Implications of the regulatory framework and activities on R&D supporting repository implementation

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Introduction

In the context of geological disposal, the mission of the Belgian regulatory body is to ensure that the repository is developed, constructed, operated and closed in a safe manner, i.e. people and the environment are protected against the hazards of ionising radiation emitted by the radioactive waste, without imposing undue burdens on future generations.

This mission involves several types of activities such as the establishment of regulatory requirements as well as of procedures and conditions for meeting these requirements for the various stages of the licensing process (IAEA, 2011). The roles of the regulatory body also include the oversight of the activities of the organisation in charge of waste disposal and the review of the safety case and of its updates throughout the whole process of developing and implementing the geological disposal programme.

In order to fulfil its mission, the Belgian regulatory body (constituted by FANC and Bel V) carries out its own R&D programme. R&D work is essential for regulators as it allows maintaining and improving their scientific and technical skills, contributes to their independence and helps to build public confidence in the regulatory system.

The following sections give an overview of the Belgian pre-licensing and licensing process. The paper then discusses the possible implications of the regulatory framework and activities (R&D, safety case reviews and issuance of regulatory advices) on the R&D programme developed by the implementer of a disposal programme.

The pre-licensing and the licensing process

In 2011, ONDRAF/NIRAS submitted a Waste Plan to the Federal Government for a decision-in-principle, in order to set a policy for the long-term management of high-level and/or long-lived waste in Belgium. In July 2013, the decision of the government is still pending.

According to this Waste Plan the next milestone is the first Safety and Feasibility Case (SFC 1). The SFC 1 would be devoted to the assessment of the safety and feasibility of disposal systems that would be built in the Boom and Ypresian Clays and located in one or several potentially suitable zones with a view to supporting a decision of the type “go for siting”.

The second Safety and Feasibility Case (SFC 2) would ideally be site-specific and seek to provide evidence of the absence of any major safety- or feasibility-related obstacle to implementation. Based on the SFC 2, a go-ahead for launching the detailed site-specific studies needed to prepare the license application could be given.

The licensing process of a geological repository comprises different steps from the application for construction and operational phase up to the release of regulatory control. The first license describes the phasing and the conditions related to subsequent licenses. Each subsequent license confirms compliance with the conditions of the previous license and defines additional conditions for the next phase.

The regulatory framework

The Royal Decree of 20 July 2001 (MB, 2011a) (laying down the general regulation on the protection of the population, the workers and the environment against the hazards of ionising radiation) outlines the main regulatory provisions that operators of nuclear facilities must comply with. According to this Royal Decree, radioactive waste disposal facilities are Class 1 facilities.

The Royal Decree of 30 December 2011 (MB, 2011b) (laying down the safety requirements for nuclear installations) outlines the general safety requirements for all Class 1 facilities.

However, the existing regulation does not cover the aspects specific to disposal facilities, e.g. the long-term aspects of radioactive waste management and the stepwise approach required to manage the licensing process over large time scales are not addressed. Therefore, Royal Decrees specifying the licensing system and the specific safety requirements for disposal facilities were developed by the FANC and are now in the stage of approval and promulgation.

FANC has also developed technical guides specific to radioactive waste disposal. These documents provide guidance on the interpretation and implementation of safety and radiation protection principles and requirements specified in the regulation. They include recommendations and regulatory expectations on the development of the safety strategy, the development and implementation of a disposal facility and the safety assessment.

Safety and radiation protection principles

The Belgian regulatory framework for radioactive waste disposal is underlain by two safety principles (the defence-in-depth and the demonstrability principles) and the radiation protection principles of the ICRP (ICRP, 2007; Weiss, 2013).

The application of the principle of demonstrability has direct implications for R&D as this principle implies that the implementer of a disposal programme:

- demonstrates that the disposal facility can be constructed with the required level of performance (i.e. feasibility of its construction);
- uses proven techniques or new techniques based on qualification tests;
- demonstrates that the effective performance of the disposal system (i.e. as-built performance) allows to protect people and the environment against the hazards of ionising radiation despite all perturbations which might reasonably be expected and construction contingencies;
- demonstrates that uncertainties are correctly managed.

It is clear that the outcomes of the R&D programme carried out by the implementer constitute an essential pillar of the demonstration of the performance and feasibility of the disposal system. Consequently, the implementer should permanently consider the various implications of the principle of demonstrability when developing its R&D programme.

The ICRP principle of optimisation of protection when applied to the development and implementation of a geological disposal system has to be understood in the broadest sense as an iterative, systematic and transparent evaluation of options for enhancing the protective capabilities of the system and for reducing radiological impacts (ICRP, 2007; Weiss, 2013).

The implementer's R&D programme provides essential data and information to identify, assess and compare options. The development of this programme is therefore strongly linked to the continuous process of optimisation of protection.

