

Passive Wireless Sensor Technology for SRS Material Storage

Michael Mets

Manager, NMO & Engineering Support, Process Controls and Automation Technology

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Savannah River Nuclear Solutions



SRNS is the M&O contractor for DOE's Savannah River Site in Aiken, S.C.

The primary initiatives for SRNS are national security, clean energy and environmental stewardship.

- We provide nuclear materials management to support national defense and U.S. nuclear nonproliferation efforts.
- We support the National Nuclear Security Administration by extracting tritium and delivering products to military and weapons design agencies.
- We develop and deploy environmental cleanup technologies.
- We conduct technology R&D on national energy independence initiatives.



Outline

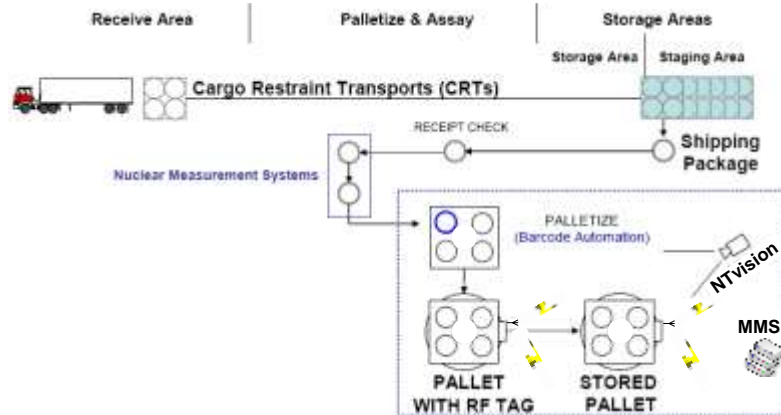
- **Nuclear Materials Storage Mission**
- **Nuclear Materials Storage Process and Facility**
- **Challenges to Providing RF Material Accountability Systems**
- **Current Material Control and Accountability System**
- **Additional Systems Available or in Development**
- **Passive Wireless Sensor Technology “Wish List”**

Nuclear Materials Storage Mission

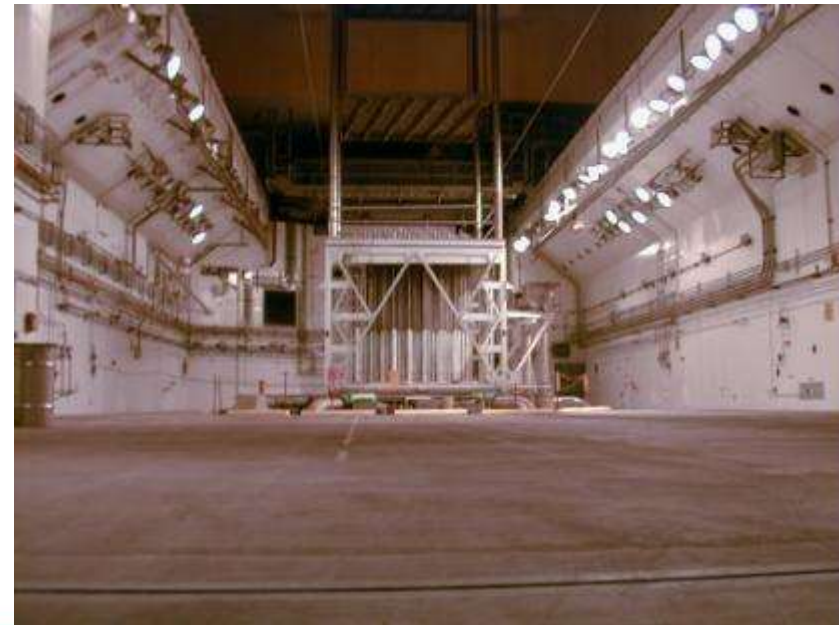
- The K Area Complex provides for the handling and interim storage of our nation's excess plutonium and other special nuclear materials as well as fulfills the US commitment to international nonproliferation efforts in a safe and environmentally sound manner. SRS is also the recognized leader for managing the plutonium surveillance program throughout the DOE Complex.



