Appendix 7.2: Stack Height Determination

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Stack Height Determination

7.2.1   A stack height determination has been undertaken to establish the height at which there is minimal additional environmental benefit associated with the cost of further increasing the height of the stack. The Environment Agency (EA) removed their detailed guidance, Horizontal Guidance Note EPR H1 [i], for undertaking risk assessments on 1 February 2016; however, the approach used here is consistent with that EA guidance which required the identification of *"an option that gives acceptable environmental performance but balances costs and benefits of implementing it."*

Methodology

7.2.2   Model simulations have been run using ADMS 5 to determine what stack height is required to provide adequate dispersion/dilution and to overcome local building wake effects.

7.2.3   The stack height determination considers ground level concentrations over the averaging periods relevant to the air quality assessment, together with the full range of all likely meteorological conditions through the use of five years (2011 to 2015) of hourly sequential meteorological data from Charlwood, near Gatwick. The model was run for a range of stack heights between 50 m and 100 m, in 5 m increments.

7.2.4   For the purposes of stack height determination, the modelled domain was 10 km by 10 km centred on the proposed development and with a grid spacing of 100 m. Results have been reported for the location where the highest concentration is predicted and for the worst-case meteorological conditions.

Stack Height Determination Results

7.2.5   The stack height modelling results have been analysed in two stages:

-   **Stage 1** - The maximum predicted Process Contributions (PCs) have been plotted against height to determine if there is a height at which no benefit is gained from increases in stack heights.

-   Graph 7.2.1 compares the maximum PCs when the plant is operating at the long-term concentration limits set out in the EU Industrial Emissions Directive (IED) for waste operations.

-   Graph 7.2.2 compares the maximum PCs when the plant is operating at the short-term concentration limits set out in the EU IED for waste operations.

