Waste Package Condition Monitoring and Inspection

In 2009, following recent changes in United Kingdom (UK) Government Policy, the Nuclear Decommissioning Authority (NDA) identified a knowledge gap in the area of long term interim storage of waste packages. A cross-industry Integrated Project Team (IPT) for Interim Storage was created with responsibility for delivering Industry Guidance on the storage of packaged Higher Activity Waste (HAW) for the current UK civil decommissioning and clean-up programmes. The IPT for Interim Storage published Industry Guidance in 2012 which established a method to define generic package performance criteria and made recommendations on monitoring and inspection. The package performance method consists of the following steps; identification of the package safety function, identification of evolutionary processes that may affect safety function performance, determination of measurable indicators of these evolutionary processes and calibration of the indicators into package performance zones.

- Nuclear Decommissioning Authority, Interim Storage of Higher Activity Waste Packages – Integrated Approach, Industry Guidance, Effective from November 2012

The IPT for Interim storage also had a remit to direct research and development projects via the NDA's Direct Research Portfolio (DRP) to fill the knowledge gap. As a result, in 2009, the NDA lot 2 (Waste processing) framework contractors, NNL and UKAEA and Hyder Consulting worked together to identify and rank waste package monitoring needs. The assessment methodology provided the following key monitoring needs:

1. Particle release (i.e. loss of material)
2. (Internal) crack formation
3. Mass of waste package
4. Deformation of waste package (stress)
5. External corrosion of waste package
6. Package lifting feature condition
7. Hazardous gaseous release
8. Salt deposition
9. Centre of gravity (to monitor movement of heavy elements)
10. Distribution of fissile material
11. Location of hot spots
12. Identification of package

This work is reported in:

- NNL 10730, Development of Innovative Solutions to Monitor Radioactive Waste Packages in order to Validate Long-Term Behaviour and Performance, Issue 2, March 2010.

Following this work, a number of desk-based studies/ reviews were performed and are reported in the following reports:

- NNL 10907 Inductive Coupling Technology to Monitor Nuclear Waste Packages, March 2010

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- NNL 10737 In-situ Monitoring of Waste Packages: Investigation of Robotic Technology, February 2010
- NNL 10926 SMART Coupons for Pro-active Waste Monitoring, March 2010
- NNL 10905 Salt Deposition Measurement: In-situ Contact Techniques, March 2010
- NNL 10906 Inspection of waster package lifting features – assessment of 2D arrays and guided wave technology, March 2010
- UKAEA/TSG(10)0633 Effects of Store Emplacement Strategies on ILW Package Longevity, Issue 1, March 2010
- TSG(10)0650 Higher Activity Waste – Interim Store Performance and Monitoring, Issue 1, March 2010
- UKAEA/TSG(10)0723 Development of a Methodology for Determining ILW Package
- Monitoring and Inspection Requirements, Issue 1, December 2010

A number of technologies were taken forward to experimental projects including:

Smart Coupon (online measurement of corrosion)

- NNL (10) 11225 SMART Coupons for Proactive Waste Package Monitoring: Supply Chain Visits, November 2010
- NNL (10) 11227 SMART Coupons for Proactive Waste Package Monitoring: Technical Specification, December 2010
- NDA 03413/06/10/01 Smart Coupon for ILW waste store monitoring: technology demonstrator, Issue 1, July 2014

Inductive Coupling (enabling technology to power and communicate with sensors)

- NNL (11) 11562 In-situ Monitoring of ILW Containers: Proof of Concept Inductive Coupling Demonstrator, March 20100
- NNL (12) 11967 Demonstration of a Radiation Tolerant Inductive Coupling Telemetry System to Enable Embedded Sensors in ILW Packages, February 2012

Ultrasonic Phased Arrays (integrity of waste package lifting feature)

- NNL (12) 11988 Demonstration of Inspection of Waste Package Lifting Features using Ultrasonic Phased Arrays, March 2012

Laser Induced Breakdown Spectroscopy (remote salt detection)

- Hyder Report UA002056-BRR-WP6, Phase 03-01 Stage 1 LIBS Technology Feasibility Study, Issue 1, December 2010
- Hyder Report 5001 UA002056-UU81R-02 Stage 2 LIBS feasibility Study, issue 1, March 2011

Passive Intermodulation (remote container crack detection)

- UKAEA/TSG(11)0769 Passive Intermodulation for Crack Detection in Intermediate Level Waste Containers, Issue 2, January 2012

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