Selection of the final and backup sites for the Czech deep geological repository including HLW and ILW disposal

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ABSTRACT

For deep geological repository the Czech Republic is in process of selecting primary and backup site. Currently there are four sites Březový Potok, Horka, Hrádek, and Janoch all in crystalline rock being considered. The selection process for the final and backup sites will be completed by 2030 in accordance with the strategic plans of the Czech Republic and international requirements concerning ensuring the long-term safety of the repository. Also, there is consideration that part of Deep geological Repository will not be used for SNF but for HLW and ILW. Two main concepts for this section are being developed i.e. silos and caverns. This section is planned to be separated form SNF section by faultline so that the engineering barriers in SNF section will not be affected by filling material (concreate). Not only the underground is being developed but also the above ground area is being architectonical processed so that its impact on surrounding will be as low as possible.

Keywords: *Deep Geological Repository (DGR), Decommissioning, Radioactive Waste (RAW), Spent Nuclear Fuel (SNF), Waste disposal package (WP)*

1 INTRODUCTION

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Also, there is consideration that part of Deep Geological Repository will not be used for SNF but for HLW and ILW. Two main concepts for this section are being developed i.e. silos and corridors. This section is planned to be separated from SNF section by faultline so that the engineering barriers in SNF section will not be affected by filling material (concrete). Not only the underground is being developed but also the above ground area being architectonical processed so that its impact on surrounding will be as low as possible.

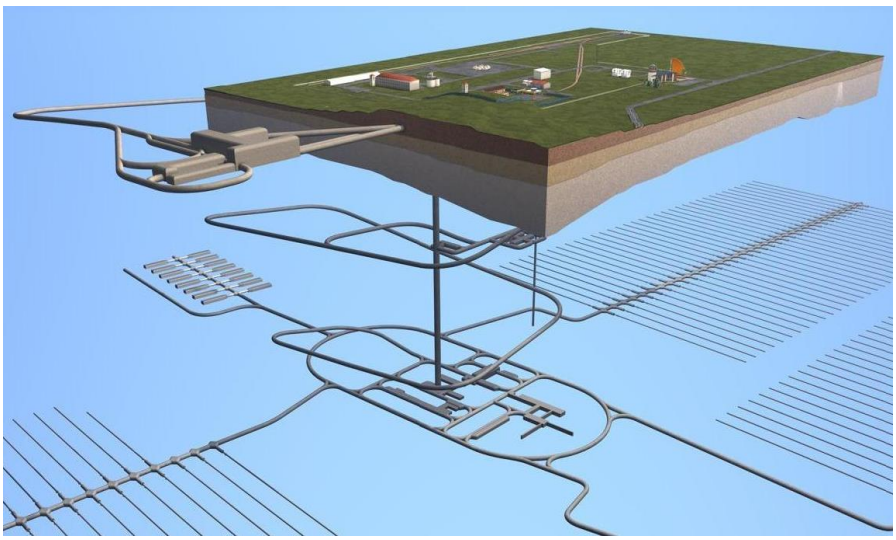

Figure 1: The Czech DGR concept

2 PROPOSAL FOR PRIMARY AND SECONDARY LOCATIONS FOR SURFACE FACILITIES AT FOUR SITES

This section gives application of the methodology for the location of surface facilities at individual sites. The aim of the methodology for the location of the surface premises of DGR was to define a logical procedure that will allow the location of the surface premises according to clearly defined rules, while maintaining all the functions imposed on it. The criteria for the selection of sites for the location of the surface complex can be divided into two basic groups:

1) Standard criteria, which include:
   a) Characteristics of the area, which, according to Czech legislation, prohibit the location of a nuclear installation,
   b) Characteristics of the territory unfavourable for the location of a nuclear installation, but not excluding,
   c) Characteristics of the territory suitable for the location of a nuclear installation according to Czech legislation and foreign recommendations.

2) Specific criteria that take into account the requirements and views of all stakeholders.

The application of this methodology ensured a uniform approach for the design of the surface premises at all potential sites for the location of the DGR and, where appropriate, quantify partial differences. Application of the Methodology was focused on the selection of suitable sites for the surface area of the DGR at four candidate sites.

The work was carried out in four steps:

• Step 1: To conduct a summary evaluation of exclusion criteria at four candidate sites. Sites that do not meet the exclusion criteria will be graphed and excluded from further evaluation.

• Step 2: To evaluate the safety criteria for sites that were not excluded.

