Appendix 10A Calculation of Emission Rates of COPCs

Stack gas flow rate = 1650000 (Nm^3/h) [1]

Air Pollutants	Target Emission Level (mg/Nm^3) [1]			Total emission rate (six flues) (g/s)	Remarks
	Hourly	Daily or as specified	1650000		
Trace Metals					
Total Heavy Metal [2]	-	0.3	0.3	1.38E-01	[9]
Antimony (Sb)	-	-	0.3	1.38E-01	[3]
Arsenic (As)	-	-	0.025	1.15E-02	[4]
Chromium (Cr)	-	-	0.092	4.22E-02	[5]
Hexavalent Chromium (Cr(VI))	-	-	0.017	8.01E-03	[5]
Cobalt (Co)	-	-	0.3	1.38E-01	[3]
Copper (Cu)	-	-	0.3	1.38E-01	[3]
Lead (Pb)	-	-	0.3	1.38E-01	[3]
Manganese (Mn)	-	-	0.3	1.38E-01	[3]
Nickel (Ni)	-	-	0.053	2.43E-02	[6]
Vanadium (V)	-	-	0.3	1.38E-01	[3]
Cadmium (Cd) & Thallium (Tl) [2]	-	0.02	0.02	9.17E-03	[9]
Cadmium (Cd)	-	-	0.02	9.17E-03	[7]
Thallium (Tl)	-	-	0.02	9.17E-03	[7]
Mercury (Hg) [2]	-	0.02	0.02	9.17E-03	[9]
Beryllium (Be)	-	-		1.80E-04	[8]
Zinc (Zn)	-	-		1.80E-01	[8]
Selenium (Se)	-	-		1.44E-03	[8]
Organic Compounds					
Gaseous and vaporous organic substances (TOC)	10	10	10	4.58E+00	[10]
Polychlorinated biphenyls (PCBs)	-	-		1.44E-04	[8]
Polychlorinated dibenzodioxins and furans (dioxins & furans) (in ng I-TEQ/m^3) [2]	-	0.04	4E-08	1.83E-08	[9]
Polycyclic aromatic hydrocarbons (PAHs)	-	-		1.80E-02	[8], [11]
Carcinogenic polycyclic aromatic hydrocarbons (CPAHs)	-	-		3.59E-04	[8], [11]
Other Compounds					
Hydrogen chloride (HCl)	8	6	8	3.67E+00	[9]
Hydrogen fluoride (HF)	2	1	2	9.17E-01	[9]
Ammonia (NH_3)	15	10	15	6.88E+00	[9], [13]

Notes:

[1] Stack gas flow rate of 1650000 m^3/h was for a total of 6 flues and was provided by the design engineer. Target emission levels and stack gas flow rate were under standard condition of 0^oC and 101.325 kPa, dry and 11% oxygen content.

[2] For total heavy metal (Sb, As, Cr, Co, Cu, Pb, Mn, Ni and V), Cd & TI, and Hg, the target emission levels are the average value over the sampling period of a minimum of 30mins and a maximum of 8 hours. For dioxins and furans, the target emission level is the average value over the sampling period of a minimum of 6 hours and a maximum of 8 hours.

[3] The total emission rate of Total Heavy Metal was assigned to each of Sb, Co, Cu, Pb, Mn and V as a conservative assumption for assessment purpose. The actual emission shall be within the emission limit specified in the prevailing guidance note on the BPM for incinerators (municipal waste incineration) in Hong Kong).

[4] According to "Guidance on assessing group 3 metal stack emissions from incinerators" (UK Environment Agency), the maximum measured concentration for As is 0.025mg/Nm^3. The maximum measured concentrations for As was applied in the emission rate calculation as a realistic and conservative approach. (https://assets.publishing.service.gov.uk/media/5a80dd59ed915d74e6230e2d/LIT_7349.pdf)

[5] According to "Guidance on assessing group 3 metal stack emissions from incinerators" (UK Environment Agency), the maximum measured concentration for Cr is 0.092mg/Nm^3. The maximum measured concentrations of Cr was applied in the emission rate calculation as a realistic and conservative approach. (https://assets.publishing.service.gov.uk/media/5a80dd59ed915d74e6230e2d/LIT_7349.pdf)
For Chromium, only Cr(VI) is identified as compound of potential concern in the health risk assessment. With reference to the 2020 National Emissions Inventory Data prepared by USEPA, the percentage of Cr (VI) in total Cr is 19% for emissions of large municipal waste combustors. Therefore, a 19% Cr(VI) speciation factor was applied to the total Cr emissions in this health risk assessment.
In the excels from the attached link below, please refer to column BA, for emission of Chromium (VI) from Large Municipal Waste Combustors (MWC): 2020MEDEP submitted 7440473 of .00104 TON times ratio of 1.900E-01, based on augmentation description: solid waste incineration, hazardous waste incineration, human cremation and animal cremation (https://gaftp.epa.gov/air/nei/2020/data_summaries/2020nei_facility_process_byregions.zip)

