

## **THE ENVIRONMENT AGENCY'S ASSESSMENT OF THE POST-CLOSURE SAFETY CASE FOR THE BNFL, DRIGG LOW LEVEL RADIOACTIVE WASTE DISPOSAL FACILITY**

I.J. Streatfield

Environment Agency, North West Region,  
Ghyll Mount, Gillan Way, Penrith 40 Business Park, Penrith, Cumbria, CA11 9BP, UK.

S.L. Duerden

Environment Agency, National Centre for Risk Assessment and Options Appraisal  
Rio House, Waterside Drive, Aztec West, Almondsbury, Bristol, BS12 4UD, UK.

R.A. Yearsley

Environment Agency, National Centre for Risk Assessment and Options Appraisal  
Kings Meadow House, Kings Meadow Road, Reading, RG1 8DQ, UK.

### **ABSTRACT**

The Environment Agency is responsible, in England and Wales, for authorisation of radioactive waste disposal under the Radioactive Substances Act 1993. British Nuclear Fuels plc (BNFL) is currently authorised by the Environment Agency to dispose of solid low level radioactive waste at its site at Drigg, near Sellafield, NW England. As part of a planned review of this authorisation, the Environment Agency is currently undertaking an assessment of BNFL's Post-Closure Safety Case Development Programme for the Drigg disposal facility. This paper presents an outline of the review methodology developed and implemented by the Environment Agency specifically for the planned review of BNFL's Post-Closure Safety Case. The paper also provides an overview of the Environment Agency's progress in its on-going assessment programme.

### **INTRODUCTION**

The Environment Agency (the Agency) is responsible, in England and Wales, for authorisation of radioactive waste disposal under the Radioactive Substances Act 1993 (RSA93). British Nuclear Fuels plc (BNFL) is currently authorised to dispose of solid low level radioactive waste at its Drigg site near Sellafield in Cumbria, NW England. Drigg is effectively the only site for the disposal of solid low level radioactive waste (LLW) generated by the UK nuclear industry. A small facility operated by the United Kingdom Atomic Energy Authority (UKAEA) at Dounreay on the north coast of Scotland is used solely for wastes arising on the UKAEA site. Drigg also offers a disposal route for smaller users of radioactive substances, such as hospitals and universities.

The current Certificate of Authorisation (1) for the Drigg site requires BNFL to use best practicable means (BPM) to compact relevant waste<sup>a</sup> and to limit the migration of radionuclides from the waste. In accordance with Government policy, the Agency conducts periodic reviews of authorisations for nuclear licensed sites to ensure appropriate operating practices and that any changes to BPM employed are reflected in the Certificate of Authorisation. This paper presents an outline of the review methodology that has been developed and implemented specifically for the Agency's planned review of BNFL's Post-Closure Safety Case (PCSC) for the Drigg site. The paper also provides an overview of recent progress.

## ENVIRONMENT AGENCY'S REVIEW PROGRAMME

The Agency's requirements for a transparent programme of review of the Drigg authorisation were formalised in 1996 when a voluntary programme of document submissions was agreed between the Agency and BNFL for the exchange of information and review of the PCSC development programme and PCSC. In early 2000, the current site authorisation was varied to place a legal requirement on BNFL to provide a PCSC for the Drigg site in September 2002, and a status report on the development of that PCSC in March 2000. As required by RSA93, the Status Report has been placed on the Agency's Public Registers, as will the full PCSC.

The Agency's review programme is progressing in 3 phases:

**Phase I:** **December 1996 to March 1999.** This phase consisted of review and assessment of interim working documents from BNFL's PCSC Development Programme.

**Phase II:** **January 1999 to September 2002.** This is a continuation of the Agency's review and assessment of interim working documents from BNFL's PCSC Development Programme. In addition, it includes assessment of BNFL's responses to issues raised in Phase I, and review of BNFL's Status Report on the development of the 2002 Drigg PCSC (2,3).

**Phase III:** **September 2002 onwards.** This phase will include review of the Drigg PCSC and review of BNFL's authorisation for disposal of low level radioactive waste at Drigg.