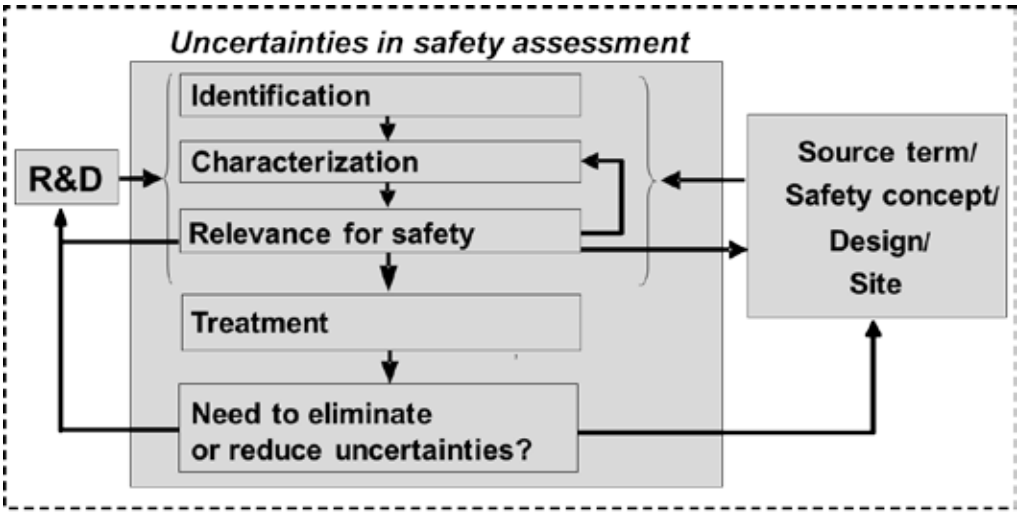
Safety requirements

The regulatory body has developed a set of requirements that the implementer has to fulfil in order to develop, operate and safely close a disposal system. Some of these requirements can have direct repercussions on its R&D programme. Indeed, the outcomes of this programme are an essential input for the argumentation that these regulatory requirements are met.

The development and implementation of a safety strategy is a key safety requirement. The safety strategy is intended to define the objectives and principles guiding the overall disposal programme.

The safety strategy addresses a number of key elements such as optimisation of protection, defence-in-depth through the provision of multiple safety functions and of robust repository components, the containment and isolation of the waste, the use of passive safety features, and the demonstrability of safety-related features. It should also define the approach that will be followed to assess safety and manage uncertainties. Figure 1 illustrates the role of R&D in the management of uncertainties (FANC, 2012). It shows that R&D is necessary for the identification and characterisation of uncertainties as well as for the understanding of their safety relevance. R&D may also be needed to reduce uncertainties the magnitude of which magnitude do not allow demonstrating the safety of the disposal system.

Figure 1: Management of uncertainties



As such, the safety strategy is the starting point to develop a geological repository and therefore to define and conduct the R&D programme. More specifically, the safety strategy should identify the objectives of the R&D programme and explain how this programme is integrated in the repository development process so as to ensure that these objectives will be reached.

Regulatory requirements specific to the engineered barriers, the host rock and the site are also important elements to be considered by the implementer when developing its R&D programme.

Additionally, requirements related to safety assessment addressing the following topics have a significant influence on this programme:

- building confidence in the assessment;
- performance assessment (i.e. the ability of the system and of its components to fulfil their safety functions);
- radiological impact assessment.

The necessity to establish confidence in the assessment derives directly from the demonstrability principle. This implies among others that (FANC, 2012):

- the assessment rests on best available knowledge;
- the disposal system is well understood;
- the identification and treatment of FEP is traceable and well-founded;
- a set of scenarios representative and bounding of the possible evolutions of the system is developed;
- models are shown to be appropriate to the objectives of the modelling through a justification, verification and validation process;
- uncertainties are properly identified, characterised, analysed, treated and assessed as illustrated in Figure 1.

To fulfil these requirements, the implementer has to develop its R&D programme with the objective of establishing a sound assessment basis. This implies that the R&D programme leads to a:

- proper identification and understanding of the safety-relevant phenomenology (i.e. processes upon which safety functions rely, events and processes that may affect safety functions and radionuclide transport);
- reliable characterisation of the disposal system and its environment;
- appropriate model verification and validation;
- reliable identification, characterisation and analysis of uncertainties.

Finally, the regulatory body requires that the implementer develops and implements a quality assurance programme. This also applies to the R&D programme and more specifically to the performed tests and experiments. In particular, the verification of the reproducibility of the measurement and experimental results is an important issue.

R&D programme in support of regulatory activities

According to the Law of 14 April 1994 on the Protection of the Public and the Environment Against Radiation (FANC, 1994), FANC is responsible for maintaining scientific and technical documentation in the area of nuclear safety and radiological protection. It is also responsible for fostering and co-ordinating R&D and establishing relationships with national and international research organisations.

