

**DRAFT PRIVATE AND CONFIDENTIAL**

**Guildford Crematorium Stack Discharge Height Error Internal Investigation**

**Date: September 2020**

**Author: [an officer]**

**1.0 Background**

**1.1 Design Process:**

The redevelopment of Guildford Crematorium took place between 2014 and 2020 by Guildford Borough Council (GBC). The design team, led by **[a company]** were appointed in Spring 2016 following a competitive procurement process. This included the appointment of the lead Architect **[a company]**, Structural and Civil Engineer **[an individual]**, M&E Engineer **[a company]**, Landscape Architect **[a company]**, CDM consultant **[a company]**, Crematoria Consultant **[an individual]**, Combustion Consultant **[a company]**.

The initial phases of the project covered feasibility work determining whether to rebuild or refurbishing the crematorium (RIBA – Stages 0-2). Following this in November 2016, the Councils Executive approved a decision to rebuild Guildford Crematorium and install temporary facilities to ensure services could continue whilst the rebuild took place on the existing footprint.

Following this decision concept designs were taken to the developed design stage (RIBA 3) and as part of this procurement of the cremator supplier took place to support the building design process prior to submitting a planning application. This included a supplier engagement day to inform the development of the Cremator, Abatement and Associated Equipment specification, building design and a formal procurement process.

The appointment covered three contracts (Appendix 1),

- 1) Pre contract Service Agreement to inform the technical design
- 2) Supply, installation and commissioning which would then be novated to the main construction contractor when appointed
- 3) On going maintenance and support term contract for the anticipated lifecycle of the cremators. (15 +5 years)

Within this contract aside from an overarching requirement to comply with the Secretary of States Process Guidance Note – Statutory Guidance for Crematoria (PG5/2 (2012)) and associated legislation, was a requirement to input to the design of the chimney and emissions stacks as follows;

*3.2.30 Chimney/Emissions Stack Detailed drawings of the proposed chimney/emissions stack must be provided with the tender submission, along with a supporting D1 calculation. Iterations of design will be required, in collaboration with the Design Team, to understand the interface between the stack and surrounding cladding and/or louvres.*

Tenders were returned from three suppliers with the contract being awarded to **[a company]** in July 2017 as the Most Economically Advantageous Tender using an 80:20Quality to Price ratio.

Post tender **[a company]** offered an option to include NO<sub>x</sub> abatement which the Council accepted and varied the contract accordingly to voluntarily improve emissions from the crematorium, and not as required by PG5/2 (2012).

The design was developed with an eventual planning application submitted in July 2017 and approval received on 5<sup>th</sup> October 2017 from the Councils Planning Committee. The planning application included stacks protruding from a pop up roof surrounded by louvres to limit stack presence. The louvres were introduced through discussion between GBC as the client for the project and the architect to minimise the visual appearance of the stack as a visible chimney, a sight that mourners can find distressing.

Following submission to the Local Planning Authority the project then went on to Technical Design (RIBA 4) where the stack height and roof design was further examined bringing in the process of environmental permitting to ensure compliance as set out below.

### **1.2 Permit to Cremate**

Local Authorities regulate crematoria under the Environmental Permitting (England and Wales) Regulations 2010 following guidance from DEFRA. In GBC the monitoring of emissions and emissions stacks is outsourced to **[a company]** by the Environmental Health service.

Aside from the planning process an application was made for a variation to the 'permit to cremate' from the Environmental Health Service as it involved the installation of new cremators and abatement plant.

The application was for the Variation of a Part B Permit under the Pollution Prevention and Control Act and 1999 Environmental Permitting (England and Wales) Regulations 2016. The regulatory process determines whether a crematorium is compliant in terms of stack height and emissions.

To prepare the variation the Councils Bereavement Service appointed **[a company]** to submit the application to Environmental Health taking account of the proposed design and operation and undertake a D1 Calculation to ensure legislative compliance as per HMIP Technical Guidance Note (Dispersion) D1; Guidelines on Discharge Stack Heights for Polluting Emissions (HMIP D1).

