

# THE CONSTRUCTION AND OPERATION OF GEOLOGICAL DISPOSAL FACILITIES FOR HIGH-LEVEL RADIOACTIVE WASTE AND SPENT FUEL CHALLENGES AND OPPORTUNITIES



A key challenge over the next decade for some national programmes and an important learning opportunity for many others will be the construction and operation of the first deep geological repositories for High Level Waste (HLW) and Spent Fuel (SF). As the orientation of work on disposal shifts from mainly research, development and demonstration to industrial implementation, waste management agencies, regulators, governments and stakeholder organizations will have important roles to play.

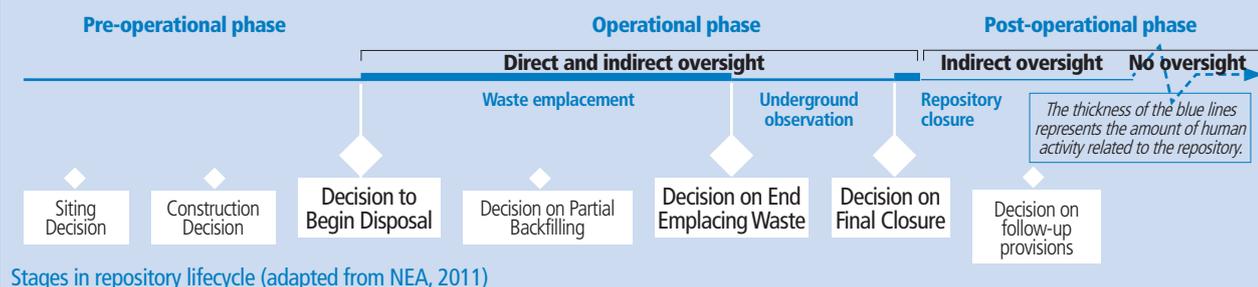


## Geological disposal is developed in stages

Geological disposal refers to the emplacement of solid radioactive waste in a facility constructed at several hundred meters' depth in a geological formation that is carefully selected for its characteristics favouring long term passive safety. A geological repository is developed in stages, each stage typically requiring a decision also involving a regulatory authorization. After identifying a site, the next important stage concerns the attainment of a general license to proceed towards construction and operation of the repository. A few waste

management agencies – notably in Finland, France and Sweden – are in the process of applying for a general license, a location for the repository having been selected already. The task of granting the general license is typically attributed to the government department in charge of nuclear safety upon the favourable advice by the technical safety authority and once it is satisfied that all the legal procedures have been followed at the local and regional levels. The license application will also draw important scrutiny from society at large.

### Repository life phases and examples of major decision points:



## Going from RD&D to a nuclear licensed industrial facility

There is relevant experience in licensing and constructing disposal facilities for low- and intermediate-level waste to draw on in some countries. However, implementation of geological repositories for high-level waste and/or spent fuel entails important additional considerations for several reasons: the waste is highly radioactive and heat emitting; the repository will be at depth of several hundred meters and will have a footprint of a few square kilometers; excavation, construction, operation and closure of the repository need to be car-

ried out in such a way that passive safety features will stay in place for millennia to come. At the same time the workers will need to be protected also from conventional risks, such as fire and flooding hazard. The realization of the project will involve large teams of highly skilled specialists, in the hundreds, and additional interface with regulators and society. Concurrent with these, is the continued integration of an R&D plan so that new techniques and procedure may be applied if developed at a later stage.

## Managing a complex licensing regime

Multiple authorities may be involved in such an important project in order to provide various types of regulatory oversight including spatial planning, mining safety, environmental protection, radiological safety, etc. This may also imply multi-level

concurrent regulatory processes. Identification of a lead regulatory authority to take charge of overall coordination is useful and it is usually done by decree or legislation. Legislation may also set the milestones for implementing the process.

## The licensing process takes many factors into account

Each major licensing decision will require the review of a safety case provided by the implementer. The safety case consists of a set of technical documents that has to address all phases of the facility lifetime, including the post-closure phase. For a license to be granted, a credible solution should exist in principle for all stages of the repository project, even if the initial repository plan and lay-out are modified during the project lifetime.

