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Disclaimer:

Phase II Vault Testing of the Argonne RFID System

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Introduction

The U.S. Department of Energy (DOE) (Environmental Management [EM], Office of Packaging and Transportation [EM-45]) Packaging and Certification Program (DOE PCP) has developed a Radio Frequency Identification (RFID) tracking and monitoring system, called ARG-US, for the management of nuclear materials packages during transportation and storage. The performance of the ARG-US RFID equipment and system has been fully tested in two demonstration projects in April 2008 and August 2009. With the strong support of DOE-SR and DOE PCP, a field testing program was completed in Savannah River Site's K-Area Material Storage (KAMS) Facility, an active Category I Plutonium Storage Facility, in 2010. As the next step (Phase II) of continued vault testing for the ARG-US system, the Savannah River Site K Area Material Storage facility has placed the ARG-US RFIDs into the 910B storage vault for operational testing. This latest version (Mark III) of the Argonne RFID system now has the capability to measure radiation dose and dose rate.

This paper will report field testing progress of the ARG-US RFID equipment in KAMS, the operability and reliability trend results associated with the applications of the system, and discuss the potential benefits in enhancing safety, security and materials accountability.

Business Summary

The purpose of this Phase II K Area test is to verify the accuracy of the radiation monitoring and proper functionality of the ARG-US RFID equipment and system under a realistic environment in the KAMS facility. Deploying the ARG-US RFID system leads to a reduced need for manned surveillance and increased inventory periods by providing real-time access to status and event history traceability, including environmental condition monitoring and radiation monitoring. The successful completion of the testing program will provide field data to support a future development and testing. This will increase Operation efficiency and cost effectiveness for vault operation.

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Facility Test Overview

Scope

The Phase II Category I Vault testing is the second field test of the ARG-US RFID system in a real storage environment. For the test, an individual test plan was written and approved for use in the facility where the test would be carried out.

The scope of this activity is short term test (January 2012-August 2012) of the Argonne Radio Frequency Identification system that is being conducted in the K Area Material Storage (KAMS) 910B vault. Twelve Mark III Radio Frequency Identification (RFID) tags were installed in the 910B vault. These RFID tags were mounted on stanchions.

Test Criteria related to performance and operability of the ARG-US System includes:

Seal Tamper Indicating Reliability

Seal Temperature Recording Indication

Seal Humidity Recording Indication

Seal Shock Sensitivity and Reliability

Radiation Monitoring

Battery Level Indication

Setup

This test was performed offline to verify the operability of the system prior to installation in the storage vault.

- Verify control computer is running and reader is responding
- Install the battery cartridge board in each tag in 910B
- Poll tags with the ARG-US Onsite software
- Verify ARG-US system identifies RFID tag
- Verify the tag clock is correct. Re-synchronize if necessary.
- Test seal open/seal closed circuit on all tags
- Enter RFID and grid location in ARG-US system
- Stage 3 RFID tags on one stanchion, per grid location
- Stage remaining RFID tags per grid location
- Confirm all tag locations on control computer
- Identify any defective tags and remove from test

Initial test

This test was performed after the initial installation of the system in the storage vault.

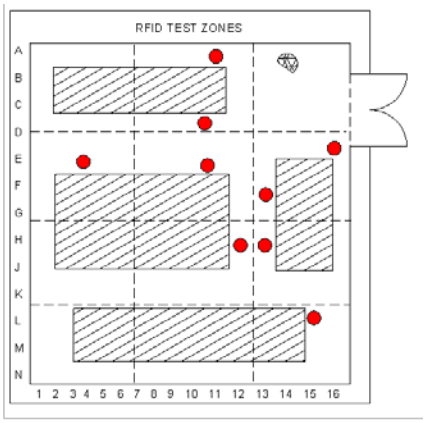
- Initiate “Collect Drums” for staged RFID tags and verify all tags are active
- ARG-US system
- Verify RFID tag data is reporting to Control computer and CIMS network
- Test seal open/seal closed circuit on all tags
- Clear any RFID tag alarms and document status

Performance test

System verification was performed each week since the system was installed in the storage vault. RFID system operation and data collection was performed each week.