## OBJECTIVES OF THE REVIEW PROGRAMME

The Agency's review of BNFL's PCSC Development Programme, and the PCSC itself, has the following principal objectives:

- To determine whether the developing PCSC is likely to be consistent with current legislation and guidance, to provide an adequate basis for regulatory decision making, and whether it is adequately supported by BNFL's programme of site investigation and characterisation, research, safety analyses and monitoring.
- To identify regulatory and technical issues that may affect the assessment of post-closure safety and develop detailed review criteria against which any responses made by BNFL on issues raised may be assessed.
- To identify the need for any further work by the Agency, such as audits of BNFL's programme, examination of further BNFL documents, assessment of BNFL's modelling codes, or possibly independent calculations on selected topics.
- To identify and communicate the need for any further work by BNFL for preparation of a PCSC to meet regulatory expectations.

The longer term aim is to provide a basis for reviewing the authorisation, in a manner that is open and transparent to the public, and to aid determination of any limits or conditions that might need to be included in a revised authorisation.

## THE BNFL DRIGG RADIOACTIVE WASTE DISPOSAL SITE

The Drigg site is located in West Cumbria in north-west England, six miles south of BNFL's Sellafield site (see Fig. 1). Radioactive waste disposal began in 1959 when the site was under the management of the UKAEA. The UKAEA continued to manage waste disposal at the site until the authorisation was transferred to BNFL in 1971.



**Fig. 1. Aerial View of the BNFL Drigg Site**

Initially, waste was disposed by tipping into a series of shallow, clay-lined trenches. This practice was similar to that used by the landfill industry. In the period to 1995, approximately 800,000 m<sup>3</sup> of waste was disposed in seven trenches. These trenches are now covered by an interim cap, which incorporates a plastic membrane to minimise water ingress.

In response to recommendations made by the House of Commons Environment Committee in its 1986 report on radioactive waste (4), BNFL initiated a major change to disposal operations which included containerisation of the waste followed by its emplacement in an engineered concrete vault. Disposals to the vault commenced in 1988. Most of the waste in the vault is packaged in freight containers that conform to International Standards Organisation (ISO) standards.

The existing vault has a capacity of approximately 200,000 m<sup>3</sup>. BNFL plans to build additional vaults to accept further waste. The total capacity of the planned vaults is approximately 750,000 m<sup>3</sup>. BNFL estimates that the site will remain operational until 2050, based on projected waste arisings and the site volumetric and radiological capacity. The end

of the operational phase will be marked by the completion of an interim site cap. Thereafter, BNFL propose a number of phases for the site as illustrated in Table I.

Table I. Phases of Control on the Drigg site following Operations

Indicative BNFL Timeframe <sup>b</sup>	Description
2050 – 2110	BNFL has proposed a post-operational management (active control) period of one hundred years from <b>2050 to 2150</b> . During this period, BNFL will be financially and managerially responsible for site activities, such as environmental monitoring, maintaining site security, undertaking safety assessments, and maintenance.
2110 – 2150	BNFL has proposed a period from <b>2110 to 2150</b> , during which time the operator will be responsible for emplacement and monitoring of engineering for final site closure, and preparation of the final PCSC.
2150	BNFL has proposed <b>2150</b> as the time of site closure and end of operator control, when security measures would be withdrawn and the site would potentially be open to other users
2150 – 2250	BNFL proposes that the end of operator controls signals the end of active controls and the start of a passive control phase of 100 years, between <b>2150 and 2250</b> . BNFL considers that at the start of this phase records and control would pass to local and national government and the operator would have no financial or managerial liability. Local planning laws may restrict site uses and activities.

The current Certificate of Authorisation requires BNFL to use best practicable means to compact relevant waste and to limit the migration of radionuclides from relevant waste. Under the Authorisation, Drigg can accept solid, low level radioactive waste with less than 4 GBq/tonne of alpha activity or less than 12 GBq/tonne of beta/gamma activity. The Authorisation also imposes annual disposals limits on specific radionuclides or radionuclide groupings, for example, 0.3 TBq uranium, 0.03 TBq radium-226/thorium-232, and 10 TBq tritium.