The R&D objectives set by the regulatory body differ generally from those set by the implementer. The regulatory body will mostly investigate issues directly related to safety with the objective to verify the adequacy of the approaches followed by the implementer to reach the safety objective. The regulatory body may decide to initiate R&D work where

it considers that there is a need for additional studies beyond those undertaken by the implementer. There may also be situations in which the regulatory body needs independent R&D work in order to perform a critical and objective review and assessment. Special attention in R&D programmes will usually be given to the detection of possible inadequate choices, assumptions, knowledge gaps, incompleteness, inconsistencies, mistakes (of reasoning or of implementation),.... R&D activities performed by the regulatory body also help to increase the credibility of its technical competence, integrity and judgement.

These activities are therefore more a “complement to” and a “verification of” than a “duplication of” the R&D activities performed by the implementer. Nonetheless, in certain situations they can interfere with each other, especially when a regulatory body’s findings lead to different conclusions than those put forward by the implementer.

Safety case reviews

The regulatory body has a continuing role to review the safety case which has to be regularly updated to remain an adequate basis for making decisions throughout the repository life cycle.

The review aims to determine whether the safety case has been developed to an acceptable level in terms of quality and confidence in safety to move to the next phase of the project.

This includes the verification that the safety case complies with the “regulatory framework”. More specifically, the regulatory body will evaluate whether the safety case provides an adequate and appropriate basis to demonstrate that the proposed facility will be operated safely and provides reasonable assurance of an adequate level of safety in the period after closure. So, the regulatory body has to verify, among other things, that the implementer’s argumentation and assessment basis rest on the findings of a sound R&D programme.

Another specific objective is to evaluate if the proposed R&D programme contributes adequately to the management of uncertainties. More specifically, the regulatory body verifies that relevant measures for mitigating uncertainties have been identified and addressed, and that adequate follow-up plans for their implementation have been put into place.

Hence, the recommendations of the regulatory body resulting from the review of a safety case will generally have a significant impact on subsequent phases of the R&D programme conducted by the implementer.

Regulatory advice

To ensure adequate and efficient steering of repository development, regular interactions between the regulatory body and the implementer on specific safety-related issues are generally needed. Such interactions can lead to formal recommendations and allow sharing views on:

- the interpretation of existing international recommendations;
- the methodological approaches to assess operational and post-closure safety;
- the scientific and technological bases needed to move to the next step of the repository development programme.

It is thus obvious that these interactions can also have repercussions on the R&D programme of the implementer.

Conclusions

Regulatory bodies are responsible for the establishment of a regulatory framework specifying the requirements and conditions for the development, operation and closure of disposal facilities. Performing an independent verification of compliance with these requirements and conditions involves different types of activities such as reviews, issuance of advice and R&D activities. These activities together with the regulatory framework can lead to recommendations addressing directly or indirectly the R&D programme of the implementer.

References

Federal Agency for Nuclear Control/Agence Fédérale de Contrôle Nucléaire (FANC) (1994), Loi du 15 avril 1994 relative à la protection de la population et de l'environnement contre les dangers résultant des rayonnements ionisants et relative à l'Agence Fédérale de Contrôle Nucléaire (AFCN), accessed 24 January 2014, www.fanc.fgov.be/fr/page/wet-van-15/04/1994/382.aspx.

FANC (2012), *Analyse de la sûreté post-fermeture des établissements de stockage définitif des déchets radioactifs*, Technical Project Guide, External Note 2012-02-28-FLE-5-4-4-FR, Rév. 0.

International Atomic Energy Agency (IAEA) (2011), "Disposal of Radioactive Waste: Specific Safety Requirements", *Safety Standards Series*, No. SSR-5, Vienna, Austria.

International Commission on Radiological Protection (ICRP) (2007), *The 2007 Recommendations of the International Commission on Radiological Protection*, ICRP Publication 103, ICRP, Ontario, CA.

Moniteur belge (MB) (2011a), Arrêté Royal du 20 juillet 2001 portant sur le Règlement Général de la protection de la population, des travailleurs et de l'environnement contre le danger des rayonnements ionisants, *Moniteur belge*, 30 August 2001, as modified (RGPRI-ARBIS).

MB (2011b), Arrêté Royal du 30 novembre 2011 portant prescriptions de sûreté des installations nucléaires, *Moniteur belge*, 21 December 2011.

ONDRAF/NIRAS (2011), *Plan déchets pour la gestion à long terme des déchets radioactifs conditionnés de haute activités et/ou de longue durée de vie et aperçu de questions connexes*, NIROND 2011-02F, ONDRAF/NIRAS, Brussels, Belgium.

Weiss, W., *et al.* (2013), "Radiological Protection in Geological Disposal of Long-Lived Solid Radioactive Waste", ICRP Publication 122, *Annals of the ICRP*, 42 (3), 1-57.