Monitoring Technology for Spent Fuel Storage

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Applications of Wireless Technology

Spent Fuel Monitoring

Wireless Feasibility Assessment
RF and Magnetic
RF Wireless Data Transmission Feasibility

Goal:
- Collect internal sensor data from within Type B packaging

Solution:
- Use of an off the shelf wireless RF radio
Feasibility Test Results using OnRamp Wireless

Results:

- Tested RF method with on hand OnRamp Wireless radios
- A quality link established and documented in report
- Range of at least 175 feet with acceptable signal loss
- 9975 Type B Packaging was also tested with successful link from within the internal lead assembly
Magnetic Field Wireless Data Transmission Feasibility

Goal:
- Collect internal sensor data from within the Type B packaging

Solution:
- Use of a Magnetic Field Wireless system (RuBee Tags by Visible Assets)
Feasibility Test Results using RuBee Wireless

Type B Packaging Internal Data Collection

- **Results:**
  - Visible Assets tested the RuBee Tags on 9978 Type B Packaging
  - A quality link established from within and just outside of internal Containment Vessel and documented in a report (Top)
  - Two way communication and signal strength documented (Bottom)
<table>
<thead>
<tr>
<th>Wireless Technology Comparison</th>
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<tr>
<td><strong>RF Wireless</strong></td>
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<tr>
<td><strong>Pros</strong></td>
</tr>
<tr>
<td>- Mesh Network Capable</td>
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<tr>
<td>- Longer range</td>
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<tr>
<td>- Low Power</td>
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<tr>
<td>- Low Cost</td>
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<tr>
<td><strong>Cons</strong></td>
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<tr>
<td>- Less penetration capability than Magnetic</td>
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| **Magnetic Field Wireless**   |
| **Pros**                      |
| - High penetration through various materials (Ferrous Metals) |
| - Low Power                   |

| **Cons**                      |
| - Point to Point Link         |
| - Very Limited Range          |
| - Higher Cost                 |
Spent Fuel Monitoring for Stress Corrosion Cracking

Purpose:
- Specific range of temperature and humidity
  - Has an increased likelihood of stress corrosion cracking

Solution:
- Continually monitor temperature and humidity at inlet and outlet of casks

Areas on East and West Coast are most susceptible.
Design Specifications

Spent Fuel Cask Monitoring

Specifications:

- **Limited Impact on Infrastructure**
  - Wireless, battery powered sensor nodes with 3 year battery life or more
  - Cellular data transmission to end user
  - Sensor nodes have enough range to reach outside of fenced security area

- **Data Collection**
  - Collected to an Excel importable ASCII text file
  - User selectable data collection rate

- **Security**
  - Implement an acceptable security to transmit Unclassified Sensitive Data
  - Decouple the data from data source
System Overview

Spent Fuel Cask Monitoring

2.4 GHz Wireless

Sensor Package
- Inlet and Outlet Temperature and Humidity
- 128 AES pre-shared keys to E10

Synapse E10
- Rugged
- Solar or AC Powered

Cellular Modem
- FIPS 140-2
- Rugged

End User Application
- Password Protected
- FIPS 140-2 VPN connection
- Run on any PC with Internet

Ethernet

Cellular Wireless Data

Environmental Management

DOE Packaging Certification Program
Wireless Sensor Node Package

Spent Fuel Cask Monitoring

- Low per node cost: $250
- Spare inputs on wireless nodes for additional sensors
- Modular radio allows for site specific frequency adjustments (2.4 GHz, 900 MHz)
Future Development Options

Applications:
- Leak Detection
- Tamper Indication
- ALARA (As Low As Reasonably Achievable)
- Radiation Monitoring
- Internal Sensor Data

Sensors and Equipment:
- Seismic and Gas Detection
- Auditory and Motion
- Video and Air Flow
- Radiation Detectors
Summary

1. Wireless Feasibility Assessment
   1. RF Wireless
   2. Magnetic Field Wireless
   3. Comparison of two Wireless Technologies

2. Spent Fuel Monitoring
   1. Current Development for Stress Corrosion Cracking
   2. Design Specifications and System Overview
   3. Future Development Option
Questions?