PREDIS

Deliverable 7.2

Innovative Integrity Testing

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Abstract

This work is a part of the European project, PREDIS, on pre-disposal treatment and management of low-level waste and intermediate-level waste, The state of the art report (D7.1) and the gap analysis (WP2) have identified the need for more research on adequate and industrially mature solutions (practices, data governance, technology, and tools) for monitoring the packages and supporting decisions in the preparation, handling, and long-term interim storage of low-level/intermediate-level cemented waste.

Within the work package 7 “Innovations in cemented waste handling and pre-disposal storage”, the task T7.3 is optimising innovative integrity testing and monitoring techniques. Three sub-tasks are specifically dealing with

- T7.3.1 External sensing technologies,
- T7.3.2 Embedded sensing technologies in an instrumented package and
- T7.3.3 Preliminary system testing and optimisation.

In this deliverable, according to the work plan of the EC project PREDIS, we are reporting two open access publications about innovative integrity testing techniques. They give examples on the work done in T7.3 but are not reporting about all techniques considered in the project. A comprehensive report (D7.3) is published at the same as this deliverable. More publications will follow.
In parallel, WP7 publishes deliverables (D7.4 – D 7.7) on the work done in tasks 7.4 (“Digital Twin and Modelling”) and T7.5 (“Data Processing and Decision Framework”).

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1 Introduction

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2 Publication 1: "New technologies for radioactive waste monitoring: Results and perspectives from recent experience"

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2.1 Abstract

With the initial support of the INFN-Energy committee throughout the last ten years a few activities have been pursued aimed at the improvement of radioactive waste management. Nowadays new technologies make possible the development of low-cost systems capable of monitoring the radioactivity coming out of (spent) nuclear fuel casks or radwaste drums. Simple, compact and effective radiation counters were developed at INFN for the detection of gamma rays and neutrons, suitable to be deployed as a distributed network for the real time monitoring of radioactive waste from the very low up to the highest level, and possibly preluding to a mass deployment benefitting both safety and security. Indeed, in such a framework any change in counting rates, or even a sensor blackout, could be interpreted as a possible safety or security breach. Techniques for sorting and segregating the radioactive waste have also been studied and a dedicated prototype for the gamma/visible imaging with spectroscopic features is currently being developed. On top of the new interesting technical features accessible by means of distributed networks of devices, one should also focus on the psychological impact they could have on the general public acceptability of a finely monitored repository. Tests performed on radioactive waste of all categories, including spent fuel, showed quite promising results.

2.2 Additional comments

This paper it is the summary of an invited talk Paolo Finocchiaro (INFN) gave at an international workshop organized last January by Sogin. It includes results from three EU projects MICADO, PREDIS and CLEANDEM, which are connected to each other.

2.3 Publication

The publication is available at:
https://www.sif.it/riviste/sif/ncc/econtents/2023/046/02/article/6

3 Publication 2: "Wireless and batteryless sensing system to assess the concrete condition within a nuclear waste drum"

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Inventions, 2024, under review

3.1 Abstract

In many current radioactive waste management programs, low and intermediate level (LLW/ILW) waste is embedded into Portland cement-based concrete in ordinary steel drums. The drums are kept in storage facilities for years or even decades before they are finally disposed of in safe places such as underground caverns. During this period, periodic inspections are carried out, but they are usually limited to visual assessment and radiation level checks. As a part of the European project PREDIS (2020-2025) on pre-disposal treatment and management of LLW and ILW, a system for permanent and wireless monitoring of the internal condition of a cemented waste drum was developed. The objective of this system is to monitor the process of hardening and the evolution of the concrete itself over time to indirectly identify potential defects such as corrosion or cracking. The measured parameters are, so far, humidity, temperature, and pressure. The sensing system is a chain of small units, called SensorNodes. Each SensorNode includes two off-the-shelf sensors for relative humidity, temperature, and pressure. The SensorNodes are connected to a communication system inside the drum, consisting of two units placed symmetrically on the two sides of the drum's lid. Energy for the sensors is wirelessly transmitted from outside to the inside unit. Data communication is wireless as well by using this interface and the data sent back to the outside. The system was successfully tested in smaller mockups and is now demonstrated in a full-scale experiment in a realistic environment in a nuclear facility.

3.2 Additional comments

This paper describes technologies which have been developed in the frame of PREDIS in joint work of two institutions (BAM and VTT) and tested at a third (UJV).

3.3 Publication

Link to the publication to be added: https://www.mdpi.com/journal/inventions