PNNL RFID White Paper

Integral RFID / RFID White Paper / Version: 1.0

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Introduction

PNNL are investigating the use of Radio Frequency Identification (RFID) technologies to assist in the tracking of chemicals and samples around the site. To this aim a new RFID laboratory has been established, equipped with state-of-the-art, commercial RFID systems for test and evaluation.

The following document describes this new laboratory and the ongoing research taking place. It is split into two major sections:

The first section describes the RFID laboratory established at PNNL, including its capabilities, and the results from initial testing at this site.

The second section discusses the use of RFID throughout the PNNL campus for chemical and sample tracking. This discussion is based on requirements of the PNNL tracking systems and the preliminary results from the RFID evaluation laboratory. It is deemed a realistic evaluation of how RFID can be utilized now, and in the future to assist PNNL.

RFID Background

RFID systems are available in their multitude, offering differing capabilities, costs and use scenarios. However the majority of RFID systems can be classified as either Passive or Active.

Passive tags are simple devices that have no onboard power. They obtain their working current via radio signals broadcast from an interrogating device known as a reader, and use this power to reflect back data contained within the tag to the same reader. This approach allows the tags to be small and low-cost, pushing much of the electronics into the reading device. However the downside of this approach is that the tag can only be 'read' when interrogated by a reader, and while within a limited range from the reader.

Active tags are more complex devices that rely on their own power source, typically a battery. This on-board power allows the tag to transmit its data without requiring activation from an interrogator. This in turn gives rise to a substantially longer read-range than their passive counterparts, but at the expense of size and cost per tag.

RFID systems can also be characterized by the frequency they operate at. The three most common RFID systems are:

- Passive tags operating at 13.56Mhz - also known as high frequency (HF) tags
- Passive tags operating at 915Mhz - also known as ultra-high frequency (UHF) tags
- Active tags operating at 433Mhz

In addition to the mode of operation (passive or active), the frequency is also a major factor in how well the RFID system works in different environments. Radio waves typically penetrate through objects, which is why RFID is so useful: tags can be 'read' even though they are not visible to the naked eye. However some objects are opaque to radio waves at certain frequencies. For example, water is opaque to most systems operating at ultra-high frequencies, but not so for high-frequency systems. Alternatively, UHF systems operate at a much larger read range than HF systems when not involving water.

Choosing which RFID system to use can be a complicated task, as each technology has its pros and cons. The following table highlights the key factors used to select an RFID system:

	HF Passive (13.56 MHz)	UHF Passive (915 MHz)	Active (433 MHz)
Size	~ 1" x 1" on flexible paper	~ 4" x 1" on flexible paper	~ 3" x 2" x 1"
Cost	~$0.50 per tag (in volume)	~$0.20 per tag (in volume)	~$ 30 per tag
Read-range through air	Up to 12 inches	Up to 30 feet	Up to 1 mile
Read-range through metal	Does not read	Does not read	Up to 100 ft
Read-range through water	Up to 12 inches	Up to 8 inches	Up to 1 mile

Table 1 – A comparison of RFID systems

(Note: table is for trend-comparison only: figures may vary depending on use case and particular system under test)

RFID Evaluation Laboratory

There is no one-size-fits-all approach for successful RFID tracking. Different RFID systems will work better in different environments of a project. For example, the long-range passive tags might allow up to 30ft of read range when the tag is placed on a cardboard box, but might not work at all when the tag is placed on a bottle of water. Conversely an HF tag might read with a 6-inch range when placed on a bottle of water, but will never be able to exceed 2ft of range on a cardboard box.

Thus the RFID laboratory was established to enable a thorough, side-by-side evaluation of the competing technologies, in an attempt to answer two questions:

1. Can RFID assist in the tracking of chemicals and samples around the PNNL site?
2. Which RFID system is most suited to this task, or should multiple technologies be used?

