SAND2017-3822C

Sandia National Laboratories

Operated for the U.S. Department of Energy / NNSA

by

Sandia Corporation
Albuquerque, New Mexico

USE OF RFID FOR TRACKING GOVERNMENT PROPERTY - PROOF OF CONCEPT/PILOT

FY 2016-2017

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Introduction

RADIO-FREQUENCY IDENTIFICATION

Radio-frequency identification (RFID) is the wireless use of electromagnetic fields to transfer data for the purpose of automatically identifying and tracking tags attached to objects. Two-way radio transmitter-receivers (called interrogators or readers) send a signal to the RFID-equipped tag and read its response.

TYPES OF TAGS

There are three types of RFID tags; active, battery-assisted passive, or passive. An active tag has an on-board battery which periodically transmits its identification (ID) signal. A battery-assisted passive has a small battery on board that boosts the tags' signal strength and is activated when in the presence of an RFID reader. A passive tag has no battery; the tag uses the radio energy transmitted by the reader. In order to operate, a passive tag must be illuminated with a power level roughly a thousand times stronger than the signal transmission of an active tag.

> NOTE:
> RFID chips are not manufactured in the U.S.; they are manufactured predominantly in South Korea, China, and Singapore.

RFID PROOF OF CONCEPT/PILOT

Objective

Sandia National Laboratories (Sandia) was investigating tracking chemicals through the use of RFID technology. Use of RFID technology has been touted (by vendors and suppliers selling the technology) as the 'gold' standard for tracking and inventorying many items, including physical assets (property). Piggy-backing onto the chemical project, Sandia Property Management (PM) wished to test the use of this technology for tracking and inventorying government personal property at Sandia.

Piggy-backing proved beneficial to PM in a number of areas; we were able to take advantage of the fact that NNSA approval to utilize RFID readers inside Sandia had already been secured for the chemical project, and we were able to capitalize on their 'lessons-learned.'

Benefits and efficiency of the overall technology as well as potential cost savings/cost avoidance was reviewed during the course of PM's proof of concept/pilot.

RFID PROOF OF CONCEPT/PILOT

Scope

In order to evaluate and test the effectiveness of RFID technology for tracking and inventorying government personal property at Sandia, PM decided to conduct a pilot of the technology (for inventory purposes) in three property-dense areas. Due to security restrictions on active tags, Sandia used only passive tags for this pilot.

SERVER ROOMS

Computer servers present specific inventory challenges to Sandia. Barcodes are placed anywhere space is identified (back, front, sides, pull-out tabs, on top, and pancaked in racks). In most cases it's necessary to pull a server partially out of a rack in order to scan the barcode label. This is risky in that there is the potential of taking an entire system down if the server is pulled out too far. Inventory of these particular property items is very time-consuming.

Three server rooms were selected to pilot:

- Two small server rooms that included racked and stand-alone servers (less than 100 servers per room)
    - Buildings 870 and CSRI
- One semi-large server room with racked servers (300-500 servers)
    - Building 899

OFFICE/WAREHOUSE

In order to evaluate the technology thoroughly for various types of property, PM wanted to test in a building representative of Sandia's general property population. An office and warehouse area is representative of this type of area. Building 957 at Sandia contains both office and warehouse environments and is representative of Sandia's general property population with a higher percentage of attractive property (87%) than equipment (13%). The attractive population contained a cross-cut of attractive property tracked at Sandia with a distribution of desktop and laptop computers, mobile assets (iPads, smart phones), cameras, radios, and projectors. The equipment population contained warehouse-type equipment (box making machines, forklifts and packing equipment, for example).

RFID PROOF OF CONCEPT/PILOT

SCIENTIFIC LABORATORY

Another common area at Sandia is the scientific laboratory environment. These areas contain multiple types of equipment and represent high possibility for interference and hindrance when performing a property inventory with RFID readers. PM wanted to test how RFID technology would work in an environment with functioning laboratory equipment. A chemical laboratory with a variety of lab equipment and computers being used in active tests was selected for this pilot. PM was curious to learn what, if any kind of overlap and/or interference with chemical RFID tags would be observed as well as any interference with on-going/active tests.

NOTE:

RFID reader signals have the potential to interfere with or jeopardize on-going tests being performed in a laboratory. This was not something specifically tested during this pilot, but interference caused by the RFID readers was not observed in any of the pilots conducted.