In preparing the application discussions took place between the operator and regulator as the introduction of the louvres presented some challenges in terms of building design versus the technical requirements of stack design and dispersal of emissions. **[a company]** provided GBC options to ensure a correct stack height in relation to the building and stack design (Appendix 1a) on 6 November 2017. Discussions were then held between the regulator, design team, operator, and, **[a company]** on the options and as to whether Air Dispersion Modelling would be accepted as an alternative to D1 to assess whether the louvres had any impact, this was declined by the regulator as the louvres as proposed could not comply with Para 6.1.2 of D1 and as such it was not consistent with D1 for stack height calculations for crematoria. Therefore, the louvres were removed and the pop up roof design (where the roof structures extend from the single storey building) amended which required a Non Material Amendment (NMA) to be submitted to the local planning authority.

The pop up roofs were one element of Contractor Design Portions (CDP's) awarded as part of the main contractor package which commenced in May 2018. This was consequently awarded to **[a company]** by the main contractor giving rise to further design development with the design team in 2018 to 2019.

Upon completion of the design process for this part of the building the NMA was submitted on 26 March 2019 to the local planning authority. The NMA was approved on 18 April 2019 under delegated authority.

This also led to a part B variation application being submitted by **[a company]** following a period of design development on behalf of the Council. This application was submitted on 13 May 2019 (Appendix 2). The application was then reviewed by the regulator using the consultant **[a company]** and a revised permit issued on 11 July 2019 (Appendix 3).

The wording of this permit in relation to Nitrogen dioxide emissions was contested by **[an individual]** at a meeting with Guildford Borough Council on 2 March 2020 and the permit was varied on 31 March 2020 (Appendix 4) in relation to how Nitrogen dioxides were expressed in the permit; (From Nitrogen dioxide to Nitrogen oxides [NO+NO<sub>2</sub>] expressed as Nitrogen dioxide equivalent) Table B - Emissions Limits and Controls.

On the 17 March 2020 Regulatory Services requested legal advice from Counsel via the Council's Solicitor. The advice was received on the 23 March 2020 and implemented as follows:

- Decision Notice A dated 4 May 2020
- Environmental Permitting Regulations 2016, Permit reference GD6P4, Installation Type PG5/2 Crematoria, Guildford Crematorium, New Pond Road, Godalming, Surrey, GU7 3DB
- Conditions relating to Permit GD6 P4 issued 31-03-2020
- Decision Notice B dated 11 June 2020
- Environmental Permitting Regulations 2016, Permit reference GD6P4, Installation Type PG5/2 Crematoria, Guildford Crematorium, New Pond Road, Godalming, Surrey, GU7 3DB
- Issue of new permit Permit GD6 P5 and variation GD V5 dated 10-06-2020 to replace Permit GD6 P4 issued 31-03-2020

The Council as operator formally notified a possible error in the stack height calculation on the 23 April 2020 to the Council's Environmental Health service (Appendix 5) following enquiries from **[an individual]**, regarding the input data in the D1 Calculation. The potential error identified related to a dimension used from the pop up roof on top of the crematory which is used to derive the T<sub>m</sub> value in the D1 calculation. The T<sub>m</sub> figure is part of the D1 calculation which relates to buildings that are taller than they are wide to provide a corrected discharge height.

The T<sub>m</sub> figure is part of the D1 calculation which relates to the basic dimensions of buildings. The value of T is calculated for each relevant building.

$T = \text{building height} + 1.5 \times \text{the smaller of the building height and its width.}$

