

DEEP REPOSITORY DEVELOPMENT - PROGRESS IN THE UK

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ABSTRACT

United Kingdom Nirex Limited (Nirex) is responsible for developing and managing a deep facility for the safe disposal of intermediate and some low-level radioactive waste. The company is concentrating its efforts on a proposed site at Sellafield in Cumbria and the conceptual design proposals were described at the Waste Management '92 Conference.

Considerable borehole investigation work has been completed and in October 1992 Nirex announced plans for advancing geological investigations. Subject to continuing satisfactory results from regional borehole drilling, a planning application for an underground Rock Characterization Facility will be submitted. This will provide data to build up a clearer picture of long-term safety potential and engineering properties of the host rock.

The paper gives details of the Rock Characterization Facility, updates Repository Design development work and outlines the Nirex future program.

INTRODUCTION

United Kingdom Nirex Limited is a Company jointly owned by the major partners in the UK nuclear industry and is responsible for developing and managing a deep facility for the safe disposal of intermediate-level (ILW) and some low-level (LLW) radioactive waste.

Since 1987, Nirex has concentrated on identifying a suitable location for such a facility in the UK. In March 1989 the Company announced its intention to undertake detailed geological investigations, including the sinking of boreholes, at Sellafield in West Cumbria, England, and at Dounreay in Caithness, Scotland. These investigations showed both sites as having the potential to meet the demanding safety requirements for a deep repository but, in July 1991, the Company announced that it was to concentrate further investigations at Sellafield. Transport of waste and the cost of that transport were major factors in this decision since an estimated 60% of radioactive waste destined for the repository arises at Sellafield.

The Nirex program of geological investigations has continued. The necessary planning permissions have been progressively obtained from the Cumbria County Council although the Lake District Special Planning Board, the responsible authority for the Lake District National Park, has refused to grant planning permission for the Company to drill within the National Park. To date, eight deep boreholes have been completed and two others are in progress. Borehole locations in West Cumbria are shown in Fig. 1. An extensive program of geophysical surveys has also been undertaken. The initial geological results confirm the existence of a potentially suitable location for a deep repository at Sellafield in the basement rock - Borrowdale Volcanic Group (BVG) - which is overlain by Brockram and sandstone.

In parallel with the exploratory program, and based on the geotechnical results, the repository conceptual design has been further developed. The preferred design concept was published in December 1991. It is based upon a system of tunnels and disposal vaults which would be excavated about 800m underground with principal operational access to depth by means of drift tunnels which would be driven from a surface location adjacent to the existing Sellafield site complex. Careful attention has been paid in the design process to minimizing the environmental impact of such a development.

GEOLOGICAL INVESTIGATIONS

The geological investigations carried out at Sellafield between November 1989 and September 1991, were aimed at providing sufficient understanding of the geological environment to allow a decision to be made about the submission of a planning application for the substantive development of the repository at the site. A preliminary interpretation of the results was published by Nirex in March 1992 (1). However in June 1992, the Company announced its decision that further investigations would be required before a sufficiently firm assessment of long-term safety could be made to allow a decision on a repository planning application. Early in 1992, the Lake District Special Planning Board refused Nirex planning permission to drill two deep boreholes in the National Park. A Public Inquiry into the subsequent appeal by the Company, began in November 1992 and lasted for two weeks. The outcome is expected to be known early in 1993.

The present assessment of results from boreholes indicates that the hydrogeology of the BVG rock, in which the repository would be built, appears to be characterized by slow percolation of small volumes of water. Some of the initial observations indicated potential for a component of upward seepage, but the only clear indication to be drawn was that the initial data was too sparse to enable a confident decision to be made on whether to begin the underground excavation. Accordingly, the intention to undertake further investigations was announced in June 1992.

