



Environmental Code of Practice For the Sale and Use of Pulverised Fuel Ash (PFA)

Preface

The document forms part of a series of documents relating to the environmental aspects and the use of pulverised fuel ash (PFA) in construction applications. PFA has a long history of successful use in a wide range of applications from use as an engineering fill material, as a pozzolanic cement, brick and block manufacture, grouting of caverns and mines, etc. There is no known UK incident of PFA causing any environmental problems. These documents explain the background to the uses of PFA, the relevant legislation, the environmental risks and what practices are recommended to ensure that no environmental damage occurs.

For the full picture one should read all these documents. These documents, by the very nature of the subject matter are frequently reviewed to ensure they reflect changes in environmental legislation and findings of testing and research projects. The user should ensure they have the latest version of the documents, which are freely available on the UKQAA web site www.ukqaa.org.uk. The documents are as follows:

- The production and applications for PFA.
- Environmental Testing and Emerging UK and European Legislation.
- Assessment of the Risk to the Environment from the use of Pulverised Fuel Ash.
- Environmental Code of Practice for the Sale and Use of Pulverised Fuel Ash (PFA).

Introduction

The Electricity Association, Joint Environment Programme (Electricity Industry) and the United Kingdom Quality Ash Association have jointly prepared this guidance. This document sets out clear and simple guidance, which is designed to prevent any risks of environmental pollution.

PFA (also known as fly ash in many countries) is a by-product of the combustion of pulverised coal or coal and other materials, known as co-combustion, in electricity power generation. It consists of oxides of silica, alumina, iron, calcium and various minor constituents. PFA, due to the high temperatures of >1,250C found in power station furnaces, is mainly in the glassy phase with a spherical particle shape. The method of its formation traps the majority of the trace elements within the glassy matrix ensuring that they are unable to leach from the material.

PFA is readily available as dry, conditioned and a stockpiled material suitable for use as a general and structural fill, grouting and for many other applications. PFA can be used for a wide range of purposes in addition to fill and grouting applications, e.g. as a cementitious material in concrete, for the manufacture of lightweight aggregates, building blocks, etc. The use of PFA is governed by many standards including:

- ❖ As a fill material - DOT Specification for Highways works, BS8002¹ and BS8006².
- ❖ For concrete as a cementitious addition - BS3892 Parts 1³ & 2⁴ and BS EN450.
- ❖ For use in the manufacture of cement – BS EN197-1⁵ and BS 6610⁶.
- ❖ For use in grouting applications – BS3892 Part 3⁷.
- ❖ For use in road construction as hydraulic road binders – EN14227 – Parts 3⁸ and 4⁹.

NB: There are many other standards and applications relating to PFA/fly ash.

There are an estimated 250 million tonnes of material on stock throughout the country with some 5.5 million tonnes being produced annually.

When using PFA good engineering practice, appropriate selection of the material and suitability of the application in conjunction with the guidelines set out below will minimise the risk of any environmental problems.

PFA and the Environment

The Environment Agency (EA) has approved the use of PFA in numerous contracts, however, it is the responsibility of the user of this document should ensure that the local EA officer gives approvals for both the application and the procedures adopted. PFA can be used in most construction situations without causing any significant environmental impact by following these recommendations. Using PFA can reduce the use of primary aggregates, therefore reducing the demand for quarrying. The Agency is fully aware PFA is a by-product of the burning of coal in power stations and, if not used, it would often have to be disposed of in landfill.

Leachates

The typical analysis of PFA shows that approximately 2% of the constituents are water-soluble with calcium sulfate being the major fraction. The pH of PFA is typically 7 to 12. The source of this alkalinity is mainly calcium hydroxide and the usual health and safety precautions¹⁰ should be observed when handling PFA. The main water-soluble trace element, which may have an impact on some plant species, is boron. To establish plant growth on PFA selected species of grasses and other plants should be used. Additionally PFA has a very low nitrogen content and fertilisers rich in nitrogen will be required to establish plant growth.

Due to the inherently low permeability of compacted PFA, the rate of leaching is extremely low in the most onerous unbound applications, i.e. fill applications. Plants adjacent to a PFA fill embankments are unlikely to be affected by such leachates due to the low permeability and concentrations of deleterious compounds. Lagoon PFA, material that has been transported and deposited in copious quantities of water at the power station, will have most of the leachable materials removed due to the nature of the process used.