## IMPLEMENTATION OF THE REVIEW PROGRAMME

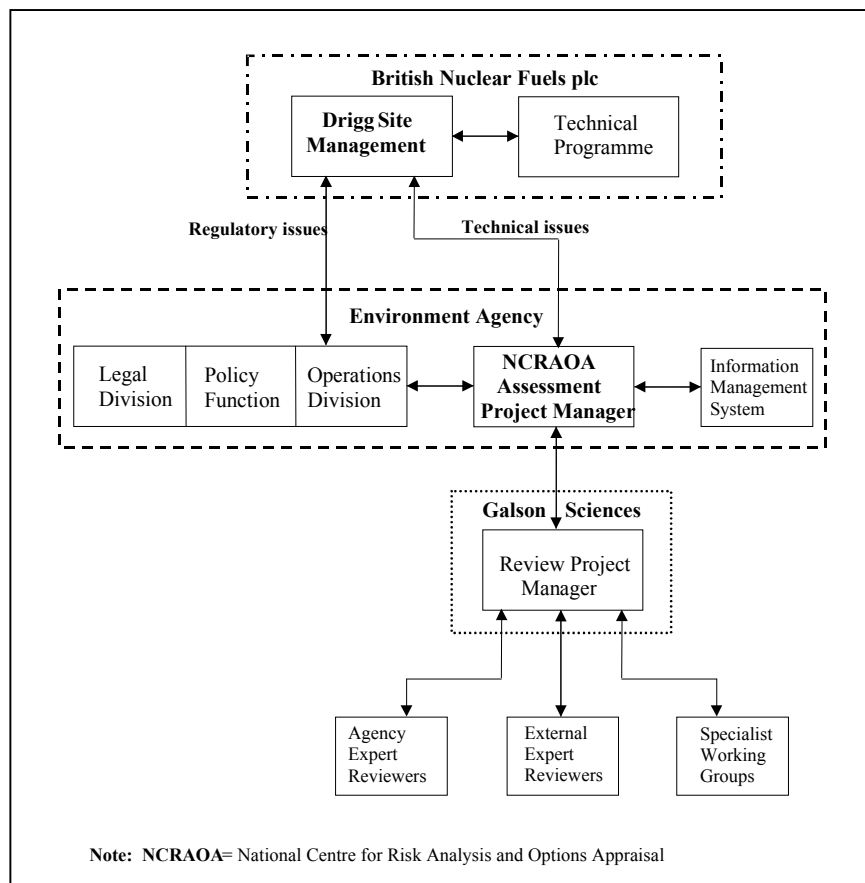
Implementation of the review programme is based on a staged process:

- Review of documents submitted by BNFL from the PCSC Development Programme.
- Identification and documentation of issues of concern.
- Development of recommendations for more detailed studies either by BNFL or the Agency.
- Review of the Drigg Post-Closure Safety Case submitted by BNFL in support of its authorisation for disposals at the Drigg site.
- Review of the authorisation for continued operations at the Drigg site.

## ASSESSMENT PROJECT STRUCTURE

The structure of the project and related information flows are shown in Figure 2. The Agency's Assessment Project Manager provides the point of contact with BNFL on all technical issues whereas contact on regulatory matters remains with the Site Inspector. To assist the Agency's Assessment Project Manager in implementing the review methodology, the Agency established, through a competitively tendered contract with Galson Sciences Limited, a Review Project Manager with responsibility for assembling a panel of experts to undertake reviews of the documents submitted by BNFL.

The composition of the panel of experts may be varied to suit the particular subject area under review and may include experts from within the Agency or outside. The Agency may also consider using specialist working groups for particularly complex or wide-ranging issues - for example, review of scenario development or of the features, events and processes (FEPs) that underpin the selected scenarios.



**Fig. 2. Drigg Assessment Project Structure.**

The Agency retains overall control of the review process and holds responsibility for:

- Initial screening of documents submitted by BNFL, to assess whether review would contribute constructively to the overall process.
- Evaluation and acceptance of reviews.
- Internal consultation on reviews.
- Formal approval of an Agency position paper based on the review.

