UPDATED CONCEPT OF RADIOACTIVE WASTE AND SPENT NUCLEAR FUEL MANAGEMENT

CONCEPT ASSESSMENT

A safe nuclear energy sector that is sustainable in the long term is one of the important preconditions for continued industrial development and for maintaining the current standard of living in the Czech Republic. Radionuclide sources are used in a number of industrial applications, in research as well as in the medical sector. All activities related to peaceful uses of nuclear energy and ionising radiation are associated with the production of radioactive wastes.

Approved by the Czech Government as early as 2002 (Czech Government Resolution No. 487/2002), the Concept of Radioactive Waste and Spent Nuclear Fuel Management proposed the principles, procedures and targets for this area. The present update is in agreement with Section 6.2 of the current Concept, which envisages its review after 2010. The update is based on an analysis of the current situation in low-level and medium-level radioactive waste management, status of preparatory activities for the sitting and construction of a deep geological repository (DGR) of radioactive wastes and spent nuclear fuel (SNF), changes in applicable legislation, Czech government programme documents and international experience and trends. Additional stimuli for updating the Concept include preparation of a new nuclear power source in the Czech Republic, development of applicable legislation in the European Union (EU) and recommendations of the IAEA and NEA-OECD. Important within the EU was the establishment of the European High Level Group on Nuclear Safety and Waste Management and of the European Nuclear Energy Forum (ENEF) in 2007, with the aim of harmonising nuclear safety and radioactive waste / SNF management related procedures in the EU.

Several European Directives and Commission Recommendations in the target area have been adopted since 2002, when the current Concept of Radioactive Waste and Spent Nuclear Fuel Management was approved. The European documents have been summarised in Council Directive 2011/70/Euratom of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste (“Directive 2011/70/Euratom”).

An overview of the conceptual goals and milestones for radioactive waste / SNF management is presented below:

Goal 1: Ensure continuity, clarity and openness of information in the radioactive waste / SNF management domain

Goal 2: Ensure independent activity and scope extension of the Working Group for Dialogue on the Deep Geological Repository; create a framework for the establishment and activities of task groups at the sites under the umbrella of the present Working Group

Goal 3: Discuss the draft legislation to enhance the role of municipalities in the selection of the deep geological repository site and submit it to the Government for approval

Goal 4: Set up a long-term programme of partnership between the SÚRAO and the municipalities impacted by the deep geological repository preparation and operation

Goal 5: Prepare appropriate documentation for the application seeking approval to rebuild the Richard repository

Goal 6: Prepare appropriate documentation to the application for approval to close the Bratrství repository

Goal 7: Prepare a study examining the feasibility of country-wide screening to ascertain the amount of NORM in the Czech Republic. If appropriate, start activities to prepare a facility for storing NORM type wastes.

Goal 8: Ensure safe storage of spent nuclear fuel and high-level, low-level and medium level radioactive wastes that do not meet the requirements for storage in near-surface repositories, until the deep geological repository is made operable

Goal 9: Select 2 or more candidate sites for the DGR, obtain the opinions of the municipalities affected, and submit the material to the Government for approval

Goal 10: Develop, type-approve and manufacture canisters for the transport and storage of vitrified waste arising from the reprocessing of SNF from the LVR-15 research reactor

Goal 11: Prepare design/safety documents for administrative procedures to issue a decision on the final DGR site (with the consent of the municipalities) and submit an application requesting territorial protection of the site selected

Goal 12: Start construction of an underground laboratory at the final site

Goal 13: Start construction of the deep geological repository

Goal 14: Start operation of the deep geological repository

Goal 15: Continually update and implement the R&D programme for deep radioactive waste / SNF disposal in harmony with the DGR preparation schedule

Goal 16: Support projects to set up a knowledge base encompassing issues of radioactive waste production minimisation, waste volume reduction and improvement of their properties; of safe and financially acceptable radioactive waste / SNF disposal and of the closed fuel cycle for a sustainable nuclear power sector

Goal 17: Support systematic preparation and education of professionals specialising in radioactive waste management

Goal 18: Monitor and assess the accumulation and withdrawal of nuclear account funds; if necessary, stimulate amendment of the Government Decree on payments to the nuclear account so as to attain a constantly well-balanced and well-grounded nuclear account

Goal 19: Attain increase in the value of the free nuclear account funds in accordance with the Atomic Act and other legislation

Goal 20: Periodically inspect the accumulation of funds to cover the costs of decommissioning of nuclear facilities, with the aim of ensuring an adequate volume of such financial resources.