RFID PROOF OF CONCEPT/PILOT

Considerations

SECURITY RISKS ADDRESSED

- Prior to start of the pilot PM ensured that all security risks associated with tags, readers and areas to pilot had been addressed
    - Chemical pilot had ensured that approval had been granted to use passive technology
    - Secure rooms (SCIFS) were not be used for any pilot
    - If any group objected to the pilot in their area another area would be sought

APPROVAL TO PILOT IN DEFINED AREAS

- Met with each server room and laboratory owner
    - Reviewed overarching project plan and equipment to be used
    - Described types of tags to be used and placement
    - Reviewed inventory scenarios/passes/data collection
    - Determined amount of time needed to complete
    - Obtained their agreement to pilot in their specific areas
    - Scheduled the pilot

GOALS

- Take the 'read' (scan) down to the room level
    - The property management industry believes it is important to be able to scan property to the building and room level in order to adequately manage and track property
- Achieve greater than 76% inventory of property on first pass
    - This is the score achieved during first pass of a wall-to-wall inventory with minimal resources
- Place RFID tags on property based on current tagging practices

COST/RESOURCES

- Ensure that adequate time, money, and resources were available in order to perform and analyze pilot results

Equipment

READER DECISION

Readers had been purchased for the chemical project and authorized (by NNSA) for operation within all Sandia limited areas. PM made the decision to use the same reader.

The model of reader used in the pilot was a Motorola MC3190-Z RFID; this reader is advertised to be the lightest UHF RFID rugged handheld reader on the market at 22.93 ounces, and had a scanner feature able to read 1d barcodes.

TAG DECISION

Considering the pilot scope PM researched RFID tag technology to determine the best possible type of tags to be used for the pilot. Due to security concerns, active tags were not a viable option for use in the pilot; therefore, only passive tags were researched. Tag attributes considered were physical (dimension and weight), electrical (frequency, antenna platform, memory, read range), environmental (operating temperature, UV resistance, durability), and other (tag programming, chip country of origin). Based on the completed research the desired criteria used by PM to determine which types of tags to test included:

- If fully deployed, would prefer one type of tag to use versus multiple
- No larger than current barcode labels
- 1d barcode and required labeling be printed on visible face, or vendor must be able to provide a combination of 1d labels and an associated RFID tag (for 'button' tags)
- Flexible or small enough (in case a second tag must be used) to affix to rounded surfaces ~45 degrees or less
- No more than 5mm thick
- Read range between 4-12'
- Average life of tag 10+ years
- Chip manufactured in non-sensitive country

TAGS TESTED

PM chose three different tags to test:

- Omni-ID FIT 210
  - Low profile, small form factor durable RFID tag
  - Designed as a metal embedded RFID tag with a high IP rating that makes it suitable for rugged environments and metal tool integration

  - Max read distance up to 9.8'
  - Hard tag optimized for metal substrates
  - Dimensions = 2.22 x 0.20 x 0.05"
- Zebra Confidex Silverline Micro
  - Small all-surface RFID label applications with industry leading printing capabilities
  - Label can be attached on a curved surface in any orientation
  - Flexible, high performance acrylic adhesive optimized for metal and painted surfaces
  - Read range on metal up to 4', on plastic up to 3'
  - Dimensions = 2.17 x .055 x 0.03"
- MPI Label Systems flag tags
  - Multiple surfaces and materials
  - Well suited for tracking liquids and chemicals
  - Flexible
  - Read range between 2-10'
  - Dimensions = 1.9 x 3" (folds to 1.9 x 1.5"; printed portion of the label is approximately 1.9 x 0.75")

Pre-pilot Preparation

DEVELOP PILOT INVENTORY SCENARIOS

PM developed specific inventory scenarios and defined inventory passes to be used in all pilot areas. PM was interested in testing how well RFID tags were read when attached to items inside cabinets or drawers. To test, two scenarios were defined for each area; Scenario 1: All doors and drawers open and Scenario 2: All doors and drawers closed.

