A STUDY OF BPEO IN THE CONTEXT OF LIQUID RADIOACTIVE WASTE GENERATED AT BNFL SPRINGFIELDS FUEL MANUFACTURING PLANT

W R Hendrickson, P Fawcett*, K Brown**

Ministry of Agriculture, Fisheries and Food, Fisheries Laboratory, Lowestoft, Suffolk NR33 0HT, UK
*BNFL Fuel Division, Springfields, Preston, Lancashire PR4 0XJ, UK
**Her Majesty's Inspectorate of Pollution, Church Street, Lancaster LA1 1BG, UK

ABSTRACT

Techniques for establishing Best Practicable Environmental Option (BPEO) in relation to the management of radioactive wastes are undergoing development. Recent experience has been gained via a study at BNFL Springfields fuels manufacturing plant involving identification of options for treating liquid waste, screened evaluation and sensitivity analysis to aid selection. Confidence in the process was such that an interim finding was accepted by the regulators and implemented as the BPEO by BNFL ahead of the finalised work on the study.

INTRODUCTION

Radioactive aqueous waste containing alpha and beta/gamma emitters associated with U-238 and Th-232 decay chains are discharged by BNFL Springfields to the tidal river Ribble in Lancashire under joint authorisation of Her Majesty's Inspectorate of Pollution (HMIP) and the Ministry of Agriculture, Fisheries and Food (MAFF). The dose impact of the discharges amounted to around 0.02 to 0.03 mSv to the critical group during the early 1990s (1). During a review of the authorisation in 1991 a number of options were identified as having potential for reducing further the impact of the discharges and in order to evaluate such options, HMIP and MAFF placed a requirement on BNFL to undertake a BPEO study. This paper describes the methodologies used, the potential difficulties encountered and how they were addressed.

METHODOLOGY

The Royal Commission on Environmental Pollution (2) have provided a conceptual approach for conducting a BPEO study. This approach formed the framework within which the study at Springfields (3) was developed and in essence consisted of option generation, screening, evaluation by multiattribute analysis, initial derivation of the BPEO and confirmation by sensitivity analysis.

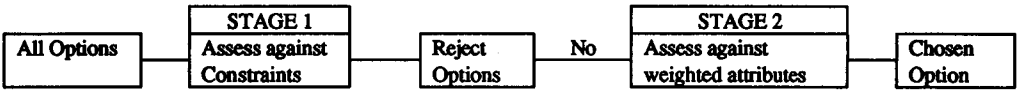
Identification of Treatment Options

Prior to considering specific options, it was considered essential that a full understanding of the waste streams should be obtained, including identification of all sources of contaminants, physical and chemical properties and waste volumes. A fully open minded approach was maintained towards identification of possible treatment options. These ranged from the obvious to the novel including the existing arrangements; options were grouped into common themes, namely (i) limiting impurities in feed materials, (ii) physico/chemical treatment, (iii) hold up to allow radioactive decay and (iv) dispersal by means of discharge. Within these groupings, a total of twenty-one options were arrived at with some options being earmarked as potentially suitable for combining.

Evaluation

In view of the number of options, a two staged approach was adopted in which low ranking options were first eliminated by screening, see Figure 1. This provided an opportunity to target the more potentially fruitful options with more detailed development and costing.

Figure 1. Schematic of Springfield BPEO Methodology



Stage 1 - Screening using Constraints

All options were first assessed against a set of constraints covering statutory obligations, technical feasibility and availability, and financial aspects. It was imperative that implementation of the BPEO did not infringe any legal requirements. Judgements on technical availability were made on the basis that the technique or process had to be accessible, proven or capable of being developed and installed within a reasonable timescale. A six year time limit was used based on a judgement that potentially effective options would not be eliminated due to the development time needed. Costs were an important factor and to avoid bias, all options were sufficiently developed so that they could be compared on an equivalent basis. The detrimental costs following discharges were taken into account and the base line figure recommended by NRPB (4) of £20,000 per man Sv was used together with other health, safety and public concern factors to identify a reasonable level of expenditure. Financial considerations were responsible for the rejection of 52% of the options in the Springfields study compared to 28% for technical constraints.