Graph 7.2.1: Maximum Predicted Process Contributions vs Stack Height at Long-term IED Limits
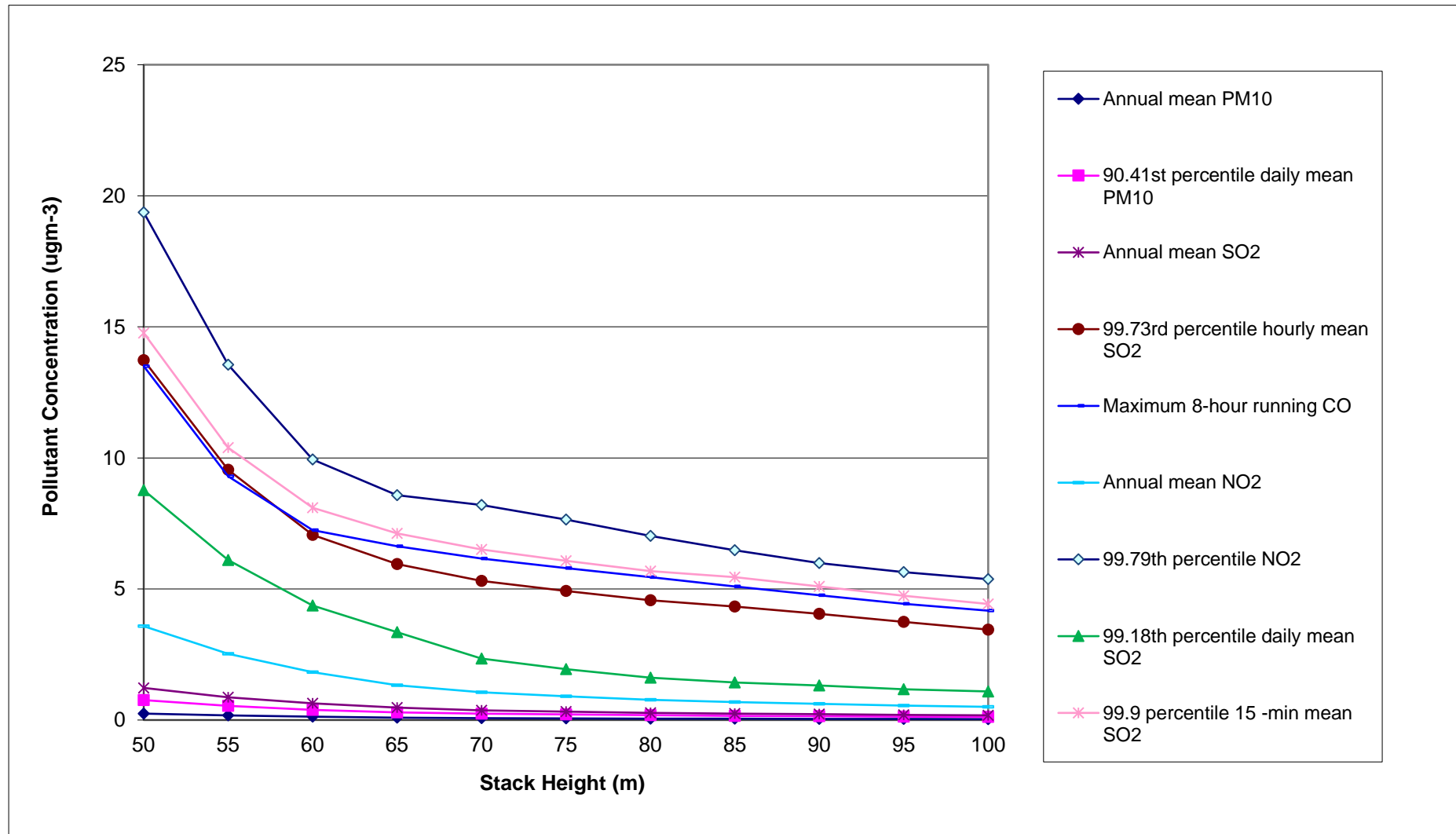
Graph 7.2.2: Maximum Predicted Process Contributions vs Stack Height at Short-term IED Limits
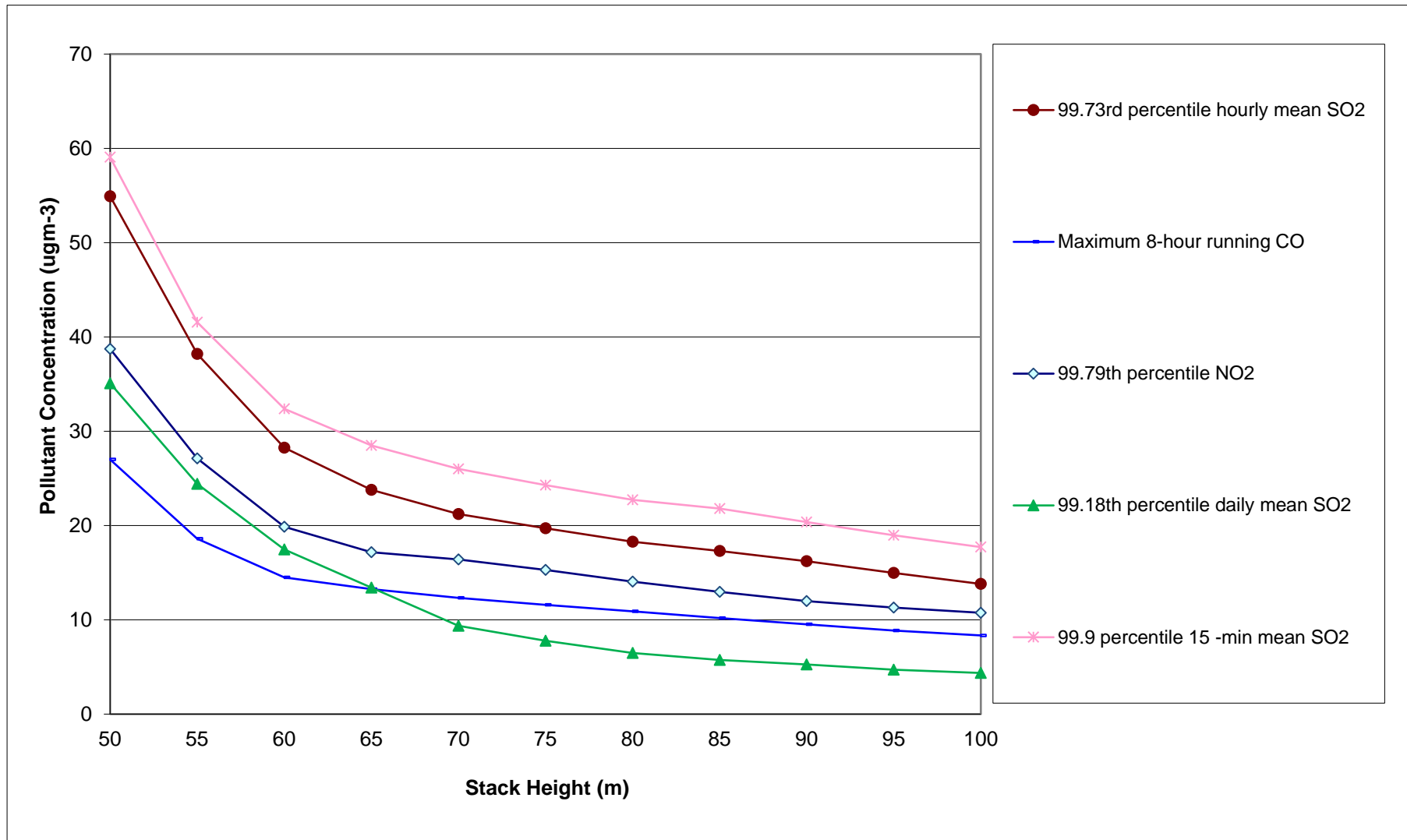
7.2.6   The graphs indicate that there are some improvements above 55 m but there is little change in the maximum predicted process contribution for stack heights above 80 m.