Nuclear Materials Storage Process and Facility



- Process Room
- Crane Maintenance
- Stack Area
- 910B Fan Room
- Purification Area (Active project)



Challenges to Providing RF Material Accountability Systems

- **Physical Environment**

- Highly Reflective and Attenuating Surfaces
- Various Sources of EMI
- Coexistence with Legacy Equipment
- Harsh Environmental Conditions
- Significant Radiation Levels



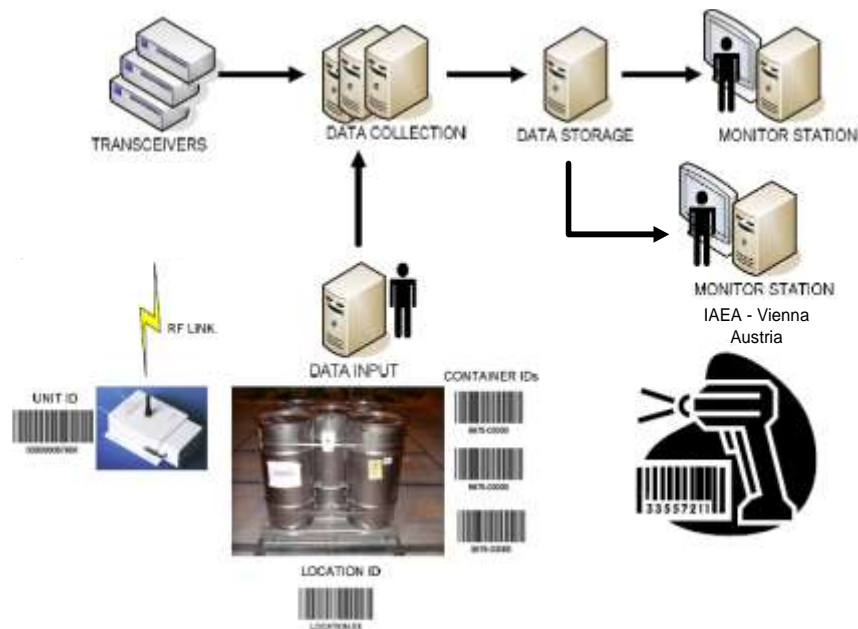
- **Regulatory Environment**

- Spectrum Supportability Authorization
- Procurement Authorization
- Risk Assessment
- Security and Test Plans

Current Material Control and Accountability System

- **Continuous Item Monitoring & Surveillance (CIMS)**

- Material Monitoring & Surveillance
- NT Vision



- Sandia National Labs software/hardware
- Radio Frequency Tamper Indicating Devices (RFTID)
- RF Receiver (Interrogator/Transceiver (I/T))
- Data Collection System
- Data Storage Server
- Data Transfer Server (Stack Area- International Atomic Energy Agency (IAEA))
- 11 high end workstations
- 2 servers

Current Material Control and Accountability System

00000006259a - DARC

File Polling Acknowledge

Poll for SOH VSOH Data Buffer ☒ Acknowledge/Add Comment ☐ Close

T1 -- 00000006259a

Description: T1 ESP

Digital	Analog
Case Tamper <input type="radio"/>	Battery 3.16 V <input type="radio"/>
Fiber Optic Seal <input type="radio"/>	Temperature 78.80° F <input type="radio"/>
Motion <input type="radio"/>	Analog 5 <input type="radio"/>
Low Temp. <input type="radio"/>	Analog 4 <input type="radio"/>
High Temp. <input type="radio"/>	Analog 3 <input type="radio"/>
Transport <input type="radio"/>	Analog 2 <input type="radio"/>
Digital Bit 1 <input type="radio"/>	Analog 1 <input type="radio"/>
Digital Bit 2 <input type="radio"/>	Analog 0 <input type="radio"/>