• Step 3: To analyse of site and environmental quality in the compliant areas from Step 2 and identification of areas that best meet the quality criteria.

• Step 4: To evaluate technical criteria on the selected areas and propose a suitable area for the location of the surface area.

Based on the procedure applied in this way, several areas suitable for the location of a surface area were identified at four candidate sites.

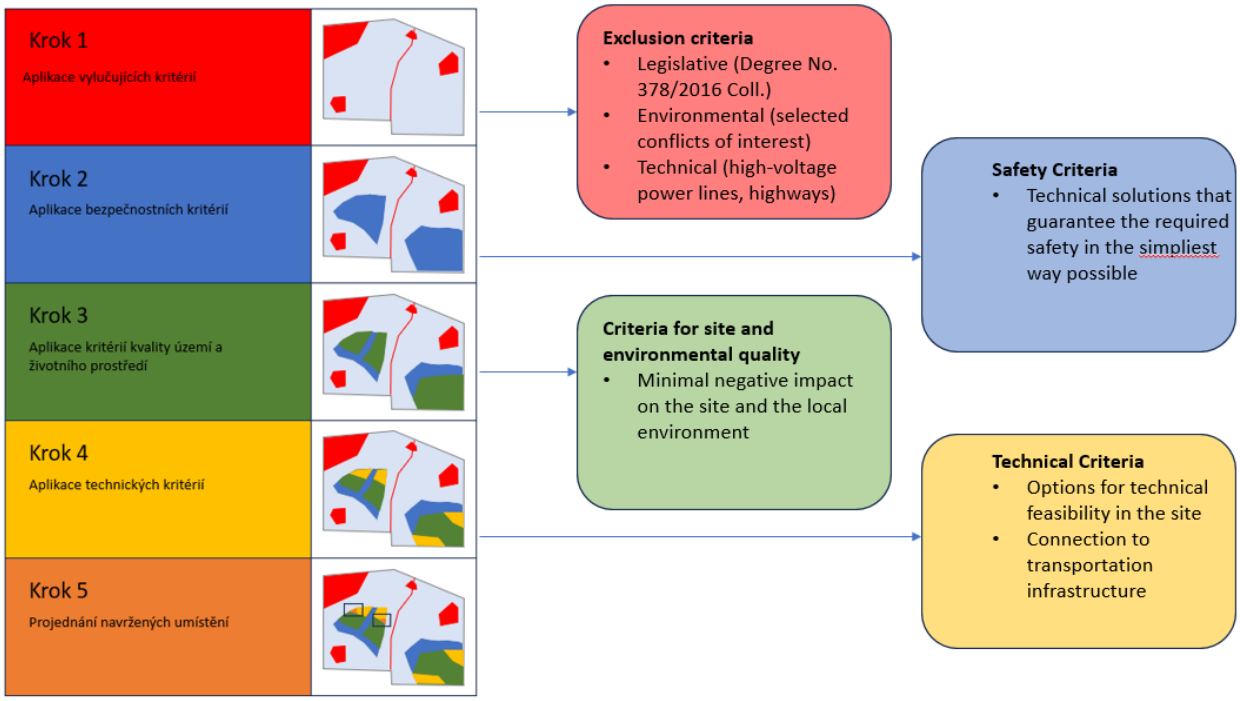

Figure 2: Schematic illustration of the methodology application process

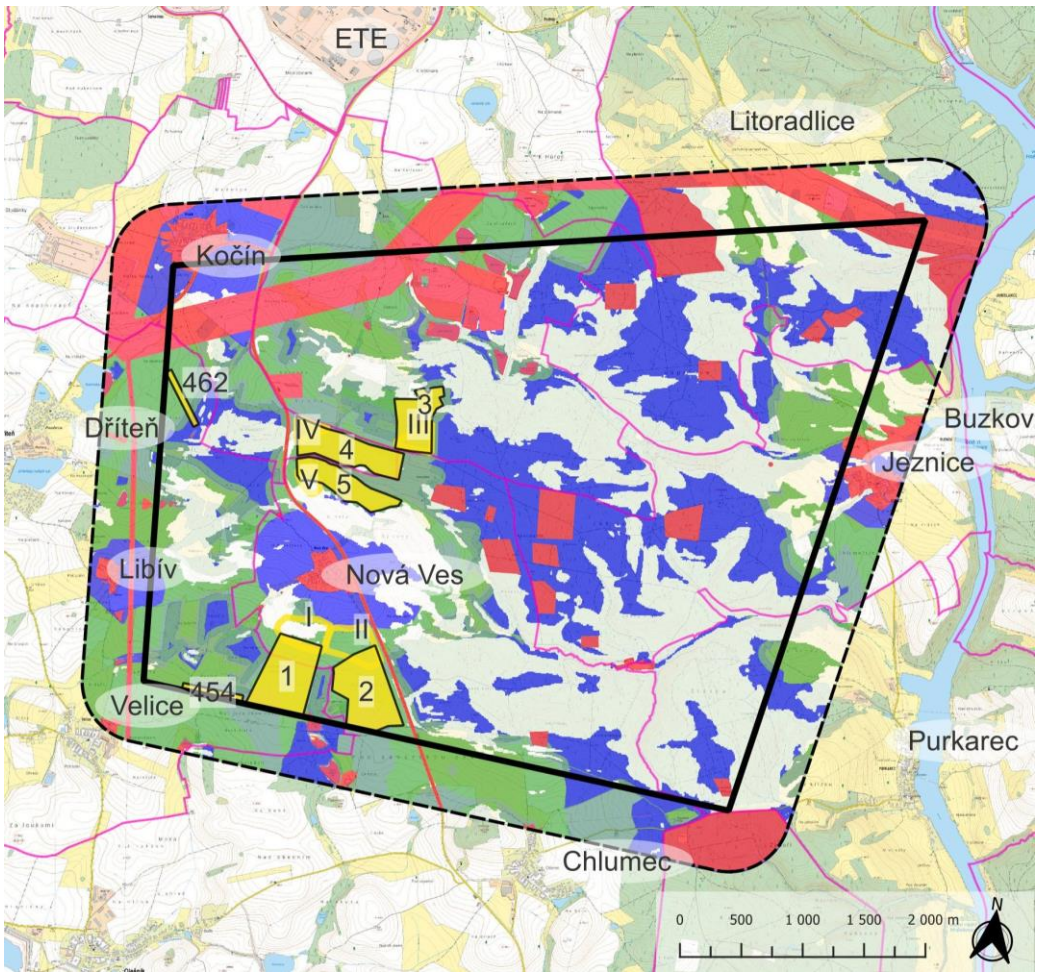

Figure 3: Illustration of proposed sites for the placement of the surface area of the DGR following the application of exclusion, safety, and technical criteria, as well as criteria related to land quality and the environment, at one potential location

3 OPTIMIZATION AND CONCEPTUAL EVALUATION OF TECHNICAL SOLUTIONS FOR THE DISPOSAL OF OTHER RAW IN A DGR

The DGR also includes disposal areas intended for RAW that does not meet the acceptance criteria of the existing repositories Richard, Bratrství, and Dukovany.

The concept for disposing of other RAW is based on the multi-barrier principle. The waste will be placed in waste packages in spaces excavated in the rock mass. After these spaces are filled with waste packages, they will be backfilled with concrete.

The optimization was fused on the technical design of the repository section designated for disposing of other radioactive waste and all related activities-from waste reception to its final disposal. The disposal areas were proposed in two variants: disposal corridor and silo, which also influences the design of handling equipment. The technical design also included the method for sealing the disposal areas.

The technical solution was subject to several uncertainties, such as the total amount of inventory to be disposed of the waste form, the current level of handling technology, and excavation methods. These uncertainties affect the final design, investment costs for implementation, and operational expenses.

Figure 4: Handling of WP with RAW in the reception and reloading hall using a forklift – loading onto a truck for transporting RAW to the disposal horizon

3.1 Option I – disposal corridor

The disposal corridor option is developed as a single-level complex consisting of two parallel main corridors connected by a transverse corridor. Parameters of disposal corridors:

- Total number of disposal corridors: 51
- Length of disposal corridor: 81.9 m
- Length of the transition section between the disposal corridor and the entrance corridor: 7 m
- Total number of WPs disposed of: 38,500 units
- Total disposal area (+20 %): 28.82 ha
- In terms of space requirements, the minimum size of the rock block is 555 m × 520 m.

