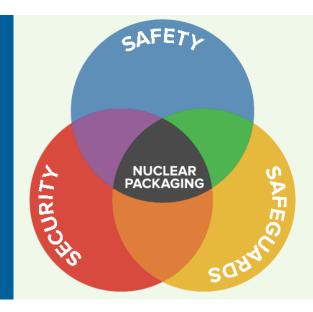


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Enhancing Safety, Security and Safeguards (3S) of Nuclear and Other Radioactive Materials



Dr. Yung Liu, Manager

Dr. James Shuler, Manager







What We Do

- Packaging Certification and life cycle management for nuclear & other radioactive materials (RAM)
- ARG-US remote monitoring systems enhancing safety security and safeguards (3S) of nuclear & other RAM

Two Platforms:

- Smart Drums
 RFID Tag/Reader
- 2. Wired and Wireless RAMM/TRAVELER































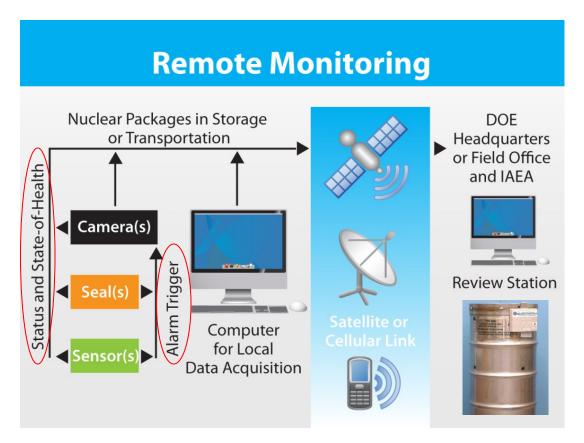
Remote Monitoring Enhancing 3S

- Materials Control & Accounting (MC&A)
- VERIFICATION



During Life Cycle, Maintain:

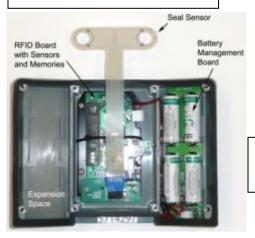
- Chain of custody (COC)
- Continuity of knowledge (COK)
- Confidentially, integrity, availability (CIA)



ARG-US RFID Surveillance Tag (433MHz)

Patented, licensed and commercially available from Evigia Systems, LLC.