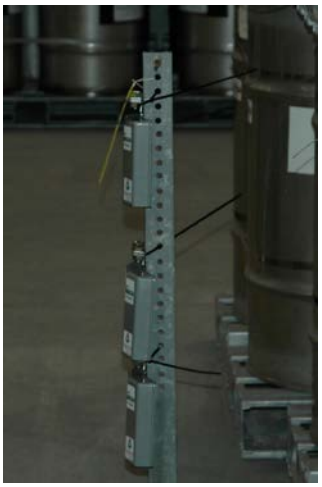
Note: The RFID unit locations were evaluated and relocated if a more desirable location was warranted for testing data. If the location changed the move was documented in the test log for records retention. System test and verification data consisted of:

- Poll tags for current field status
- Verify all tags are active
- Obtain dose rate and RFID data readings from tag
- Clear any RFID tag alarms and document status



RFID Tag Location Detail

12 ARG-US RFID units, with built in gamma dosimeters, were placed into the 910-B Storage Vault. This vault experiences high traffic of type B packages containing radioactive material during facility operation.



Typical Stanchion Mounting

Preliminary Facility Test Results

RFID tags were positioned in specified areas throughout Process Area. The test plan was specific in altering the general tag positioning each month to accumulate data for comparison related to environmental and physical conditions at time of data polling.

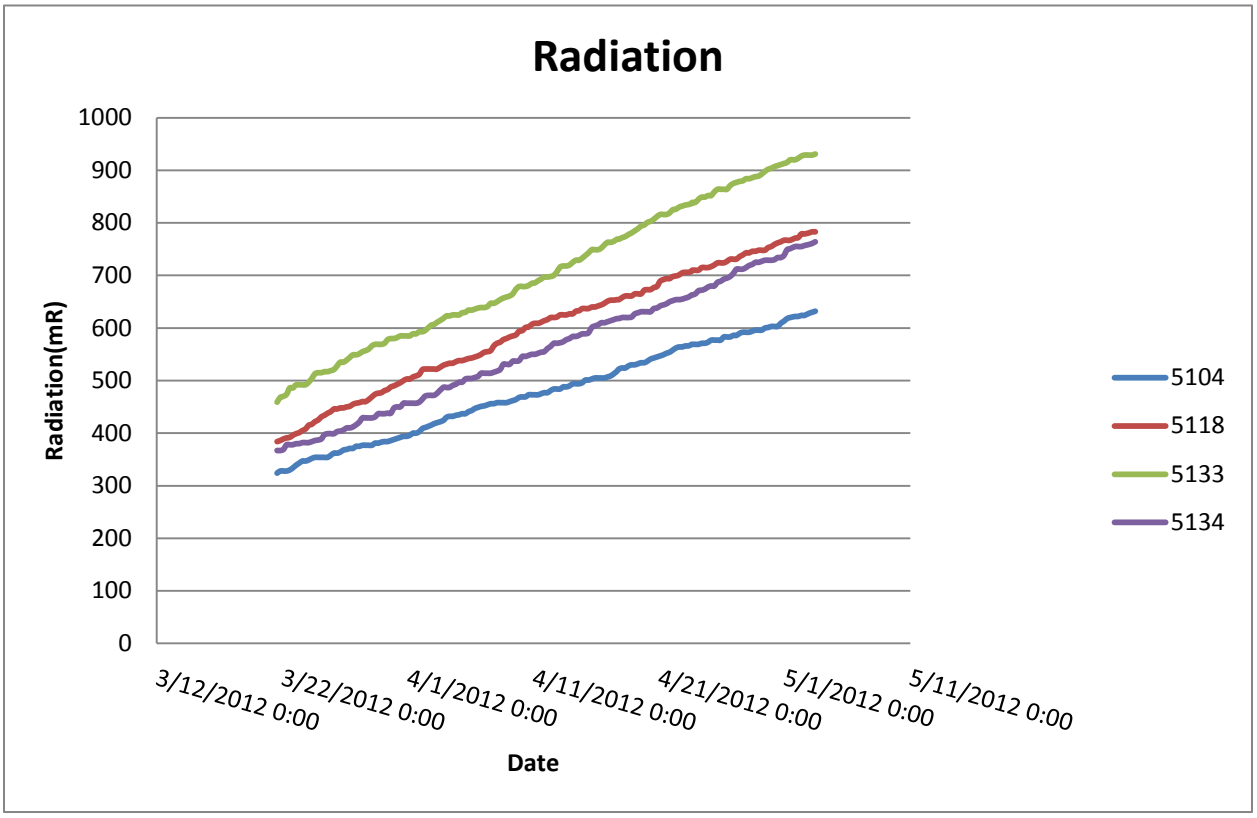
Maps and locations were recorded in the test log for use in final result analysis following the end of the testing period.