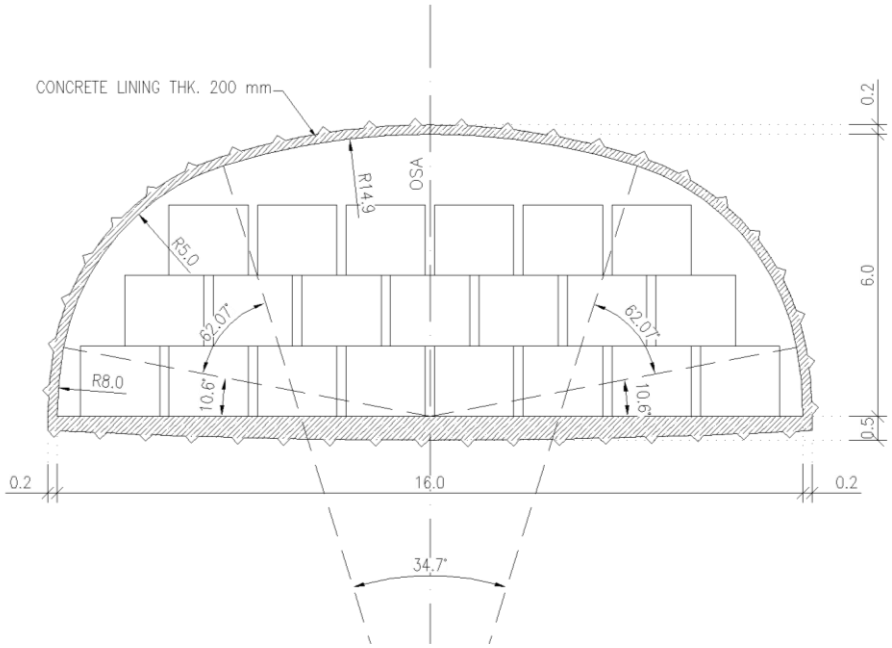

Figure 5: Cross section through the disposal corridor

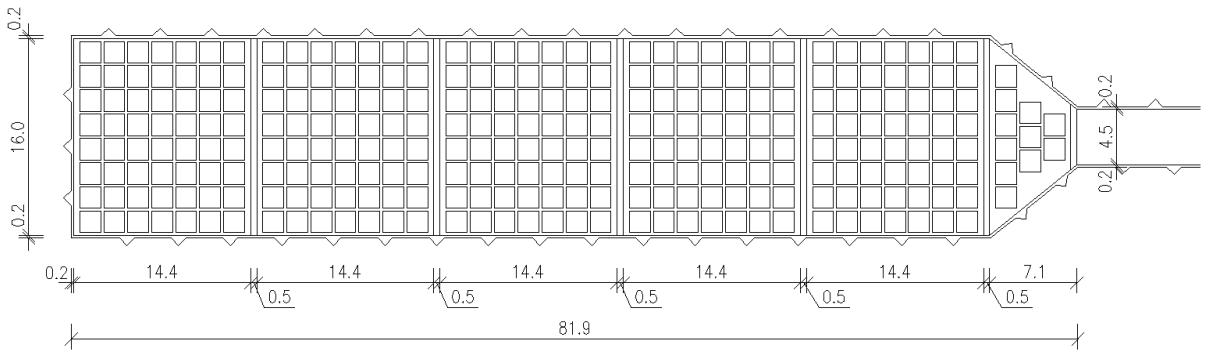

Figure 6: Diagram of WP disposal

3.2 Option II – disposal silo

This option is envisaged as a single-level complex with a system of main corridors, from which the access corridors leading to the silos themselves then exit. The silo itself consists of two parts, a cylindrical silo for storing RAW and a cavern for the silo operator. Parameters of disposal corridors:

- Inner diameter of the silo: 22 m
- Number of WPs in one level: 82
- Depth of silo designed to accommodate WPs: 55 m
- Number of WPs disposed of in one silo: 2460
- Number of forces needed to dispose of 38,500 WPs: 16
- Total disposal area (+20%): 9.34 ha
- The minimum size of the rock block is 340 m × 330 m. It should be noted, however, that in the case of disposal silos, the height of the structure is about 70 m, compared to disposal corridors, where it is only 6.7 m.