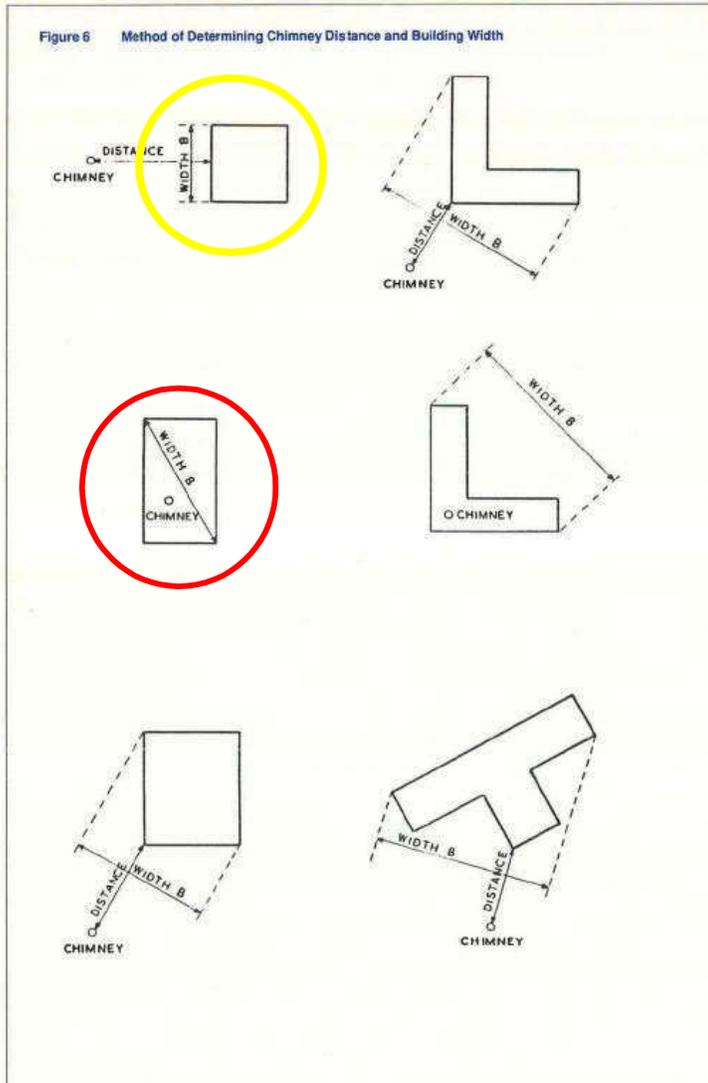
T<sub>m</sub> is the maximum value of T for the relevant buildings.

For single buildings, wider than their height, the value of T<sub>m</sub> is simply  $2.5 \times \text{building height.}$

A dimension referred to as 'width' in figure 6 in the HMIP D1 guidance used a value of 3.17 metres to determine the width of the pop up roof (highlighted yellow below), whereas upon reviewing the guidance, the hypotenuse dimension across the pop up roof should have been used instead (highlighted red below), which equates to 4.672 metres.

Based on a finished pop up roof height of 7m, excluding the raised lip of 300mm on three sides of the pop up as less than 1% of the roof area as used by **[a company]**, this increases the value of T<sub>m</sub> from 11.755m to 14.008m. Inclusion of the raised lip, increasing the pop up roof height to 7.3m, further increases the value of T<sub>m</sub> to 14.308m

Figure 6 Method of Determining Chimney Distance and Building Width



This has the effect of increasing the final corrected discharge height to 8.58 metres, or when rounded up takes the height up to 9 metres. This adds a further 0.9 metres to the current stack height.

**[a company]** issued a revised D1 calculation, dated 18 March 2020, to support the increased stack height. The calculation was submitted in **[a company]**'s normal format with parallel results issued in the formats used by both **[an individual]** and **[a company]** to allow easier checking by all parties. The revised D1 calculation was submitted to the Environmental Health Team (Appendix 6) **[a company]**'s calculation is shown in parallel to **[an individual]**'s format to show differences arising with a view to seeking clarity on the error. **[a company]**'s calculation was not submitted as a stand alone calculation because of this.

Environmental Health used an external consultancy **[a company]** (Appendix 7) for an independent review of the calculation. The calculations were agreed as corrected and a varied permit was issued on 10 June 2020 with a condition to see the stack height increased to 9 metres (Appendix 8)

Following this a planning application was registered on 25 June 2020 for the amended stack height.

On 15 September 2020 prior to the planning application being heard at the committee, advice was sought by the Environmental Health Service from **[an individual]**, Advisor Local Authority Unit, Environment Agency, regarding the appropriate course of action if the permit condition 53 was not met by the due date. **[an individual]** replied on the 16 September 2020.

The application was approved by the planning committee on 16 September 2020 (Appendix 9).

## **2.0 Where did the error occur in the D1 Calculation**

### **2.1 HMIP D1**

The D1 calculation requires the following of the HMIP Technical Guidance Note (Dispersion) D1; Guidelines on Discharge Stack Heights for Polluting Emissions (HMIP D1). There are a number of inputs required and some variable factors to assess to make the calculation. For example, the dimensions of the building, proximity of other buildings, air quality and geographical factors. It is not unusual that some of these factors change as the design process happens and input data is updated and issued by relevant authorities for example DEFRA.

2.9 of HMIP D1 guidance states '*Heights determined using the method should be regarded as a guide rather than a mathematically precise definition of discharge stack height. The conclusion may need to be modified in the light of particular local circumstances or of practical experience*'.

