THE DEVELOPMENT OF A DEEP REPOSITORY-PROGRESS IN THE UK

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ABSTRACT

United Kingdom Nirex Ltd, a company jointly owned by the major partners in the UK nuclear industry, is responsible for developing a deep disposal facility for low-level and intermediate-level radioactive waste. In July 1991 Nirex announced its intention to concentrate geological investigations at Sellafield, where BNFL's existing operations give rise to approximately 60% of the wastes destined for a repository. The main features of the Nirex design process, from early considerations through the main features of a preferred conceptual design and its advantages, are described.

Subject to Nirex obtaining planning permission, following a Public Inquiry, the proposed program would allow the UK nuclear industry to fulfill its responsibilities with respect to declared Government policy by providing a safe deep geological disposal facility early in the next century.

INTRODUCTION

United Kingdom Nirex Limited ("Nirex"), a company jointly owned by the major partners in the UK nuclear industry, is responsible for developing a deep disposal facility for low-level and intermediate-level radioactive waste. On 23rd July 1991, Nirex announced that it was concentrating its geological investigation work for the siting of an underground repository at Sellafield in West Cumbria. Initial investigations indicate that the geology at Sellafield, like that at the alternative site at Dounreay, Caithness, could enable Nirex to meet the demanding safety requirements for an underground repository.

Following the July 1991 announcement, Nirex, with support from BNFL, has had continuing discussions with local authorities and communities in Cumbria. Depending on continuing good results from the geological investigations and a detailed environmental impact assessment, the program assumes a Public Inquiry into the proposal for the development of a repository at Sellafield will take place during 1993/4.

The design presented is not intended, at this early stage, to be definitive in detail, however, its key features are clear.

SITE SELECTION

Since 1987 Nirex has been working in conformity with the approach recommended by the International Atomic Energy Agency (IAEA) for identification of a preferred site for the development of a deep underground repository. Essentially, three stages are involved in this process:

- a search on a national scale to select potential repository regions;
- identification of specific sites for comparative evaluation and selection from amongst these of sites offering outstanding prospects for detailed physical exploration to confirm their suitability; and
- a provisional choice of site based on the results of geophysical investigations and other studies.

The principal requirement is that the design of the repository and the geology of its location must together enable the requisite level of radiological safety to be met. Secondary but important factors include the effects of the development on all aspects of the local environment and overall project costs. As well as the search for suitable geological environments and the identification of specific sites having particular potential, studies have taken account of the suitability of sites in terms of availability and current usage, planning and socio-economic considerations and also the development of appropriate conceptual designs. Consideration has also been given to transport systems required to bring packaged waste to the repository and to carry construction materials, rock spoil and personnel.

The site selection process began in 1987 with desk studies based on available data and theoretical knowledge. As the identification and assessment of potential sites proceeded, some were eliminated and others emerged as offering potential. This allowed increasingly detailed appraisals to be undertaken of relevant matters specific to each site and the number of sites to be carried forward for consideration was progressively reduced.

Nirex sought to explore public attitudes through publication in 1987 of a discussion document entitled The Way Forward. Thereafter, as the site selection work progressed in parallel with the discussion process, it became clear that potential sites could be divided into two categories, i.e. those where there is some understanding of, and a measure of support for, nuclear activities in the local community and those where such support is lacking. In view of this, and in recognition of the practical difficulties involved in investigating numerous sites in parallel, the Company decided to concentrate further investigations at Dounreay in Caithness and Sellafield in West Cumbria. This decision was announced in 1989. During the following two years, investigations were continued at both sites. These included geological investigations involving deep drilling and geophysical surveys to provide fundamental inputs to safety assessments, and geotechnical information relevant to repository excavation. Detailed studies of the impact and costs of transporting waste to the two sites was carried out and the developing repository design was used as a basis to assess the environmental impact of the proposed development at both sites.

In July 1991, Nirex announced its intention to concentrate investigations at Sellafield. The initial investigations indicate that the geology at either Sellafield or Dounreay could be suitable for safe disposal of intermediate and low-level waste in a deep underground repository. The announcement of Sellafield as the preferred site reflected the fact that approximately 60 per cent. of the wastes destined for a Nirex repository arise from BNFL's Sellafield operations. Locating the repository in the Sellafield area would therefore allow the transport of waste to be minimized. In other respects the two

sites appear broadly comparable and Dounreay remains an option should further geological work show the West Cumbrian site to be unsuitable.