Equipment

In setting up the RFID laboratory, the best-of-breed, off-the-shelf, commercial hardware and software was selected for the different RFID technologies. This resulted in four stations being built into the laboratory, each station focusing on a different technology. All systems comply to ISO standards where appropriate, and hardware is designed for rugged, industrial deployment. Furthermore all handheld readers were selected so that they support traditional barcode reading as well as RFID tags: it is expected that RFID may not work in all circumstances, so a back-up barcode will likely be built into a final solution. The list of hardware and software is detailed in the sections below.

RFID Test Station 1 – UHF Print and Program Station

The UHF print and program station is designed to commission UHF labels. Labels are commissioned by programming the embedded tags and also by printing on the label itself with regular ink. RFID printers perform this task, being able to both print and program at the same time. Labels are usually 2” x 4” in size and each contain an embedded RFID tag. These labels are supplied on rolls of 1000 units, which feed directly into the printer/programmer.

The printer/programmer is controlled by software running on a connected PC. The software used in the RFID laboratory is the commercially available Bartender RFID package. This package allows RFID labels to be graphically designed (allowing each label to contain text, barcodes and images) and to easily generate sequences of labels, where a printed barcode number matches the number programmed into the RFID tag.

Item	Image	Description
1		**Zebra R110Xi – UHF Printer** The Zebra printer is an industrial strength RFID printer/programmer. It will print onto various sized labels, and program embedded RFID tags in special label stock. The printer connects via Serial or Ethernet and is controlled via a proprietary printer language known as ZPL.

2		**RFID Labels - UHF** RFID labels are tags embedded into printable labels. They are supplied as a roll of 1000 units and are designed to be used by the Zebra printer. The printer can print ink on top of the label, and program the tag at the same time. Label format: 4” x 2”, ISO-18000C compliant tags

RFID Test Station 2 – UHF Read Station

The UHF read station comprises a fixed RFID reader and two different types of handheld reader.
The fixed reader, an Impinj Speedway device is connected to external antennas – one antenna is a far-field, long-range antenna delivering up to 30 feet of read range. The second antenna is a near-field, short-range antenna designed to read up to 12 inches through water.

The Impinj reader is controlled using the EPC Hotspot software. This software offers a device-independent way to operate the reader, providing easy-to-use graphical tools for RFID test and evaluation. With this station operating, UHF tags can be presented to the fixed reader and the results of the tag reads /programming be seen immediately on the computer screen. Both near field and far field systems can be tested in real-time and side-by-side with this station.

In addition the handheld readers can also be used for experimental purposes. The handhelds are all supplied with their own vendor-specific RFID demonstration software that will be sufficient for the RFID laboratory use.

Item	Image	Description
1		**Impinj Speedway – UHF Fixed Reader** The Impinj Speedway is a fixed UHF reader that handles both far-field UHF tags and near-field UHF tags. It connects to a PC via Ethernet connection and can be programmed using .NET libraries and Java libraries.
2		**Impinj Farfield Antenna – UHF Antenna** The Impinj Farfield Antenna connects to the Impinj reader to read ISO-180006C tags at up to 30ft range. Two antennas are recommended for doorway coverage (one for left and one for right of door)
3		**Impinj Nearfield Antenna – UHF Antenna** The Impinj Nearfield Antenna connects to the Impinj reader. It is specially designed to magnetically couple to ISO-180006C tags, allowing them to be read or programmed, even through water. Read ranges are up to 12 inches.

4		**Symbol MC-9090-G - UHF Handheld Reader** The Symbol UHF reader is a rugged, combination RFID and barcode reader. The device is controlled by the built-in Windows Mobile computer with integrated 801.11 wireless connectivity. The device can be programmed using .NET or Java libraries.
5		**Intermec IP4 - UHF Handheld Reader** The Intermec UHF reader is a rugged, combination RFID and barcode reader. The device is controlled by the built-in Windows Mobile computer with integrated 801.11 wireless connectivity. The device can be programmed using .NET.
8		**RFID Tags - UHF** An assortment of RFID tags will be supplied. Each tag will be pre-programmed and have an adhesive backing. The assortment will contain different size and form-factor tags, and include near-field tags and far-field tags. All tags will be ISO-18000C compliant

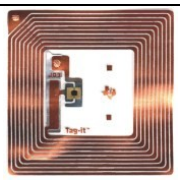
RFID Test Station 3 – HF Read Station

The third station is the HF read station, comprising a fixed Tagsys reader connected to a PC via serial cable. Multiple handheld readers are also connected via USB-charging-and-sync cradles.