[6] According to "Guidance on assessing group 3 metal stack emissions from incinerators" (UK Environment Agency), the two highest concentration of Ni are outliers, so the third highest concentration 0.053mg/Nm^3 was used. The third highest concentration of Ni were applied in the emission rate calculation as a realistic and conservative approach. (https://assets.publishing.service.gov.uk/media/5a80dd59ed915d74e6230e2d/LIT_7349.pdf)

[7] The emission rates of "Total Cd & TI" is assigned to Cd and TI individually as a conservative approach for assessment purpose. The actual emission shall be within the emission limit specified in the prevailing guidance note on the BPM for incinerators (municipal waste incineration) in Hong Kong.

[8] For Be, Zn, Se, PCB, PAHs and CPAHs, the emission rates were derived from the maximum emission rates in "Quantitative risk assessment of stack emissions from municipal waste combustors" (Zemba et al.,1996) for a municipal waste combustor with a design treatment capacity of 1,500 tpd multiplying by 4 for I.PARK2 with a design treatment capacity of 6,000 tpd. The maximum emission rate for Be, Zn, Se, PCBs, PAHs and CPAHs in "Quantitative risk assessment of stack emissions from municipal waste combustors" (Zemba et al.,1996) are 0.0000449 g/s, 0.0449 g/s, 0.000359 g/s, 0.0000359 g/s, 0.00449 g/s and 0.0000897 g/s respectively.

[9] The emission rates (g/s) were derived from the hourly target emission levels (if available) for both acute and chronic health risk assessments. If there is no hourly target emission level, the emission rates (g/s) were derived from the daily target emission level or the target emission level as specified as the best available information for both acute and chronic health risk assessments. The emission rate (g/s) as derived above will be the maximum emission rate to be emitted from the proposed incinerator.

Emission rate = Target emission level * Stack gas flow rate

[10] TOC will be measured continuously as a key indicator for the quality of combustion in the incineration process.

[11] Emission rate of PAHs was used for chronic and acute health risk assessments while emission rate of CPAHs was used for carcinogenic health risk assessment. The total CPAHs represent the sum of all carcinogenic PAHs weighted by TEQ as benzo(a)pyrene.

[12] The key air pollutants emitted from the stack as identified in the EIA report shall be monitored in accordance with the prevailing guidance note on the BPM for incinerators (municipal waste incineration) in Hong Kong or other international standards acceptable to the Authority to demonstrate compliance with the target air emission levels / emission rates. For key air pollutants not covered in the prevailing guidance note on the BPM for incinerators (municipal waste incineration) including Be, Zn, Se, PCBs, PAHs and CPAHs, commissioning test will be conducted upon commissioning of I•PARK2 to demonstrate compliance with the emission rates assumed in the EIA report.

[13] The hourly target emission level of 15 mg/Nm^3 for ammonia is additional to the requirements in the prevailing guidance note on the BPM for incinerators (municipal waste incineration). Continuous stack monitoring will be conducted during operation stage to demonstrate compliance with this emission limit.

Appendix A Calculation of Emission Rates of COPCs

Source for footnote [4] to [6]

This file is downloaded from "Guidance on assessing group 3 metal stack emissions from incinerators" (UK Environment Agency) on 17/07/2024.

(https://assets.publishing.service.gov.uk/media/5a80dd59ed915d74e6230e2d/LIT_7349.pdf)

Environment Agency

Releases from waste incinerators

Version 4

Guidance on assessing group 3 metal stack emissions from incinerators

Scope

This guidance is for Applicants for environmental permits for Municipal Waste Incinerators (MWI) and Waste Wood Co-incinerators under Paragraph 5.1, Schedule 1, of the Environmental Permitting Regulations 2010 (EPR).

It relates to air quality impact assessments from Group 3 metals emissions to air. Metals assessments from other plant may only use the method in this guidance if they can show the data is representative.

Background

Applicants should predict the process contribution (PC) of their plant compared to the environmental standards in our risk assessment guidance[1].

