

Introduction

Traditionally, R&D on geological repositories for High Level Waste (HLW) focuses on the short- and long-term safety aspects of the repository. If the repository will also be used for the disposal of spent fuel, safeguards aspects have to be taken into account. Safety and safeguards requirements may be contradictory; the safety of a geological repository is based on the non-intrusion of the geological containment, while safeguards require regular inspections of position and amount of the spent fuel. Examples to reconcile these contradictory requirements are the use of information required for the safety assessment of the geological repository for safeguards purposes and the adaptation of the safeguards approach to use non-intrusive inspection techniques.

The principles of an inspection approach for a geological repository are now generally accepted within the IAEA. The practical applicability of the envisaged inspection techniques is still subject to investigation. It is specifically important for the Belgian situation that an inspection technique can be used in clay, the geological medium in which Belgium intends to dispose its HLW and spent fuel.

The work reported in this chapter is the result of an international cooperation in the framework of the IAEA, in which SCK·CEN participates.

Implied facilities

The part of the nuclear fuel cycle that is considered includes a conditioning plant, an open geological repository and a closed repository. In the encapsulation plant spent fuel elements are prepared for final disposal. In an open repository galleries are excavated and spent fuel canisters are emplaced. In the closed repository galleries and shafts will be backfilled and sealed, all facilities and equipment will be removed and the surface will be returned to its original state as far as possible.

The conditioning plant will be inspected by classical safeguards techniques. The main problem is the accurate verification of the fissile material in the spent fuel. This is not a specific problem for the final disposal of spent fuel but is a general safeguards problem. There is still not an approved method for the verification of spent fuel on a pin level (cfr. contribution FORK detector). The operating and closed geological repositories do not resemble to present safeguarded installations. Since the disposed spent fuel is not accessible for inspection, an indirect way of inspection has to be used.

Diversion path analysis

A diversion path analysis has been performed for the three facilities. Specific features of the facilities are the fact that at a certain point there is no more verification of nuclear material possible, the geographical extension of the geological repository and the fact that the IAEA does not want to terminate safeguards on a closed geological repository. Apart from direct diversion of nuclear material, underground reprocessing in an operating repository is considered as a possible diversion strategy.

Inspection techniques

Classical safeguards techniques like monitoring, the application of seals, gamma and neutron measurements are envisaged to be applied, but also novel techniques like satellite monitoring, environmental sampling, ground penetrating radar, active and passive seismic techniques. Design Information Verification (verifying that the as-built facility meets the design specifications) will play a central role in the safeguards inspections.

Specifically for the Belgian situation porewater pressure measurements are considered as an option to detect undeclared excavation activities. Due to the low resistivity of clay, the envisaged host medium for the Belgian repository, seismic techniques and ground penetrating radar are very hard to apply.

Conclusions

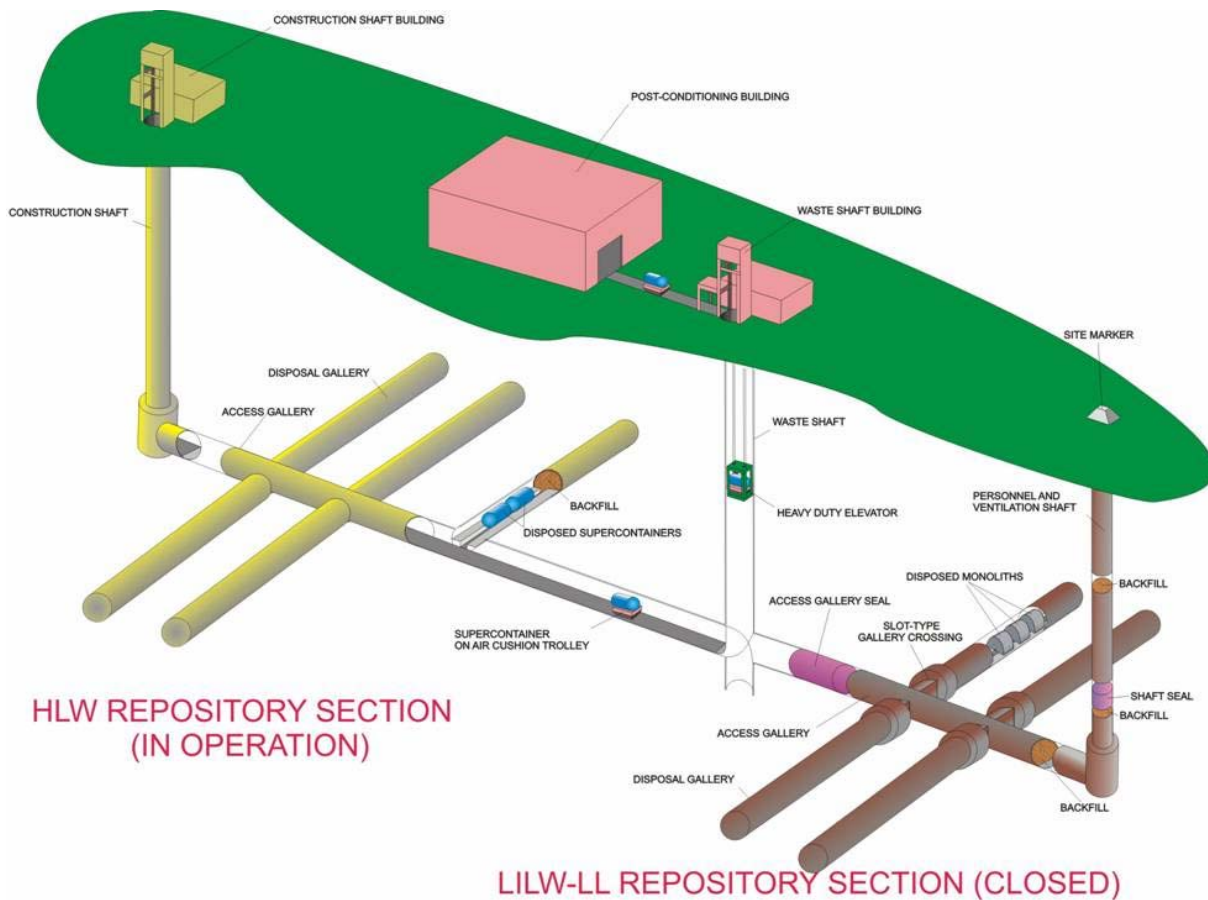
A generically applicable safeguards approach for a geological repository has been developed by the IAEA according to the following principles:

- continuous Design Information Verification of the repository during the complete pre-operational and operational phase (verify that no undeclared access routes exist);
- a last and accurate verification of the spent fuel by NDA, followed by a continuous monitoring and surveillance of the spent fuel until the closure of the repository. Once the spent fuel is underground, it suffices to verify there is no transport of spent fuel to the surface. No reverification is envisaged underground;

- verification that no undeclared activities (mainly reprocessing) are performed in the repository by e.g. environmental sampling of ^{85}Kr .

No termination of safeguards on a closed geological repository containing spent fuel is foreseen by the IAEA as long as there is a valid Safeguards Agreement with the concerned State.

Once the repository is closed, verification of the repository is limited to see whether there are no undeclared excavation activities in the vicinity of the repository. For other repository sites a combination of satellite imagery and seismic monitoring is proposed. For the clay medium seismic monitoring will probably not be appropriate, while satellite imagery in itself is not considered as sufficient to detect undeclared activities. Porewater pressure measurements combined with temperature measurements are proposed as a possible solution here.



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