POWERFUEL

Portland energy recovery facility

Environmental statement
Second addendum
Appendices

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5.1 Impact of Dioxins Using the TDI Approach

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Impact of dioxins using the TDI approach

1 Introduction

As part of the consultation process on the planning application for the Portland Energy Recovery Facility (ERF), Public Health England (PHE) has requested that the impact of releases of dioxins and dioxin like furans, and dioxins like PCBs (collectively referred to as dioxins) is assessed against the tolerable daily intake (TDI).

Fichtner Consulting Engineers (Fichtner) has carried out this assessment which supplements the Human Health Risk Assessment (HHRA) carried out to support the planning application by ERM.

2 Assessment criteria

The Environment Agency science report SC050021/ TOX 12 "Contaminants in soil: updated collation of toxicological data and intake values for humans Dioxins, furans and dioxin-like PCBs" (referred to as "the TOX report") sets out recommended health criteria values (TDIs) and an estimate of mean daily intakes (MDI) of dioxins in the UK. The MDI is the typical intake from background sources (including dietary intake) across the UK.

The following criteria are outlined:

Table 1: Summary of MDI and TDI data for dioxins

Parameter	Units	Oral and inhalation combined
MDI	pg WHO-TEQ / day	49
MDI for 70-kg adult	pg WHO-TEQ kg / bw / day	0.7
MDI for 20-kg child	pg WHO-TEQ kg / bw / day	1.8
TDI	pg WHO-TEQ kg / bw / day	2

Source: Environment Agency Science Report SC050021/TOX 12

The TDI is defined as "an estimate of the amount of a contaminant, expressed on a bodyweight basis, which can be ingested daily over a lifetime without appreciable health risk". Therefore, if the total exposure is less than the TDI, it can be concluded that the impact of the Portland ERF is 'negligible', and the effect is not significant.

3 Approach

The IRAP model used for the HHRA includes all the outputs to determine the concentration of dioxins in the air, and in the different ingestion routes. Therefore, to carry out this additional analysis no changes have been made to the model used for the HHRA and the input assumptions are as detailed in the HHRA.

The only additional assumptions needed to carry out this analysis are as follows:

- The inhalation rates for adults and children:
  - adults - 20m³/day; and
  - children – 7.2m³/day.
- For breast milk the standard assumptions within IRAP were used as follows:
  - Exposure duration of infant to breast milk 1 year
  - Proportion of ingested dioxin that is stored in fat 0.9
  - Proportion of mother's weight that is stored in fat 0.3
  - Fraction of fat in breast milk 0.04
  - Fraction of ingested contaminant that is absorbed 0.9
  - Half-life of dioxins in adults 2,555 days
  - Ingestion rate of breast milk 0.688kg/day

The intake via breast milk was contained in the IRAP model but the assumptions were not stated in the HHRA as this exposure route was not previously assessed.

Dioxins are a group of similar halogenated organic compounds, which are generally found as a complex mixture. The toxicity of each compound is different and is generally expressed as a Toxic Equivalent Factor (TEF), which relates the toxicity of each individual compound to the toxicity of 2,3,7,8-TCDD, the most toxic dioxin. A full list of the TEF values for each dioxin is provided in Table 3. The total concentration is then expressed as a Toxic Equivalent (TEQ).

The split of the different dioxins and furans is based on split of congeners for a release of 1 ng I-TEQ/Nm³ as presented in in Table 3. This data is taken from Table 7.2a from the HMIP document "Risk Assessment of Dioxin Releases from Municipal Waste Incineration Processes".

To determine the emission rates, this split of the different dioxins has been multiplied by normalised volumetric flow rate to determine the release rate of each congener.

There are a total of 209 PCBs, which act in a similar manner to dioxins, are generally found in complex mixtures and also have TEFs. The UK Environment Agency has advised that 44 measurements of dioxin like PCBs have been taken at 24 MWIs between 2008 and 2010. The following data summarises the measurements, all at 11% reference oxygen content:

- Maximum = 9.2×10^{-3} ng[TEQ]/m³
- Mean = 2.6×10^{-3} ng[TEQ]/m³
- Minimum = 5.6×10^{-5} ng[TEQ]/m³

For the purpose of this assessment, the maximum monitored PCB concentration has been used.

The IRAP software, and the HHRAP database which underpins it, does not include any data on individual PCBs, but it does include data for take-up and accumulation rates within the food chain for two groups of PCBs, known as Aroclor 1254 and Aroclor 1016. Each Aroclor is based on a fixed composition of PCBs. Since we are not aware of any data on the specification of PCBs within incinerator emissions, as a worst-case assumption we have assumed that the PCBs are released in

each of the two Aroclor compositions. The Aroclor has then been assumed to have a TEF of 1 and the maximum concentration added to the dioxins TEQ to determine the total dioxin (and dioxin like PCB) TEQ impact.

