PREPARATION OF THE SAFE AND SUSTAINABLE DISPOSAL OF LLW IN THE FUTURE SURFACE DISPOSAL FACILITY IN BELGIUM

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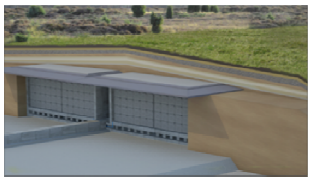
1. The surface disposal facility

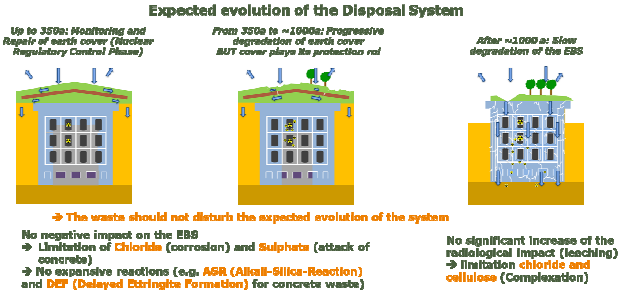
ONDRAF/NIRAS plans to build and operate a surface disposal facility at Dessel for category A waste (conditioned low-level radioactive waste). In the considered disposal concept, radioactive waste is emplaced and grouted in concrete standardised disposal packages called monoliths. The monoliths are subsequently positioned and stacked within concrete modules, that will be covered in a later stage by a multi-layer cover to form a tumulus. This cover will protect the underlying concrete components.

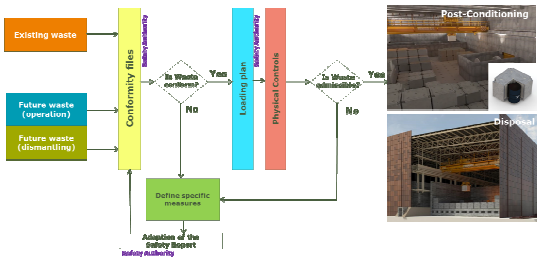
2. The admissibility programme

2.1. Introduction

The waste that will be presented for surface disposal must comply with the requirements and conformity criteria that are laid down in the creation and operating license and/or in the safety report to guarantee long-term safety. Indeed, the long-term radiological safety assessment of the disposal facility for the category A waste is a key issue, as radiological hazards for a surface disposal facility continue to exist for a long period of time, due to the presence of very limited quantities of long-lived radionuclides in the waste.



In order to confirm that category A waste (i.e. future and legacy waste) meets the various conformity criteria, the waste will have to undergo an admissibility process.



2.2. Conformity files

The conformity files address the conformity of the waste. The key issue is the knowledge of the waste in order to assess the conformity of the waste. Taking into account the knowledge gaps, a prioritization was performed allowing to identify the legacy waste expected to conform easily for the first conformity files and to define action plan to fill in the missing information. For future waste, the waste acceptance system of ONDRAF/NIRAS is currently evolving in order to integrate the new requirements and criteria set by the license (Royal Decree 16 May 2023), allowing the collection and the controls of all relevant information before the conditioning in monoliths.

2.3. Loading Plan

Specific requirements and rules during loading also apply to ensure the safe disposal of the waste. To tackle this, several loading plans were defined:

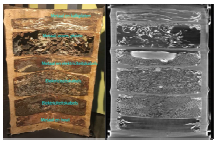
- The global loading plan at the level of the disposal site to evaluate different scenarios in order to define adequate strategy. The global loading plan identified the risk of expansion of concrete waste as a priority challenge. It made it possible to identify the waste that would a priori be taken into account for the operation of the first 4 modules. This volume represents approximately 5 modules (so about 25% margin) and is mainly composed of the future waste arising from the dismantling of nuclear power plants,
- Based on the selected waste, a preliminary loading plan can be established to evaluate in more details the filling of the first 4 modules and the respect of the requirements and loading rules. This plan is a prerequisite in order to start the operation of the disposal of the first 4 modules,
- During operation, a production plan is established to manage the production of monoliths. The production plan is continually updated taking into account the boundary conditions set in the preliminary loading plan and the accepted monoliths disposed in the modules,
- The exact location of the disposed monoliths in the modules is also recorded in the final loading plan.

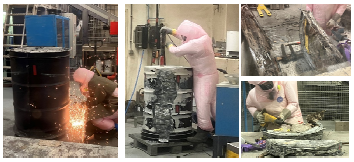
2.4. Physical controls

In order to confirm the admissibility of the waste, independent and complementary controls will be performed. Based on the results of an experimental verification programme, 4 techniques were selected to verify the conformity criteria. Those techniques are expected to be implemented in a dedicated building for the realization of the controls. The promising techniques are:

- The high energy photon imaging for the non-destructive verification of the physical criteria (empty spaces, free liquids, amount of conditioning mortar) and the cellulose criterium (for concentrated cellulose amounts > 1kg)
- The X-ray fluorescence - WDXRF (verification of chloride and sulphate criteria)
- The Raman spectroscopy (verification of cellulose criterium)
- The gamma spectrometry – SGS (verification of key nuclides)

It has to be considered that the protocols for the destructive controls are still under evaluation. To gain knowledge, ONDRAF/NIRAS decided to launch with BELGOPROCESS a pilot project using the existing installation and techniques. 11 legacy waste packages were selected in the high-priority legacy waste and were submitted to non-destructive and destructive controls allowing to build knowledge not only on the techniques needed for these controls on an industrial scale, but also on the nature of the legacy waste.


High-energy photon imaging on dummy waste (right: 3D tomography; left dummy waste)


Destructive controls of legacy waste

2.5. R&D studies for non-compliant waste

Some waste (mainly legacy waste) will not comply with the conformity criteria. The solutions allowing the admissibility of those waste are classified according to three groups of solution:

- Group I: Modification of parameters or models via the acquisition of new scientific knowledge and/or a more detailed approach taking into account the specificities of the wastes
- Group II: Modification/adaptation of the engineered barriers in order to reinforce them and ensure the compatibility of the waste with the repository
- Group III: Modification of the waste (reconditioning)

The risk of expansion due to ASR/DEF was identified as a priority challenge. The reference option to solve this issue is by using a compressible material inside the caisson (Group of solution II). Long-term R&D studies are currently ongoing to demonstrate the long-term safety of this option (potential degradation of the material, impact on the sorption, ..). Conceptual prototypes will be made and tested for all options.

Key chemical property of concern in the safety assessment is the sorption behaviour of cementitious material. In order to reduce the level of uncertainties and hence to reduce the high level of conservatism in the reference scenario, ONDRAF/NIRAS started an R&D project to get a better knowledge on the sorption on specific radionuclides on cementitious materials (Group of solution I). The project is still running at this day, but in the meantime important results have been obtained:

- scoping calculation identified the radionuclides of interest (Pu & Nb) as well as the sorption values which should (preferably) be obtained in order to have a significant reduction of the conservatism included in the reference scenario.
- preliminary results from sorption experiments confirm that the sorption values for Nb and Pu are significantly higher than the sorption values considered in the safety assessment.

With this increase of knowledge, the uncertainties and the high degree of conservatism can be reduced allowing to propose to the safety authority a modification of the conformity criteria to ensure the admissibility of legacy waste.

3. Conclusions and Acknowledgements

ONDRAF/NIRAS plans to build and operate a surface disposal facility for the low-level radioactive waste in Dessel. An admissibility program was launched to prepare and ensure the safe and sustainable disposal of the category A waste.

The author would like to thank all colleagues at ONDRAF/NIRAS and BELGOPROCESS who contributed to the admissibility programme.