Andra Call for Projects
with the support of the
Investments for the Future Programme

INSPECT

Online and remote dosimetry for the inspection of nuclear equipment and infrastructure

Project supported by Andra under the "Investments for the Future Programme" ("Investissement d'Avenir") - Selected under the Andra Call for Projects: "Optimisation of post-dismantling radioactive waste management", organised in cooperation with the French National Research Agency (ANR).

Duration: 48 month

Project launch: 11/2016

Total project cost: €1.79 million

Sum covered under the Investments for the Future Programme: €890,000 million

Type of financial support: Subsidy with ROI guarantees for the State

Locations: Saclay, Saint-Maur-des-Fossés, Gif-sur-Yvette

Coordinating body: CEA LIST

Partners:
- CEA LIST
- CEA DTN
- ORANO GROUP
- SDS (System Developments and Solutions

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BACKGROUND

Radiological inspection operations must be carried out on nuclear facility clean-up and dismantling sites in order to identify the radioactivity level of the sites, which is used to determine the impact of clean-up and dismantling operations on personnel and develop an optimal scenario for logistics, costs, risk control and waste management.

Under perfect access conditions, the (2D) gamma camera is the ideal tool for radiological inspection. For facilities with restricted or difficult access, e.g. inside reactor vessels, reactors, reactor cavities and waste storage silos, inspections of their initial state and developments during decontamination can prove complex, time-consuming and costly as they are carried out using (0D) point detectors, moved point by point (ionisation chambers, CZT or GM detectors).

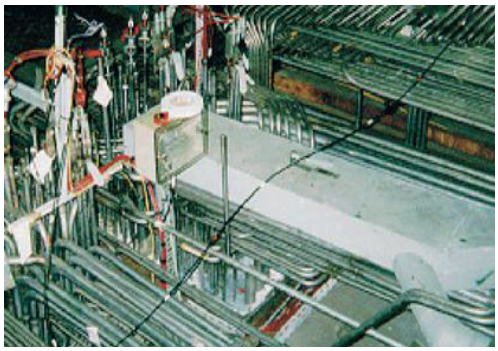
A critical instance is inspection through tubes with a small diameter (< 1 cm) and limited radius of curvature, such as steam generator tubes. The use of conventional (0D) detectors for remote dosimetry readings in areas with restricted access and at long range (> 20 m, with the unit of measurement placed outside of the radiological zone) is complicated due to signal degradation by the remote cables (TRIAX cable with electromagnetic shielding) and the difficulty in designing smaller versions (presence of electrical current, signal conditioning [amplification, etc.] or thermalisation).

OBJECTIVES

The INSPECT project aims to develop a radioactivity measurement system in the form of a cable that can be easily transported into difficult-to-access zones. This system is based on Optically Stimulated Luminescence - Fibre Optics (OSL/FO), which uses a luminescent material attached to the tip of an optical fibre. This technology has the following advantages:

- It can be used for operational dosimetry (direct online reading of radiological measurements).
- It is not sensitive to electromagnetic disturbances, so does not require shielding like other technologies, meaning that a smaller version would be possible.
- It can be used very remotely (long-distance measurements with the measurement analysis unit placed outside of the radiological zone) and to measure a wide range of dose rates (from several µGy/h to several Gy/h).

The feasibility of these remote inspections has already been demonstrated by CEA LIST on several dismantling sites (APM and UP1 in Marcoule, new-generation reactor in Cadarache) using point and radiation-resistant OSL/FO sensors. For these tests, the sensors were placed on the tip of a reinforced optical cable and displaced point by point to reconstitute the facility's radiological profile.



▶ Figure 1: Inspection of a contaminated pipe system using an OSL system

ANDRA
French national radioactive waste management agency

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INSPECT: Online and remote dosimetry readings for the inspection of nuclear equipment and infrastructure

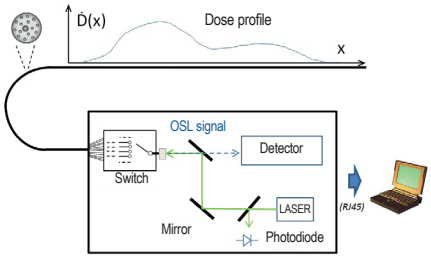

Figure 2: Diagram of the system developed under the INSPECT project

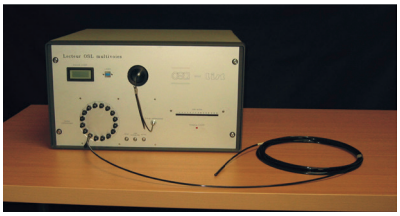

Figure 3: Prototype of the current remote inspection system

Figure 4: Remote inspection system feasibility test

PROJECT SEQUENCE

The INSPECT project will last four years (November 2016 - November 2020) and is organised around four stages:

- Design of the OSL/FO (1D) detectors, measuring the curvilinear profile of the dose rate within the range of µGy/h – several Gy/h;
- Production of two multichannel OSL/FO measurement units and a human-machine interface adapted to various decontamination scenarios, in line with the specifications of the manufacturer (SDS) and partner operators (Orano and CEA);
- Analysis of feedback from experiments conducted with this instrumentation on 4 different pilot sites (Orano La Hague; CEA Marcoule (one CEA site and one Orano site), CEA Cadarache);
- Transfer of this instrumentation to the manufacturer (SDS) at the end of the project with the aim of taking the product to market.

EXPECTED RESULTS

Innovation

An innovative (1D cable) sensor for dose profile/dose rate measurement will be developed under INSPECT. Several OSL/FO laboratory prototypes for reading instrumentation have been developed (CEA LIST, US Navy, University of Oklahoma, RISOE in Denmark, etc.) but no product has yet been commercialised for operational dosimetry (online via fibre optics). The INSPECT project aims to launch this new product on the clean-up and dismantling market in the years following the end of the project.

Economic impact

CEA LIST intends to commercialise the know-how it has developed over many years. SDS, a French manufacturer, was chosen to create added value and jobs in France. The technological developments obtained through the INSPECT project will contribute to France's technology offering and know-how to meet the country's needs and also win export markets in a highly competitive environment.

Impact on radioactive waste management

The device developed under INSPECT will improve the performance of remote dosimetry, which is an essential tool for nuclear facility clean-up and dismantling operations. It will be used to take measurements in areas that are difficult or impossible to access using conventional technologies in order to provide greater understanding of the radiological state of facilities. The device will therefore reduce the impact of clean-up and dismantling operations on personnel, and optimise risk control and waste management.

Application and commercialisation

Clean-up and dismantling is the main sector targeted under this project. In 2013, France had 125 nuclear facilities, around thirty of which were being dismantled, mainly belonging to CEA, EDF and Orano. Worldwide, 300 reactors will need to be shut down in the next 20 years. At the same time, this device could be used for radiological inspections on power plants (around 50 reactors in France) or for medical purposes (radiotherapy and radiology).

During the first years of marketing the (0D and 1D) OSL/FO device, most sales will be made on a comprehensive offer, which will include the measurement unit, software, detectors and operator training for using this new tool. The global market is estimated to be worth between €20 and €30 million. After this (several years later), once the technology has reached facility operators, sales will continue for software (which will require constant development), detectors, which will need to be renewed as they are used (destruction or contamination) and after-sales service for units that have already been sold.