Nirex has always seen the need for underground laboratory work to be undertaken in the first stages of excavations. The purpose of this work would be to complement investigations conducted from the surface through the borehole program, and so develop a fuller understanding of the geology and hydrogeology of the site and surrounding region. That understanding will provide a basis for refining long-term safety assessments and geotechnical information required for detailed design of the repository.

In October 1992, Nirex announced plans for advancing geological investigations. Depending on the results from the continuing program of regional borehole drilling, a planning application for an underground Rock Characterization Facility (RCF) will be submitted in mid-1993. The RCF will complement the surface-based investigations and build up a clearer picture of long-term safety potential and engineering

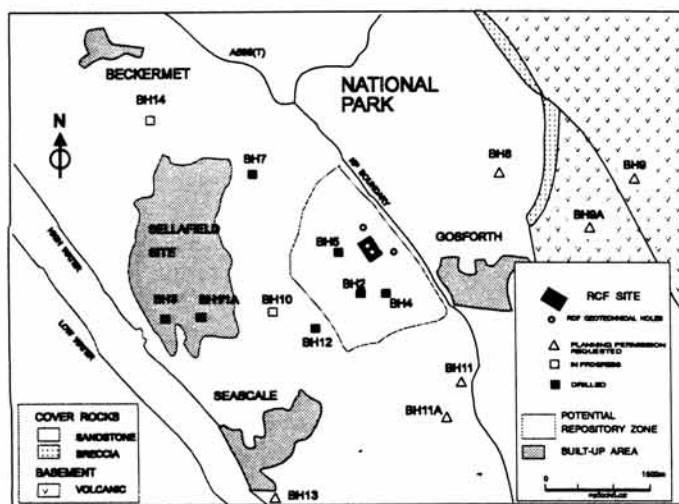


Fig. 1. Locations of boreholes in West Cumbria.

properties of the host rock. With the additional data, the uncertainties on geology, hydrogeology and underground construction will be narrowed in a much more effective way than can be achieved from the surface. This approach demonstrates the commitment of Nirex to put safety considerations first and to promote an informed discussion of safety issues at the Public Inquiry into Repository Development.

ROCK CHARACTERIZATION FACILITY

The characterization program at Sellafeld is designed to obtain data on a wide range of properties in order to develop an assessment of post-closure safety and to support work on the repository design. It has been principally focused on obtaining rock core and groundwater samples from a number of 6 inch diameter boreholes drilled down to depths of 2000 m. The borehole investigations are supplemented by seismic surveys, other geophysical sensing and geological mapping. Site characterization now needs to focus on the potential repository rock mass itself, on more detailed work on a larger scale, and in three dimensions within that rock mass. This work will be carried out in the RCF.

The RCF (2) is proposed as a free-standing phase and quite separate from any planning application for the development of a repository at Sellafeld. None of the RCF workings could become part of the repository unless entirely separate planning approval was given and regulatory licenses and authorizations were obtained.

The RCF will be constructed and operated to:

- provide geological and hydrogeological characterization data and scope for a model validation program which will allow a firmer assessment of long-term safety;
- provide data needed to decide a footprint location, design and orientation of a repository within the geologically suitable zone; and,
- provide geotechnical data on rock competence and fracture characteristics to inform decisions on repository construction methods and enable cost estimates to be refined.

The RCF will offer the following additional testing capabilities to those available from surface investigation.

- Bulk data can be obtained in three dimensions from a large volume of rock compared to isolated lengths of rock core drilled from the surface.
- Specialized tests can be performed directly on specific features.
- Tests are less constrained by the limitations of design or location of surface investigations.

The proposed location of the RCF has been chosen to minimize the risk of compromising the long-term integrity of the potential repository site. This location is shown in Figure 1. An assessment will be conducted to demonstrate that post-closure performance of the geosphere will not be significantly affected by the RCF.

