

STACK HEIGHT CALCULATION using HMIP Guidance Note D1

Contract Guildford Crematorium Temporary Installation

Contract No Including 350 mg/m³ NO_x, assuming 35% is NO₂

Comment Facultatieve Technologies Unabated Cremator Flue Gas Treatment System

Operator Tony Readman

Date 11-Mar-19

Building dimensions (m)		Height (m)	Width (m)	Dist (m)	Within 5Um
This is the building attached to the stack		3.5	6.1		
Other Buildings	Rear of crematory	3.5	15	10.6	yes
	Crematory	8	10	16.7	no
	Chapel	10.5	30	24	no
	Closest Cottage (garage corner)	3.5	7.5	28	no

Summarised Calculation Result

Minimum height required 6.0 m

5Um 10.8 m

For multiple buildings, or for one building higher than its width, within a radius of 5U

Area category used in this calculation (where applicable)

4 Partially developed area

Stack diameter or circular equivalent mm 420

	Flue 1	Flue 2	Flue 3	Flue 4	Flue 5
Gas volume (Am ³ /h)	5152				
Moisture content (% v/v)	7.51				
Gas temperature (°C)	375.00				
Oxygen content (% dry v/v)	16.84				
Efflux velocity (m/s)	10.33				
1)<3d, 2)<Um/2, 3)<5Um, 4)>5Um	1				

Pollutants	15				
(mg/m ³ @ 11% O ₂ dry)	PG5/2(12)				
Hydrogen chloride	200				
Sulphur dioxide	80				
Hydrogen Fluoride					
Nitrogen dioxide	123				
Nitric oxide	148				
Carbon monoxide	100				
Particulate matter	80				
Ozone					
Cadmium					
Mercury					
Metals					
Volatile Organic Compounds	20				

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Background conc	User Defined			
Hydrogen chloride		0.0161	mg/m ³	from D1 tables for area 4
Sulphur dioxide		0.003	mg/m ³	from DEFRA, 2019
Hydrogen Fluoride		0.0098	mg/m ³	from D1 tables for area 4
Nitrogen dioxide		0.0517	mg/m ³	from DEFRA, 2019
Nitric oxide		0.1000	mg/m ³	from D1 tables for area 4
Carbon monoxide		0.1392	mg/m ³	from DEFRA, 2019
Particulate matter		0.0126	mg/m ³	from DEFRA, 2019
Ozone		0.1300	mg/m ³	from D1 tables for area 4
Cadmium			mg/m ³	
Mercury		1.545E-06	mg/m ³	from CEH
Metals		6.343E-06	mg/m ³	from CEH
Volatile Organic Compounds		0.0003	mg/m ³	from DEFRA, 2019

Short term guideline (mg/m ³)	User Defined	1	2	3	4	5
Hydrogen chloride	0.750	0.101	0.101	0.101	0.101	0.101
Sulphur dioxide	0.350	0.440	0.440	0.440	0.440	0.440
Hydrogen Fluoride	0.160	0.063	0.063	0.063	0.063	0.063
Nitrogen dioxide	0.200	0.200	0.200	0.200	0.200	0.200
Nitric oxide	4.400	1.000	1.000	1.000	1.000	1.000
Carbon monoxide	14.286	57.000	57.000	57.000	57.000	57.000
Particulate matter	0.085	0.300	0.300	0.300	0.300	0.300
Ozone	0.171	0.180	0.180	0.180	0.180	0.180
Cadmium	0.003	0.001	0.001	0.001	0.001	0.001
Mercury	0.008	0.004	0.004	0.004	0.004	0.004
Metals	0.000					
Volatile Organic Compounds	0.353					

Discharge rate g/s	Flue 1	Flue 2	Flue 3	Flue 4	Flue 5
Gas volume (Nm ³ /s @11% O ₂)	0.229	0.000	0.000	0.000	0.000
Hydrogen chloride	0.046	0.000	0.000	0.000	0.000
Sulphur dioxide	0.018	0.000	0.000	0.000	0.000
Hydrogen Fluoride	0.000	0.000	0.000	0.000	0.000
Nitrogen dioxide	0.028	0.000	0.000	0.000	0.000
Nitric oxide	0.034	0.000	0.000	0.000	0.000
Carbon monoxide	0.023	0.000	0.000	0.000	0.000
Particulate matter	0.018	0.000	0.000	0.000	0.000
Ozone	0.000	0.000	0.000	0.000	0.000
Cadmium	0.000	0.000	0.000	0.000	0.000
Mercury	0.000	0.000	0.000	0.000	0.000
Metals	0.000	0.000	0.000	0.000	0.000
Volatile Organic Compounds	0.005	0.000	0.000	0.000	0.000

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Pollution index	Flue 1	Flue 2	Flue 3	Flue 4	Flue 5
Hydrogen chloride	62.359	0.000	0.000	0.000	0.000
Sulphur dioxide	52.755	0.000	0.000	0.000	0.000
Hydrogen Fluoride	0.000	0.000	0.000	0.000	0.000
Nitrogen dioxide	189.043	0.000	0.000	0.000	0.000
Nitric oxide	7.896	0.000	0.000	0.000	0.000
Carbon monoxide	1.618	0.000	0.000	0.000	0.000
Particulate matter	253.886	0.000	0.000	0.000	0.000
Ozone	0.000	0.000	0.000	0.000	0.000
Cadmium	0.000	0.000	0.000	0.000	0.000
Mercury	0.000	0.000	0.000	0.000	0.000
Metals	0.000	0.000	0.000	0.000	0.000
Volatile Organic Compounds	12.993	0.000	0.000	0.000	0.000