7.2.7   **Stage 2** – The on-line EA guidance is for risk assessments and provides details for screening out substances for detailed assessment. In particular, it states that:

"To screen out a PC for any substance so that you don't need to do any further assessment of it, the PC must meet both of the following criteria:

▪   *the short-term PC is less than 10% of the short-term environmental standard; and*

▪   *the long-term PC is less than 1% of the long-term environmental standard.*

If you meet both of these criteria you don't need to do any further assessment of the substance.

If you don't meet them you need to carry out a second stage of screening to determine the impact of the PEC."

7.2.8   The PEC refers to the Predicted Environmental Concentration calculated as the PC added to the Ambient Concentration (AC).

7.2.9   The on-line EA guidance continues by stating that:

"You must do detailed modelling for any PECs not screened out as insignificant."

It then states that further action may be required where:

"your PCs could cause a PEC to exceed an environmental standard (unless the PC is very small compared to other contributors – if you think this is the case contact the Environment Agency)

the PEC is already exceeding an environmental standard"

On that basis, the stack height has been determined as the height at which:

▪   The impacts are not considered significant if the short-term PC is less than 10 % of the short-term Environmental Assessment Level (EAL);

▪   The impacts are not considered significant if the long-term PC is less than 1 % of the long-term EAL; and

▪   The impacts are not considered significant if the PEC is below the EAL.

▪   The EAL refers to the AQS air quality objective and the EU limit value.

7.2.10   Table 7.2.1 provides the maximum predicted PC when the plant is operating at the long-term concentration limits set out in the EU IED for waste operations. Table 7.2.2 provides the maximum predicted PC as a percentage of the EAL when the plant is operating at the long-term concentration limits set out in the EU IED for waste operations.