The Industrial Emissions Directive (IED) has a mandatory Emission Limit Value (ELV) of 0.5 mg/m³ aggregated for nine Group 3 metals (antimony, arsenic, chromium, cobalt, copper, lead, manganese, nickel, vanadium and their components). Conservatively assuming each metal comprises 100% of this limit could result in exceedances of the environmental standards. Where this theoretical risk exists, we require a more detailed assessment using more realistic emissions data.

Detailed Modelling Assessment Methodology

Step 1 - worst case screening

Make predictions based on assuming each metal is being emitted at 100% of the group ELV (i.e. 0.5 mg/m³). Where the PC of any metal exceeds 1% of a long-term or 10% of a short-term environmental standard we consider this a potential for significant pollution. Under these circumstances the predicted environmental concentration (PEC) should be compared against the environmental standard. If the PEC is greater than 100% of the environmental standard proceed to step 2.

Step 2 - Case specific screening

Use the maximum emissions data listed in Appendix A to revise your predictions. Where the PC of any metal exceeds 1% of a long-term or 10% of a short-term environmental standard the PEC should be compared against the environmental standard. This can be screened out where the PEC is less than 100% of the environmental standard.

We require Applicants to justify their use of any data lower than the maximum emission concentrations listed, i.e. where using the maximum emission concentration cannot be screened out. We also require applicants to provide evidence for any chromium VI background levels of less than 20% of total background chromium.

[1] Environment Agency and Department for Environment, Food & Rural Affairs, Environmental management – guidance Air emissions risk assessment for your environmental permit : https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit

Appendix A

Table A1 contains a summary of 34 measured values for each metal recorded at 18 MWI and Waste Wood Co-incinerators between 2007 and 2015. Note these data may differ from previous guidance notes.

Table A1- Monitoring data[a] from Municipal Waste Incinerators and Waste Wood Co-Incinerators

Pollutant	Measured Concentrations (mg/Nm³)			Percentage of the IED group 3 ELV		
	Max	Mean	Min[b]	Max	Mean	Min[b]
antimony	0.0115	0.0014	0.0001	2.3%	0.3%	0.02%
arsenic	0.0250	0.0010	0.0002	5.0%	0.2%	0.04%
total chromium	0.0920	0.0084	0.0002	18.4%	1.7%	0.04%
chromium VI[c]	1.3×10^{-4}	3.5×10^{-5}	2.3×10^{-6}	0.03%	0.01%	0.0005%
cobalt	0.0056	0.0011	0.0002	1.1%	0.2%	0.03%
copper	0.0290	0.0075	0.0019	5.8%	1.5%	0.4%
lead	0.0503	0.0109	0.0003	10.1%	2.2%	0.1%
manganese	0.0600	0.0168	0.0015	12.0%	3.4%	0.3%
nickel[d]	0.2200	0.0150	0.0025	44.0%	3.0%	0.5%
vanadium	0.0060	0.0004	0.0001	1.2%	0.1%	0.0%

[a] Note all data are referenced to 11% oxygen. Guidance on conversion between oxygen contents can be found in Part 7 Annex VI of the IED.

[b] Minimum values correspond in some cases to the detection limit.

[c] Chromium VI concentrations presented in the table are based on stack measurements for total chromium and measurements of the proportion of chromium VI (to total chromium) in Air Pollution Control (APC) residuals collected at the same plant.

[d] The two highest nickel concentrations are outliers being 44%, as above, and 27% of the ELV. The third highest concentration is 0.53 mg/Nm³ or 11% of the ELV.