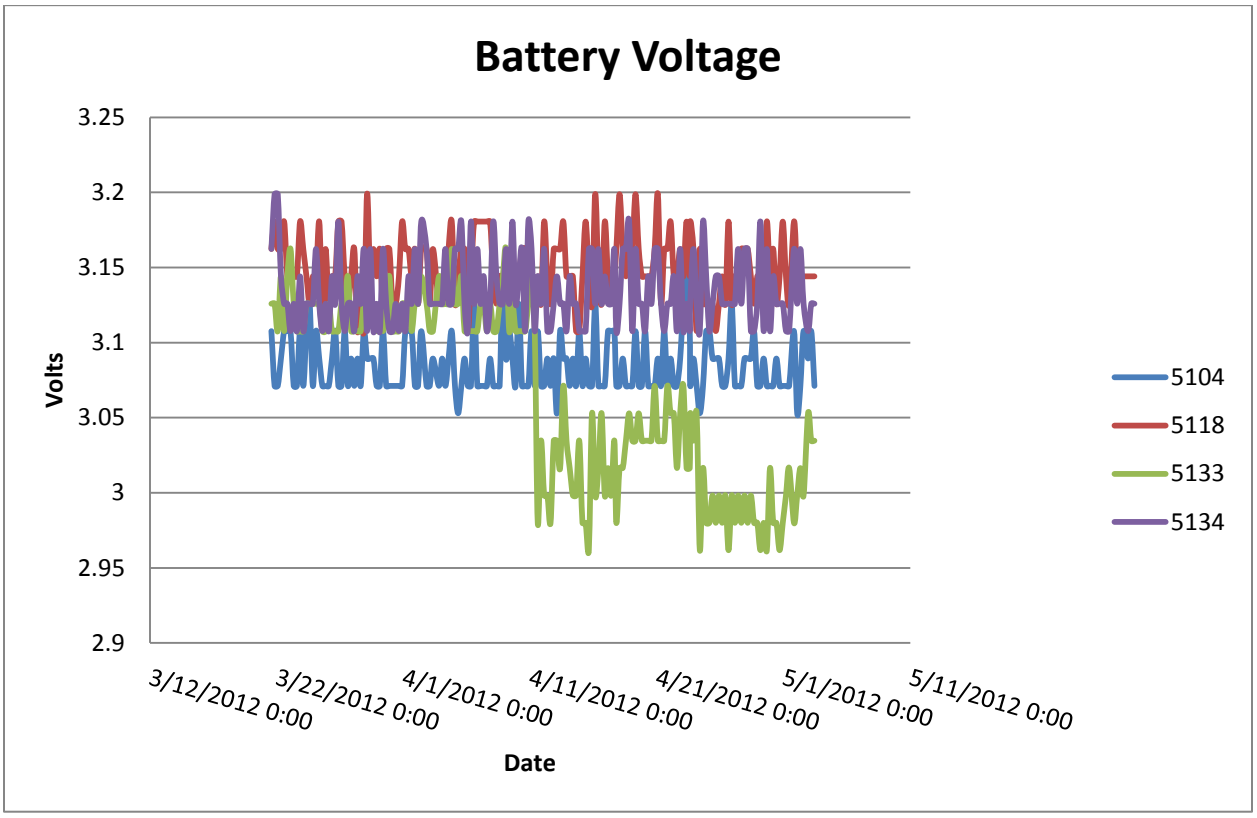
Observations and Results to date:

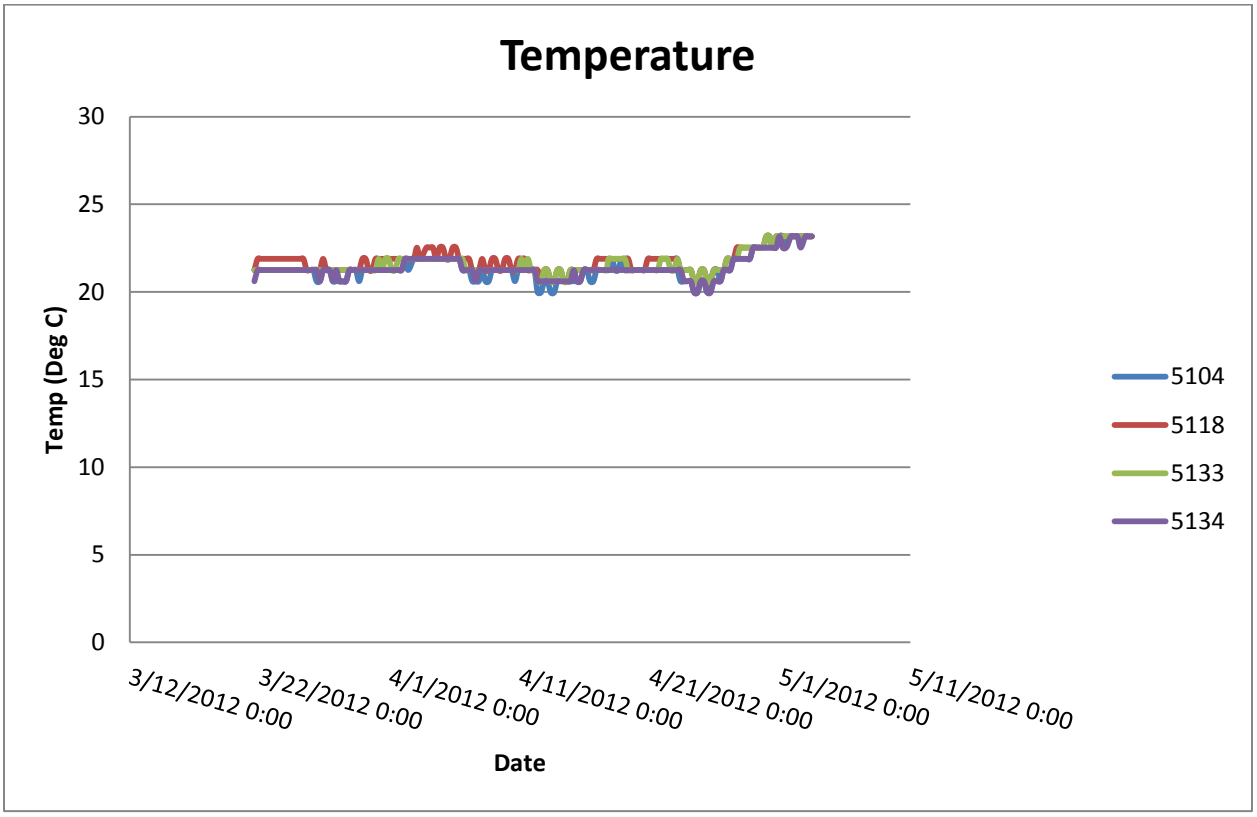
- Current field conditions have ranged from 20 deg C to 24 deg C.
- Humidity has been ~23% to 66%.
- Radiation Levels ~1mR/Hr - General Area
- The system has been relatively stable. Setup and software configuration of the ARG-US system is simple and operation is very user friendly
- RFID tags report every 34 minutes.
- Continuing to verify tamper and seal open alarms periodically.
- Initial problem with Seal open alarms. Replaced these sensors and units appear to still have a problem. Piezo-resistive sensors on approximately 1/3 of the units have been issuing false seal open alarms, but are failing in the alarm state. (Argonne is aware and working on this issue)
- Physically relocating RFID tags in field based on accessibility and noting any changes.
- Test conditions: Other than a small percentage of Seal Open indications, no unusual alarms were noted and the system has reported as designed.

During our five months of testing at the time of this paper being written, we have continued to see various trends and data which support an operable, reliable seal.

