



UNITED KINGDOM QUALITY ASH ASSOCIATION

Statement on Dioxin levels in Furnace Bottom Ash and Pulverised Fuel Ash from coal burning power stations

11 February 2002

Background: On Tuesday 3 July 2001, during the Newsnight programme on BBC 2, questions were raised to Michael Meacher, the Environment Minister, about the use of ash from a waste incinerator in the manufacture of building blocks. A follow up Newsnight programme on 21 November 2001 raised questions to Baroness Young (Chief Executive of the Environment Agency) about the safety of a stockpile of incinerator fly.

Statement: The UKQAA would like to clarify that these stories referred to ash from waste incinerators and NOT pulverised fuel ash (PFA) or furnace bottom ash (FBA) from coal fired power stations. Incinerator ashes have significantly differing properties to the PFA or FBA from power stations.

Aerated concrete blocks are either made from PFA or ground silica. Due to the exacting nature of the manufacturing process for aerated concrete blocks these do not contain incinerator ashes. Lightweight concrete blocks are widely made using FBA as a lightweight coarse aggregate. PFA may be added to these blocks to improve the quality of the final product. Such blocks made solely with materials from coal fired power stations, e.g. PFA and FBA, which do not have significant levels of dioxins.

The generating industry in England has recently taken samples of pulverised fuel ash (PFA) and furnace bottom ash (FBA) from seven coal-fired power stations. These were tested at accredited laboratories for the 17 dioxins and furans chlorinated at the 2,3,7,8 positions. All of the results show levels of dioxins and furans to be in the range 0.049ng/kg to 2.4ng/kg I-TEQ. These values are close to or below detection limits and are similar or lower than background levels typically found in soils.

Further information: Only anthracite, bituminous or hard coals are burnt in UK power stations. Hard coal originated in the Carboniferous period, part of the Palaeozoic era, about 345 to 280 million years ago, from vegetable matter (trees and ferns) which has been compacted and heated by geological processes. The ash from a modern power station results from the soils and minerals these trees grew in. These are low in chlorine. The firing temperatures of a power station furnace are >1250C. The coal being combusted and the high firing temperatures mean the quantities of dioxins formed are minimal.

Waste Incinerators are burning domestic waste, which by the very nature of the material can be highly variable in chemical constituents, including chlorine. Chlorine is required for dioxins to form. The furnace temperatures are around 900C, significantly lower than found in a coal fired power station. The nature of the material being combusted and the lower firing temperature can lead to the formation of dioxins in the resulting fly ash. However, we understand that Incinerator Bottom Ash contains significantly less dioxins than Incinerator Fly Ash.

FBA and PFA from coal fired power stations have been used in the manufacture of building blocks for a number of years. PFA has been used in the manufacture of aircrete blocks for over fifty years in the UK. These products have a long established history of usage without any known problems associated with dioxins.

The following appendix gives details about dioxins of PFA and FBA from coal fired power stations.

Appendix - Information about Dioxins in PFA

Polychlorinated dibenzo-p-dioxins (PCDD) are a family of chemicals based on the tri-cyclic molecule benzo-p-dioxin, which has two benzene rings, linked by two oxygen atoms. PCDD's have some or all of the hydrogen on the benzene rings replaced by chlorine (up to the maximum of eight chlorines). These are often associated with polychlorinated dibenzofurans, (PCDF) which have only a single oxygen atom. Dioxins are considered to be toxic to humans, as are furans although less so than dioxins. 2,3,7,8-tetra CDD (TCDD) is considered to be the most toxic and therefore the most studied.

Dioxins are usually associated with the incomplete combustion of material containing chlorine and as such are commonly associated with the ash from municipal waste incineration, but can be found in small traces in soils. The low chlorine content of coal combined with the high temperatures found in the furnaces of power stations mean that dioxins are unlikely to form and only traces would be expected in the resulting ash. Dioxins are ubiquitous and are present in a wide range of soils and although they can be persistent, they rapidly decay when exposed to light.

Work by the CEGB¹ in the 1980's examined 18 PFA samples from a range of sources for dioxins from the tetrachlorinated to the octachlorinated. The findings were that the levels were very low, typically less than 25 pg/g, with levels of 2,3,7,8-TCDD less than 2 pg/g¹ in all but two samples. The only exceptions were samples of PFA from the low NO_x burners at one station (A). It was thought that the low NO_x burners might have had some effect, although the same increase was not observed for samples from another power station utilising similar burners. Although the dioxin levels in the samples from low NO_x burners at station (A) were higher, 210 and 270 pg/g, they were still within the range found in soils in the UK; data from unpublished work cited an upper limit in soils of 290 pg/g.