7.2.11   Table 7.2.3 provides the maximum predicted PC when the plant is operating at the short-term concentration limits set out in the EU IED for waste operations. Table 7.2.4 provides the maximum predicted PC as a percentage of the EAL when the plant is operating at the short-term concentration limits set out in the EU IED for waste operations.

Table 7.2.1 Maximum Predicted Process Contributions (µg.m^{-3}) at each Stack Height Modelled – Long-term IED Concentration Limits

Height (m)	Concentration (µg.m^{-3})									
	Annual-mean PM_{10}	90.41st percentile daily mean PM_{10}	Maximum hourly HCl	Annual mean SO_2	99.73rd percentile hourly mean SO_2	Maximum 8-hour running CO	Annual-mean NO_2	99.79th percentile NO_2	99.18th percentile daily mean SO_2	99.9th percentile 15-minute mean SO_2
50	0.25	0.76	3.97	1.23	13.73	13.50	3.58	19.36	8.77	14.76
55	0.17	0.54	3.53	0.87	9.55	9.29	2.53	13.55	6.10	10.39
60	0.13	0.39	3.12	0.63	7.06	7.24	1.83	9.94	4.37	8.09
65	0.09	0.29	2.75	0.47	5.95	6.63	1.33	8.58	3.35	7.12
70	0.07	0.24	2.52	0.37	5.30	6.16	1.06	8.20	2.34	6.50
75	0.06	0.21	2.32	0.32	4.93	5.80	0.90	7.65	1.94	6.07
80	0.06	0.18	1.50	0.28	4.57	5.45	0.77	7.03	1.62	5.68
85	0.05	0.16	1.38	0.25	4.33	5.10	0.69	6.48	1.44	5.45
90	0.04	0.15	1.32	0.22	4.05	4.76	0.62	5.99	1.31	5.09
95	0.04	0.13	1.26	0.20	3.74	4.43	0.56	5.64	1.18	4.74
100	0.04	0.12	1.20	0.18	3.45	4.17	0.50	5.37	1.09	4.43

Table 7.2.2 Maximum Predicted Process Contributions as a Percentage of the Relevant EAL at each Stack Height Modelled – Long-term IED Concentration Limits

Environmental Assessment Level ($\mu g.m^{-3}$)	Percentage of Environmental Assessment Level (%)									
	40	50	750	50	350	10000	40	200	125	266
Height (m)	Annual-mean PM_{10}	90.41st percentile daily mean PM_{10}	Maximum hourly HCl	Annual mean SO_2	99.73rd percentile hourly mean SO_2	Maximum 8-hour running CO	Annual mean NO_2	99.79th percentile NO_2	99.18th percentile daily mean SO_2	99.9th percentile 15-minute mean SO_2
50	0.6	1.5	0.5	2.5	3.9	0.1	8.9	9.7	7.0	5.6
55	0.4	1.1	0.5	1.7	2.7	0.1	6.3	6.8	4.9	3.9
60	0.3	0.8	0.4	1.3	2.0	0.1	4.6	5.0	3.5	3.0
65	0.2	0.6	0.4	0.9	1.7	0.1	3.3	4.3	2.7	2.7
70	0.2	0.5	0.3	0.7	1.5	0.1	2.6	4.1	1.9	2.4
75	0.2	0.4	0.3	0.6	1.4	0.1	2.3	3.8	1.6	2.3
80	0.1	0.4	0.2	0.6	1.3	0.1	1.9	3.5	1.3	2.1
85	0.1	0.3	0.2	0.5	1.2	0.1	1.7	3.2	1.2	2.0
90	0.1	0.3	0.2	0.4	1.2	0.0	1.5	3.0	1.1	1.9
95	0.1	0.3	0.2	0.4	1.1	0.0	1.4	2.8	0.9	1.8
100	0.1	0.2	0.2	0.4	1.0	0.0	1.3	2.7	0.9	1.7

Cells are shaded grey where the predicted process contribution is above 1% of EAL for long-term average periods and 10% for short-term average periods.

