

SAFETY ASSESSMENT OF THE DISPOSAL OF SEALED RADIATION SOURCES IN BOREHOLES

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ABSTRACT

The Radioactive Waste Management Laboratory (RNML) at the Nuclear Energy Research Institute (NERI) in São Paulo, Brazil, is developing the concept of a repository for disused sealed radiation sources in a deep borehole. Several thousands disused sealed radiation sources are stored at NERI awaiting the decision on final disposal and tens of thousands are still under the possession of the licensees. A significant fraction of these sources are long-lived and will require final disposal in a geological repository. The purpose of this paper is to identify and discuss suitable safety assessment strategies for the repository concept and to illustrate a rational approach for a long-term safety assessment methodology.

1. INTRODUCTION

The safe disposal of long-lived sealed radioactive sources is a problem yet to be resolved. Sealed radioactive sources have been used globally for many decades in a wide range of applications in medicine, industry, and research. At the end of their useful life, the radioactive sources are defined as 'spent' or 'disused', but can still have high residual level of radioactivity, representing a significant radiological hazard [1].

Several thousand disused sealed radiation sources are stored at the Nuclear Energy Research Institute (NERI) in Sao Paulo, Brazil, awaiting decision on final disposal. Many tens of thousands more are still under the possession of licensees. A final disposal route must be timely planned for them. Disposal of these sources will require a geological repository, taking into account that many sources are long-lived [2].

The Radioactive Waste Management Laboratory (RWML) at NERI is developing a concept of repository that could be adopted for the Brazilian inventory of disused sources. According to this concept, the sources would to be disposed of in a deep borehole, drilled in the crystalline bedrock, hundreds of meters below ground surface [3].

This type of facility is particularly indicated to developing countries because of the small amount of investment involved in comparison with those necessary for other types of disposal facilities [4].

The proposed repository concept is a deep, dedicated borehole, drilled to a depth of about four hundred meters in a granite batholith. Figure 1 shows a schematic view of the borehole.

expensive disposal alternative will discourage or even make impractical all current applications of sealed sources.

The purpose of this paper is to identify and discuss suitable safety assessment strategies for the proposed repository concept that can contribute to keeping investment costs at feasible levels.

2. METHODOLOGY

The disposal of long-lived radioactive wastes involves emplacement in a deep underground repository, designed to ensure prolonged containment. The post-closure safety case for such a repository must consider times extending far into the future. Consequently, the safety assessment of the disposal facility must address different time scales with increasing uncertainties. The safety system has many components. Consequently, the assessment must address the performances of aging individual parts of the isolation set and their interactions. For each component and for each time scale, the most appropriate way of quantifying performance and safety may vary, as the system and its environment evolve together and different phenomena and uncertainties become relevant.

In the present work, the long term safety of the facility will be analyzed under two aspects: a) the evolution of the system under the effects of natural processes, and b) consequences of disruptive events.

Evolution under natural processes is the occurrence of those phenomena that lead to a slow breakup of the isolation, the result of the aging and degradation of each repository component.

Disruptive events encompass the non-customary events leading to a relatively short time breakup of the isolation. These may result from human beings intruding into the emplacement zone, natural disruptive events like earthquakes, faulting, or other cataclysms.

As stated before, the safety analysis methods developed for geological disposal are very complex and expensive because a large number of parameters is necessary in order to implement the physical and mathematical models on which those methods are based. The safety analysis proposed in the present work will be based on the integration of quantitative, qualitative and semi-quantitative methods that describe or give evidence of the long term performance of the facility. These methods include, among others,

- a) Safety Indicators (SI) [6, 7];
- b) Features, Events and Processes (FEP) [8]; and
- c) Safety Features Check List (SFCL) [9].

Over long time intervals, the most common safety indicators, radiation dose and risk, are complemented by a number of other quantitative indicators and qualitative arguments for safety, based on logical reasoning statement and on evidences of safety. [10]

The life cycle safety of the repository will be divided into operational phase, institutional control period, and post-closure period. The pos-closure period will be divided in a number of

discrete “time frames”, for which particular types of indicators and/or arguments are most suitable.

The analysis will be made in steps. First, the main components of the disposal facility and environment will be described in detail. Second, an interaction table will be used to set the possible relationship between the system components themselves and the environment. Third, possible scenarios will be identified taking into account the different time scales involved - basically, the objective is to characterize the scenarios generated by the conceivable FEP's that can cause human exposure. Fourth, a time function describing the overall capacity of the facility to restrain the movement of radionuclides will be constructed, using the best performance indicators of each time interval. Fifth, results will be compared with a checklist of safety requirements and end points of a disposal system.

The repository will be analyzed as a physical system with interacting components, initial parameters and boundary conditions, evolving with time. The function describing this evolution can be used as a benchmark for hypothetical facilities of this type, and actual data can be used to feed models and describe particular cases.

3. FINAL REMARKS

In this work, a series of quantitative, semi-quantitative and qualitative methods are being used to create a set of arguments that would allow assuring the safety of a borehole disposal concept. This type of analysis was not applied before to the type of repository referred to in the present paper.

The main objective of the research work is to develop a safety analysis method that avoids or minimizes the use of complicated modeling, despite the fact that some calculation can still be necessary, simplifying the safety assessment, yet assuring high reliability in the analyses, and serving as a benchmark for other facilities. Another important goal is to translate the safety assessment language into a speech that can be easily understood by a more general public.

The research presented here is of academic nature and is being developed as a doctorate thesis.

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