	Flue 1	Flue 2	Flue 3	Flue 4	Flue 5
Total acid indices	115.114	0.000	0.000	0.000	0.000
Overall index per flue (m ³ /s)	253.886	0.000	0.000	0.000	0.000
Heat released (MW) {0.03-100}	0.278	0.000	0.000	0.000	0.000
Factor a	-1.004				
Factor b	0.487				
Momentum (m ⁴ /s ²) {1-20000}	6.455	0.000	0.000	0.000	0.000
Factor x	-2.873				
Factor y	5.395				
Factor z	-2.689				

Calc.buoyancy height 1.47 m

Minimum buoyancy height 1.53 m

Uncorr.buoyancy height $U_b =$ 1.53 m

Calc.momentum height 2.16 m

Minimum momentum height 1.49 m

Uncorr.momentum height $U_m =$ 2.16 m

Min(U_b, U_m) 1.53 m

U_m/U_b 1.41 m

Calculated height 5.02 m

Corrected height (m) 5.02 m

Minimum stack height required is 6.00 m

"5 U_m " (m) 10.79 m

Efflux Velocity (ref D1 - 6.1.1)	Flue 1 m/s	Flue 2 m/s	Flue 3 m/s	Flue 4 m/s	Flue 5 m/s
Discharge Heat release	11.0	0.0	0.0	0.0	0.0
Discharge Momentum	9.8	0.0	0.0	0.0	0.0
Minimum Efflux Velocity Required	11.0	0.0	0.0	0.0	0.0

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Contract Guildford Crematorium Temporary Installation
Contract No
Comment Facultative Technologies Unabated Cremator Flue Gas Treatment System
Operator Tony Readman
Date 11-Mar-19

Data sources used in the calculation

Crematorium dimensions, drawings and geographic location

Building dimensions were taken from clients architect drawings and/or actual measurement

Geographic location is from clients data and, internet based, Ordnance Survey published maps

The crematorium location is taken as: X 498598 (standard 6 figure OS reference)
Y 145883 (standard 6 figure OS reference)

Flue Gas Volume and conditions

Flue gas volume, temperature, oxygen content, moisture content and efflux velocity are derived from in house heat and mass balance calculations.

Gas flows are based on maximum cremation rate without burner input

Pollutant emission levels

Emission concentrations are assumed to be at the maximum allowed, for regulated substances, under the relevant legislation or guidance.

Cremation equipment is covered by Process Guidance Note 5/2(12)

Area Category

D1 include five area types for estimation of background pollutant levels.

These are generally used for pollutant species where no other information is available

The D1 category used is area 4, Partially developed area



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Background concentrations

Background concentration data is available, from DEFRA, for the following species:

Sulphur dioxide	2001 data
Nitrogen dioxide	2019 data
Carbon monoxide	2001 data
Particulate matter	2019 data
Mercury	CEH Annual Mean, Wytham Wood
Metals	CEH Annual Mean, Wytham Wood
Volatile Organic Compounds	2001 data

The remaining species use the relevant data from D1, using the area category

Sulphur dioxide, Nitrogen dioxide, carbon monoxide, particulate matter and volatile organic compounds

Data source: UK Air Quality Archive

<https://uk-air.defra.gov.uk/data/laqm-background-maps?year=2013>

Guildford 115

Local_Auth_Code 115

Grid Reference X 498500 (standard 6 figure OS reference)

(1km square centre) Y 146500 (standard 6 figure OS reference)

geo_area 6

EU_zone_agglom_01 31

Distance from subject site 625 m

Sulphur dioxide

Nitrogen dioxide

Carbon monoxide

Adjusted to 2019 levels

Particulate matter

Volatile Organic Compounds

Assumed as Benzene

Adjusted to 2019 levels

Mercury and other metals

Data source: UK Pollutant Deposition portal <http://www.uk-pollutantdeposition.ceh.ac.uk/>

Wytham Wood

Grid Reference X 446150 (standard 6 figure OS reference)

Y 208150 (standard 6 figure OS reference)

Distance from subject site 81 km

Mercury average (2005 & 2006)

Metals (as lead) average (2004 to 2007)

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Short Term Guidelines

Data source:

<https://www.gov.uk/guidance/air-emissions-risk-assessment-for-your-environmental-permit>

Hydrogen chloride	750 $\mu\text{g}/\text{m}^3$	1 hourly EAL
Sulphur dioxide	350 $\mu\text{g}/\text{m}^3$	1 hourly AAD Limit value
Hydrogen Fluoride	160 $\mu\text{g}/\text{m}^3$	1 hourly EAL
Nitrogen dioxide	200 $\mu\text{g}/\text{m}^3$	1 hourly TG16 Table 1.1
Nitric oxide	4400 $\mu\text{g}/\text{m}^3$	1 hourly EAL
Carbon monoxide	14286 $\mu\text{g}/\text{m}^3$	8 hourly TG16 Table 1.1
Particulate matter	85 $\mu\text{g}/\text{m}^3$	Daily Mean, converted to hourly basis
Ozone	171 $\mu\text{g}/\text{m}^3$	Short Term EAL converted to hourly
Cadmium	2.54 $\mu\text{g}/\text{m}^3$	Short Term EAL converted to hourly
Mercury	7.5 $\mu\text{g}/\text{m}^3$	1 hourly EAL
Metals (ass. Lead)	0.42 $\mu\text{g}/\text{m}^3$	Short Term EAL converted to hourly
VOC (ass. Benzene)	353 $\mu\text{g}/\text{m}^3$	1 hourly EAL



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Cremation & Incineration Equipment

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