Construction of the RCF shafts and galleries will tend to disturb the hydrogeological regime across the potential repository site. The response of the groundwater to sinking shafts in the vicinity can provide useful data about the hydrogeological properties of the rock. Accordingly, an array of four monitoring boreholes is proposed for the RCF site to establish the hydrogeology of the location and to yield information on the response to the RCF construction work as it proceeds. This information will be valuable in validating numerical models of groundwater flow.

Safety considerations require underground workings to have two separate means of access or escape. In the case of the RCF this will be provided by two shafts, each 5m internal diameter and 50 m apart. The shafts will be sunk in two stages. Initially, a foreshaft will be excavated by conventional drill and blast techniques to a depth of around 30 m. Each foreshaft will be lined with concrete on which the winding gear will be set up for the main shaft excavation. The shafts will be lined through the sandstone and Brockram layers to prevent water ingress, but lining is not deemed necessary in the BVG where the groundwater flow is expected to be low. From the shafts, and primarily at a depth of 650 m, exploratory galleries and chambers will be excavated in the BVG. It would be possible to extend one shaft to allow investigation of the BVG down to 900m if this were required. A schematic diagram of the RCF is given in Fig. 2 and a projection from WSW, indicating the location of the RCF shafts within the host rock, is shown in Fig. 3.

It is estimated that sinking two shafts to 650 m would take 27 months, while overall construction of the RCF, including test galleries, would take a further 9 months.

The RCF would be set in rolling terrain with trees and farm buildings, and a landscaping strategy will be implemented to mitigate visual impact of the development at all stages. Landforming, using surface and sub-surface spoil, will be created in harmony with the local topography and screen planting of local species - close to local settlements and viewpoints - will form the basis of this strategy. Environmental impacts of the development will be fully evaluated and measures taken to minimize the effects by controlling water resources, atmospheric emissions, noise, vibration, rights of way, recreational facilities, cultural heritage, historical and archaeological features, ecological issues, local economy and traffic impact.

The cost of the RCF construction is estimated to be about US \$200 million at 1992 prices and represents a relatively small proportion of the cost of a deep repository at Sellafeld. The introduction of the RCF as a separate phase of the repository program is expected to have little impact on overall

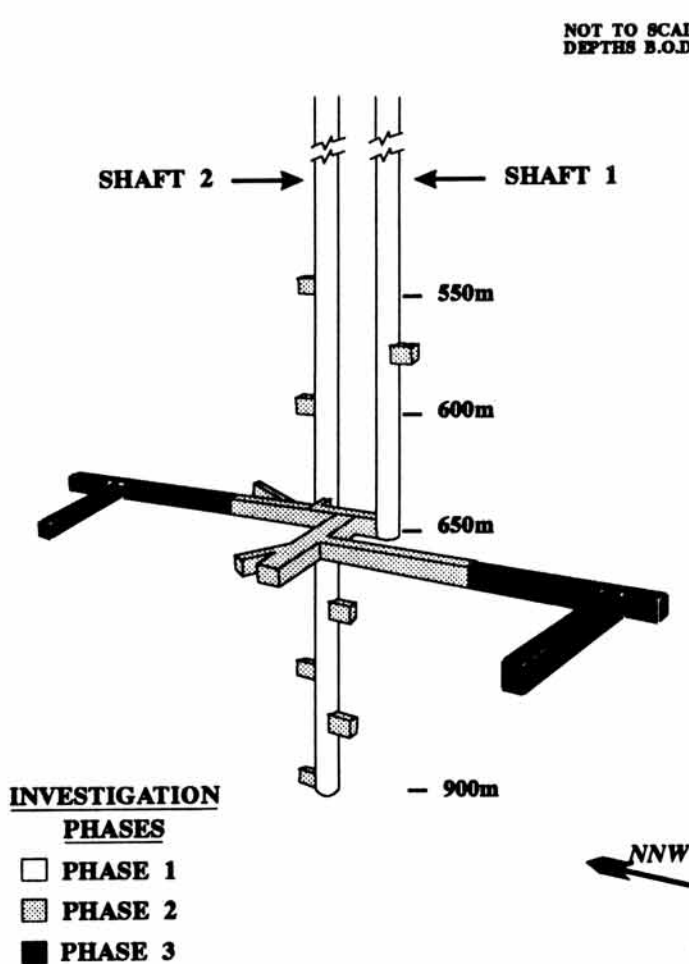


Fig. 2. Schematic diagram of the rock characterization facility (RCF).

costs, the main effect is a re-phasing of cost rather than any increase or decrease in the total amount.