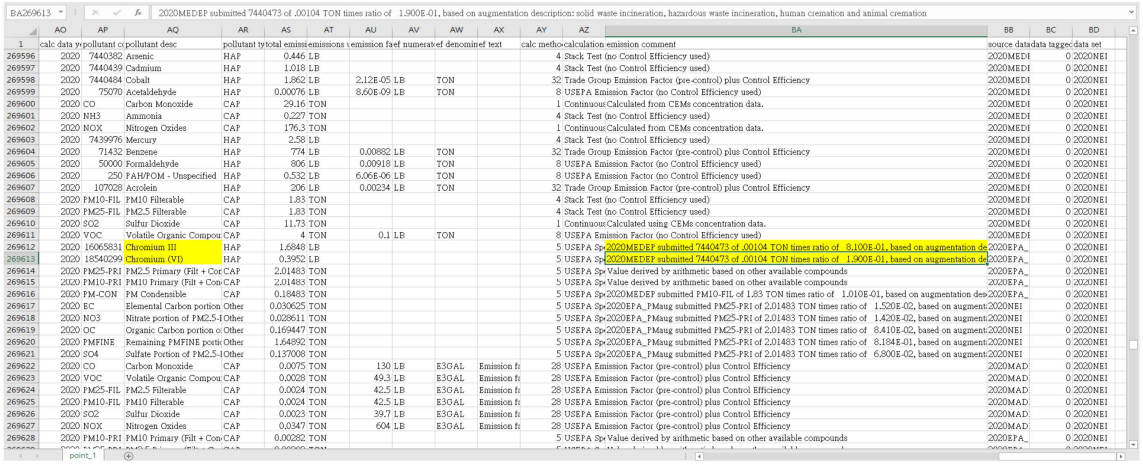
Source for footnote [5]

This file is downloaded from the USEPA 2020 National Emissions Inventory (NEI) Data website on 26/06/2024.

(https://gaftp.epa.gov/air/nei/2020/data_summaries/2020nei_facility_process_byregions.zip)

https://www.epa.gov/air-emissions-inventories/2020-national-emissions-inventory-nei-data 2020nei_facility_process_byregions.zip

point_1.csv



BA269613 | 2020MEDEF submitted 7440473 of .00104 TON times ratio of 1.900E-01, based on augmentation description: solid waste incineration, hazardous waste incineration, human cremation and animal cremation