- Transmittal of the position paper to BNFL.

After BNFL has received a review report, a Technical Exchange Meeting is usually arranged to discuss the review contents. Members of the expert panel can be invited to participate in the meeting to provide clarification or amplification of review comments.

## REGULATORY GUIDANCE

The Agency will review BNFL's developing safe case documents and, in particular, the PCSC against the requirements set out in the Environment Agencies' publication "*Radioactive Substances Act 1993 - Disposal Facilities on Land for Low and Intermediate Level Radioactive Wastes: Guidance on Requirements for Authorisation*" [the GRA](5) and more recently published Government guidelines on environmental risk assessment and management (6).

The review methodology developed and implemented by the Agency is firmly based on the principles and requirements set out in the GRA. The GRA describes general principles for protection of the public, detailed radiological requirements, technical requirements for the safety case and guidance on the supply of supporting information. Two radiological criteria are stated:

- ***Before control is withdrawn, the effective dose to a representative member of the critical group shall not exceed a source-related dose constraint of 0.3 mSv/yr [30 mrem/yr] or an overall site-related dose constraint of 0.5 mSv/yr [50 mrem/yr].***

The critical group can be based on an actual population subgroup expected to receive a significant dose because of its location, habits and characteristics.

- ***After control is withdrawn, the assessed radiological risk from the facility to a representative member of the potentially exposed group at greatest risk should be consistent with a risk target of  $10^{-6}$  per year.***

The estimated risk must take adequate account of uncertainties due, for example, to limited site information, uncertainties in waste characterisation, and incomplete understanding of the relevant processes.

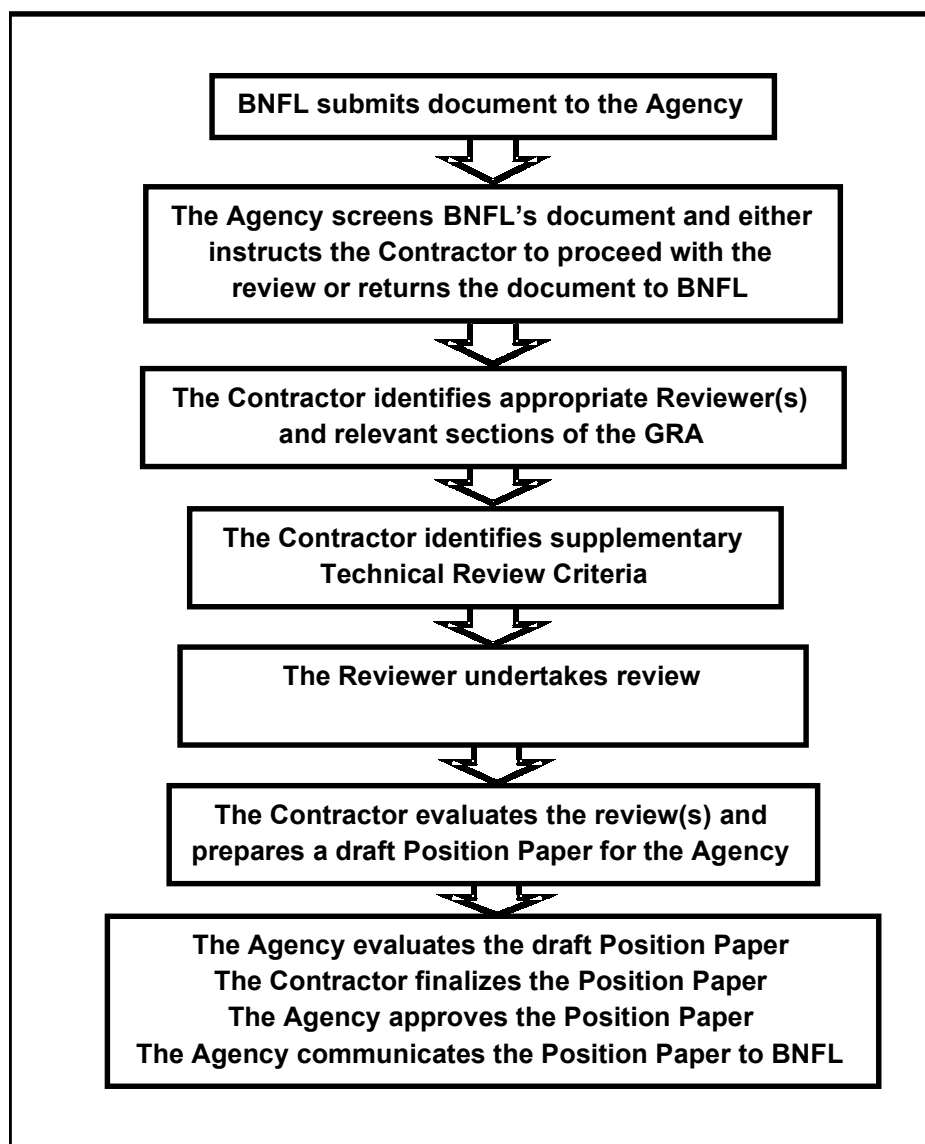
Regulatory decisions will not be made based on a quantitative risk calculation alone. A post-closure safety case will also need to include multiple and complementary lines of reasoning against the principles and requirements set out in the GRA. The GRA requires, for example, demonstration of the use of good engineering practice in design construction and operation of a radioactive waste disposal facility. There is also a requirement for application of good science in investigating the suitability of the site; in supporting research and development work; interpreting the resulting data; and developing safety assessment methodologies.