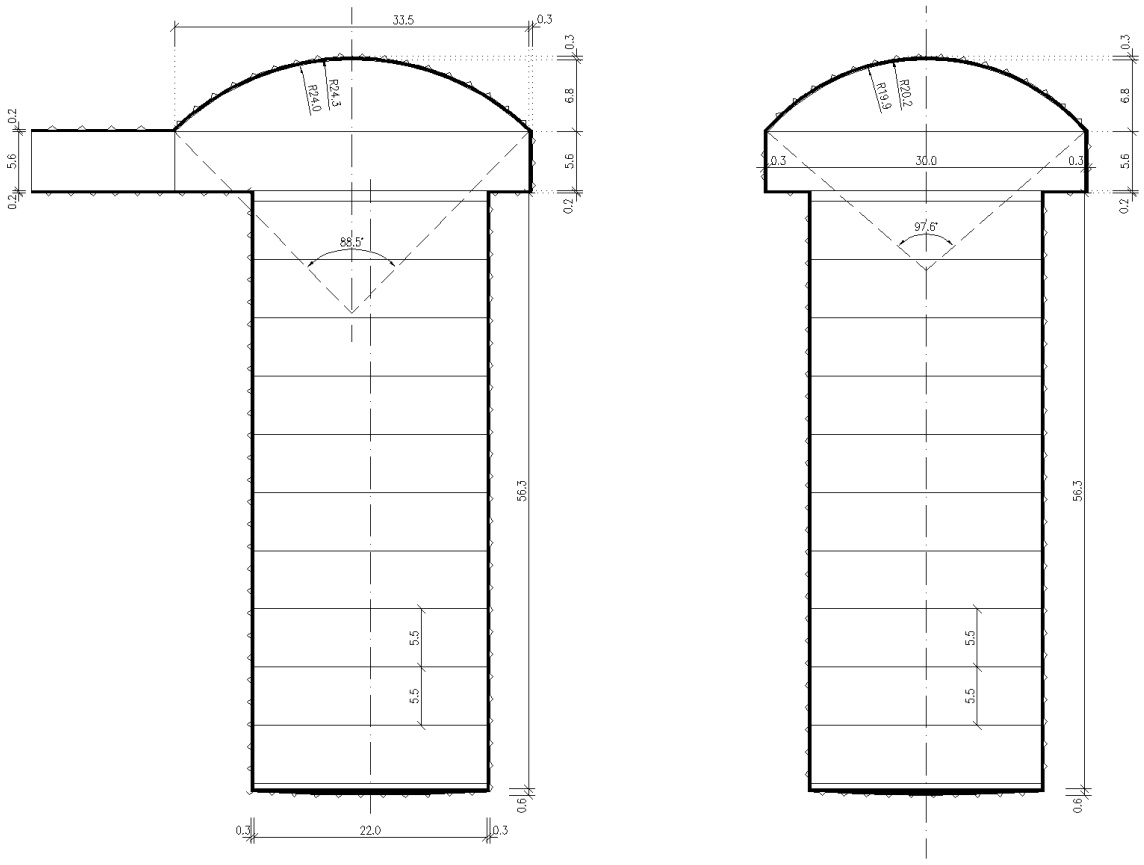

Figure 7: Cross section through the disposal silo – in the axis of the access corridor/perpendicular to the axis of the access corridor

4 VERIFICATION OF THE REQUIRED SIZE OF ROCK BLOCKS IN THE FOUR SITES IN VIEW OF THE UPDATED (LARGER VOLUME) INVENTORY OF RAW AND SNF

The aim of the verification was to assess whether the host rock blocks at individual sites are large enough to dispose of SNF and RAW, which are expected to be disposed in a DGR according to the updated Concept for the Management of Radioactive Waste and Spent Nuclear Fuel in the Czech Republic (Table 1).

The result of the assessment is the verification of whether all waste can be safely and effectively disposed of in the rock blocks of the assessed sites.

Table 1: Inventory of RAW and SNF

	Site Selection Study (2020)	**Concept (2025)**
Estimated number of containers with SNF	9 120	15 100
Estimated number of containers with RAW	3 600	38 500