	AO	AP	AQ	AR	AS	AT	AU	AV	AW	AX	AY	AZ	BA	BB	BC	BD
1	calc data yp	pollutant co	pollutant desc	pollutant ty	total emissi	emissions u	emission fac	ef numerato	ef denomina	ef text	calc metho	calculation	emission comment	source data	data tagge	data set
269596	2020	7440382	Arsenic	HAP	0.446	LB					4	Stack Test	(no Control Efficiency used)	2020MEDI	0	2020NEI
269597	2020	7440439	Cadmium	HAP	1.018	LB					4	Stack Test	(no Control Efficiency used)	2020MEDI	0	2020NEI
269598	2020	7440484	Cobalt	HAP	1.862	LB	2.12E-05	LB	TON		32	Trade Group	Emission Factor (pre-control) plus Control Efficiency	2020MEDI	0	2020NEI
269599	2020	75070	Acetaldehyde	HAP	0.00076	LB	8.60E-09	LB	TON		8	USEPA	Emission Factor (no Control Efficiency used)	2020MEDI	0	2020NEI
269600	2020	CO	Carbon Monoxide	CAP	29.16	TON					1	Continuous	Calculated from CEMs concentration data.	2020MEDI	0	2020NEI
269601	2020	NH3	Ammonia	CAP	0.227	TON					4	Stack Test	(no Control Efficiency used)	2020MEDI	0	2020NEI
269602	2020	NOX	Nitrogen Oxides	CAP	176.3	TON					1	Continuous	Calculated from CEMs concentration data.	2020MEDI	0	2020NEI
269603	2020	7439976	Mercury	HAP	2.58	LB					4	Stack Test	(no Control Efficiency used)	2020MEDI	0	2020NEI
269604	2020	71432	Benzene	HAP	774	LB	0.00882	LB	TON		32	Trade Group	Emission Factor (pre-control) plus Control Efficiency	2020MEDI	0	2020NEI
269605	2020	50000	Formaldehyde	HAP	806	LB	0.00918	LB	TON		8	USEPA	Emission Factor (no Control Efficiency used)	2020MEDI	0	2020NEI
269606	2020	250	PAH/POM - Unspecified	HAP	0.532	LB	6.06E-06	LB	TON		8	USEPA	Emission Factor (no Control Efficiency used)	2020MEDI	0	2020NEI
269607	2020	107028	Acrolein	HAP	206	LB	0.00234	LB	TON		32	Trade Group	Emission Factor (pre-control) plus Control Efficiency	2020MEDI	0	2020NEI
269608	2020	PM10-FIL	PM10 Filterable	CAP	1.83	TON					4	Stack Test	(no Control Efficiency used)	2020MEDI	0	2020NEI
269609	2020	PM25-FIL	PM2.5 Filterable	CAP	1.83	TON					4	Stack Test	(no Control Efficiency used)	2020MEDI	0	2020NEI
269610	2020	SO2	Sulfur Dioxide	CAP	11.73	TON					1	Continuous	Calculated using CEMs concentration data.	2020MEDI	0	2020NEI
269611	2020	VOC	Volatile Organic Compou	CAP	4	TON	0.1	LB	TON		8	USEPA	Emission Factor (no Control Efficiency used)	2020MEDI	0	2020NEI
269612	2020	16065831	Chromium III	HAP	1.6848	LB					5	USEPA	Sp 2020MEDEF submitted 7440473 of .00104 TON times ratio of 8.100E-01, based on augmentation de	2020EPA_	0	2020NEI
269613	2020	18540299	Chromium (VI)	HAP	0.3952	LB					5	USEPA	Sp 2020MEDEF submitted 7440473 of .00104 TON times ratio of 1.900E-01, based on augmentation de	2020EPA_	0	2020NEI
269614	2020	PM25-PRI	PM2.5 Primary (Filt + Con	CAP	2.01483	TON					5	USEPA	Sp Value derived by arithmetic based on other available compounds	2020EPA_	0	2020NEI
269615	2020	PM10-PRI	PM10 Primary (Filt + Con	CAP	2.01483	TON					5	USEPA	Sp Value derived by arithmetic based on other available compounds	2020EPA_	0	2020NEI
269616	2020	PM-CON	PM Condensible	CAP	0.18483	TON					5	USEPA	Sp 2020MEDEF submitted PM10-FIL of 1.83 TON times ratio of 1.010E-01, based on augmentation des	2020EPA_	0	2020NEI
269617	2020	EC	Elemental Carbon portion	Other	0.030625	TON					5	USEPA	Sp 2020EPA_PMaug submitted PM25-PRI of 2.01483 TON times ratio of 1.520E-02, based on augment	2020NEI	0	2020NEI
269618	2020	NO3	Nitrate portion of PM2.5-I	Other	0.029611	TON					5	USEPA	Sp 2020EPA_PMaug submitted PM25-PRI of 2.01483 TON times ratio of 1.420E-02, based on augment	2020NEI	0	2020NEI
269619	2020	OC	Organic Carbon portion o	Other	0.169447	TON					5	USEPA	Sp 2020EPA_PMaug submitted PM25-PRI of 2.01483 TON times ratio of 8.410E-02, based on augment	2020NEI	0	2020NEI
269620	2020	PMFINE	Remaining PMFINE portic	Other	1.64892	TON					5	USEPA	Sp 2020EPA_PMaug submitted PM25-PRI of 2.01483 TON times ratio of 8.184E-01, based on augment	2020NEI	0	2020NEI
269621	2020	SO4	Sulfate Portion of PM2.5-I	Other	0.137008	TON					5	USEPA	Sp 2020EPA_PMaug submitted PM25-PRI of 2.01483 TON times ratio of 6.800E-02, based on augment	2020NEI	0	2020NEI
269622	2020	CO	Carbon Monoxide	CAP	0.0075	TON	130	LB	E3GAL	Emission fa	28	USEPA	Emission Factor (pre-control) plus Control Efficiency	2020MAD	0	2020NEI
269623	2020	VOC	Volatile Organic Compou	CAP	0.0028	TON	49.3	LB	E3GAL	Emission fa	28	USEPA	Emission Factor (pre-control) plus Control Efficiency	2020MAD	0	2020NEI
269624	2020	PM25-FIL	PM2.5 Filterable	CAP	0.0024	TON	42.5	LB	E3GAL	Emission fa	28	USEPA	Emission Factor (pre-control) plus Control Efficiency	2020MAD	0	2020NEI
269625	2020	PM10-FIL	PM10 Filterable	CAP	0.0024	TON	42.5	LB	E3GAL	Emission fa	28	USEPA	Emission Factor (pre-control) plus Control Efficiency	2020MAD	0	2020NEI
269626	2020	SO2	Sulfur Dioxide	CAP	0.0023	TON	39.7	LB	E3GAL	Emission fa	28	USEPA	Emission Factor (pre-control) plus Control Efficiency	2020MAD	0	2020NEI
269627	2020	NOX	Nitrogen Oxides	CAP	0.0347	TON	604	LB	E3GAL	Emission fa	28	USEPA	Emission Factor (pre-control) plus Control Efficiency	2020MAD	0	2020NEI
269628	2020	PM10-PRI	PM10 Primary (Filt + Con	CAP	0.00282	TON					5	USEPA	Sp Value derived by arithmetic based on other available compounds	2020EPA_	0	2020NEI

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