PM determined that three different passes were needed to determine under what circumstances and how well the different RFID tags would perform. The first pass would be considered the best case possible, where a Property Coordinator (PC) or other individual performing the inventory would walk into a room, stand in a central location, and be able to read most of the tags assigned to the property. The second pass represents the more realistic case where a PC (or other individual) would walk through the room and be able to read most of the tags. The third pass is similar to Sandia's current inventory methodology of line-of-sight. The following passes defined in the test plan were used for each area:

- Statue of Liberty – the inventory taker would walk to the center of the room, hold the reader high and 'read' for 60 seconds, stop, and exit the room
- Casual Stroll – the inventory taker would make one complete pass through the room, walking the perimeter and then up and down each isle once, then exit the room
- Line-of-sight – the inventory taker would make a slow complete pass over each server in each rack, and do the same for each property item outside of racks, passing the reader over each property item. During the first pilot test in Building 870, PM realized that a more focused line-of-sight was needed. Line-of-sight was modified so that the inventory taker would attempt to locate the individual RFID tag on each property item and pass the reader over the tag.

Each pass was conducted using three hand-held readers, each set to a different power setting for signal strength; low, medium and maximum. A read distance of 3' to 5' was desired, and PM wanted to ensure that reads could be taken down to the room level for inventory purposes. Using three different power levels would determine if any bleed over tag reads from adjacent rooms or cubes would occur and at what power level setting.

RFID PROOF OF CONCEPT/PILOT

CREATE AN INVENTORY POINT-IN-TIME (PIT) AND PREP READERS

A controlled sample in each environment was necessary to ensure PM could compare the results of each. During creation of the PIT, quality checks were performed to ensure that accurate associations were created and locations of tags were documented for statistical analysis of the results. PM completed the following steps for property in each pilot area.

- An RFID tag was assigned (and affixed) to each property item and an association between the RFID tag number and the Sandia barcode number currently assigned to the item was created in order to create an inventory baseline for each pilot room. This was completed through the RFID reader by scanning the Sandia barcode and then reading the RFID signal from the RFID tag to be assigned to the property.
- Using two-person teams, tagging personnel worked with a partner who verified Sandia barcode and RFID tag information was correct by recording the Sandia property barcode and RFID tag number manually on a log sheet
- Once each property item had an RFID tag affixed to it, an inventory PIT baseline was created by downloading the reader data to a laptop and importing each file into a database. Information captured in the baseline included Sandia barcode number and the associated RFID tag number, and total number of items tagged with RFID tags.
- PIT baseline item counts were verified against data from log sheets used by individuals tagging the property to ensure a match between data sets
- Immediately prior to conducting the pilot inventory in each area, readers were prepped by setting the signal strength (low, medium, maximum) and then setting the scenario and pass
- Once an inventory was completed, PM removed all RFID tags from property included in the baseline

Conducting the Pilot Inventories

SERVER ROOM – BUILDING 870

- A total of 22 items (servers, desktops, laptops) were tagged with RFID tags in Building 870 using a mix of Zebra and Omni tags
- Item were tagged as a server would normally be tagged (top, back sides, some pancaked)
- There were no doors on the servers in Building 870 rendering Scenario 2 moot
- Electrical disturbance was noted during the Building 870 inventory
- Due to poor performance (lack of acceptable results) after three passes, PM made a decision to do an additional modified line-of-site pass. This modification consisted of locating the individual RFID tag on each item and passing the reader over the tag with the reader set to maximum power.
- Results
    - Statue of Liberty resulted in only one read (4.5%) using the reader set to maximum power
    - Casual stroll was ineffective for reader set to low and medium power but resulted in 0 reads even for the maximum power reader
    - Original line-of-sight pass resulted in 14 unique tags being read (63.6%), most of which were on maximum power settings. While this produced some improvement from the casual stroll it did not return expected results.
    - The forth line-of-sight pass was the most effective resulting in 18 tags being read on the maximum power reader for a total of 81.8%. This result was achieved, however, by slowly passing the reader closely (within inches) over each tag, essentially duplicating how property coordinators currently conduct inventory using non-RFID scanners.
    - Out of the 22 tags affixed, 4 (18%) were not read in any of the sweeps

NOTE:
The modified line-of-sight version was used in all remaining pilots.

SERVER ROOM – BUILDING CSRI

- A total of 49 items were tagged with RFID tags in the CSRI. All items were tagged with the Zebra tags and were tagged as a server would normally be tagged (top, back, sides, some pancaked).
- Results were similar to Building 870
    - Statue of Liberty resulted in only two reads; one on medium power (2%) and one on maximum power (2%)

- Casual stroll was ineffective for all readers; only three tags (6%) were read (medium/maximum power)
- Line-of-sight resulted in 39 tags being read on the maximum power reader, resulting in a 79.6% inventory. Again, this result was achieved by slowly passing the reader closely over each tag.
- Out of the 49 tags affixed, 10 (20%) were not read in any of the sweeps

SERVER ROOM – BUILDING 899

PM ran into an issue in Building 899. Although prior permission by the server owner had been given, the server owner and the room owner were separate individuals. The room owner was not comfortable with the pilot and upon consulting with his management, asked PM to leave. Once concerns (security concerns, concerns regarding the readers and tags) were eliminated, PM was allowed to return and complete the pilot.