To determine the intake via inhalation the air concentration has been extracted from IRAP and multiplied by the daily inhalation rate and divided by the body weight of an adult to determine the air intake per kilogram body weight per day. This has then been multiplied by the relevant TEF to determine the intake via inhalation per kilogram body weight per day as a TEQ.

To determine the intake via ingestion the intake via each pathway per kilogram body weight per day has been extracted from IRAP and multiplied by the relevant TEF to determine the intake via ingestion per kilogram body weight per day as a TEQ.

It has been assumed that the Aroclors have a TEF of 1 and the maximum concentration from either Aroclor 1254 or Aroclor 1016 has been added to the dioxins TEQ to determine the total dioxin (and dioxin like PCB) TEQ impact.

These have been summed to determine the sum of intake per kilogram body weight per day from ingestion and inhalation for dioxins and dioxin like PCBs. As per the HHRA, results have been presented for scenarios 1 and 2 as detailed in the HHRA.

4 Results

Detailed results tables outlining the impact of emissions from the Portland ERF at the identified receptors are provided at the end of this note. A summary of the most impacted receptor is provided in the following table.

Table 2: Impact Analysis – Dioxins and Dioxin-Like PCBs – Maximum Impacted Receptor

Receptor Type	MDI (% of TDI)	Process Contribution (% of TDI)	Overall (% of TDI)
Adult			
Scenario 1	35.00%	0.0089%	35.01%
Scenario 2	35.00%	0.0409%	35.04%
Child			
Scenario 1	90.65%	0.0310%	90.68%
Scenario 2	90.65%	0.1007%	90.75%

As shown, the overall impact (including the contribution from existing dietary intakes) is less than the TDI for dioxins and dioxin-like PCBs. The impact at the maximum impacted receptor is only 0.1 % of the TDI, and the total impact, including background dietary intakes, remains below the TDI.

The total accumulation of dioxins in an infant, considering the breast milk pathway at the most impacted receptor feeding an infant, is:

- Scenario 1 – 1.92×10^{-4} pg WHO-TEQ / kg-bw / day which is 0.0096% of the TDI
- Scenario 2 – 3.59×10^{-3} pg WHO-TEQ / kg-bw / day which is 0.18% of the TDI

There are no ingestion pathways besides breast milk ingestion for an infant receptor. As the process contribution is less than the TDI, it is considered that the operation of the Portland ERF will not increase the health risks from the accumulation of dioxins in infants significantly.

5 Conclusions

This analysis has been carried out to supplement the HHRA submitted with the planning application for the Portland ERF. This has shown that the predicted impact of emissions of dioxins and dioxins like PCBs from the Portland ERF at the identified sensitive receptors are well below the TDI. As such there would not be an appreciable health risk based on the emission of dioxins and dioxins like PCBs, and it can be concluded that the impact is 'negligible', and the effect is not significant.

A Detailed results tables

Table 3: COPC Emissions Modelled

COPC	Split of Congeners for a release of 1 ng I-TEQ/Nm³(1)	I-TEFs for the congeners	Emission concentration (ng/Nm³)(2)	Emission rate (ng/s)
Sum I-TEQ dioxin[s]	-	-	0.06 ng I-TEQ/Nm³	-
2,3,7,8-TCDD	0.031	1	0.002	0.073
1,2,3,7,8-PeCDD	0.245	0.5	0.015	0.574
1,2,3,4,7,8-HxCDD	0.287	0.1	0.017	0.673
1,2,3,6,7,8-HxCDD	0.258	0.1	0.015	0.605
1,2,3,7,8,9-HxCDD	0.205	0.1	0.012	0.480
1,2,3,4,6,7,8-HpCDD	1.704	0.01	0.102	3.993
1,2,3,4,6,7,8,9-OctaCDD	4.042	0.001	0.242	9.472
2,3,7,8-TCDF	0.277	0.1	0.017	0.649
1,2,3,7,8-PCDF	0.277	0.05	0.017	0.649
2,3,4,7,8-PCDF	0.535	0.5	0.032	1.254
1,2,3,4,7,8-HxCDD	2.179	0.1	0.131	5.106
1,2,3,6,7,8-HxCDF	0.807	0.1	0.048	1.891
1,2,3,7,8,9-HxCDF	0.042	0.1	0.003	0.098
2,3,4,6,7,8-HxCDF	0.871	0.1	0.052	2.041
1,2,3,4,6,7,8-HpCDF	4.395	0.01	0.264	10.299
1,2,3,4,7,8,9-HpCDF	0.429	0.01	0.026	1.005
1,2,3,4,6,7,8,9-OctaCDF	3.566	0.001	0.214	8.357
Total	20.150	-	1.209	47.22
Dioxin-like PCBs	-	-	0.092	3.594

Notes:
(1) Split of the Congener taken from Table 7.2a from the HMIP document.
(2) All emissions are expressed at reference conditions of dry gas, 11% oxygen, 273.15K.
(3) Emission release rate calculated by multiplying the normalised volumetric flow rate (39.07 Nm^3/s) by the emission concentration.