Stage 2 - Performance against Attributes

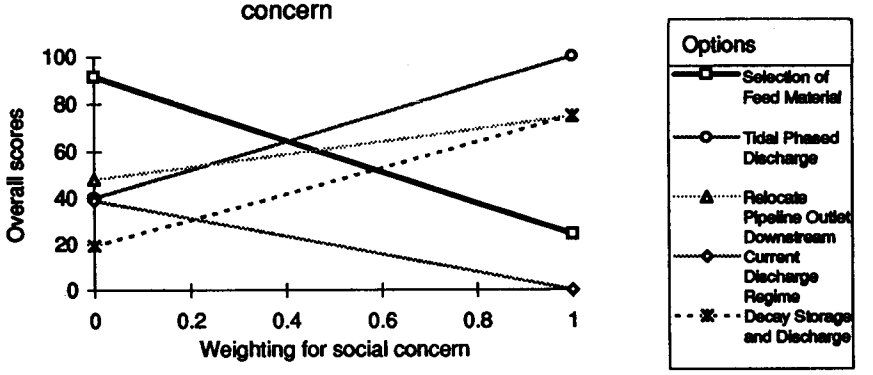
This stage was designed to assess the options which remained after screening using multi-attribute analysis. Attributes were chosen *inter alia* from a review of the constraints. Seven attributes covering quantitative and qualitative factors were arrived at, namely collective dose, skin dose and committed effective dose equivalent to the critical group, timescale, cost, non radiological environmental impact and social concern. For each option in turn, a score was derived according to its performance against each attribute. Linear functions were set by assigning the best performing option (or options in the event of a tie) a score of 100 and the worst performer a zero score. Alternatives to linear relationships were difficult to justify in the present case. A range of weights was chosen for the attributes to take account of their relative importance and the scores were weighted and summed. The highest score was indicative of the likely BPEO.

Assessing relative weights for each attribute is arguably the most difficult and potentially controversial part of the BPEO process. A balanced view can be obtained through consultation between operator and regulators who took account of local and environmental concerns. The outcome of consultation for the Springfields study was that dose was the most important factor with a average relative weighting of 0.4 (85% CEDE, 10% collective and 5% skin), cost was next with weighting of 0.25 and the remaining 0.35 shared roughly equally between all other attributes.

Sensitivity Analysis

The sensitivity of the BPEO to changes in input parameters and assumptions was examined to ascertain that it was reasonably sound. The choice of these parameters depends on how the study was conducted. In this case the weights assigned to each attribute were less well established than the input data for each option and hence the better target for sensitivity analysis. The weights were adjusted by a factor of 4; this accommodated around 90% of the suggested weightings from the consultation exercise and hence was considered to be a reasonable range. This variation did not alter the BPEO arrived at; this was an option under (i) above entailing restricting impurities in the process material. An illustration of this is given in Figure 2 which relates to the attribute social concern and the options remaining after Stage 1 screening. The sensitivity work also indicated that combining the BPEO with the option to change the operating regime in connection with dispersal of radionuclides on discharge could enhance the overall benefit and hence the latter option was earmarked for further evaluation.

Figure 2. Overall scores in relation to weighting for social concern



ISSUES ARISING

A number of difficult issues arose during the course of this study some of which have been already indicated. Some additional issues are highlighted below to assist in future studies.

- A balance may need to be considered between radiological benefits and potential worsening in environmental impact from discharge of chemical species.
- A balance between public and operator doses may have to be addressed.
- Implications for commercial viability and related employment factors may need to be addressed in admitting costly treatment options.
- Public perception stemming from export of waste and hence risks to a different population may have to be addressed.
- There may be a tendency as a result of public or political expectations to implement the best environmental option rather than the BPEO.

CONCLUSION

An open, structured and well documented approach towards BPEO studies with appropriate consultation and demonstration by sensitivity analysis is likely to produce a result which is more universally acceptable. Support for this can be drawn from the present study.

REFERENCES

1. Radioactivity in surface and coastal waters of the British Isles, Aquat. Environ. Monit. Report, Series, MAFF-DFR, Lowestoft.
2. Cmnd 310 (1988). Royal Commission on Environmental Pollution, Twelfth Report. HMSO London.
3. BPEO Study for Springfields Liquid Radioactive Discharges - Report 1993.
4. NRPB (1986), Cost Benefit Analysis in the Optimisation of Radiological Protection.