The above concept is subject to assessment under Act No. 100/2001, i.e. to a fact-finding procedure and subsequently (once the fact-finding procedure conclusion has been published by the Ministry of the Environment) to the development of the

(submitted) Environmental Impact Assessment. Following publication and public debate, the Ministry of the Environment issues its Statement on the concept.

The EIA structure conforms to the requirements of Annex 9 to Act No. 100/2001. The coverage of the sections is governed by the significance of the concept with respect to environmental protection and public health.

The submitted EIA includes Annex 1: Assessment of impacts on the NATURA 2000 nature protection system.

The scope of the environmental impact assessment of the Updated Concept was determined by the conclusion of the fact-finding procedure pursuant to Section 10d of Act No. 100/2001, issued by the Ministry of the Environment's Department of Environmental Impact Assessments and Integrated Prevention on 15 January 2016, document ref. 998/ENV/16.

The aim of the submitted EIA was to assess (quantify) the expected impacts of this concept on the environmental and, also, on the health of Czech population.

The Updated Concept of Radioactive Waste and Spent Nuclear Fuel Management addresses both current and future management of radioactive wastes admissible to near-surface repositories and preparation of the deep geological repository (DGR) for spent nuclear fuel and radioactive wastes, the infinite storage of which in near-surface repositories is infeasible.

The only potential DGR site lying near national borders (with Austria) is Chlum. This is a site for which no application for a survey area has been submitted. In fact, submission of such an application is not envisaged in the future either. Taking into account the locations of the surveyed DGR sites and of SNF storage facilities, near-surface and aboveground radioactive waste repositories, radioactivity transport to the future DGR is not expected to have any transboundary impacts. Hence, any international assessment with respect to the Updated Concept can be ruled out. If no final (and backup) variant(s) are selected for the DGR from among the surveyed sites, then additional sites considered (either with Chlum included or not) have to be assessed. This, however, would be the subject of a new Updated Concept.

If no final (and backup) variant(s) are selected for the DGR from among the surveyed sites, then additional sites considered (either with Chlum included or not) have to be assessed. This, however, would be the subject of a new Updated Concept.

The proposed Concept can be generally adopted because it is appropriately aimed at protecting the environment (and public health) in all the fundamental environmental compartments, such as water, air, wastes, etc. The Concept also complies with essential legislation, both at the national level and at the level of the municipalities. The existing concept and the strategies of other sectors are also respected.

It is not the Updated Concept's task to address the specific locations of the aboveground and underground areas of the DGR. This will only be addressed for the specific DGR site and surface area.

The Environmental Impact Assessment of the Updated Concept encountered a number of difficulties due to the specific nature of the concept and, in particular, the postulated time horizons for the selection of 2 suitable candidate sites as a minimum:

- Select 2 or more suitable candidate sites for the DGR, with the opinions of the municipalities, and to submit this to the Government for approval – 2020/SÚRAO
- Start construction of the deep geological repository – 2050/SÚRAO
- Start operation of the deep geological repository – 2065/SÚRAO

A basic problem was encountered when formulating the approach to the SEA: absence of reliable and unified geographic data capable of credibly and reliably interpreting direct conflicts with the defined criteria for the environmental impact assessment, particularly with respect to the milestones – candidate site selection by 2020 and DGR construction start in 2050. In fact, the time horizons reach beyond the framework of the concept.

In order to ascertain whether and, if so, how the Updated Concept of Radioactive Waste and Spent Nuclear Fuel Management may seriously impact the environment, the impacts of implementation of the concept goals on selected environmental compartments were assessed, as summarised in Table 22.