- A total of 493 servers were tagged with RFID tags in Building 899 using a mix of Zebra and Omni tags
- Servers were tagged differently in this room due to the use of blade servers and their configuration in racks. PM tagged the servers anywhere space could be found on the front of the server.
  - Non-traditional tagging due to surface space and inability to pull servers out and tag them as they would be tagged in reality
- Based on results of previous pilot tests PM made some adjustments
  - Stopped using low power
  - Enabled one of the readers to use a software-enabled read versus using the manual trigger pull. The software enhancement built into the reader produced a continuous read signal until manually stopped, whereas the manual trigger pull relied on an individual holding the trigger down throughout the read. The trigger pull would occasionally time-out after a period of time and have to be re-engaged by the individual taking the inventory.
- Results were different than other two pilot areas
  - Statue of liberty resulted in zero reads
  - Casual stroll results increased, but were still ineffective; (19 tags, 3.85% and 40 tags, 8.11% for maximum power trigger reader and maximum power software-enabled read respectively.) Medium power resulted in zero reads.
  - Line-of-sight once again yielded the best results, 238 tags, 48.27% (medium power), 451 tags, 91.48% (maximum power trigger reader), and 463 tags, 93.9% (maximum power software-enabled read.) These results were excellent, however, the caveat is that the servers were tagged on the front due to the inability to pull them out and tag them appropriately.
  - Out of the 493 tags affixed, 10 (2%) were not read in any of the sweeps

RFID PROOF OF CONCEPT/PILOT

OFFICE/WAREHOUSE – BUILDING 957

Items included in the pilot area were general property; computers, warehouse equipment, cameras, projectors and the like.

- A total of 99 items were tagged with RFID tags. MPI Label System flag tags were predominantly used with a few Zebra and Omni tags tossed into the mix
- Based on results of previous pilot tests, PM made some adjustments
    - Only two readers were used for this pilot; one using medium power and one set to maximum power and using the software-enabled read (versus trigger read)
    - PM used the one reader on medium power to test for 'bleed-over' between office cubicles
    - Because of previous ineffectiveness and the size of different areas in the building, PM did not use the statue of liberty pass in this building
- Results for Building 957
    - Casual stroll resulted in a 32 tags, 32% read rate for the maximum power software-enabled reader, and 3 tags, 3% for medium power reader
    - Line-of-sight again resulted in the best reads, 73 tags, 74% (medium power), 81 tags, 82% (maximum power, software-enabled)
    - Out of the 99 tags affixed, 16 (16%) were not read in any of the sweeps

SCIENTIFIC LABORATORY – BUILDING 823

General laboratory equipment was tagged in this laboratory. In order to increase the PIT count, other items that would not normally be included in Sandia's trackable property population were also tagged with RFID tags.

PM used a slightly different methodology in this pilot area due to lessons learned in the previous pilots. During the other inventory pilots PM staff was involved in tagging and creating the PIT as well as conducting the inventory passes. In order to simulate 'real-world situation' inventory, two PM staff members tagged the property in the laboratory and a third individual conducted the inventory. This emulates a true inventory situation where individual employees not familiar with what property is tagged and where it is tagged conduct the inventory walk-through.

The other unique element to this pilot area was a massive amount of chemicals that had been tagged with chemical MPI Label System flag-tags as part of the chemical RFID initiative. A large number of these tags were read during the inventory, and while this presented no particular interference, PM had to filter the chemical tag reads from the property tag reads in order to calculate results.

RFID PROOF OF CONCEPT/PILOT

- A total of 49 items were tagged with RFID tags. A total of five Omni tags were used and the other items were tagged with Zebra tags.
- One individual was conducting the inventory using one reader maximum power and software-enabled read
- Pilot results for Building 823:
    - Statue of liberty resulted in zero reads
    - Casual stroll resulted in 15 tags, 30.6%
    - Line-of-sight resulted in 30 tags, 61.2%
    - Out of the 49 tags affixed, 16 (33%) were never read in any of the sweeps

A significant amount of chemical tag reads were picked up by the PM individual conducting the inventory. PM could not identify any apparent interference associated with reads of co-mingled chemical tags and PM tags.