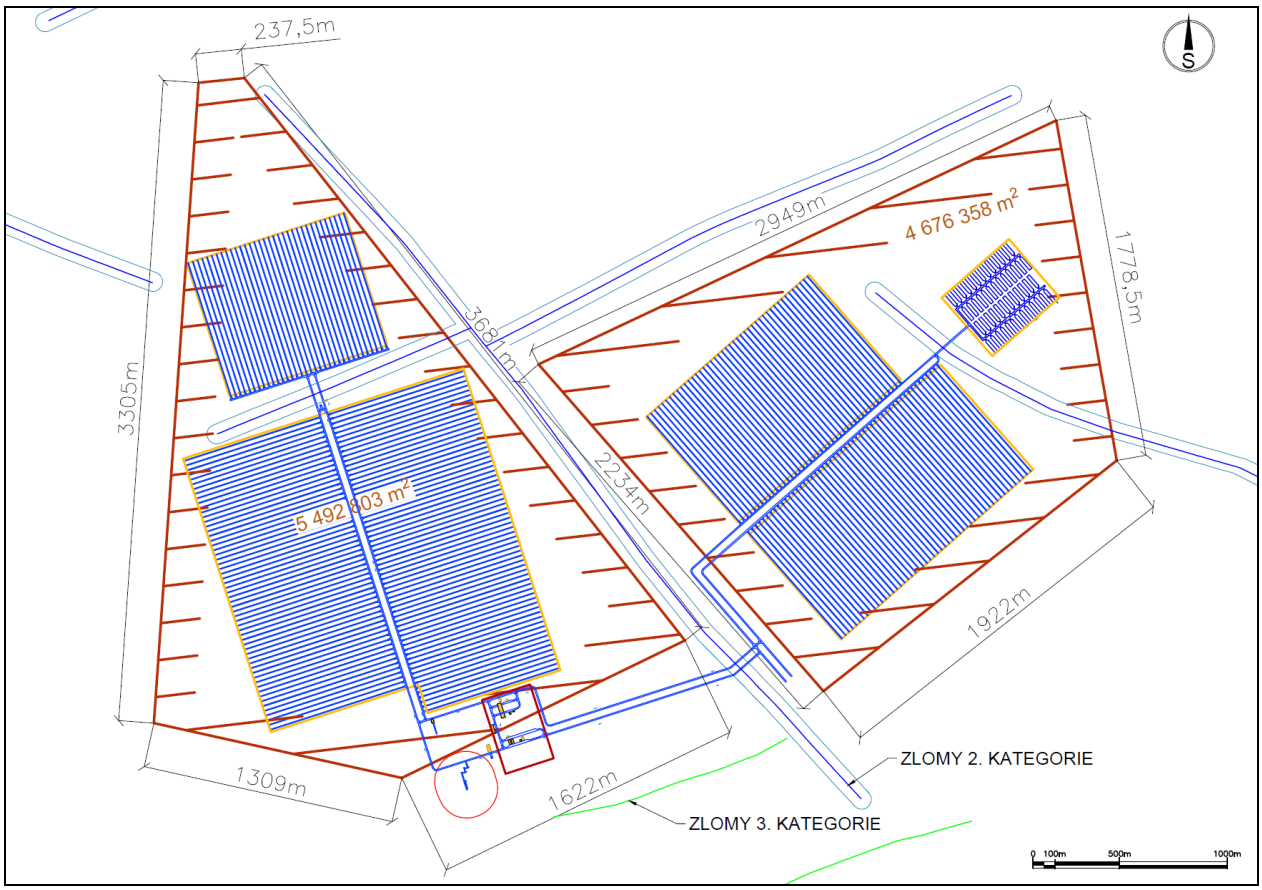

Figure 8: Layout of the disposal horizon at one of the sites for DGR

The performed calculations show that all four potential sites have a reserve capacity of 40% or higher. The preliminary assessment demonstrates that it is possible to dispose of all RAW and SNF with sufficient reserve capacity in the rock formations at the assessed sites.

5 CONCLUSION

Study of the technical and architectural design of surface facilities in the four sites (Proposal for the technical and architectural design of the surface facility on the area according to the SÚRAO decision).

- Technical solution and localization of surface facilities – August 2026
- Local architectural design for each site – November 2026
- Virtual reality models for each site – November 2026

Participation in expert groups dealing with the evaluation of the parameters of the mechanical and physical properties of rocks and the size of the underground part of the DGR necessary for the selection of the final and backup sites.

Preparation of general conceptual documents for the DGR project (proposal for a safety concept).

- Safety Concept – by the end of 2027
- Design Bases – by the end of 2029
- Radiation protection (General Criteria) – by the end of 2027

Handling of SNF and RAW in the SNF and RAW reception and transfer facility and at the disposal horizon, optimization of the hot cell and transfer hub.

- Detailed Schedule for SNF and RAW disposal
- Disposal implemented in parallel with construction
- Completion – by the end of 2027

Feasibility study.

- Update of the disposal horizon
- Update of the thermal numerical model
- Security study
- All by the end of 2029

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