It is noted in the GRA that the Environment Agencies will use the document in reviewing the authorisations for future disposals to existing specialised land disposal facilities, applying the general principles it contains. They will, however, not seek to apply the more specific requirements identified in the GRA retrospectively to historical disposals at existing facilities where the standards adopted at the time of disposal were significantly different. Whatever the facility, the Environment Agencies will lay particular emphasis on the principle of

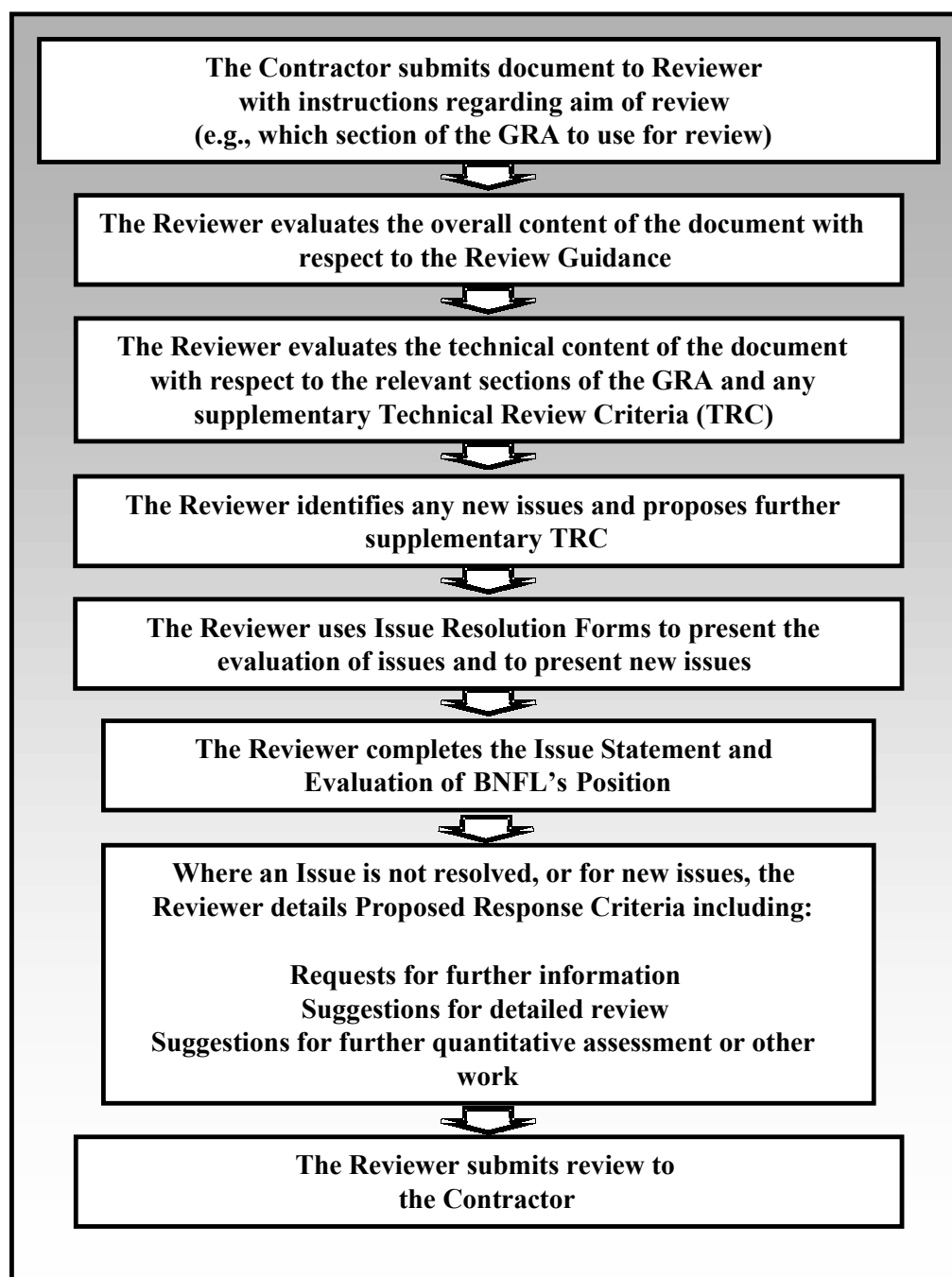
optimisation, through the application of best practicable means to ensure that the radiological detriment to the public is as low as reasonably achievable.