The following graphs are a sample of the data collected



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25
20
15
10
5
0
Temp (Deg C)
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3/22/2012 0:00
4/1/2012 0:00
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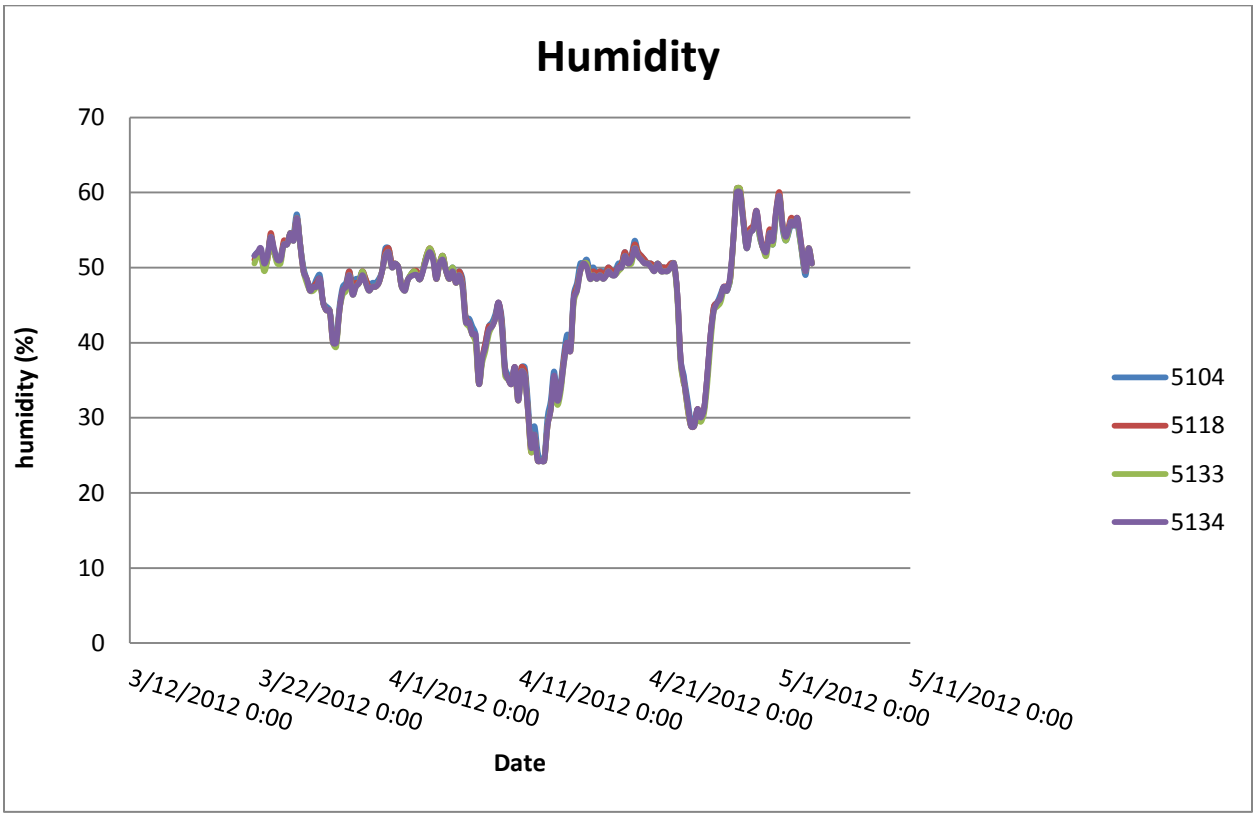
Date
5104
5118
5133
5134


Humidity
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60
50
40
30
20
10
0
humidity (%)
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3/22/2012 0:00
4/1/2012 0:00
4/11/2012 0:00
4/21/2012 0:00
5/1/2012 0:00
5/11/2012 0:00
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Remaining Test Scope

To reiterate, we are currently in the fifth month of a six-month testing program. We will continue to follow our test plan for the remainder of the test period and continue collecting data on sensor performance and system reliability. With maps and locations and relevant data recorded in the test log, we will be able to do trending and a final analysis of the results at the end of the testing period.