Geological investigations at Sellafield are continuing. Five boreholes, some over one mile deep, have been completed and the sixth is in progress. The boreholes and rock core have been subjected to an intensive program of testing and the drilling has been backed up by extensive geophysical surveys involving the use of seismic and aeromagnetic techniques. Detailed work on the specification of transport systems and the assessment of the environmental impact associated with waste transport, repository construction and operation is being progressed. Good progress is also being made in the preparation of a post-repository closure safety case.

INITIAL DESIGN STUDIES

In parallel with the site assessment and selection process, conceptual design work for the repository was commissioned by Nirex. The first step was production of an outline generic design for a deep hard rock repository to form the basis for continuing conceptual design development. The initial outline design (Fig. 1) envisaged a receipt facility for material delivered by rail with areas for monitoring, checking, conditioning and grouting of waste packages and their transfer onto an internal transport system to the disposal point. Access to the disposal location was by a conventional mine shaft, at the bottom of which tunnelled roadways would lead to large vaults where the waste containers would be emplaced. A second shaft would be equipped with facilities for ventilation and operator access. It was envisaged that the shaft headworks would be 35 to 50 meters (115 to 165 feet) high.

In parallel with waste emplacement activities, excavation of additional vaults is planned to proceed over most of the 50-year operating life of a repository. Accordingly, the generic design provided for third and fourth shafts for continuing construction access and ventilation, independent of the waste emplacement operation. The design also included all the normal support buildings required by any major development of this kind, including offices, gatehouses, stores and similar facilities.

Following the 1989 decision to concentrate geological investigations on Dounreay and Sellafield, the generic repository design was developed into first conceptual designs specific to each site. That work was based on traditional mining technology and nuclear waste design methods.

The main features of the first conceptual design for the repository at Sellafield can be summarized as follows:

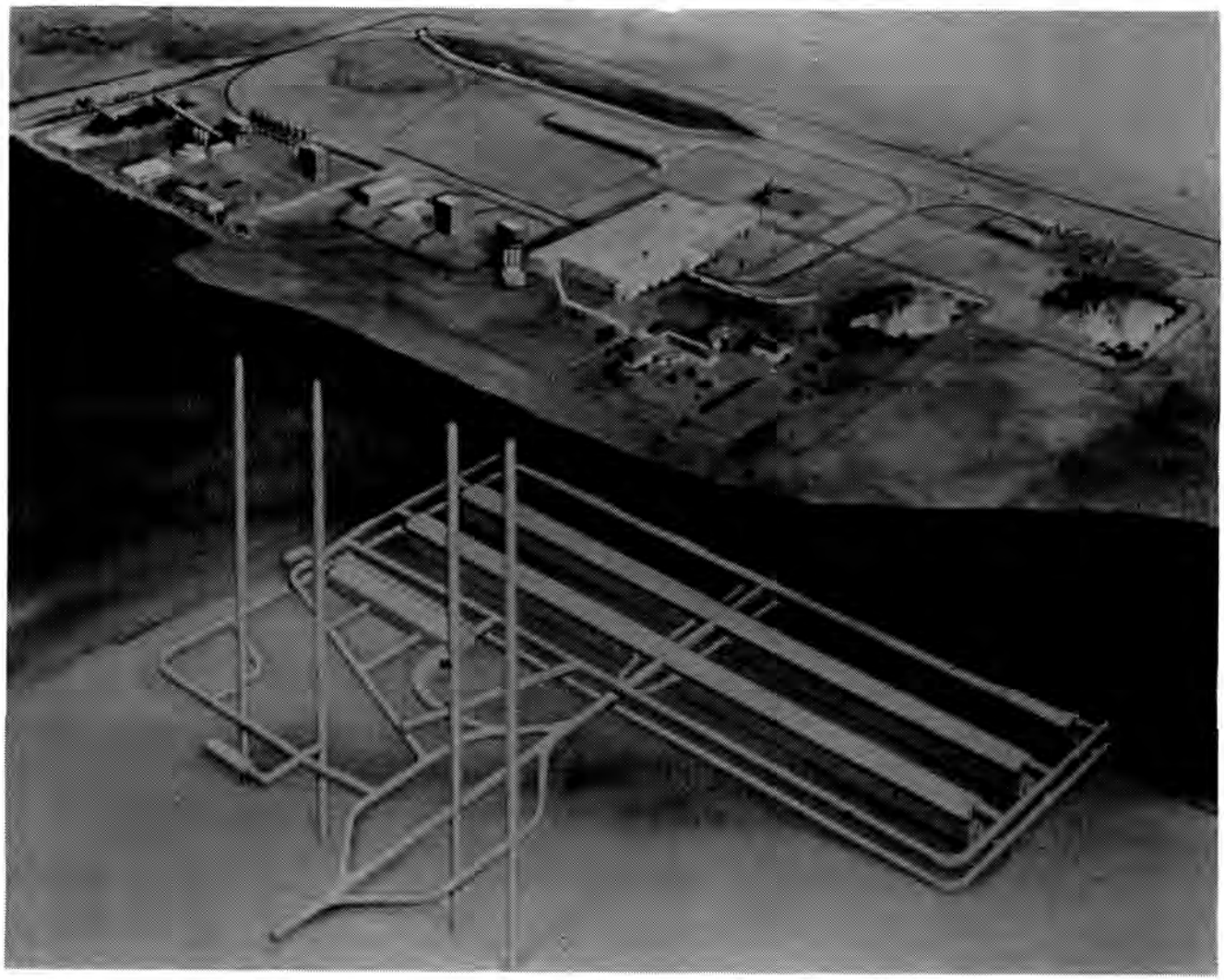

Fig. 1. Initial outline design.

- a new railway connection from the main West Cumbria line to a marshalling yard adjacent to the existing BNFL Sellafield site,
- an associated waste receipt and handling building, maintenance facilities and office accommodation,
- a link corridor to the waste disposal area some 3 Km (1.86 miles) away with both above and below ground rail lines,
- headworks, occupying a site of about 40 hectares (100 acres), to handle construction and waste emplacement activities,
- headwork site providing underground access via four shafts, each with a winding tower some 65 meters (215 feet) high, rapid loading facilities for spoil removal, changerooms, a mine rescue station and other support buildings,
- a new access road would have been required and about 60 hectares (150 acres) of landscaping were envisaged to reduce visual intrusion.

Output from the first conceptual designs was used as the basis for initial environmental impact studies, during which the consultants used by Nirex held preliminary consultations with representatives of local communities. This was as required by statutory procedures for environmental impact assessment.

The information gained from those consultations - and from local reactions generally - pointed to specific environmental concerns which required consideration.

PREFERRED CONCEPTUAL DESIGN

Design Requirements

As in the development of any engineering project, certain key requirements have been defined. For the repository these are that the design shall:

- be robust in terms of safety - both during the construction and operational periods - providing maximum protection for the workforce and general public,
- satisfy the requirements for longterm radiological safety laid down by the Department of the Environment (1),
- as far as possible, incorporate technology and equipment which is already in use elsewhere. This will minimize the risks associated with new developments and provide opportunity to draw on expertise acquired by existing users.

The repository project will inevitably involve engineering challenges not encountered in the design of other types of nuclear facility. Many of these can be addressed by the use of technology/engineering approaches which are well established in other industries. Compared with either a nuclear power station or a nuclear chemical plant the radiological significance of repository operations will be small. Detailed design and operating systems will, moreover, be subject to close scrutiny by regulatory agencies, including the Nuclear Installations Inspectorate ("NII") of the Health and Safety Executive ("HSE").

Waste Handling

The key operations to be performed on radioactive materials at a Sellafield repository would be as follows:

- receive waste packages by rail and road from various locations around the UK. All such packages will be in containers which meet IAEA Transport Regulations,
- receive waste packages from stores or conditioning plants located on the adjacent BNFL Sellafield site. Such packages will not enter the public domain but will be moved on-site in containers similar to those used for off-site transport,
- check that containers received match the documentation accompanying them,
- check for any external visible damage and for any external radioactive contamination,
- transfer the containers to a rail vehicle for internal repository movement,
- transport the containers to the entrance to the disposal vaults,
- within a closed cell, remove the waste packages from each container and emplace them within the disposal vault,
- check and, if necessary, refurbish the container before returning it to the consignor for further use.

There are a number of other peripheral requirements and the needs of continuing construction. Operations in support of these will not directly involve handling of waste packages.