## **GUIDANCE TO REVIEWERS**

In addition to the published regulatory guidance, the Agency has developed technical guidance to reviewers which provides general review guidance, supplementary technical review criteria and instructions to reviewers on conduct of reviews (7). The guidance also describes an “Issue Resolution Procedure” adopted by the Agency for documenting and resolving any concerns that arise from review of BNFL’s documents, which has been discussed in detail elsewhere (8). The review methodology is illustrated in outline in Figure 3 with a more details of the document review process given in Figure 4.



**Fig. 3. Outline of Review Methodology.**



**Fig. 4. Document Review Process.**

### **General Review Guidance**

The General Review Guidance is intended to assist reviewers in undertaking and presenting reviews of documents from the PCSC Development Programme. The General Review Guidance provides a basis for reviewing the overall presentation, technical quality and adequacy of documents.



The principal points to be considered are:

- *Document Presentation*
  - Overall Presentation
    - Structure of document
    - Breadth of content
    - Depth of content
    - Quality control of document production.
  - Referencing
    - Sufficiency of cross-referencing to relevant supporting material.
    - Availability of references, particularly for key arguments.
- *Technical Quality*
  - Technical Quality
    - Clarity of presentation of judgements, assumptions and data.
    - Validity of judgements, assumptions and data.
    - Evidence of quality control of data collection and interpretation.
  - Model Development
    - Clarity of presentation of model development process.
    - Fitness-for-purpose of models.
    - Evidence of quality control of models and codes.
- *Implications for the Post-Closure Safety Case*
  - Sufficiency
    - Sufficiency of data to support a safety case.
  - Gaps in R&D
    - Gaps in BNFL's research and assessment programme.
  - Overall Approach
    - Appropriateness of approach for assessing post-closure safety.

The General Review Guidance also provides a common structure for the review reports.

## **Technical Review Criteria**

While the GRA forms the main technical focus of the review, the Agency has also developed a list of supplementary Technical Review Criteria (TRC). Development of supplementary criteria has been necessary for two main reasons:

- To place appropriate emphasis in the review on issues relevant to Drigg site authorisation.
- To help evaluate whether the requirements contained in the GRA have been met. It is recognised that it may be difficult to make the necessary evaluation against the GRA from individual documents submitted as part of the PCSC Development Programme. The development and application of review criteria at a greater level of detail is intended to help in evaluating the adequacy of BNFL's treatment of the relevant parts of the GRA.