Table 4: Impact Analysis – Dioxins and Dioxin-Like PCBs - Scenario 1 - Adults

Receptor	Total Inhalation, (pg WHO-TEQ kg^{-1} bw day^{-1})	Total Ingestion, (pg WHO-TEQ kg^{-1} bw day^{-1})	Total uptake, (pg WHO-TEQ kg^{-1} bw day^{-1})	Comparison (% of limit)
			MDI (as % of TDI)	35.000%
R1	1.77E-04	0.00E+00	1.77E-04	35.009%
R2	5.93E-05	0.00E+00	5.93E-05	35.003%
R3	6.95E-05	0.00E+00	6.95E-05	35.003%
R4	4.13E-05	0.00E+00	4.13E-05	35.002%
R5	1.53E-05	0.00E+00	1.53E-05	35.001%
R6	1.45E-05	0.00E+00	1.45E-05	35.001%
R7	1.26E-05	0.00E+00	1.26E-05	35.001%
R8	1.53E-05	0.00E+00	1.53E-05	35.001%
Note: Assumes no home grown produce and no soil ingestion				

Table 5: Impact Analysis – Dioxins and Dioxin-Like PCBs - Scenario 1 - Child

Receptor	Total Inhalation, (pg WHO-TEQ kg^{-1} bw day^{-1})	Total Ingestion, (pg WHO-TEQ kg^{-1} bw day^{-1})	Total uptake, (pg WHO-TEQ kg^{-1} bw day^{-1})	Comparison (% of limit)
			MDI (as % of TDI)	90.650%
R1	2.24E-04	3.97E-04	6.20E-04	90.681%
R2	7.47E-05	1.33E-04	2.08E-04	90.660%
R3	8.75E-05	1.55E-04	2.43E-04	90.662%
R4	5.20E-05	9.24E-05	1.44E-04	90.657%
R5	1.92E-05	3.42E-05	5.34E-05	90.653%
R6	1.83E-05	3.25E-05	5.08E-05	90.653%
R7	1.59E-05	2.82E-05	4.40E-05	90.652%
R8	1.93E-05	3.43E-05	5.37E-05	90.653%
Note: Assumes no home grown produced and some soil ingestion				

Table 6: Impact Analysis – Dioxins and Dioxin-Like PCBs - Scenario 2 - Adults

Receptor	Total Inhalation, (pg WHO-TEQ kg^{-1} bw day^{-1})	Total Ingestion, (pg WHO-TEQ kg^{-1} bw day^{-1})	Total uptake, (pg WHO-TEQ kg^{-1} bw day^{-1})	Comparison (% of limit)
			MDI (as % of TDI)	35.000%
R1	1.77E-04	6.40E-04	8.17E-04	35.041%
R2	5.93E-05	2.14E-04	2.73E-04	35.014%
R3	6.95E-05	2.51E-04	3.20E-04	35.016%
R4	4.13E-05	1.49E-04	1.90E-04	35.010%
R5	1.53E-05	5.51E-05	7.03E-05	35.004%
R6	1.45E-05	5.24E-05	6.69E-05	35.003%
R7	1.26E-05	4.54E-05	5.80E-05	35.003%
R8	1.53E-05	5.53E-05	7.07E-05	35.004%
Note: Assumes home grown produce – fruit and vegetables, chicken, eggs (no home grown milk, beef or pork)				

Table 7: Impact Analysis – Dioxins and Dioxin-Like PCBs - Scenario 2 - Child

Receptor	Total Inhalation, (pg WHO-TEQ kg^{-1} bw day^{-1})	Total Ingestion, (pg WHO-TEQ kg^{-1} bw day^{-1})	Total uptake, (pg WHO-TEQ kg^{-1} bw day^{-1})	Comparison (% of limit)
			MDI (as % of TDI)	90.650%
R1	2.24E-04	1.79E-03	2.01E-03	90.751%
R2	7.47E-05	5.99E-04	6.74E-04	90.684%
R3	8.75E-05	7.02E-04	7.89E-04	90.689%
R4	5.20E-05	4.17E-04	4.69E-04	90.673%
R5	1.92E-05	1.54E-04	1.73E-04	90.659%
R6	1.83E-05	1.47E-04	1.65E-04	90.658%
R7	1.59E-05	1.27E-04	1.43E-04	90.657%
R8	1.93E-05	1.55E-04	1.74E-04	90.659%
Note: Assumes home grown produce – fruit and vegetables, chicken, eggs (no home grown milk, beef or pork)				