Main Elements of the Preferred Design

To meet the requirements discussed above, the preferred conceptual design includes:

- a marshalling yard within the existing BNFL Sellafield site fence and connected by a new spur to the British Rail line. The marshalling yard will provide a holding facility to enable the disposal system to handle incoming waste containers on a planned basis. It will also provide a buffer capacity for use in the event of any interruption of underground operations, so that waste containers already in transit would not require re-routing,
- a waste receipt building, also within the existing BNFL site, covering area where waste containers will be checked and transferred to internal transit vehicles. No nuclear activities will be carried out in this building, which would be a relatively simple structure,
- two drift access tunnels will be provided starting in the waste receipt area. The tunnels will be up to 8 kilometers long (5 miles), at a gradient of about 1 in 6, and of 6 to 8 meters (20 to 26 feet) diameter. Both tunnels will form part of the ventilation system. One will be used to transfer the waste down to the disposal vaults - about 800 meters (2600 feet) below the surface - using a rack and pinion electric locomotive controlled from the surface. The second tunnel will be used to transfer men and construction materials underground, and will incorporate a conveyor system to lift rock spoil from the underground excavations

to a rail loading facility for off-site disposal. Rubber-tired vehicles could be used in the tunnels by contractors during the initial construction period,

- two ventilation shafts, each of about 5 meters (16 feet) diameter, above the repository vaults. These two shafts will connect with ventilation fans installed deep underground. They will also have emergency access facilities for men and equipment, all within two buildings about 16 meters (50 feet) high in a landscaped area of approximately 10 acres. Following construction there will be little need for above-ground access to this site. As no manned operations are involved appropriate road access can be provided from the Sellafield direction,
- underground vaults and tunnels for the emplacement of waste with the necessary handling facilities. Each vault or tunnel will have an enclosed handling cell at its entrance. In this cell the waste packages will be remotely removed from transport containers for placement inside the disposal area and eventual backfilling. The transport containers will then be checked, returned to the surface, and refurbished as necessary for re-use,
- a number of miscellaneous buildings to provide facilities such as office accommodation, maintenance workshops, gatehouse and other similar requirements will be sited in the waste receipt area (Fig. 2).

Advantages of Preferred Scheme

The preferred conceptual design offers some significant benefits:

- reduced visual intrusion
- simplified waste package handling
- intrinsically simpler internal transport systems
- no 'nuclear' operations above ground
- most buildings within, and repository access from, within the existing BNFL Sellafield site.

SAFETY

The safety of the repository during all phases of its existence is of over-riding importance.

Before the NII, the Department of the Environment (DoE) and Ministry of Agriculture, Fisheries and Food (MAFF) can give Nirex the necessary approvals, these bodies will have to be satisfied that the safety case for the repository meets government requirements. The Company will be publishing a preliminary assessment of safety-related matters well in advance of the Public Inquiry into the development of a repository at Sellafield.