### **2.2 [a company]**

**[a company]** were appointed as the successful "Specialist/sub-contractor to the Main Contractor" to supply the cremation and abatement equipment as defined in the Scope of Works section of the GBC- 013093 – Invitation to Tender. **[a company]** produced the initial D1 Calculation as part of their tender response. The invitation to tender and subsequent contract required **[a company]** to assist in the design iteration regarding the interface between the stack and surrounding cladding and/or louvres. This went through various iterations as the design developed in the lead up to submission of the permit to cremate. **[a company]** produced several D1 calculations, five of which were issued to GBC. One of the five was not issued directly to GBC, but passed on to GBC by **[a company]**. An example was provided at tendersubmission dated 5 June 2017 (Appendix 10), revised calculations (post contract award to **[a company]**) on 16 October 2017, (Appendix 1a) 15 March 2019 (Appendix 11), 27 March 2019 – issued indirectly by **[a company]** (Appendix 12) and 18 March 2020 (Appendix 6).

A representative of **[a company]** has reviewed the issue of D1 Calculations by **[a company]** (Appendix 18), the observations were as follows:

- 1) The first D1 calculation was issued with the tender response and is dated 05 June 2017.
  - It showed 11 metre discharge height.
  - A building width of 30 metres was used scaled from building plans
  - The building was treated as a simple block in relation to figure 6 of D1. The assumption that the building is a large block, wider than its height, is the worst-case scenario as it produces the tallest discharge height in the calculation as it was done at that time. Because the building width, when treating it as simple blocks, has no influence on the calculated stack height once the building is wider than it is tall, accuracy was not of concern regarding the building width. The second block, the chapel, is outside 5Um and did not influence the calculation.
  - At that time NO<sub>x</sub> and SO<sub>x</sub> were not included in the D1 calculation.

- Only pollutants included in the Process Guidance Note were considered.
  - Building dimensions used were from information provided with the tender.
- 2) The second D1 calculation was the result of discussions with **[a company]** regarding revisions to the building design and is dated 16 October 2017
- Again, at that time NO<sub>x</sub> and SO<sub>x</sub> were not included in the D1 calculation.
  - It showed an 8 metre discharge height due to a substantially lowered building roof.
  - A building width of 29 metres was used
  - The building was treated as a simple block in relation to figure 6 of D1 (as per bullet point 3 of (1) above)
  - **[a company]** followed on by notifying GBC of the changed stack height and issues to consider in relation to the building design (Appendix 1a)
- 3) The third D1 calculation is dated 15 March 2019.
- The calculated discharge height was 8 metres, based on a 7 metre building height.
  - A building width of 3.17 metres was used. Until receipt of a copy of the **[a company]** calculations, dated November 2018, on 14 March 2019 the pop up concept had not been considered by **[a company]**. (**[a company]** had considered the pop up roof to be a building in its own right altering the way building width was determined and the subsequent D1 calculation).
  - This calculation was produced following **[a company]** checking of **[a company]** calculations using emissions test results from **[a company]**.
  - The **[a company]** calculations contained errors in interpretation of the emissions test data by **[a company]**.
  - Recalculated heights, using the correct interpretation of the emissions test data were later given as a list to **[a company]** within a series of comments on an **[a company]** email of 25 March 2019.
  - The D1 dated 15 March 2019 was to update previous calculations using the building dimensions provided by **[a company]**.
  - This calculation is the first occurrence of the “pop up” in **[a company]** calculations and used the same building dimensions provided by **[a company]**.
  - The calculation included DeNO<sub>x</sub> and assumed 35% conversion NO<sub>x</sub> to NO<sub>2</sub>.
- 4) The fourth D1 calculation, dated 27 March 2019, was sent to **[an officer] [a company]** on that date as a result of the **[a company]** checking of **[a company]** calculations.
- This calculation included a revision of the gas flows from the stack to bring the calculated gas flows closer to those experienced in emissions tests.
  - The calculation included DeNO<sub>x</sub> and assumed 50% conversion NO<sub>x</sub> to NO<sub>2</sub>, as recommended by the Environment Agency for short term basis screening calculations.
  - The discharge height calculated is 8 metres.
  - A building width of 3.17 metres is used
  - The calculation was produced solely to apply the revised flue gas conditions and NO<sub>x</sub> conversion consideration to the building with dimensions as provided by **[a company]**.
  - The calculation dated 27<sup>th</sup> March 2019 was issued to **[a company]** as the final part of the **[a company]** checking of the **[a company]** D1 calculations using emissions test results from Perth and

Gedling crematoria and to assist **[a company]** prepare the Permit to Cremate and supporting D1 calculation.