Considering the low permeability of PFA fill, typically 10^{-7} m/s, it is very difficult to saturate the material in embankments. Therefore, any leachates can only occur from the surface layers of embankments through the action of rainwater, presuming adequate drainage is provided beneath the embankment. Water may rise by capillary action in PFA even after compaction. A drainage layer of coarse material is essential, this may consist of 150 - 450mm in depth placed below the PFA and will eliminate capillary action. This may consist of Type 1 material and Type 6D from the Specification for Highway Works, Furnace Bottom Ash, hogging and/or a geotextile membrane. The potential for capillary rise in PFA, as with other silty materials, can render PFA susceptible to frost heave.

In bound applications, such as grouting and concrete, the addition of Portland Cement and/or lime reduces the permeability further than found with PFA used in unbound applications. This, combined with the high pH resulting from the PFA and the Portland Cement/lime generally ensures that insignificant amount of leaching will occur. However, consideration does have to be given to leachates arising from the binding material(s) and/or aggregates being employed. These leachates may predominate within the resulting bound material.

Complete details of "Environmental Aspects of PFA" are available from the UKQAA web site at www.UKQAA.org.uk.

Dust

Avoid creating airborne dust wherever possible. Where dust is generated then engineering control measures should be considered (water sprays) to maintain the airborne dust concentration as low as is reasonably practical. If PFA is to be stockpiled for a long period (several months) then dust suppressants can be used to treat the surface and eliminate the problem of dust blow.

PFA is classified as a nuisance dust and personal exposure should be controlled to the minimum that is reasonably practical and, in any case, should not exceed 10 mg/m³ in an 8 hour Time Weighted Average (TWA) total inhalable dust. Respirable dust exposure should not exceed 5 mg/m³ in an 8 hour TWA. Monitor as for airborne inhalable dust using the gravimetric determination method.

Waste Classification

PFA is classed as a 'Controlled Waste' in the UK and has no special requirements for its disposal at appropriately licensed facilities. They are included in the combined European Waste Catalogue and Hazardous Waste List¹¹ as 'coal fly ash' (Code No. 10 01 02) as non-hazardous materials. Co-combustion fly ashes may be classified as hazardous wastes should they contain dangerous substances as follows; (10 01 16*) 'fly ash from co-incineration containing dangerous substances' and (10 01 17) 'fly ash from co-incineration other than those mentioned in 10 01 16'. The classification 'containing dangerous substances' for co-incineration ashes depends on the composition of the waste being co-incinerated and the resulting ash.

Waste Transfer Notes should not be required for transportation within the UK. Coal fly ashes are also 'Green List' materials for transfrontier shipment.

Specific Guidance for the use of PFA in Unbound and Bound Applications

1. Method Statements

- 1.1. **Customers Method Statement** – a method statement shall be prepared by the customer setting out the details of how the PFA is to be received, handled, stored and placed/used on the construction site. The measures shall be designed to protect the environment from dust blow and leachate problems. Power station operators are able to provide a sample document that may be used as a basis of the method statement.
- 1.2. **Suppliers Method Statement** – The power station operator, or his agent, shall prepare a method statement for the extraction/ production, loading and transport of PFA to the construction site. The measures shall be designed to protect the environment from dust blow and leachate problems.

The customers and suppliers method statements shall address the following aspects:

2. Working areas

- 2.1. **Stockpiles – at the power station** – The working face should be kept to a minimum to prevent dust problems, particularly in drying / windy conditions. Provision of water sprays on the face of the exposed area and haul roads to prevent dust problems are required.
- 2.2. **Storage on the Construction site** – Stockpiles should be kept to a minimum. The working area should be kept to a minimum. Provision for water sprays shall be made, particularly in drying/windy conditions. The protective layer should be applied as soon as practicable after completion of the construction of an embankment. PFA should be stored in site in such a way as to prevent the accidental discharge of the material into water courses.

3. Transporting the PFA to site

- 3.1. Moistened PFA, e.g. from conditioning plants, stockpiles and lagoons, should be transported in sheeted tipping vehicles.
- 3.2. The vehicle should be in a clean state before travelling on public roads, e.g. wheel washers and similar should be provided.
- 3.3. Vehicles shall travel to site by the most reasonable direct route.
- 3.4. Drivers shall only discharge PFA on the site and at the location as instructed by the contractors, as shown on the delivery ticket.
- 3.5. Dry PFA shall only be carried in sealed tankers, similar in design to cement tankers.
- 3.6. PFA shall only be discharged into tankers at the supply point from appropriate systems capable of preventing dust emissions and accidental releases.
- 3.7. PFA shall only be discharged into silos provided with appropriate discharge and filtration systems. These silos are the responsibility of the customer and should be designed and maintained in such a manner to prevent accidental escape of dust, etc.
- 3.8. Should a delivery of PFA be rejected the driver shall return the material to the supplier.