Location: 105-K/PR/S02/B
Containers
9975-00001

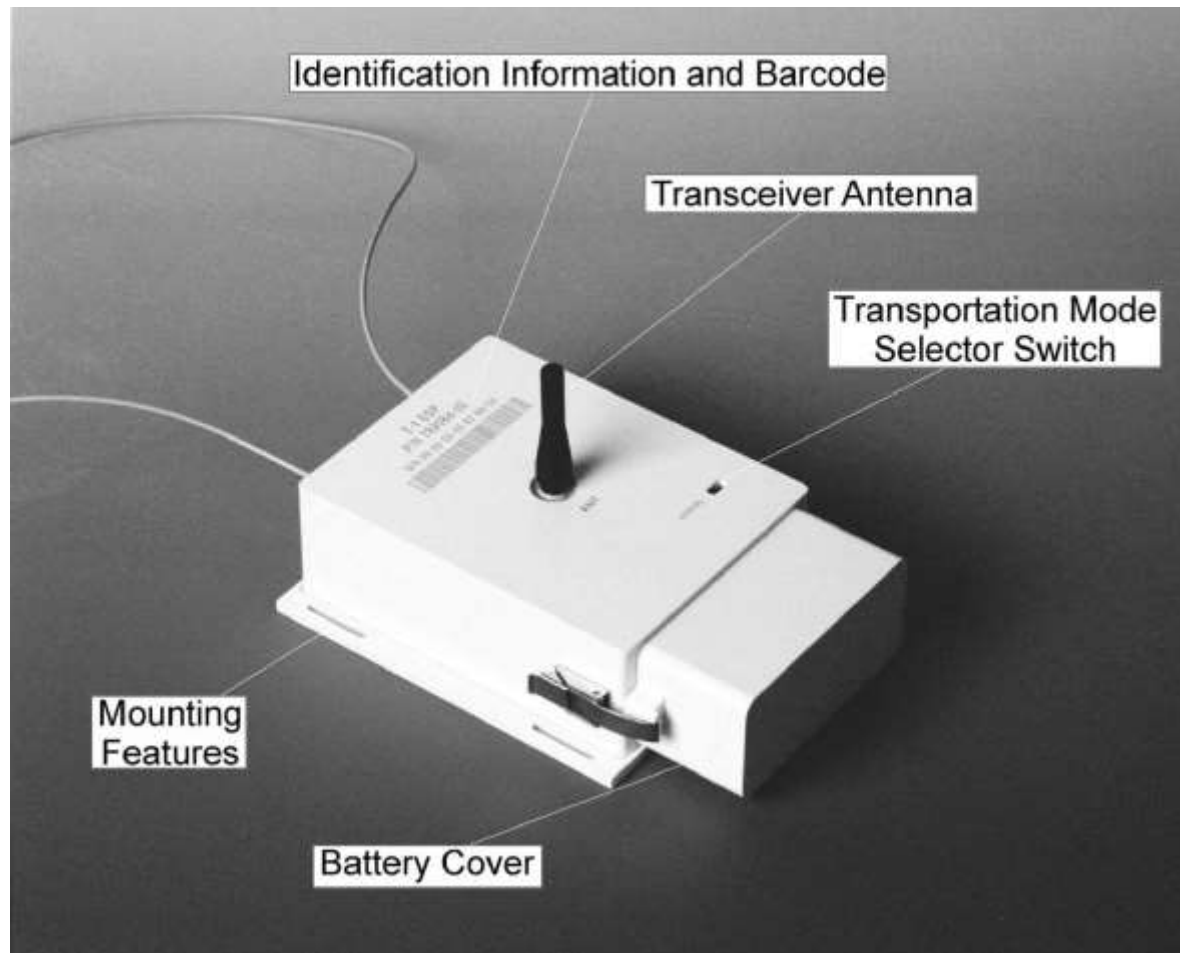
Last Transmission: 08:52:18, September 22, 2000
Last SOH: 08:52:18, September 22, 2000
Last VSOH: 08:52:04, September 22, 2000

Event Type	Sensor Description	Time	Data	Comment
SOH With Analog	SOH	09/22/2000, 08:52:18		
T1 Battery Voltage	Battery	09/22/2000, 08:52:18	3.16 V	
T1 Temperature	Temperature	09/22/2000, 08:52:18	78.80° F	
T1 Low Battery Voltage	Battery	09/22/2000, 08:52:12	229.00	
SOH With Analog	SOH	09/22/2000, 08:52:07		
T1 Battery Voltage	Battery	09/22/2000, 08:52:07	3.26 V	
T1 Temperature	Temperature	09/22/2000, 08:52:07	78.80° F	
SOH With Analog	SOH	09/22/2000, 08:52:04		

Ready SOH poll attempt success

User Interface

Current Material Control and Accountability System



T1 RFTID

Current Material Control and Accountability System



T1-A RFTID

Current Material Control and Accountability System

- **Case Tamper**
- **Seal Open**
- **Temperature**
- **Battery voltage**
- **Missing/Unknown event**
- **State of health**