- 5) The fifth, and final D1 calculation, dated 18 March 2020, was the result of a meeting on 2 March 2020 and subsequent communications between **[an individual]** and **[a company]**.
  - It was produced following a checking of the calculation methods, data input and building dimensions.
  - The calculation also used updated pollutant background information from DEFRA.
  - This calculation showed a discharge height of 9 metres, which was used to determine the revised discharge height.
  - A building width of 4.672 metres was used

Of the 5 calculations listed, only the first, second and fifth have used building width dimensions determined by **[a company]** examinations of the drawings provided.

**[a company]**'s initial calculations used a different methodology to **[a company]** in determining building width, an approach that would generate the tallest stack height required. The approach does not appear to be wrong.

**[a company]** are of the view the incorrect pop up roof dimension originated from **[a company]** in a document issued November 2018 (Appendix 2). This document appears to have altered the method for determining building width from previous **[a company]** calculations as the pop up roofs were deemed as individual buildings and multiple buildings in their own right. The method of considering multiple buildings and for buildings taller than they are wide does not appear to be wrong, however the method to determine the building width by **[a company]** in accordance with HMIP D1 figure 6 upon review is incorrect. **[a company]** did not receive a copy of this document (Appendix 2) until 14 March 2019 in the lead up to submitting the variation to the Permit. The **[a company]** calculation dated 27<sup>th</sup> March 2019 was issued to **[a company]** as a part of the checking **[a company]** were doing of the **[a company]** calculations. There was no stated intent that it could be used for any other purpose. **[a company]** admit they did not check the building dimensions and relied upon the information from **[a company]** (Appendix 13) which had already been approved by GBC's Environmental Health Service.

**[a company]** accepted that due to the various building iterations the stack height of 8.1m needs to be extended to 9m. As manufacturer of the equipment, **[a company]** are best placed to undertake the modifications to the stack liners and to mitigate any future warranty claims that may be raised due to unauthorised changes to the stack have offered to undertake the work at no additional cost to the council.

### **2.3 [a company]**

**[a company]** were appointed to prepare the variation of the permit to cremate for the site and undertake a D1 Calculation to ensure legislative compliance. **[a company]** worked with the data supplied from 2018 as the design developed;

- 1) The dimensions used for the roof area were derived from the architects plans by **[a company]**. Some dimensions used are detailed within the Variation application and supplementary information submitted on 13 May 2019 (Appendix 2). However, there is no dimensioned drawing of the pop up roof structure surrounding the stack within the application, specifically the values needed to calculate  $T_m$  in D1.

- 2) To validate the proposed stack discharge height following on from **[a company]**'s recalculation of the stack height in 2017 and development of the roof design, submissions were sent in by **[a company]** on behalf of GBC as the operator to the Environmental Health Team for checking. **[a company]** produced D1 calculations to support this as a check and balance on the proposed design, the first was submitted on 25 October 2018 (Appendix 14) with a calculated height of 7.9 metres. This submission was withdrawn the next day (Appendix 15) as they weren't happy with some components of the report and replaced by another calculation on the 15 November 2018 (appendix 16). This resubmitted information showed a calculated stack height of 8.1 metres. Further supplementary information on the revised roof design was submitted on 21<sup>st</sup> November 2019 related to the upstands on the roof and the D1 Calculation (Appendix 16). Within this submission is stated;

*'The D1 calculation is a highly conservative assessment, meaning that it generally results in a taller stack than would be provided for via dispersion modelling. The client desires a stack height in keeping with the design, and as the maximum stack height calculated is less than the next half metre, the overall stack height has not been rounded up to the nearest whole metre.*

*If rounded up, overall chimney height would be 9 metres above ground level. Environmental Health should confirm the required chimney height with the Operator.'*