Some of the goals of the Updated Concept of Radioactive Waste and Spent Nuclear Fuel Management actually target communication with the public; preparation of documents when seeking permission to rebuild the Richard repository and close the Bratrství repository; and preparation of design and safety documents for the administrative procedure for approval of the final DGR site.

Taking into account the conceptual goals of the Updated Concept, environmental impacts can particularly be expected when commencing survey activities for selecting the DGR site, and especially during the detailed survey work to select the DGR site; during the construction of the underground laboratory at the final site; and during the construction of the DGR itself.

The concept goals involving site survey and DGR construction always imply intervention into the rock and potential impacts on all environmental compartments. However, the generally designed concept, without specific DGR site location and without any design documentation, does not allow the impacts to be identified or quantified. This will be done at the design level within the EIA process. Also for this reason, the Czech DGR concept formulates suitable site selection indicators, project/design requirements and deep geological repository site selection criteria, safety requirements and criteria, operational safety criteria and also environmental requirements and criteria which should minimise any impacts on the environmental compartments or public health.

This will all ensure safe radioactive waste and spent nuclear fuel handling.

Impacts on public health

Impacts of the handling of radioactive wastes admissible for storage in near-surface repositories on public health

The handling of radioactive wastes admissible for storage in near-surface repositories cannot have any significant effect on public health. Safe operation is under the supervision of the State Office for Nuclear Safety (SÚJB).

Impacts of the DGR

Any actual impacts on public health will be associated with the DGR construction and operation, depending on the specific DGR site actually selected. Although this lies beyond the scope of the concept, some potential impacts are addressed in it. Safe operation is under the supervision of the SÚJB.

Environmental impacts of handling radioactive wastes admissible for storage in near-surface repositories

The issue of near-surface radioactive waste repositories has been well managed based on existing experience, and additional development and operation of such facilities pose no significant risk of short-term, medium-term or long-term environmental impacts or risk of any new effects compared to the current situation.

Environmental impacts of the DGR

Any actual environmental impacts will be associated with the DGR construction and operation, depending on the specific DGR site actually selected. Although this lies beyond the scope of the concept, some potential impacts are addressed in it.

The following should be considered with respect to the DGR site selection:

Geological survey, occurring by stages

- Site search stage
- Site survey stage
- Detailed site survey stage

The site search stage is associated with no environmental impacts.

The site survey stage is associated with some effects on the environment – accessing the land to prepare drilling work, the drilling work itself, use of technologies (transport and noise). The effects can be minimised by organisational and technical provisions – by selecting suitable access routes to the survey site, survey activities limited to a season (and time of the day) disturbing the environment to the least extent with respect to the fauna and flora (e.g. beyond the amphibian propagation season, beyond the plant growth season, etc.) as well as with respect to agricultural land damage.

The detailed survey stage is associated with more substantial environmental impacts – due to the extensive drilling work and to the construction of the underground laboratory. It is recommended that an environmental impact study be developed for this stage unless the activity is subject to environmental impact assessment at that time (currently pursuant to Act No. 100/2001, Annex 1- 3.5. Facilities for final storage, final disposal or long-term storage planned for a period longer than 10 years of spent or irradiated nuclear fuel and of radioactive wastes at a site different from that at which they are produced – does not include survey work). The study should be discussed with the affected municipalities as a minimum.

An underground laboratory at the -250 m horizon must be built well before starting the construction of the DGR. The laboratory area will include a system of interconnected galleries and chambers for installation of the measuring/testing equipment.

The laboratory will serve to develop and test host rock examination methods, to gain local characteristics of the rock massif, to develop, test and demonstrate technologies to be used in the DGR, and to assess the DGR safety.

Thus, the underground laboratory must be built to demonstrate, based on practical experience, either that the planned technical solution is suitable for the specific site or that the technical solution needs to be modified for implementation in the specific conditions of the site.

However, technical background must also be built for the underground laboratory to be operable. This means that buildings & technological equipment must be built and installed, first for constructing the underground laboratory and then to make the laboratory operable. The majority of the buildings can be subsequently used for DGR operation; some will be provisional, some will be built to the relevant extent (some storage facilities, site roads, power distribution systems, etc.).