4. Embankments

- 4.1. Embankments should be constructed on a drainage blanket to provide a capillary break, preventing saturation and frost heave in the PFA.
- 4.2. The PFA supplier should establish that the material being supplied is typical with regard to leachate and that a method statement is provided. This should detail the handling of the PFA on site and that transport and other aspects are in line with this Code of Practice.
- 4.3. Where a capillary break is not practicable and the design of the embankment reflects this, then an appropriate assessment of the environmental impact of leachates should be made in conjunction with the Environment Agency officer.
- 4.4. The PFA supplier should be able to provide specific environmental information to assist in this assessment.
- 4.5. Protection for side slopes; to prevent side slope erosion and water run off side slopes should be designed with suitable planting, topsoil and/or an impermeable material to form a protective layer.

5. Grouting

- 5.1. In grouting applications, consideration should be given to bleed water that may appear prior to setting of the grouts within the cavity being filled. This water may be used to produce more grout and/or channelled to foul sewerage systems.
- 5.2. Care should be taken to avoid contamination of groundwater, rivers, streams, ponds, etc.

6. Bound applications, including concrete –

- 6.1. Normally there are no specific environmental requirements for bound materials containing PFA.
- 6.2. Concrete containing coal PFA may be used in concrete for use in contact with drinking water without further testing.
- 6.3. Co-combustion fly ash containing dangerous substances (10 01 16 - European Waste Catalogue) should NOT be used in bound applications unless a full environmental impact assessment has been carried out. This shall be assessed to the satisfaction of the Drinking Water Inspectorate (DWI) for materials designed to be in contact with drinking water.

7. Leachates

- 7.1. The consistency of the leaching potential of the PFA is established if the producer can demonstrate this by the production of, at least annual leachate test data.
- 7.2. If there is a major change in fuel source and/or type, the producer shall demonstrate that this does not adversely affect the leaching properties of the PFA.
- 7.3. PFA produced from co-combustion shall be tested for leachates on at least a six-monthly basis. If there is a major change in fuel type, co-combustion fuel or proportion and/or firing conditions the producer shall demonstrate this does not pose a potential environmental risk from leachates in the most sensitive applications being supplied.

8. Sensitive Sites

- 8.1. If the PFA is to be used in a particularly sensitive site then more rigorous monitoring may be required. This is to be established through consultation with the producer of the PFA and the local Environment Agency officer.

9. **Environmental Risk Assessment** – The UKQAA have produced a "A Generic Risk Assessment for PFA", which is available from www.UKQAA.org.uk.

Further Information

For further advice and information please contact the supplier of the PFA or:

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¹ BS8002, Code of practice for Earth retaining structures, 1994, BSI, Chiswick, London.

² BS8006, Strength/reinforced soils and other fills, 1995, BSI, Chiswick London.

³ BS3892 Part 1:1997, Pulverised fuel ash, Part 1, Specification for pulverised fuel ash for use with Portland Cement, BSI, Chiswick, London.

⁴ BS3892 Part 2:1996, Pulverised fuel ash, Part 2, Specification for pulverised fuel ash to be used as a Type I addition, BSI, Chiswick, London.

⁵ BS EN197-1: 2000, Cement-Part 1: Composition, specifications and conformity criteria for common cements, BSI, Chiswick, London.

⁶ BS6610: 1996, Specification for Pozzolanic pulverised fuel ash cement, BSI, Chiswick, London.

⁷ BS3892 Part 3:1997, Pulverised fuel ash, Part 3, Specification for pulverised fuel ash for use in cementitious grouts, BSI, Chiswick, London.

⁸ PrEN 14227 Part 3: due for publication 2003, Unbound and hydraulically bound mixtures – Specification – Part 3: Fly ash bound mixtures, BSI, Chiswick, London

⁹ PrEN 14227 Part 4: due for publication 2003, Unbound and hydraulically bound mixtures – Specification – Part 3: Fly ash for hydraulically bound mixtures, BSI, Chiswick, London

¹⁰ Health & Safety Datasheet, UKQAA

¹¹ European Waste Catalogue and Hazardous Waste List, valid from 1 January 2002, ISBN 1-84095-083-8