Flexible Sensor Suite





Tactile Seal Sensor







Modular Design/Universal Form Factor













Tags approved as Tamper-Indicating device (TID) for 5 DOE-Certified RAM Packages

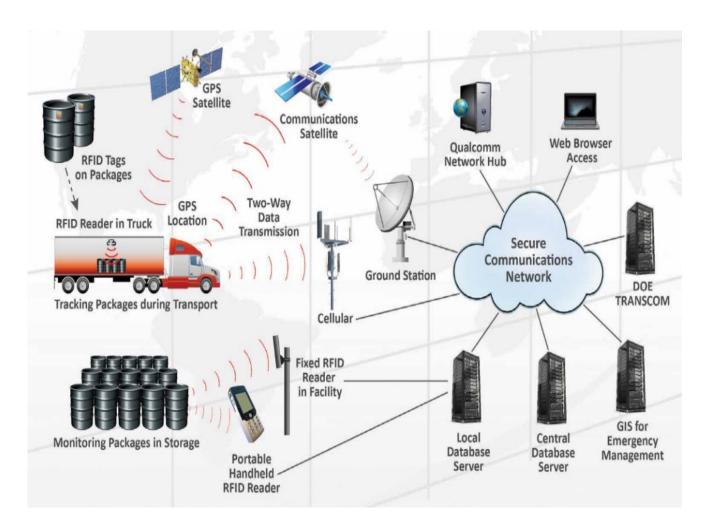
Smart Drums: RFID Tag/Reader

Reader

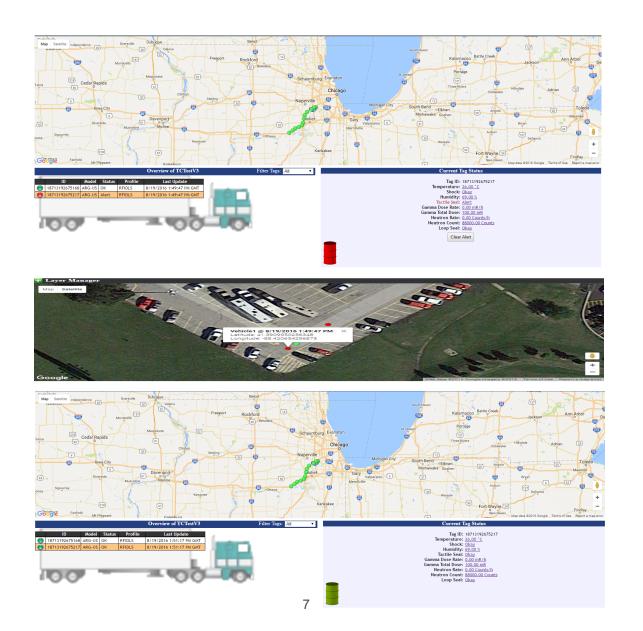


CommBox All-in-One





ARG-US Demo RFID Automatic Tactile Seal Alarm

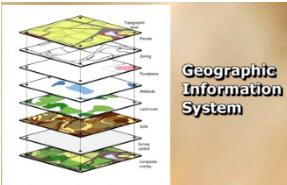


ARG-US Command Center

Information for Action

Platform/Protocol Development









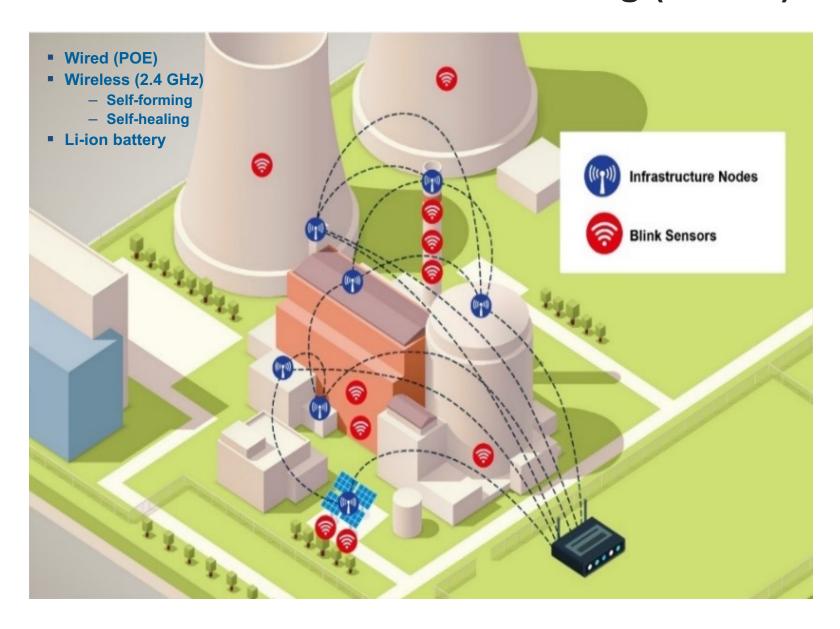
Training/Certification







Remote Area Modular Monitoring (RAMM)



ARG-US RAMM with Sensors and Digital Camera

Patented, licensed and commercially available from Evigia Systems, LLC.



Multiple Sensors

- Customized suite of sensors
- Adjustable alarm thresholds













Gamma Sensor

Neutron Sensor





Electronic Loop Seal

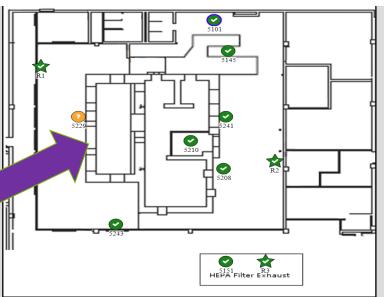
Digital Video Camera

Power Over Ethernet (POE)

Alpha-Gamma Hot Cell Facility (AGHCF)