REPOSITORY DESIGN DEVELOPMENT

The preferred repository design concept is based on drift tunnel access to the underground facilities from a surface location adjacent to the existing Sellafield site. The two drifts would each be 8km (5 miles) long to the repository located at a depth of approximately 800m. A rack and pinion railway would be used to transport waste containers underground. This approach would avoid the necessity of handling heavy and bulky equipment, and ultimately the waste packages themselves, down a vertical shaft.

Conceptual design work has progressed well and the preferred design continues to be optimized with a cost-effective approach, consistent with the overriding safety requirements. Progress has been made in firming up a number of factors on which the design - and hence the cost - is dependant, particularly the volume of waste for emplacement and certain geotechnical data. It is recognized that a reduction in the waste emplacement rate would have significant cost benefits. However, a focus at the system level is being maintained so that cost-effective designs can be developed specifically as the design parameters become more clearly defined.

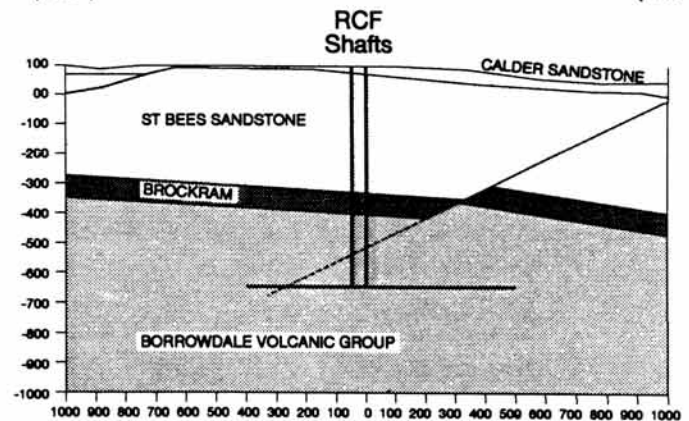


Fig. 3. Projection of the RCF viewed from WSW.

FUTURE PROGRAM

Under the revised program, a repository planning application will not be submitted before late 1996. The revised program allows for further optimization of the design, a more detailed review of construction costs to be undertaken, and for the plans to be optimized for construction over a tight, but achievable, timescale. A key input at every stage comes from the site characterization program at Sellafield. A repository commissioning date in 2006/2007 is explicitly conditional on having established sufficient geological confidence to submit a planning application late in 1996.

On the subject of consultation, Nirex is under no illusions that everyone in West Cumbria welcomes the Company with open arms. The aim always is to give people information to make up their own minds. A major information campaign is underway in the area. This has included the opening of a local information office. A number of Nirex staff, from the Managing Director downwards, have also given frequent presentations to County, local and parish audiences. Local opinion research shows a growing acceptance of Nirex activities. At the same time the understanding of local issues is improving. This process of consultation will continue.

CONCLUSION

The actions of the Company show that Nirex is serious about following a strictly scientific approach, taking as much time as is necessary to demonstrate that the proposals are safe. A second-rate proposal will not be made just because the site has so many advantages in terms of waste transport and location. If the site's geological promise is not confirmed, then other options would be sought. However, results to date continue to support the decision to concentrate on Sellafield as the preferred site for a national deep repository.

REFERENCES

1. The Geology and Hydrogeology of Sellafield, Nirex Report No 263, March 1992.
2. A Rock Characterization Facility Consultative Document, Nirex Report No 327, October 1992.