A sample of cenospheres ("floaters") from one source was sent to Rechem International Ltd for analysis in 1993. The analysis included the 17 most significant dioxins and furans with the result quoted as a toxic equivalent (TEQ), relating the total concentration of the 17 species to the concentration of 2,3,7,8-TCDD with equivalent toxicity. This involves applying a weighting factor, the toxic equivalent factor (TEF), to each dioxin or furan, the factor being consistent with its perceived toxicity; the individual results for each species are added together to get the TEQ. The highest factor (1) is for 2,3,7,8-TCDD; the lowest is 0.001 for OCDD and OCDF. The results are shown in Table A.

¹ NB: pg/g (pica grams per gram) is equivalent to ng/kg (nano grams per kilogram).

Table A - Results of tests on cenospheres (floaters)

| Dioxin/Furan | Concentration (pg/g) | Toxicity Equivalence Factor | Typical Background Level in Soils (pg/g) |
|---------------------|----------------------|-----------------------------|--|
| 2,3,7,8-TCDF | 3.0 | 0.1 | |
| Total TCDF | 30 | | <0.5-237 |
| 2,3,7,8-TCDD | 2.0 | 1 | <0.5-2.1 |
| Total TCDD | 15 | | <0.05-69 |
| 1,2,3,7,8-PCDF | 5.0 | 0.05 | |
| 2,3,4,7,8-PCDF | 5.0 | 0.5 | |
| Total PCDF | 35 | | <0.5-185 |
| 1,2,3,7,8-PCDD | 2.0 | 0.5 | <0.5-2.4 |
| Total PCDD | 10 | | <0.5-165 |
| 1,2,3,4,7,8-HxCDF | 10 | 0.1 | |
| 1,2,3,6,7,8-HxCDF | 2.0 | 0.1 | |
| 1,2,3,7,8,9-HxCDF | 1.0 | 0.1 | |
| 2,3,4,6,7,8-HxCDF | 7.0 | 0.1 | |
| Total HxCDF | 35 | | 4.3-212 |
| 1,2,3,4,7,8-HxCDD | 40 | 0.1 | |
| 1,2,3,6,7,8-HxCDD | 50 | 0.1 | |
| 1,2,3,7,8,9-HxCDD | 60 | 0.1 | |
| Total HxCDD | 350 | | 2.8-165 |
| 1,2,3,4,6,7,8-HpCDF | 110 | 0.01 | |
| 1,2,3,4,7,8,9-HpCDF | 20 | 0.01 | |
| Total HpCDF | 175 | | 1.5-138 |
| 1,2,3,4,6,7,8-HpCDF | 1000 | 0.01 | |
| Total HpCDF | 2000 | | 7.5-234 |
| OCDF | 6000 | 0.001 | <2.0-144 |
| OCDD | 25000 | 0.001 | 28-832 |
| TEQ | 65 | | 10-40 |

The TEQ is shown as 65 pg/g, which is slightly higher than found in soils (10 to 40 pg/g) using this method of assessment. However, the density of the floater particles is low compared to soil, with a density of 0.5 Mg/m³ compared to 2.6 Mg/m³. If the value is corrected to an equivalent density then the value would be 12.5 pg/g, similar to the background level in soils and in agreement with the earlier data.

Junk et alⁱⁱ looked at 2, 3, 7, 8 – Tetrachlorodibenzo-p-dioxin (TCDD) at a detection limit of 10 parts per trillion. No TCDD was found in the effluents in any of the boilers at two power stations tested. Even when refuse derived fuel was added no dioxins were observed. This was explained by the high furnace temperature (~1100C) and the excess oxygen used in combustion.

The above observations have been reaffirmed by work carried out by the power generation industry during the end of 2001/early 2002. All of the results show levels of dioxins and furans to be in the range 0.049ng/kg to 2.4ng/kg I-TEQ. These values are considerably lower than found in soils.

Dioxins in PFA - Summary

1. The level of dioxins are < 25 ng/kg for ashes from coal fired power stations.
2. Thus although dioxins are present in PFA the levels are generally very low and similar to or lower than the background levels found in typical soils. Thus PFA is no more hazardous than soil.

ⁱ Freedman A N. The analysis of power station fly ash for the presence of polychlorinated Dibenzo-p-dioxins. CEGB. 1988.

ⁱⁱ Junk G A, Richard J J and Avery M J. Organic compounds in effluents related to coal combustion. Pre-prints of papers – American Chemical Society, Division of Fuel Chemistry. V 30 N 2. PP 171-178. 1985 Published by ACS.