ARG-US RFID system

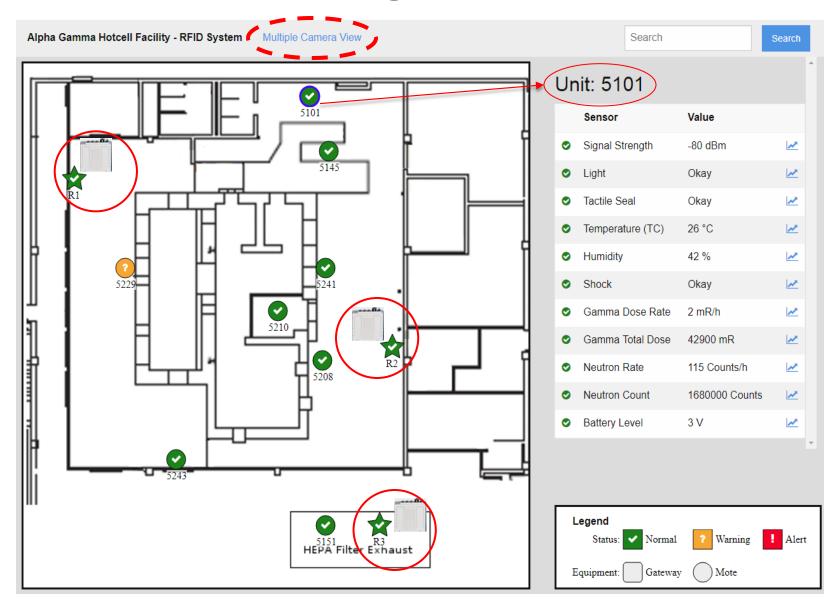




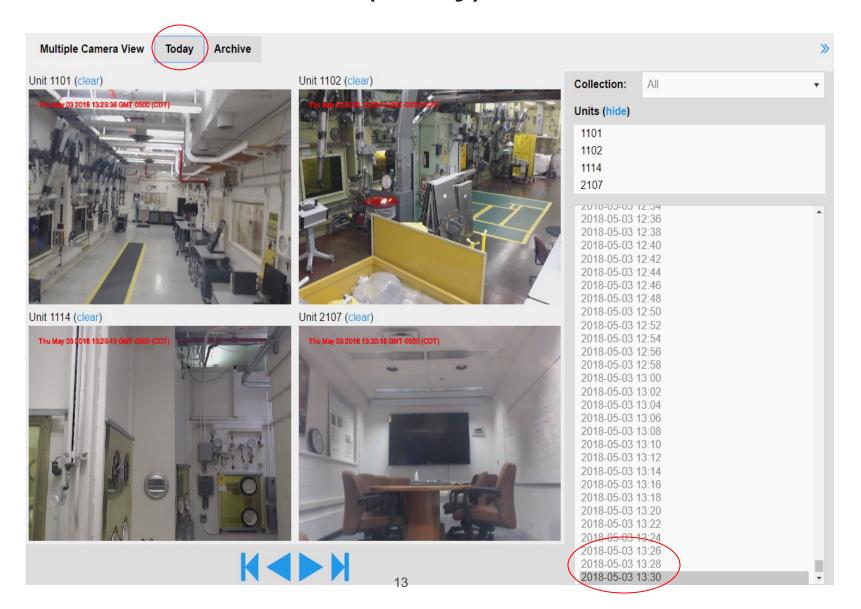


ARG-US RAMM system

ARG-US RFID Tags/Readers in AGHCF



RAMM Operational Surveillance in AGHCF (Safety)



Event Detection by RAMM in AGHCF (Security and Safeguards)

By comparing successive images for changes in pixels intensity





Wed, May 02 2018 <u>08:44:52</u> GMT-0500 (CDT)

Wed, May 02 2018 <u>08:46:52</u> GMT-0500 (CDT)

Detection of event and alarm in < 2 minutes

TRAVELER for Monitoring/Tracking Cargo Conveyance

Patented, licensed and commercially available from Embedded Planet, Inc.