The Technical Review Criteria (TRC) are directly related to the GRA and cross-references to relevant sections of the GRA are identified against each of the TRC. The TRC are presented

in the form of expectations that the Agency has of the PCSC. An example of a TRC with the relevant references to the GRA is:

**TRC 7.17(a)** Present the inventory used in calculations of post-closure performance and the assumptions on which it is based. [see also GRA 8.11 and 8.13]

- **GRA Section 7.17;** Requirement R8 (Waste form and characterisation) The developer shall derive waste acceptance criteria consistent with assumptions made in assessments of the performance of the system and with the requirements for handling and transport.
- **GRA Section 8.11;** In applying for authorisation for disposal of specific categories and quantities of waste, the operator of the facility will need to show that this is consistent with the overall plans for disposal up to the time of closure. The philosophy and provisions, if any, with regard to monitoring and retrieval of waste should be stated and justified.
- **GRA Section 8.13;** Information on the form of the waste, its physical and chemical properties and the radionuclide inventory will need to be maintained and progressively updated so that it can provide a continuing basis for strategy, planning, design and safety studies.

The supplementary Technical Review Criteria, combined with the GRA represented an initial set of review criteria for the Phase 1 work. It was recognised that the list was not comprehensive. Reviewers can propose additional detailed review criteria where they consider that such criteria will benefit the assessment of the PCSC Development Programme or the PCSC when presented in 2002.

### **Issue Resolution Procedure**

The Agency has developed an Issue Resolution Procedure, based on a standardised form, to assist with documenting and resolving concerns that arise during review of BNFL documents. The Issue Resolution Form is used by the Agency and BNFL to provide a traceable record of:

- The Agency's evaluation of BNFL's documents against the requirements in the GRA, and any supplementary Technical Review Criteria (TRC) developed by the Agency.
- The development of response criteria where concerns arise.
- BNFL's responses to issues raised in the Agency's review.
- The Agency's evaluation of BNFL's response.

A separate Issue Resolution Form is used to document each concern raised and proposed response criteria are noted for application during any subsequent reviews. In raising a concern a reviewer might, for example, identify a need for further information from BNFL, make suggestions for more detailed review of supporting documents, or make suggestions for quantitative assessment studies either by BNFL or possibly by the Agency. Reviewers are

asked to state the relevance of the concern to the GRA and, where possible, to identify the potential significance of the concern to estimates of future radiological impact.

Issues are recorded on an Issues Database designed to provide a clear and auditable record of issues raised by the Agency and actions taken by BNFL to address the issues. The Issue Resolution Procedure provides a traceable mechanism through which:

- The Agency can prepare for the review of the 2002 PCSC by documenting detailed review criteria.
- The Agency may provide comments and site-specific guidance to BNFL without compromising its independent, regulatory position.
- BNFL can address the Agency's comments and supplementary TRC in developing a PCSC that is fit-for-purpose.

The Agency believes that BNFL may be able to supply information fairly rapidly in order to satisfy some of the supplementary TRC. Complex issues will inevitably require the conduct of further work for their resolution. The Issue Resolution Procedure will provide a record of how the PCSC develops and improves over time with the acquisition of further knowledge. The process of issue resolution will continue throughout the period until submission of the PCSC in September 2002, and may extend beyond this date to track BNFL's work towards resolution of any outstanding issues. Outstanding issues may be included as Information and Improvement Requirements in a future Certificate of Authorisation.

## **PROGRESS IN REVIEW OF BNFL'S PCSC DEVELOPMENT PROGRAMME**

During Phase I, twenty-one documents from BNFL's PCSC Development Programme were reviewed. In addition, seven underlying documents were reviewed. The reviews were conducted following the procedures set out above. Each document was reviewed by the Agency's staff and at least two members of the Agency's panel of experts. Groups of reviewers were established for documents that covered a wide range of technical areas. Meetings were held between reviewers as necessary.