The foregoing gives evidence that an environmental impact study or the “voluntary” EIA (unless the activity – Stage of detailed site survey and underground laboratory construction – is subject to EIA by law) is highly useful and necessary.

Impacts of radioactive discharges into air and water streams during the DGR operation stage

The amount of radioactive substances released into the environment will be held below the level of the approved authorised limit. The methods applied to reduce the discharges ensure that any hazard to the affected population's health will be negligible.

Radiation effects due to the natural radionuclides present in the mined rock can only be quantified after the radiological survey results are available. Limitations to discharges from nuclear facilities (into air, into water) are governed by the SÚJB permission (operating licence), which is reviewed and updated periodically.

Air impacts

Air impacts of handling radioactive wastes admissible to near-surface repositories

The handling of radioactive wastes admissible for storage in near-surface repositories cannot have any significant effect on the air.

Air impacts of the DGR

Within the scope of the Updated Concept of Radioactive Waste and Spent Nuclear Fuel Management in the Czech Republic, relevant impacts on the air can be expected from the construction and operation of the DGR. Although the DGR construction and operation lie beyond the Updated Concept's time frame, the potential impacts are addressed in the document.

Preparatory work to select the DGR site cannot have any significant impact on the air.

Construction stage

It is planned that prior to starting the mining work, some buildings will be constructed aboveground to serve as background for the mining work. This will include:

- Mining area ventilation
- Area for transitional mined rock storage
- Area for mined rock treatment – crushing & sorting

Operational stage

This stage should include a fully built surface area, with the underground part operational and with complete connection to the transport infrastructure and networks. As to the impacts on air, the typical pollutants from the running boiler house at up to 5 MW power and from transport means (cars, trucks and, perhaps, diesel locomotives) can be expected. As far as radionuclide release to the environment is concerned, VAC of the underground part of the deep geological repository and VAC of the aboveground part of the deep geological repository (controlled zone) will contribute. The specific emission limits, however, will not be exceeded.

Impacts on water

Surface waters and ground water

The Updated Concept of Radioactive Waste and Spent Nuclear Fuel Management respects the existing and planned drinking water sources and protective zones. Water sources are among the deep geological repository site selection criteria.

Effects of handling radioactive wastes admissible to near-surface repositories on surface and ground water

The handling of radioactive wastes admissible to near-surface repositories cannot have any significant impacts on surface and ground water.

Impacts of the DGR on surface and ground water

The impacts of the construction and operation of the DGR and of the aboveground structures can only be assessed for the specific DGR site selected (including the variant site). Although this lies beyond the scope of the concept, some potential impacts are addressed in it.

The following recommendations and measures aimed at minimising any impacts on surface waters and ground water will be proposed for the generally selected DGR site in the final report of the Updated Reference Design Project of the Deep Geological Radioactive Waste Repository:

- The specific conditions for waste water discharging into surface waters will be governed by the decision issued by the appropriate water management authority. Surface waters are not expected to be excessively burdened (above the environmental harm limit) provided that the conditions set by the water management authority are complied with.
- Impacts on the ground water level in the wider mine area cannot be ruled out. Since no residential areas are expected to exist in the immediate vicinity of the construction site, loss of water in existing wells is not expected (the extent of the effect depends on the structure of the geological strata). If any adverse effect on a public drinking water source occurs, compensatory provisions can be implemented (e.g. installation of municipal water mains). Once the operation is terminated, the ground water regime stabilises slowly to a condition closely approaching the initial situation existing before the start of the driving work. However, this issue can only be addressed in detail after the results of a detailed geological and hydrogeological survey are available.
- As to the effects on surface waters, the descriptive part of the Concept is accompanied by basic water management maps and protected zone/flood area maps.

Once again, the issues and risks can only be addressed in detail after the final DGR site has been selected, viz. within the project EIA of that site.

Impacts on soil

Impacts of the handling of radioactive wastes admissible to near-surface repositories on soil

The handling of radioactive wastes admissible for storage in near-surface repositories cannot have any significant effect on soil.