The significance of this inventory was the score achieved by someone who walked into the room not knowing where property tags were placed or what items were tagged. Very significant 'real-world' inventory simulation.

RFID PROOF OF CONCEPT/PILOT

Key Outcomes

IDENTIFIED STRENGTHS

There are multiple read capabilities using the RFID reader; it will read a 1d (typical industry standard) barcode as well as an RFID signal.

The software-enabled 'read' switch worked significantly better and was much less awkward than using the reader's trigger to read the RFID signal.

RFID tag availability is good; there is a wide variety of brands and types to choose from.

Flag tags read very well; however, PM found that environment was a key factor with flag tag reads. In a condensed environment (like a laboratory) they read very well; however, in an environment (similar to a warehouse or office) where they were spread out, they did not read as well.

IDENTIFIED WEAKNESSES

RFID tag chips are foreign manufactured, some from sensitive countries such as China.

A high inventory rate for servers was only achieved through tagging in a non-traditional manner (front).

Electronics can interfere with reading of tags, and tags are susceptible to EM (electromagnetic) damage potentially produced in laboratories and other areas here at Sandia.

Flag tags were difficult to fold and apply, they didn't adhere well to property and they wore easily. An example is a tag that was on a camera and had worn down to the antenna due to the camera being taken in and out of a camera case. From a property tracking standpoint, these are impractical to use.

Significant manual manipulation of the reader had to be used in order to get a signal read from individual tags. This is due to the fact that the readers do not produce a strong enough linear signal to avoid the need to angle the scanner in such a way to get a read from the tag. The scanners are bulky and heavy; this along with the manual gyrations needed to get a signal read could prove to be a future ergonomic issue.

Reader battery life for the software-enhanced read feature put a large strain on the battery, cutting the battery life in half compared to a scanner utilizing the manual trigger.

RFID PROOF OF CONCEPT/PILOT

One tag will not work for every asset in Sandia's population. Tags are designed for specific surfaces; i.e., metal, and did not perform well when placed on a different surface. Going forward, multiple tags would have to be purchased and used depending on the type of property to be tracked which adds complexity to the tagging process. Training taggers (including JIT vendors) which tag to use for which property type would be challenging.

Readers are not approved for all areas (SCIFs, VTRs, for example) and people are uncomfortable with emerging technology in a secure government environment. Based on this, different types of inventory methodologies would have to be conducted and multiple types of hardware/software purchased and maintained.

Use of RFID tags will have little positive effect during a statistical sample inventory when looking for specific individual items. RFID tag usage would likely add complexity to the programming and process due to non-RFID tag usage for existing property, and reads of non-property issued RFID tags would need to be mitigated during an inventory.

RFID tags will have little benefit during a wall-to-wall inventory as well because individuals performing the inventory would still be required to get within inches of the tags to get a read (no difference in how inventory is currently conducted.)

RFID tags are more expensive than traditional tags, and the better-performing tags are much larger and much thicker than traditional barcodes making them potentially difficult to use.

Tag obstruction is an issue; tags are much less likely to be detected and the same amount of rigor used for non-RFID tags will have to be used to locate these items.

There is not a way to determine when an RFID tag is no longer viable, making it difficult to trouble-shoot issues.

LESSONS-LEARNED

- Size matters – larger tags offer better signal strength
- Using the manual trigger on the reader does not perform as well as the software-enabled read.
- The signal repeat was slower using the manual trigger which caused it to periodically time-out
- Surface space of equipment needs to be considered when selecting tags

RFID PROOF OF CONCEPT/PILOT

- Piloting larger sample sizes will give you a clearer picture of the tags' performance in a given environment
- Attention to detail is paramount when collecting data; must ensure that you are collecting all data elements needed to understand your results
- 'Low' power read on a reader was ineffective; medium was not much better; maximum power was the most effective. However, 'bleed-over' might result in office cubes if larger tags or readers with stronger signal strength are used
- PM should have involved Sandia statistical science staff at the beginning of the pilot

Cost Data

PILOT COSTS

Labor

- Pilot Leads = 240 hours total time which includes pre-work, benchmarking, programming, development, meeting, pilot testing, analysis, and documentation (presentation & proof of concept) = $32,481.60
- Pilot Testing participants (excluding pilot leads); there were a total of nine individuals who participated in three different pilot tests; total cost = $8,255.74