Cellular/Satellite Communication

- Adjustable transmission interval
- Two-way communication



Multiple Sensors

- Customized suite of sensors
- Adjustable alarm thresholds





Temperature Sensors

3-axis Digital Accelerometer





Gamma Sensor

Neutron Sensor





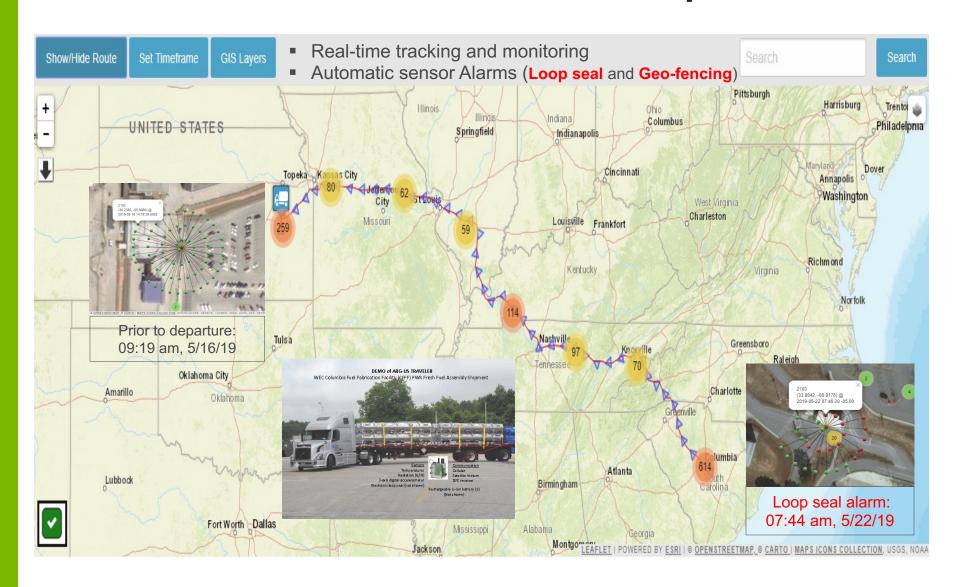
Electronic
Loop Seal

Rechargeable Li-ion Battery

TRAVELER DEMO in Rail Shipment

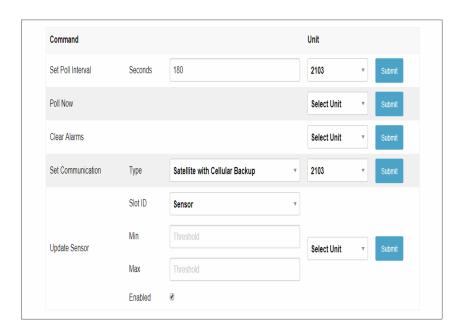


TRAVELER DEMO in Truck Shipment



TRAVELER Demo of Sensor Alarms (loop seal)

- Set sensor thresholds (Max/Min)
- Set polling interval
- Clear alarms
- Switch cellular to Iridium satellite and vice versa
- "INSTANTANEOUS" sensor alarms via cellular communication – When, Where and What
- Electronic loop seal alarm shown below





TRAVELER and Geo-fencing (GF)

- GF is a server-based program for TRAVELER that establishes a virtual geographic boundary for vehicle/truck shipment.
- GPS location and travel time defines geo-fence for a trip; constraints can be dynamically adjusted by Admin.

Zone: region of interest **Leg**: zones and window

Inclusive or Exclusive

Route: collection of leg(s)

Trip: route with start/end date and time

ARG-US	Admin Zones	Routes Notifications	Trips		Monitor Command	s Subscriptions Logout				
Monitor Trips										
Unit	Collection	Active Trip(s)	Future Trip(s)	Current Location	Communication Type	Alarm Status				
2102	2102			41.713957, -87.980540	Cellular	OK				
2103	2103	2103 at Argonne		41.715448, -87.983635	Cellular	OK				
2105	2105			41.715244, -87.982010	Satellite	OK				
2112	2112		2112 Zone Test	41.715244, -87.983584	Cellular	OK				
2113	2113			41.715449, -87.983633	Cellular	ОК				

GF Notifications/Alarms in TRAVELER DEMO



argus-notification@anl.gov

Vander Wal, Lucas

ARGUS Geofence Notification: Argonne Arrival Notification

A notification was triggered at Thu Apr 18 2019 15:02:52 GMT+0000 for unit 2103 This unit has arrived at Argonne National Lab