System Outlook

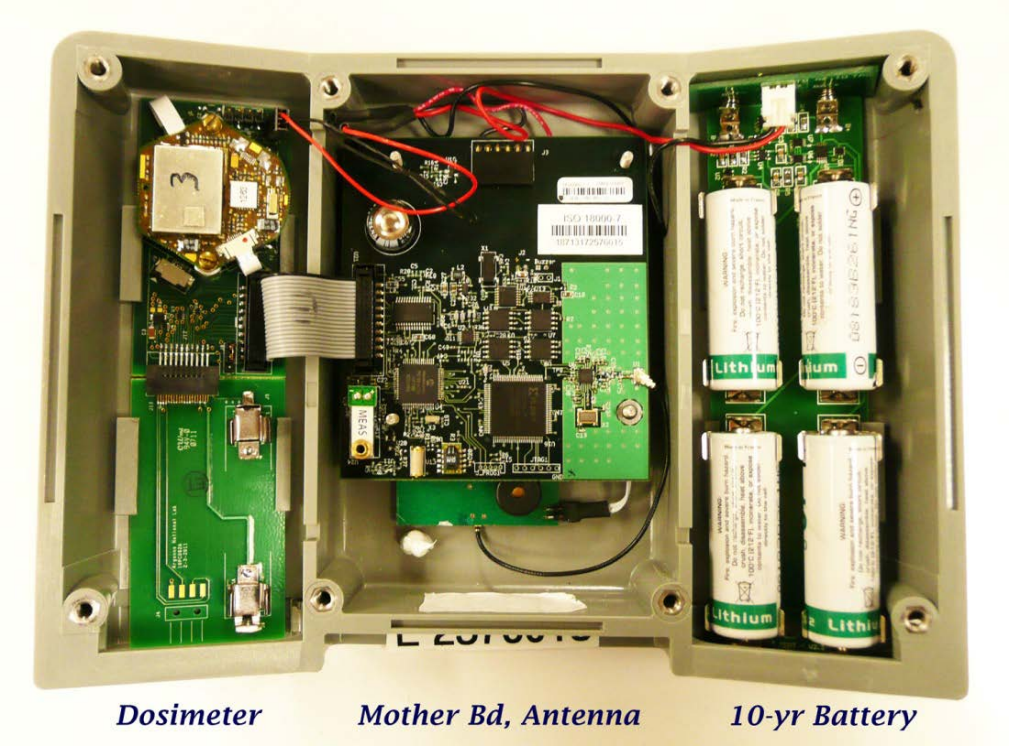
The Category I Vault testing is the second field testing attempt of ARG-US RFID system in a real storage environment at KAMS. Data collection and field testing beyond six months would extend our knowledge on sensors and system long-term reliability, which is valuable information that cannot be obtained otherwise.

Extending the leakrate testing interval of the 9975 package from annual to a maximum of five years by continuous environmental temperature monitoring can result in significant operating cost reduction, i.e., approximately $10,000 per package over 5 years. Studies have shown that the elastomer O-ring seals used in the 9975 package can perform their sealing function for many years without degradation, if the temperature of the O-ring can be kept below 93 deg C (200 deg F). The ARG-US RFID system provides a means of verifying seals on a particular package have not been subjected to temperature extremes that could degrade the O-rings. [3]

The ARG-US RFIDs have the unique feature of radiation monitoring. The units can be attached to individual drums or used as a standalone monitoring device. Gamma radiation levels can be observed remotely via the operator control station which can reduce or even eliminate the need for personnel exposure to hazardous areas. Field testing has validated accurate radiation, temperature and humidity capabilities of the RFIDs and also demonstrated the ability to remotely monitor a process environment.

The ARG-US RFID monitoring has already been approved for allowing extended maintenance for the 9977 package from one to two years. Approval for five year extended maintenance has been requested for the 9975 package based on the referenced analysis.

Safeguards and materials control and accountability is another potential area of application for the ARG-US RFID system in KAMS, if the seal integrity sensor in the RFID tag can be credited for its tamper indication function and increase the interval of periodic validation.



MK-III tag with a dosimeter carrier board incorporated in the left compartment.

References

1. *Report on a 2009 Mini-Demonstration of the ARG-US Radio frequency Identification)RFID) System in Transportation, ANL/DIS-09-06, Tsai et.al., Argonne National Laboratory*

2. *Justification of Extended Maintenance with Use of the Radio Frequency Identification System, S-SARA-G-00008, Revision 1.*

3. *Thermal Evaluation of 9975 Package O-Rings under Varying Thermal Loading and Storage Ambient Temperature Conditions for RFID Implementations, M-CLC-A-00380, Revision 0.*

4. *Report on Radio Frequency Identification 2010 Category I Vault Testing Program*