- 3) To achieve this calculation **[a company]** stated in their submission they had;
- 'undertaken six D1 runs in total, (these are within the appendices of the above submissions) using data from two crematoria operating a 2 x FTIII abated configuration. All stack heights come out within 9cm of each other. I would recommend that the minimum stack height be no less than 8.10m above ground level, which was the tallest stack height generated.'*
- 4) Upon review and while the dimensions have been taken from the architects plans, the wrong dimension has been used in the D1 calculation.
- 5) **[a company]** validated the calculation and submission on 21 November 2018 to GBC's Environmental Health service and **[a company]** and to the operator on 7<sup>th</sup> December 2018 (Appendix 18), the response states;
- 'I think this satisfies the stack height requirements. The lip will cause some turbulence round the stack but the revised stack should be acceptable. I am not overly concerned re rounding up to the nearest metre.'*
- This confirmation was then taken on to develop the technical design by the design team.
- 6) The D1 submitted in the variation application dated 13 May 2019 (Appendix 2) was produced by **[a company]** (Appendix 12) as a part of the checking **[a company]** were doing of the **[a company]** calculations. It had a minimum stack discharge height of 8.0 metres but the building design took the higher value determined by **[a company]** of 8.1 metres from earlier in the design process and checking by Environmental Health to meet the approved planning permission. **[a company]** did not submit any calculation of their own in the final variation application, **[a company]**'s calculation was submitted as part of the application (Appendix 17) following various revisions and reviews as stated above (section 2.2). **[a company]** checked the calculation with their own spreadsheet and the calculations agreed. This check however was not provided to GBC (Appendix 17).
- 7) As stated in section 2.2 **[a company]** did not check the building dimensions in the D1 submitted on 13 May 2019 (Appendix 13) but relied upon **[a company]**'s information which had already been approved as per points 4 and 5 above.

- 8) **[a company]** reviewed the variation application dated 13 May 2019 and issued a varied permit on 11 July 2019.
- 9) Upon identification of the error and notification to the Environmental Health Service **[a company]** reviewed the error and agreed that there had been confusion on the width of the building. **[a company]** also agreed that they had no issue in increasing the stack height to 9 metres (Appendix19).

### 3.0 Summary Conclusion

**[a company]** and **[a company]** have not checked the building dimensions and used the building dimensions as previously used in relation to figure 6 of the D1 guidance submitted as part of the application to vary the sites permit submitted on 13<sup>th</sup> May 2019. **[a company]** appear to have misinterpreted the guidance in producing D1 calculations that informed the design process in 2018 and the subsequent D1 calculations by **[a company]** submitted as part of the application to vary the sites permit.

3.18 metres was used as the width on **[a company]**'s calculations dated in October 2018 and 3.17 metres in November 2018 which was the incorrect width.

29 metres width was used in **[a company]**'s calculations dated 16 October 2017, 3.17 metres was used in calculations dated 15 March 2019 and 27<sup>th</sup> March 2019. 4.672 metres was used on 18 March 2020.

No party has stated how they determined the building width in the D1 calculations. In **[a company]**'s early calculations the building width, when assuming it as a simple block, has no influence on the calculated stack height since the building is wider than it is tall. The building width became an issue when the pop up roof is considered as a building in its own right as per **[a company]**'s methodology.

While the supplementary information submitted as part of the application to vary the permit was comprehensive, having no dimensioned plan which directly relates to the values required and used to calculate the stack does not provide the ability for sufficient independent validation or checking by others.

However, each party should not only be checking the calculation but the input data and variable parameters as well. Future calculations should refer to the method used for determining building width and any other variable parameters, and why, along with dimensioned plans to ensure that the rules by which a calculation is being undertaken is clear.

The Council is reliant on expertise to advise it on matters relating to stack design and it is difficult to suggest further reasonable controls that should be in place. The Council appointed two parties to check and balance this technical role in the design of the building and the regulatory team utilised a consultant as a further check.

As the Council appointed competent and qualified persons and contractors this outcome is disappointing. **[a company]**, **[a company]** and **[a company]** have accepted that the error has occurred. This appears to be human error on interpretation of the architectural drawings and oversight rather than any intent to deceive or manipulate the technical requirements of HMIP D1 guidance.

It is important to reflect on the impact of the error in relation to para 2.9 of the HMIP D1 Guidance:

*Heights determined using the (D1) method should be regarded as a guide rather than a mathematically precise definition of discharge stack height. The conclusion may need to be modified in the light of particular local circumstances or of practical experience.*

The Council was made aware of an error in the method of calculation and took steps to remedy it by informing the Environmental Health Service who have required a revised stack height of 9 metres as part of the sites permit to cremate. This has now been addressed and the matter rectified.

We do acknowledge and are grateful to **[an individual]** for questions on this specific issue. His enquiry did lead to identification of an error.

DRAFT & CONFIDENTIAL