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# Monitoring Technology for Spent Fuel Storage

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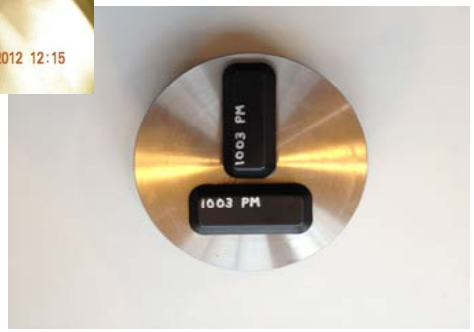
**R&D Engineering**

EM Environmental Management
safety ❖ performance ❖ cleanup ❖ closure
DOE Packaging Certification Program

# Applications of Wireless Technology

## Spent Fuel Monitoring


## Wireless Feasibility Assessment RF and Magnetic

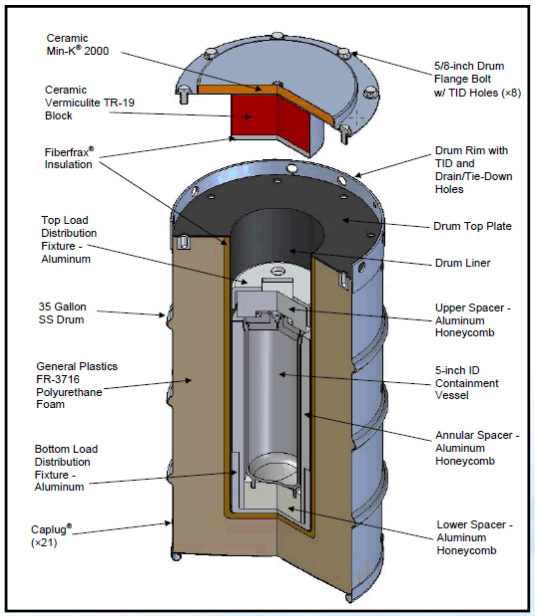
# RF Wireless Data Transmission Feasibility

**Goal:**

- **Collect internal sensor data from within Type B packaging**

**Solution:**

- **Use of an off the shelf wireless RF radio**

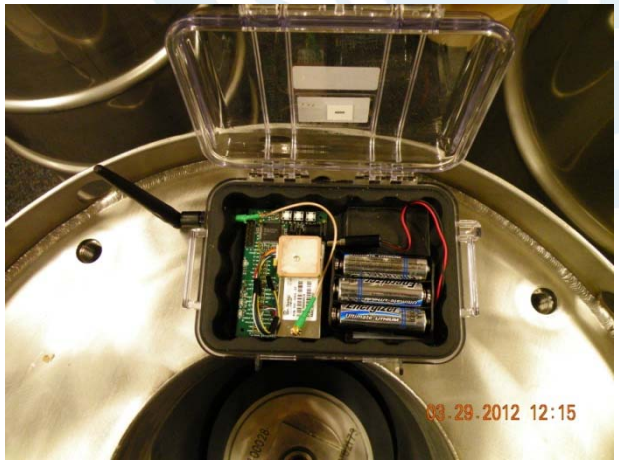



9978 Type B Packaging

# Feasibility Test Results using OnRamp Wireless

## Type B Packaging Internal Data Collection

- **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**

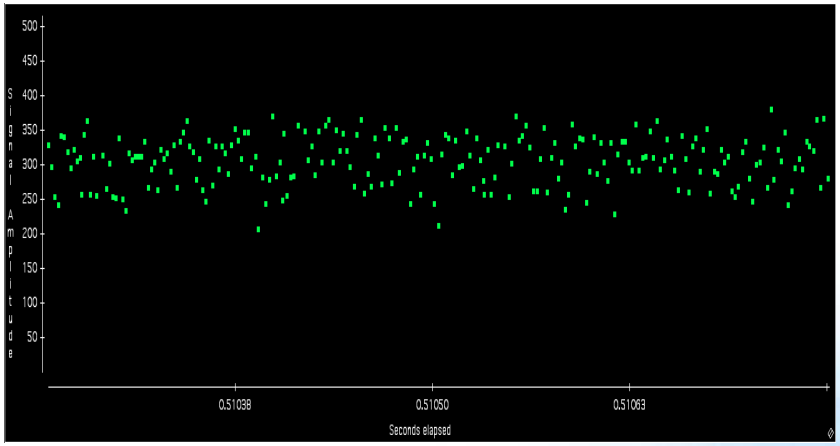
**Solution:**

- **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)



