Instrumentel

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WIRELESS TELEMETRY GOES NUCLEAR

Instrumentel's inductively-coupled metrology systems offer the potential for long-term in-situ monitoring of intermediate-level nuclear waste containers with the provision of a tamper-proof unique ID

Overview

The nuclear decommissioning industry has long required a reliable and robust means of sampling internal conditions, such as temperature, from within intermediate nuclear waste containers but to date, no measurement method has been able to survive the harsh radiation environment. We report here how Instrumtentel's inductivelycoupled metrology systems offer the potential for long-term in-situ monitoring of intermediate-level nuclear waste containers with the provision of a tamper-proof unique identification number (ID).

Nuclear Intermediate-Level-Waste (ILW) is a by-product of nuclear fuel processing and nuclear plant decommissioning. Such waste is exclusively encapsulated in a cementatious grout prior to being sealed in 10mm thick steel barrels that must be stored in repositories for at least 300 years before the contents no longer pose an environmental hazard.

Currently, there is no method for monitoring and transmitting important indicators such as temperature from within these barrels that might predict unstable internal conditions or loss of the structural integrity of the containers. If available, in-situ monitoring, with the added capability of uniquely identifying each container would greatly increase the security and safety of intermediatelevel waste storage.

This Case Study demonstrates the capability of Instrumentel's wireless data acquisition system to function within an elevated radiation environment such as that found in intermediate level waste containers. We show how the advanced XT01 transponder chip was able to continue to operate effectively after a cumulative gamma radiation does of 11.5 MGy, almost double the required exposure for the lifetime of an ILW container.



The XT01 tag

The core of Instrumentel tag is the XT01 transponder ASIC, specifically designed to collect and send data wirelessly from harsh and extreme environments.

Manufactured using advanced siliconon-insulator (SOI) technology the device is capable of operating from -40°C to +225°C and has shown outstanding resilience to gamma radiation and mechanical shock.

Instrumentel Ltd - leaders in data acquisition systems for extreme environments enquiries@instrumentel.com +44 113 346 6223

Instrumentel wireless solution

Instrumentel have developed a range of wireless measurement systems comprising battery-less tags (or transponders) and inductively coupled readers, including the XT01 tag which is designed specifically to operate in extreme environments. By embedding an XT01 tag in an ILW container coupled to an external reader, it should be possible to monitor internal conditions such as temperature without breaching the integrity of the container. Such a system would have the added benefit of providing a tamper-proof unique identifier for each barrel for asset tracking and inventory management.

This initial program of work demonstrated the capability of the XT01 to continue to operate and transmit data after receiving cumulative radiation exposure representative of the 6,000kGy expected over the required lifetime of the ILW containers.

During the trials, six XT01 tags were irradiated by gamma radiation from a Co-60 source and periodically interrogated by an Instrumentel reader capable of auto-tuning. It was shown that following cumulative radiation exposure of 11.5 MGy, four of the 6 tags continued to function normally. The remaining two were able to operate normally after retuning of the external inductive coupling circuit, required due to a change in the input impedance as a result of radiation damage to external passive components. Increased tolerance of the tags and readers to such changes is now being addressed through the development of active tuning circuits.

Summary

We have shown here that the Instrumentel XT01 tag is capable of operating after 11.5 MGy of cumulative gamma radiation exposure, a dose that is typical of the lifetime exposure required for nuclear ILW containers. This initial work demonstrates the feasibility of adopting inductively coupled batteryfree sensors for in-situ monitoring and identification of ILW.

Such radiation tolerance also demonstrates the potential for Instrumentel's extreme metrology solutions to be adopted in related harsh environments such as radiation-based sterilisation and space applications.

Further work was also successfully completed to demonstrate transmission of data through steel containers allowing data to .



leading inductivelycoupled telemetry

The Instrumentel wireless telemetry system comprises a tag coupled to a reader through an inductive link. The reader incorporates DSP and communication interfaces allowing onboard analysis and transmission of data over a wide variety of communication protocols.

Instrumentel - leaders in electronic systems for data acquisition from extreme environments

Instrumentel specialises in electronic systems for acquiring data from extreme and difficult to access environments.

Our expertise has been proven in multiple markets including engine and electric motor telemetry, explosion metrology and condition-based monitoring of industrial processes and railway rolling stock.

The Instrumentel product range includes:

MDS: A versatile system for collecting data from moving parts such as internal combustion engine pistons and valves, turbines and electric motors.

EDS: A robust high-temperature system for collection of process-related data from extreme environments. The EMU has been applied to a diverse range of applications including monitoring the temperature of molten steel in a foundry and determining the temperature and pressure form the centre of an explosive blast.

DDU: The Doors Diagnostic Unit is optimised for condition-based monitoring of sliding doors, particularly those used in rail rolling stock and elevators. The DDU is quickly retrofitted without the need to break into existing safety systems, and provides continuous feedback on door operation.

Proven in multiple markets

Instrumentel's world-leading capabilities have been validated in a number of industries.

These include explosion, earthquake and nuclear waste monitoring, as well as monitoring moving parts in the rail, automotive and machine tool industries.

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