The lead regulatory organization will prepare itself for the licensing process, e.g., by allocating increased financial and human resources, by interacting early on with the government and the implementer and by funding specific research. One objective is to manage the review process in a way that is technically complete and will allow the definition of appropriate technical conditions

that the implementer will need to fulfill and that will be submitted to inspection. The licensing process will take into account items such as operational safety, provisions for short-term retrievability, and long-term post-closure safety. Different options concerning, e. g., the lay-out of the disposal facility, number of ventilation shafts, vertical or horizontal emplacement of canisters, etc. will be compared and evaluated with a view to check the feasibility of the various options and assure that potential impacts and risks to workers, people and the environment are as low as reasonably practicable. Eventually, the licensing stipulations should also allow for sufficient flexibility in operation so that new technical provisions may be adopted later, if the concurrent R&D plan develops new and more appropriate techniques or procedures. All this is seen as a part of a process of "optimization".

## Preparing for an operational period of 100 years and more

To prepare for future operation of the repository, the implementer will be asked to show that the operational procedures are sufficiently tested and reliable, and that the materials properties chosen for the waste packages are reproducible with a high level of reliability. Additional challenges in obtaining a license for repository operation include managing concurrent construction of new galleries as existing galleries continue

operation or are filled and closed; establishing sufficient confidence that the methods for closing the individual disposal units comply with the safety objectives; addressing the issue of ageing of materials during an operational period of roughly 100 years; and implementing a safety culture that will include records preservation and knowledge management, amongst other requirements.

## Constructing now, with millennia of performance in mind

There is considerable experience in civil and mining engineering that can be applied for constructing a deep geological repository. A specific challenge is to protect the integrity of the favorable safety features of the rock formation. Disturbances to the host rock will be minimized through specific excavation techniques, so that the sealing of the galleries and shafts will be most effective.

Special grouts will be used for lining underground excavations. Clearly-defined technical specifications and an effective quality management plan are important licensing requirements. A monitoring plan supported by proper documentation of construction and operational progress is another tool that will be provisionally defined at the time of the general license.

## Opportunities at the regional and international level

Siting, construction and operation of a repository can be a favorable outcome for all involved stakeholders or a win-win project for the region where the repository is located and for the nation at large. Provisions not to impair local well being and opportunities will be created to improve quality of life durably. The economic activity in the whole region will develop from incoming staff and construction workers, a large number of visitors and increased tax revenues. The new a highly skilled

resident workforce will contribute to maintain or increase the educational level of the community and will stimulate the local service economy. Involvement of the stakeholders at the local level will increase understanding of the local interests and will create new cooperation structures. The experience from the first implementations of geological repositories for high-level radioactive waste will help other national programmes move forward in a more efficient manner.

*LICENSING OF THE FIRST GEOLOGICAL REPOSITORIES FOR HIGH-LEVEL RADIOACTIVE WASTE AND/OR SPENT FUEL IS ONLY A FEW YEARS AWAY. PREPARING FOR THE INITIAL GENERAL LICENSE REQUIRES SHIFTING THE OPERATION MODE OF THE WASTE AGENCIES FROM BEING RESEARCH ORIENTED TO BEING INDUSTRIALLY ORIENTED. DEMONSTRATION OF OPERATIONAL RELIABILITY AND SHORT- AND LONG-TERM SAFETY WILL COUPLE WITH THE NEED TO MANAGE LARGER TEAMS AND LARGER BUDGETS UNDER A STRICT QUALITY ASSURANCE PROGRAMME. PREPARING FOR REVIEWING THE LICENSE APPLICATION WILL REQUIRE THAT REGULATORS BUILD ADDITIONAL STAFF AND COMPETENCIES. BOTH REGULATORS AND IMPLEMENTERS WILL FACE IMPORTANT PUBLIC SCRUTINY. , THERE IS A MUTUAL INTEREST INTERNATIONALLY IN SHARING LESSONS AND UNDERSTANDING COMMONALITIES AND DIFFERENCES. AT TERM, THIS WILL INCREASE THE GENERAL LEVEL OF EXPERTISE AND MATURITY IN THE FIELD OF RADIOACTIVE WASTE MANAGEMENT.*