Notifications:

- Arrivals
 - Destination
 - Border crossing

Subject: ARGUS Alert - Unit 2103
Alarm Triggered

This is a notification for Unit 2103

Most recent position: (33.88406, -80.91757)

A new alarm has been triggered for the following sensor(c):

- Geofence (slot 25)
- Alarm time:

2019-05-22T13:17:51.000Z value: 1

- Current time:
- 2019-05-22T13:17:51.000Z value: 4

Subject: ARGUS Alert - Unit 2103 Alarm Cleared

This is a notification for Unit 2103

Most recent position: (33.88406, -80.91757)

The alarm has been cleared for the following sensor(s):

- Geofence (slot 25)
- Alarm time:

2019-05-22T13:17:51.000Z value: 1

- Current time:

2019-05-22T13:22:41.000Z value. 0

- Alarms
 - Clearance
- Subscriber list
 - SMS
 - e-mail

M---00 047 AM

Transport Security Plan (TSP) and GF (1/2)

	RAM			NM	
TSP Topic	DOT	NRC	ICAO/ IMO	NRC	INFCIRC/ 225
6. Information Management					
a. Information Security		X	X	X	Х
b. Records Retention	X	X		X	X
c. Confidentiality		Х	X	X	X
d. Protection of Information	Х	Х	X	Х	Х
7. Operational Transport Security / Physical Protection Measures	>				
 a. Primary and Alternate Routes, Intermodal Transfers, Storage in Transit, Stopping Places 	Х	Х	х	Х	Х
b. Description of Security System	Х	Х	X	Х	Х
 Equipment and Modes of Transport	<u> </u>	_x	X	Х	Х
 Operations Communications, Command and Control; 	Х	Х	Х		- * -
Shipment Tracking					
Escort, Guards and Response Force Personnel	_ X	X	Х	X	Х
 Additional Security Measures 	X	Х	X	X	X
 Maintenance and Testing of Systems and Equipment 	Х	Х	X	Х	Х
8. Emergency Response					
a. Non-tactical Emergency Response				Х	Х
b. Tactical Emergency Response				X	Х
c. Incident Communication					Х
d. Notification of Relevant Agencies					X

- RAM: Radioactive Material; NM: Nuclear Material
- DOT: U.S. Department of Transportation; NRC: U.S. Nuclear Regulatory Commission
- ICAO: International Civil Aviation Organization; IMO: International Maritime Organization
- INFCIRC/225: IAEA The Physical Protection of Nuclear Material
- X: Required/Recommended

Transport Security Plan (TSP) and GF (2/2)









■ The **GF** capability of **TRAVELER** greatly enhances implementation of **TSP** for transportation of nuclear and other radioactive material during normal operation, and <u>any of the 3S incidents requiring immediate</u> <u>emergency response</u>. (When, Where, What)

Summary and Future Work

- The remote monitoring systems described here included ARG-US RFID smart drums and RAMM/TRAVELER. Use cases have demonstrated significant enhancements of safety, security, and safeguards (3S) of nuclear and other RAM packages in nuclear fuel cycle facilities and during transportation.
- The ARG-US systems technology have been patented, licensed and are commercially available via technology transfer, with partners in industry and other research institutions.
- Future work will focus on transport emergency response, facility and environmental monitoring, information security (block-chains), sensors, and energy harvesting.

Transport Emergency Response

- GIS emergency response resources near locations of incidents
- Develop a course on Transport
 Emergency Response combining
 operational experiences and technical
 aspects on packaging, radiation
 protection, engineering controls
- Leverage technology to increase realism of scenarios for difficult operational environments and hazards not suitable for field training by using
 - Virtual Reality (VR) tools and
 - small Unmanned Aerial Systems (sUAS)







Environmental Monitoring









Questions?

Acknowledgment

This work is supported by the U.S. Department of Energy, Office of Packaging and Transportation, Office of Environmental Management under Contract No. DE-AC02-06CH11357.

https://rampac.energy.gov/home/tracking-and-monitoring