Total labor cost = **$40,737.34**

Programming = **$4,812.50** (38.5 hours)

Reader Cost = **$5,176.80** ($2,588.40 x 2)

Supplies (tags)

- Omni tags = $629 (for 100 tags = $6.29 each)
- Zebra = $574.81 (for 1000 tags = $.58 each)
- MPI Flag tags were printed by Chemical Folks and provided to us no charge

Total supplies (tags) cost = **$1,203.81**

Note: Neither Omni nor Zebra tags came pre-programmed with identifiers. The cost for programming is included in overall programming costs.

Statistical Analysis cost = **$1,071**

Total pilot cost = **$53,001.45**

**Average loaded labor band = $135.34/hour. This figure was based on the cost used in FY15/FY16's Cost to Inventory activity.

RFID PROOF OF CONCEPT/PILOT

Participants and Partnering

Many individuals across multiple organizations both inside and outside of Sandia were a part of this pilot. They include:

- Sandia Property Management Inventory Team
- Chemical inventory team
- Sandia server room and lab room owners
- Sandia Statistical Science staff
- Honeywell
- Department of Energy (DOE)
- Office of Secure Transportation (OST)
- MetalCraft

Statistical Analysis

CONCLUSION

Statistical analysis of the data collected during the pilot found that if a lower level of inventory performance is acceptable RFID scanning might be a viable option. However; the overarching results of the pilot did not provide evidence that line of sight RFID scanning at max power can achieve the goal of at least 76%.

RFID PROOF OF CONCEPT/PILOT

Summary

The objective of the pilot was to test the use of RFID technology for tracking government personal property at Sandia with the goal of increasing efficiencies (achieving greater than 76% inventory on first pass) which is the current average of scanning property during phase one of a wall-to-wall inventory.

The technology was tested in three of the most common environments at Sandia; these included server rooms, common office areas and laboratory areas.

Research was completed in order to determine which type of tags would likely produce the most beneficial results. Readers were predetermined based off NNSA approval for use. In order to have controlled testing in all three environments, very specific inventory scenarios were developed and utilized.

Modifications were made during the course of the testing in an attempt to improve results. These modifications were based on observations noted during the course of the pilot tests.

Tag placement was found to be a key component for positive reads. Any obstruction resulted in lower read results overall. In all instances, line-of-sight approach (locating the barcode on each item) was necessary to achieve greater than 76% results. Highest score achieved was 93.9% in Building 899 and lowest was 61.2% in Building 823. It is important to note that while the results in Building 899 were excellent, the servers were tagged on the front due to the inability to pull them out and tag them appropriately. Tag placement in the real world would not be placed as such and these results would not be achieved in real application. It is our opinion that the Building 823 score of 61.2% would be an accurate representation of an inventory being conducted by a Property Coordinator or other individual unfamiliar with tag placement.

RFID is still an emerging technology and while it has some identified strengths, weaknesses that have yet to be overcome by the industry makes this technology no more efficient than Sandia's current property tracking methodology.

Line-of-sight is the current methodology used by Sandia when performing physical inventories with 1d barcodes. Based on the pilot results and other observations (in order to read an RFID tag, the reader had to be within inches of the tag the same as 1d barcodes) the same amount of effort currently being expended during an inventory would still be necessary even with full implementation of RFID technology, leading to

little efficiencies or cost savings to the laboratory. In addition, use of RFID tags will have little to no positive effect during a statistical sample inventory when looking for specific individual items and would likely add complexity to the programming and process.

Sandia is held to high inventory standards and goals of greater than 99% inventory find rates. In order to achieve this goal we must be able to reconcile our inventory within a specific inventory time-frame. During a 100% inventory we must continue to search for items not located during the initial inventory pass. Statistical analysis shows that we are not likely to locate even 75% of our property during an initial pass utilizing RFID. This means that we will be searching for more items after an initial pass using RFID technology then we currently have to search for using our current methodology.

Inventory scores are a critical component for maintaining property system approval. We are unlikely to reach our inventory goal of 99% using RFID technology due to failure of RFID antennas, potential electrical interference, and damaged or destroyed tags.

It is our recommendation that Sandia Property Management continue to study the technology in anticipation of chip advancements leading to stronger signals with smaller tag sizes.

RFID PROOF OF CONCEPT/PILOT

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