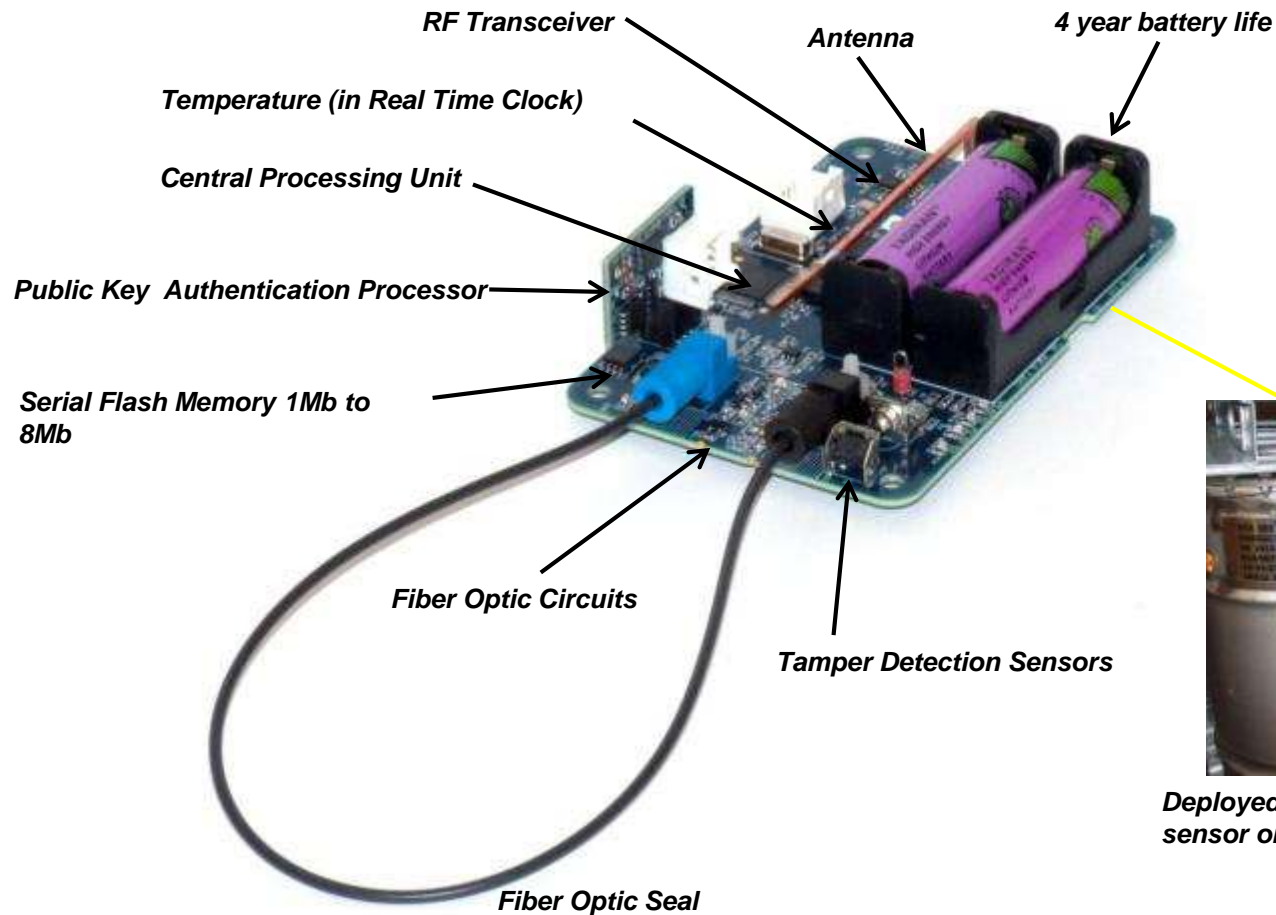
Current Material Control and Accountability System



ACTIVE TAG TAMPER INDICATING DEVICE
(Training Mock-up Shown)

Active Tag Application

Current Material Control and Accountability System



Deployed RF fiber optic seal security sensor on nuclear material containers

Anatomy of an RMSA / T1-A RFTID

Additional Systems Available or in Development



- **RF in ISM bands (902 MHz)**
 - Periodic state-of-health communication
 - Time variants (e.g., real-time, event and message counters)
 - Strict formatting for message structure
 - AES Encryption/Authentication

- **Robust**

- Affirmative protocol
- Collision mitigation utilizing clear channel assessment (CCA)
- Embedded cyclic redundancy check (CRC)
- Data whitening to increase effective sensitivity

- **Remotely Monitored Seal Array (RMSA) – Sandia National Lab**

Additional Systems Available or in Development

ARG-US RFID



- **Argonne National Lab System**
 - MK-III RFID Tags
 - ARG-US software (Laptop)
 - RFID Reader
 - Computer System
 - Development and Testing

Passive Wireless Sensor Technology “Wish List”

- Low cost <\$500
 - -40° to +85° C ambient operation
 - RF low power
 - Security (AES 128-bit encryption)
 - Authentication (AES 128-bit CMAC)
 - Store messages locally
 - Fiber optic loop (up to 50 meters)
 - Remote data collection
 - Real time clock
 - Tamper detection
 - Radiation Level Monitoring and Reporting
 - Temperature and Humidity Monitoring
- } NIST approved cryptography

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Questions?