# Wireless Technology Comparison

## RF Wireless

**Pros**

- Mesh Network Capable
- Longer range
- Low Power
- Low Cost

**Cons**

- Less penetration capability than Magnetic

## 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

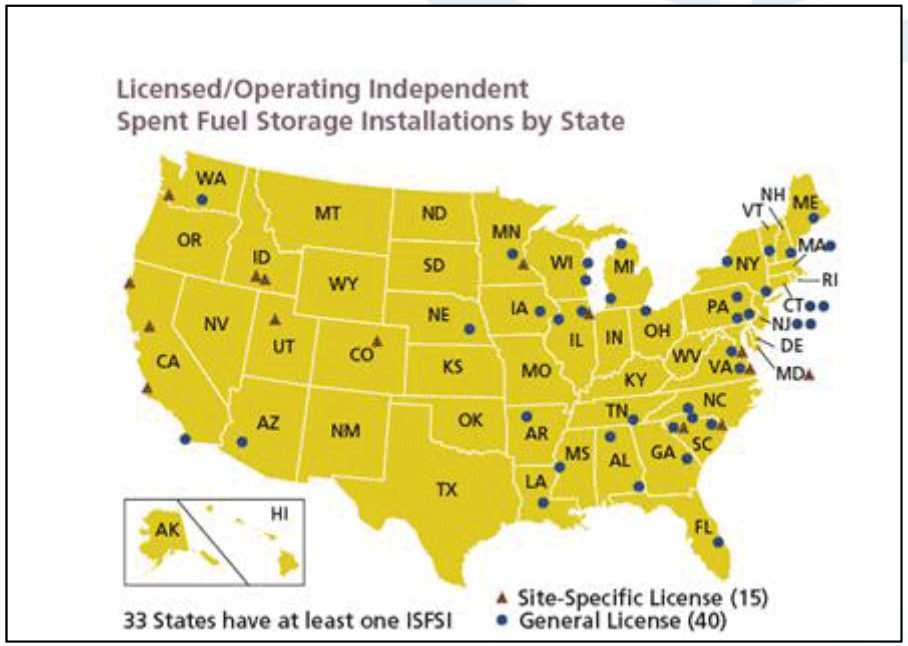
## Dry Spent Fuel Casks Storage Sites.

**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**



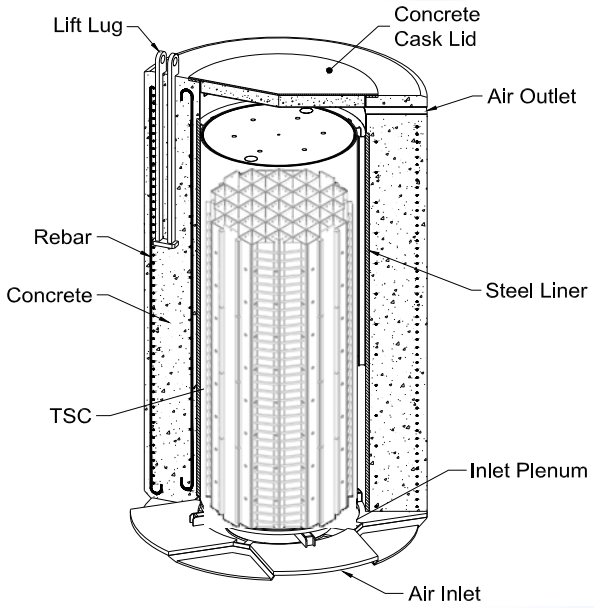

Areas on East and West Coast are most susceptible.

# 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

Ethernet

Cellular Wireless Data


### 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

# 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?