Extract from:

"Safety Case for a
Proposed Novel Cementitious Leachate Barriers"

P A Claisse and E Ganjian Coventry University
A Atkinson and M Tyrer Imperial College

May 2004

1. Introduction

1.1 Purpose of document:

The purpose of this document is to establish the safety case for the construction of a novel cementitious barrier as a landfill liner. It is intended for submission to the Environment Agency and describes the work that has been carried out since 1998 to establish the safety of the barriers. It is anticipated that the document will evolve in discussion with the EA.

The safety case is developed on the basis of predictive models which are validated by site trials. These trials have taken place at the Risley landfill site in Cheshire. Three trial cells have been constructed containing a total of 70m^3 of concrete. The data used in the models has been derived from laboratory experiments with permeability (high pressure through flow) and diffusion tests.

The principal intended benefits of the new barrier are:

- Low permeability combined with high cation exchange capacity to give improved containment.
- Construction from waste materials which would otherwise go into landfills.
- A relatively hard concrete surface to permit operation of vehicles and to prevent damage from large items of waste compacted onto it.

1.2 General description of barrier and construction methods:

1.2.1 Location of proposed barrier

Poplars landfill site at Cannock (a Biffa site).

1.2.2 Current Barrier System in use at the site

This is a clay site and they currently only use "Bentomat" (this consists of layers of fabric with bentonite powder between them and is about 20mm thick) on top of milled and compacted layers of existing clay. Geotextiles are then used to protect the Bentomat. The novel barrier is proposed as an alternative.

1.2.3 Basic Design

A 300mm layer of concrete on the clay. Note that this simple design has been chosen for this particular site and much of our research relates to multi-layer systems intended for less secure sites.

1.2.4 Construction Method

One hectare (10,000 m2) of barrier this will need 3000 m3 of concrete. A pump will be used and target placing rates should be at least 200m3 per day.

There is plenty of space to stockpile material before starting mixing.

1.2.5 Materials

A candidate mix design for the proposed barrier is made up of the materials given in Table 1.

Material	Kg/m3	Total quantity Tonnes
Cement Kiln Dust	150	450
Steel slag Dust (0-5mm)	700	2100
Conditioned ash	150	450
Shell sand	700	2100

Table 1.1: Candidate materials proposed for use in Poplars site.

1.2.6 Dates

It is hoped that it will be possible to construct the barrier in late summer 2004.

1.3 Background to the containment system:

1.3.1 Previous research

During the 1980's a very large research programme was carried out in the UK to develop designs for repositories for nuclear waste [1-3]. Three of the present authors (Claisse Atkinson and Tyrer) worked on this programme. The design which was developed to the greatest extent was the repository for intermediate and low level waste. This repository was required to have a predictable performance in a deep saturated geological environment over a timescale of up to a million years. The design essentially involved placing the waste in concrete containers and placing these containers in an excavated underground cavern. This cavern was then to be backfilled with a relatively soft cementitious grout.

One of the achievements of the nuclear programme was to analyse and define the performance which was actually required of the concrete when used for this application. This performance requirement is quite different from the requirements for concrete in normal construction and lead to the development of some very unusual concrete mixes.

The barrier design uses conventional engineering materials but its method of operation is far from conventional for an engineering structure because it is essentially sacrificial [4]. The main function of the barrier is to condition the chemistry of the repository to high pH by dissolving alkalis in the groundwater. The alkalis are free sodium, potassium and lime and subsequently the calcium silicate hydrate which forms the structure of the hardened cement. At the high pH values the harmful species from the waste which are permeating through the barrier are adsorbed onto the cement matrix and immobilized. Clay based liners were considered for the nuclear repository but concrete was chosen as the best option for the UK. The nuclear programme was stalled in the 1990's by the refusal of planning permission for the test facility at Sellafield in Cumbria.