient and safe plant operation and to provide the records of emissions and events for the purposes of demonstrating regulatory compliance. The CEMS monitors and continually records the following parameters:

- Water vapour content;
- Temperature;
- Pressure;
- Oxygen;
- Carbon monoxide;
- Hydrogen chloride;
- Sulphur dioxide;
- Nitrogen oxides;
- Ammonia;
- Volatile organic compounds; and
- Total particulates.

The installation of the CEMS and will be subject to control and to periodic surveillance tests by an independent certified testing company.

In addition, the Environmental Permit includes a requirement for periodic monitoring by an independent certified testing company for emissions of the following substances:

- Hydrogen fluoride;
- Cadmium and thallium and their compounds;
- Mercury and its compounds;
- Other trace heavy metals and their compounds;
- Dioxins and furans;
- Dioxin like polychlorinated biphenyls (PCBs); and
- Poly-cyclic aromatics (PAHs).

These are substances are not typically monitored on a continuous basis as the amount of substances instantaneously released is very low and below the level of detection for the equipment. Periodic monitoring of these substances is carried out using extractive monitoring over a minimum of 30-minutes to a maximum of 8-hours to ensure sufficient material is captured.

Although these substances are only monitored periodically, continual monitoring of total particulate matter and hydrogen chloride is used to indirectly determine the effectiveness of the abatement of these substances and to control the dosing system.

9 Regulation

An Environmental Permit has been granted for the Rivenhall IWMF. The Environmental Permit includes a series of conditions which need to be complied with prior to operation and during operation. For reference, the limits on emissions to air as set out in the Environmental Permit for the CHP Plant are set out in Table 1. The Operator is required to pay an annual subsistence fee to the EA for them to regulate the operations.

The Operator will be required to provide the information to the EA to discharge the pre-operational conditions before the IWMF can operate. In addition, there is a requirement for the operator to provide report annually on a range of key performance indicators (KPI).

A site inspector will be allocated to the site and it will be their responsibility to check whether the Operator is complying with the Environmental Permit, and visit the site. These visits are usually planned, but can be unannounced. It is the site inspector's role to investigate any complaints made to the EA relating to the operations on site.

When the EA visits site or assesses a complaint, the inspector produces a Compliance Assessment Report (CAR), which will record anything that is not being done in correctly and state what needs to occur to correct this. If a CAR is served this may increase the annual subsistence fee. The EA can take enforcement action against an Operator if needed.

The EA regularly reviews Environmental Permits to ensure that they reflect the latest regulations and environmental standards.

Table 1: Emission limit to air for CHP Plant

Parameter	**Limit (mg/Nm^3 unless stated)**	**Reference period**	**Monitoring frequency**
Particulate matter	30	Half-hour average	Continuous
	5	Daily average	Continuous
Total Organic Carbon (TOC)	20	Half-hour average	Continuous
	10	Daily average	Continuous
Hydrogen chloride	60	Half-hour average	Continuous
	6	Daily average	Continuous
Hydrogen fluoride	1	Periodic over minimum 1-hour period	Quarterly in first year, then bi-annual
Carbon monoxide	100	Half-hour average	Continuous
	50	Daily average	Continuous
Sulphur dioxide	90	Half-hour average	Continuous
	30	Daily average	Continuous
Oxides of nitrogen (NO and NO_2 expressed as NO_2)	200	Half-hour average	Continuous
	100	Daily average	Continuous
Cadmium & thallium and their compounds (total)	0.02	Periodic over minimum 30-minue, maximum 8-hour period	Quarterly in first year, then bi-annual

Parameter	Limit (mg/Nm^3 unless stated)	Reference period	Monitoring frequency
Mercury and its compounds (total)	0.005	Periodic over minimum 30-minue, maximum 8-hour period	Quarterly in first year, then bi-annual
Sb, As, Pb, Cr, Co, Cu, Mn, Ni and V and their compounds (total)	0.3	Periodic over minimum 30-minue, maximum 8-hour period	Quarterly in first year, then bi-annual
Ammonia	10	Daily average	Continuous
Dioxins / furans (I-TEQ)	0.1 ng/Nm^3	Periodic over minimum 6-hours, maximum 8-hour period	Quarterly in first year, then bi-annual
NOTES: Limits expressed as dry air, 273K, 101.3kPa and 11% oxygen content			

Source: EPR/FP3335YU/V002

10 Conclusions

Detailed air dispersion modelling was carried out to support the Environmental Permit application and was audited by the EA. This used a series of conservative assumptions and concluded that the plant would not have a significant impact on air quality. As a result, an Environmental Permit has been granted for the Rivenhall IWMF. This includes a series of conditions which need to be complied with prior to operation and during operation.