Impacts of the DGR on soil

Once again the actual effects of the DGR, including the facilities on the ground, on soil can only be assessed for the specifically selected DGR site. Although this lies beyond the scope of the concept, some potential impacts are addressed in it.

Impacts on the rock

Impacts of radioactive waste handling on the rock

The radioactive waste handling procedures cannot have a significant effect on the rock.

Impacts of the DGR on the rock at the site

The impacts of the construction and operation of the DGR and of the aboveground structures on the rock at the site can only be assessed for the specific selected DGR site (including the variant site). Although this lies beyond the scope of the concept, some potential impacts are addressed in it.

Impacts on the fauna, flora, ecosystems

Impacts of the handling of radioactive wastes admissible for storage in near-surface repositories on the fauna, flora, ecosystems

The handling of radioactive wastes admissible for storage in near-surface repositories cannot have a significant impact on the fauna, flora, ecosystems.

Impacts of the DGR on the fauna, flora, ecosystems

The impacts of the construction and operation of the DGR and of the aboveground structures on the fauna, flora, ecosystems can only be assessed for the specific selected DGR site (including the variant site). Although this lies beyond the scope of the concept, some potential impacts are addressed in it.

Impacts on protected nature areas, including 'Natura 2000'

Impacts of the handling of radioactive wastes admissible for storage in near-surface repositories on protected nature areas

The handling of radioactive wastes admissible for storage in near-surface repositories cannot have a significant impact on protected nature areas

Impacts of the DGR on protected nature areas

The impacts of the construction and operation of the DGR and of the aboveground structures on protected nature areas can only be assessed for the specific selected DGR site (including the variant site). Although this lies beyond the scope of the concept, some potential impacts are addressed in it. In this context it is noted that, compared to the remaining sites examined, the Hrádek site is quite prominent as regards the high concentration of specific nature protection interests. This fact must be taken into account when considering the selection of the main and alternative sites.

As to the impacts on the sites of the Natura 2000 system, it is concluded that the "Updated Concept of Radioactive Waste and Spent Nuclear Fuel Management" (when excluding the Chlum site) will have no significant effect on the SCI or SPA, or on the subjects of their protection, although a potential slight adverse impact on the SCI and/or SPA has been preventively stated for Goals 9, 12 and 13. Specifically, this involves actions associated with capital investments around the deep geological repository at the DGR design preparation, construction and, potentially, operation stages (in fact, the two latter stages appreciably overreach the time frame of the Concept).

Impacts on the landscape

Impact of the handling of radioactive wastes admissible to near-surface repositories on the landscape

The handling of radioactive wastes admissible for storage in near-surface repositories cannot have any significant effect on the landscape.

Impacts of the DGR on the landscape

The impacts of the construction and operation of the DGR and, in particular, of the aboveground structures on the landscape can only be assessed for the specific selected DGR site (including the variant site). In this context, the fact must be taken into account that natural parks (as a general landscape protection category) are present at five sites considered for the DGR. The effects lie beyond the scope of the concept.

Any effect is limited by the "Requirements, suitability indicators and criteria for the selection of sites for the construction of the deep geological repository" (2015) (as continually updated), as in the case of the remaining environmental compartments that may potentially be affected.

The fact should be borne in mind in this context that the Updated Concept is not supposed to address the specific sitting of the aboveground and underground DGR structures.

A deep geological repository is the only feasible solution to the problem of disposal of radioactive wastes that cannot be eternally stored in near-surface repositories and of spent nuclear fuel. The Updated Concept of Radioactive Waste and Spent Nuclear Fuel Management only considers the following feasible and currently implementable variants:

- The zero variant (= long-term storage in SNF storage facilities). In view of the radionuclides present in the SNF and their half-lives in the orders of tens of hundreds of years, this is a variant whose technological potential is limited by the service life of the technical equipment (i.e. storage facilities with their technical equipment & storage casks). Once the design life expires, the SNF (whose structural material will also degrade) will have to be repeatedly reloaded into new packaging. If this variant is selected, a project to build and maintain a plant for repeated SNF reloading will have to be developed.
- Use of the reprocessed spent fuel in Generation IV fast reactors and disposal of the residues from this process only: addressed by the Concept, this variant only affects the DGR size.