Table 7.2.3 Maximum Predicted Process Contributions (µg.m⁻³) at each Stack Height Modelled – Short-term IED Concentration Limits

Height (m)	Concentration (µg.m⁻³)					
	Maximum hourly HCl	99.73rd percentile hourly mean SO_2	Maximum 8-hour running CO	99.79th percentile NO_2	99.18th percentile daily mean SO_2	99.9th percentile 15-minute mean SO_2
50	23.8	54.9	27.0	38.7	35.1	59.1
55	21.2	38.2	18.6	27.1	24.4	41.6
60	18.7	28.3	14.5	19.9	17.5	32.4
65	16.5	23.8	13.3	17.2	13.4	28.5
70	15.1	21.2	12.3	16.4	9.4	26.0
75	13.9	19.7	11.6	15.3	7.8	24.3
80	9.0	18.3	10.9	14.1	6.5	22.7
85	8.3	17.3	10.2	13.0	5.8	21.8
90	7.9	16.2	9.5	12.0	5.3	20.4
95	7.6	15.0	8.9	11.3	4.7	19.0
100	7.2	13.8	8.3	10.7	4.4	17.7

Table 7.2.4 Maximum Predicted Process Contributions as a Percentage of the Relevant EAL at each Stack Height Modelled – Short-term IED Concentration Limits

Level Environmental Assessment (µg.m⁻³)	Percentage of Environmental Assessment Level (%)					
	750	350	10000	200	125	266
Height (m)	Maximum hourly HCl	99.73rd percentile hourly mean SO_2	Maximum 8-hour running CO	99.79th percentile NO_2	99.18th percentile daily mean SO_2	99.9th percentile 15-minute mean SO_2
50	3.2	15.7	0.27	19.4	28.1	22.2
55	2.8	10.9	0.19	13.6	19.5	15.6
60	2.5	8.1	0.14	9.9	14.0	12.2
65	2.2	6.8	0.13	8.6	10.7	10.7
70	2.0	6.1	0.12	8.2	7.5	9.8
75	1.9	5.6	0.12	7.6	6.2	9.1
80	1.2	5.2	0.11	7.0	5.2	8.5
85	1.1	4.9	0.10	6.5	4.6	8.2
90	1.1	4.6	0.10	6.0	4.2	7.7
95	1.0	4.3	0.09	5.6	3.8	7.1
100	1.0	3.9	0.08	5.4	3.5	6.7

Cells are shaded grey where the predicted process contribution is above 10% of the EAL.

Discussion

7.2.12   The results in Table 7.2.2 indicate that there are no heights below 100 m at which the impacts can be screened-out as insignificant based on the PC alone when the plant is operating at long-term IED concentration limits. In particular, the maximum predicted PC for annual-mean NO_2 is above 1% at all heights. If the maximum predicted PC for annual-mean NO_2 is disregarded, the maximum PCs are below 1% and 10% for long- and short-term impacts respectively at heights of 60 m and above.

7.2.13   The results in Table 7.2.4 indicate that the maximum predicted process contributions are all below 10% for short-term impacts at heights of 70 m and above, when the plant is operating at short-term IED concentration limits.

7.2.14   Returning to Table 7.2.1, the maximum predicted PC for annual-mean NO_2 at 95 m, is 0.56 $\mu g.m^{-3}$. The Defra mapped NO_2 concentration estimate for the grid square of the Application Site is 11.9 $\mu g.m^{-3}$. When the maximum predicted PC for annual-mean NO_2 is added to the Defra mapped NO_2 AC estimate, the total PEC is 12.46 $\mu g.m^{-3}$. This is well below the EAL of 40 $\mu g.m^{-3}$ for NO_2. Moreover, it is more than half of the EAL. On that basis, and according to the EA guidance, the impacts would not be considered significant at 95 m.

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i   Environment Agency (2010) Environmental Permitting Regulations (EPR) – H1 Environmental Risk Assessment, Annex K