The Agency's reviews from Phase I were documented in a series of 15 Position Papers which include 86 Issue Resolution Forms; a further 228 supplementary Technical Review Criteria were identified for consideration in the later stages of the review process. In reviewing the BNFL Status Report in Phase II, the Agency specifically commented on the following areas of BNFL's programme:-

- Regulatory interpretation;
- Comprehensiveness and integration of BNFL's approach;
- Optimisation;
- Models and data flow;
- Treatment of uncertainty;
- Traceability of assumptions and data; and
- BNFL's progress and forward programme.

BNFL has committed to responding to the Agency's comments and are actively participating in the Issue Resolution Procedure. As a result of the ongoing dialogue and review by the Agency, BNFL have also:-

- Implemented a tiered approach to risk assessment
- Mapped their safety case against the regulatory guidance
- Changed their safety case philosophy in certain areas (e.g. human intrusion)
- Significantly improved their safety case presentation.

## CONCLUSIONS

The on-going review of BNFL's Post-Closure Safety Case Development Programme has placed the Environment Agency in a strong position to undertake its regulatory role in assessing the PCSC in 2002/2003. The Agency has:

- Implemented appropriate review procedures.
- Initiated an Issue Resolution Procedure.
- Developed detailed site-specific review criteria.
- Gained an understanding of the Drigg site by examination of BNFL's site characterization data.
- Gained an understanding of BNFL's approaches to the future management of the site and to the PCSC.

Phase 1 of the Review Programme established an appropriate methodology for reviewing a complex, developing safety case. This will be of benefit to the Environment Agency in assessing BNFL's 2002 PCSC and in fulfilling its regulatory role during the authorisation review. Furthermore the review methodology developed may have application to other areas of the Agency's regulatory programme.

## REFERENCES

1. Department of the Environment and Ministry of Agriculture, Fisheries and Food, Radioactive Substances Act 1960, Certificate of Authorisation for the Disposal of Solid Low-Level Radioactive Waste at the Drigg Site (1988). As varied effective 1 January 1991 and 14 February 2000. London: DOE and MAFF.
2. BNFL, "Status Report on the Development of the 2002 Drigg Post-Closure Safety Case" (2000).
3. Environment Agency, "Review of the Status Report on the Development of the 2002 Drigg Post-Closure Safety Case". National Centre for Risk Analysis and Options Appraisal, Position Paper No 25. (2000) .
4. Radioactive Waste: First Report from the (House of Commons) Environment Committee, Session 1985-86. House of Commons Paper HC191, London, (1986).

5. Environment Agency: Environment Agency, Scottish Environment Protection Agency, and Department of the Environment for Northern Ireland. "Radioactive Substances Act 1993 - Disposal Facilities on Land for Low and Intermediate Level Radioactive Wastes: Guidance on Requirements for Authorisation" (1997).
6. Department of the Environment, Transport and the Regions, Environment Agency and Institute for Environment and Health "Guidelines for Environmental Risk Assessment and Management". London: The Stationery Office. 88pp (ISBN 0-11-753551-6) (2000).
7. Environment Agency, "PCSC Development Programme Review Plan and Instructions for Reviewers" (Version 1.0). National Centre for Risk Analysis and Options Appraisal, Guidance Note Number 1 (Version 1.0). (1997).
8. Yearsley, R. A., Streatfield, I. J. & Bennett, D.G. "Use of Formal Procedures in Developing Dialogue Between Operator and Regulator on Radioactive Waste Disposal", Proceedings of the second VALDOR Symposium Addressing Transparency in Risk Assessment and Decision-making, Stockholm, Sweden (2001).

## FOOTNOTES

<sup>a</sup> Relevant waste means solid radioactive waste which has been treated or packaged in such a way as to render it so far as is reasonably practicable insoluble in water and not readily flammable. Radioactive waste is as defined in RSA 1993.

<sup>b</sup> These timeframes are indicative and have yet to be fully justified in the Post-Closure Safety Case.

<sup>c</sup> The Environment Agencies refers to the Environment Agency in England and Wales, the Scottish Environment Protection Agency in Scotland and the Environment and Heritage Service in Northern Ireland.