- SNF/radioactive waste disposal in the DGR: this is the only feasible approach from the safety aspect with respect to the nature of the wastes. Whether the deep geological repository should have an international reach to cover the needs of more than one country must be addressed by legislation of the countries involved. Currently, radioactive waste imports are out of the question; return of SNF reprocessing wastes to the originator's country is the only exception.

The deep geological repository variants only differ in size(depending on the new SNF sources and reprocessing variants). And also in the selection of the DGR site; the final site should be selected by 2025. The DGR construction stage lies beyond the reach of the Updated Concept.
As regards the environmental impact aspects, the variants only perhaps differ in the time frame and in the DGR size (without impacts on the aboveground facilities).

Although it follows from the summation of the Updated Concept's impacts on public health and the environment that no significant environmental impacts are expected, certain minor adverse impacts of the processes to attain some of the above goals are possible. They are as follows:

Goal 5: Prepare appropriate documentation to the application for approval to rebuild the Richard repository – *subsequent implementation and operation*

Minor adverse effects on the following are conceivable:

- Public health – non-radiative effects on the public, including socio-economic impacts
- Impacts on air and weather
- Impacts on the noise situation and, perhaps, additional physical and biological characteristics
- Impacts on soil

Goal 7: Prepare a study examining the feasibility of country-wide screening to ascertain the amount of NORM in the Czech Republic. If appropriate, start activities to prepare a facility for storing NORM type wastes – *subsequent implementation*

Minor adverse effects on the following are conceivable:

- Public health – non-radiative effects on the public, including socio-economic impacts
- Impacts on the noise situation and, perhaps, additional physical and biological characteristics
- Impacts on surface waters and ground water
- Impacts on soil
- Impacts on the rock environment and natural resources
- Impacts on the fauna, flora and ecosystems

Goal 9: Select 2 or more suitable candidate sites for the DGR, with the opinions of the municipalities, and to submit this to the Government for approval – the *detailed survey stage*

Minor adverse effects on the following are conceivable:

- Public health – non-radiative effects on the public, including socio-economic impacts
- Impacts on air and weather

- Impacts on the noise situation and, perhaps, additional physical and biological characteristics
- Impacts on soil
- Impacts on the rock environment and natural resources
- Effects on the fauna, flora and ecosystems

Goal 11: Prepare design/safety documents for administrative procedures to issue a decision on the final DGR site (with the consent of the municipalities) and submit application seeking territorial protection of the site selected

Minor adverse effects on the following are conceivable:

- Public health – non-radiative effects on the public, including socio-economic impacts

Goal 12: Start construction of an underground laboratory at the final site

Minor adverse effects on the following are not impossible:

- Public health – non-radiative effects on the public, including socio-economic effects
- Impacts on air and weather
- Impacts on the noise situation and, perhaps, additional physical and biological characteristics
- Impacts on surface waters and ground water
- Impacts on soil
- Impacts on the rock environment and natural resources
- Effects on the fauna, flora and ecosystems
- Impacts on the landscape

Goal 13: Start construction of the deep geological repository

Minor adverse effects on the following are conceivable:

- Public health – non-radiative effects on the public, including socio-economic impacts
- Impacts on air and weather
- Impacts on the noise situation and, perhaps, additional physical and biological characteristics
- Impacts on surface waters and ground water
- Impacts on soil
- Impacts on the rock environment and natural resources
- Impacts on the fauna, flora and ecosystems
- Impacts on the landscape

Goal 14: Start operation of the deep geological repository

Minor adverse effects on the following are conceivable:

- Public health – non-radiative effects on the public, including socio-economic impacts
- Impacts on air and weather
- Impacts on the noise situation and, perhaps, additional physical and biological characteristics
- Impacts on surface waters and ground water

Where such minor adverse impacts are identified, appropriate steps to counteract them are listed in Section 6.

Fig. 1- Nuclear facilities and DGR potential sites in the Czech Republic