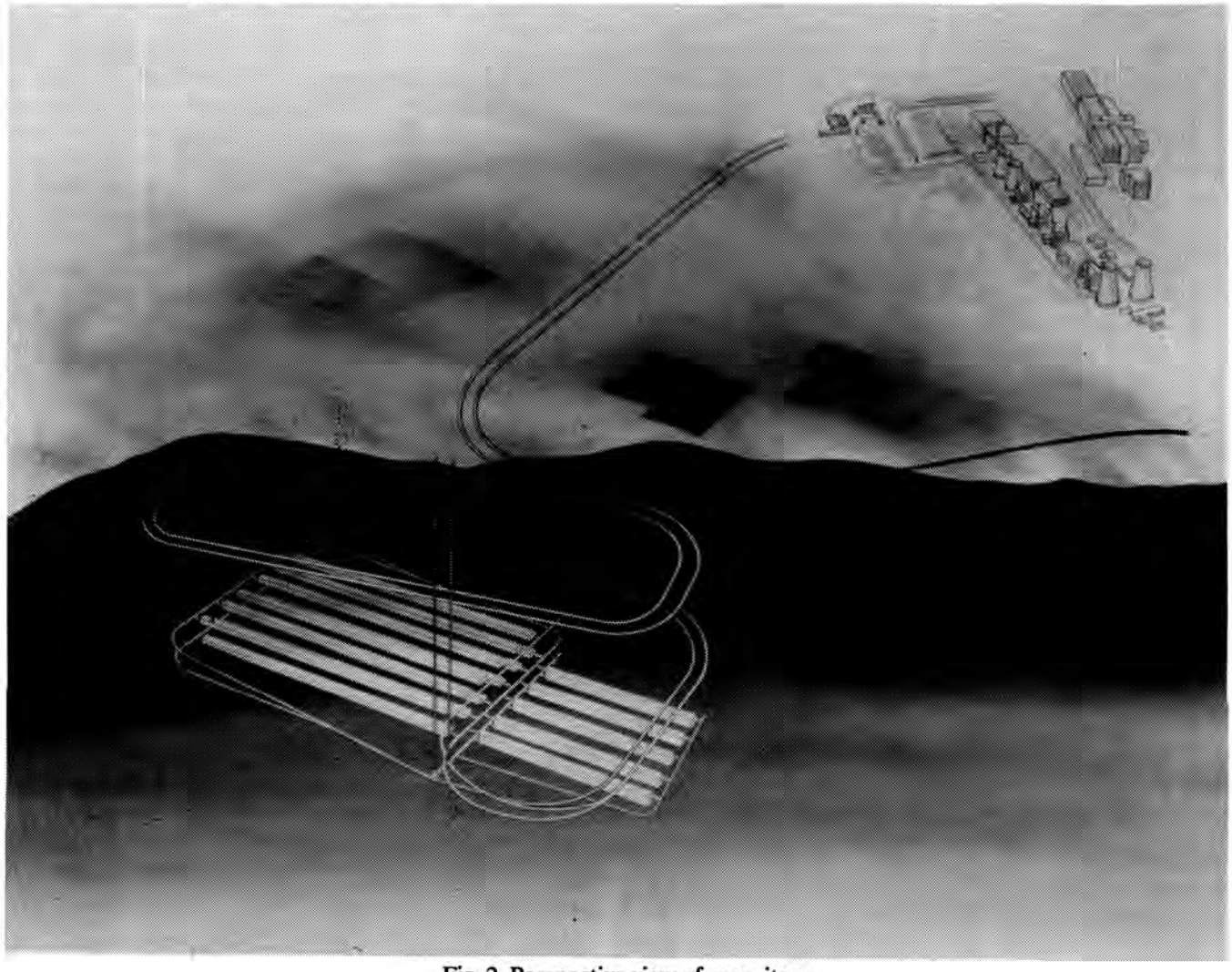

Fig. 2. Perspective view of repository.

In deciding whether to grant a license, the NII will need to be satisfied that the design, construction and operation of the repository will meet its stringent requirements. They will be particularly interested in the operational safety case to be developed in association with the design and will only give their consent to construct, commission and operate the repository following the staged submission of an evolving safety case based on detailed proposals.

Authorizations granted by the UK Department of the Environment (DoE) and Ministry of Agriculture, Fisheries & Food (MAFF) covering discharges to the environment and disposal of solid waste underground will only be given following their assessment of the Nirex proposals against requirements laid down in the statement of *Principles for the Protection of the Human Environment* published by the government in 1984. (1). Those requirements cover the operational and post-closure radiological safety of the repository. Development of the full post-closure safety case will depend on information from continuing geological investigations. Only when the final safety case has been made to the full satisfaction of DoE and MAFF will authorizations be granted to allow waste disposal operations to begin.

PROJECT PROGRAM

Subject to Nirex obtaining planning permission and all necessary authorizations, the target date for completion of initial construction is 2005, when waste emplacement would begin in a first set of disposal chambers. Design development provides for the production of a basic design as supporting documentation for a planning application which would be submitted in late 1992. The preliminary operational safety case will be produced in parallel with that design.

The period from the end of 1992 until the start of construction would be used to complete the detailed design to provide the necessary working drawings. Subject to the outcome of a Public Inquiry, construction could commence about the end of 1995.

CONCLUSIONS

This document has described the design process from early considerations through to the main features of a preferred conceptual design for a deep repository adjacent to the BNFL Sellafield site. It is considered by Nirex that this project represents a significant step forward in providing a disposal facility for the low and intermediate level waste produced by the UK nuclear power program. Its commissioning would allow the industry to meet the declared UK Government policy by providing a safe deep geological disposal facility early in the next century.

REFERENCE

1. "Disposal Facilities on Land for Low and Intermediate Level Radioactive Wastes: Principles for the Protection of the Human Environment", HMSO, December 1984, ISBN 0117517755, Department of the Environment.