The fixed reader is controlled using the EPC Hotspot software. This software offers a device-independent way to operate the reader, providing the user with easy-to-use graphical tools for RFID test and evaluation. With this station operating, HF tags can be presented to the fixed reader and the results of the tag reads / programming be seen immediately on the computer screen.

In addition the handheld readers can also be used for experimental purposes. The handhelds are all supplied with their own vendor-specific RFID demonstration software that will be sufficient for the RFID laboratory use.

Item	Image	Description
1		**TagSys L100 - HF Fixed Reader** The TagSys L100 HF reader is a fixed reader device that connects to a PC via Serial cable and is operated using a proprietary protocol.

2		**TagSys Inventory Wand – HF Antenna** The Inventory Wand is an antenna for the L100 reader. It allows shelves of items to be easily accessed and read. Typical read ranges are up to 3 inches.
3		**TagSys Flat Antenna – HF Antenna** The Flat Antenna is a single antenna for the L100 reader. It is designed for use on a desktop and is ideal for reading and programming tags, and for 'checking-out' tags on a counter-top. Typical read ranges are up to 12 inches.
4		**Psion Teklogix Workabout Pro - HF Handheld Reader** The Psion Workabout Pro handheld reader is a rugged, combination RFID and barcode reader. The device is controlled by the built-in Windows Mobile computer with integrated 801.11 wireless connectivity. The device can be programmed using .NET libraries.
5		**RFID Tags - HF** An assortment of RFID tags will be supplied. Each tag will be pre-programmed and may have an adhesive backing. The assortment will contain different size and form-factor tags. All tags will be ISO-15693 compliant.

RFID Test Station 4 – Active Read Station

The fourth station is the Active read station, comprising an RF Code fixed reader connected to a PC via serial cable. The fixed reader is controlled using the EPC Hotspot software. This software offers a device-independent way to operate the reader, providing the user with easy-to-use graphical tools for RFID test and evaluation. With this station operating, Active tags can be presented to the fixed reader and the results of the tag reads be seen immediately on the computer screen.

Item	Image	Description
1		**RF Code Mantis II– Active Tag Reader** The RF Code Mantis II fixed reader reads active tags up to 300 ft away. It connects to a PC via RS232 cable (supplied). It is supplied with two integrated antennas.
2		**RF Code Tags – Active Tags** The RF Code tags are small battery powered tags, transmitting their unique IDs to the Mantis II reader device. They are ideal for tracking larger assets such as steel drums and boxes.

RFID Evaluation – Preliminary Results

Preliminary trials were conducted, comparing the performance of the RFID systems for tracking simulated chemical samples. The following results were observed:

UHF Technology

The UHF tags read very well, with up to 30 feet of range observed when the tag was applied to the outside of an empty container. However applying the RFID tag directly to a bottle containing water reduced the read range down to inches. Similarly applying the RFID tag directly to metal dropped the read range completely to zero.

Three different UHF tag types were tested, each tag varying in size. Ideally the largest tag should be applied to all samples for maximum read range. However some samples are simply too small to hold a 4” x 1” tag and thus smaller tags should be considered.

Tag	Environment	Read-Range
Alien Gen 2 Squiggle Tag  4” long, 0.5” high. Printed on flat flexible film	Tag placed on empty plastic bottle	30 feet
	Tag placed on plastic bottle filled with water	12 inches
	Tag placed on aluminium box	Zero inches

Tag	Environment	Read-Range
Alien Gen 2 Baggage Tag  2” long, 2” high. Printed on flat flexible film	Tag placed on empty plastic bottle	20 feet
	Tag placed on plastic bottle filled with water	12 inches
	Tag placed on aluminium box	Zero inches

Tag	Environment	Read-Range
Avery Button Tag 0.5” diameter. Printed on flat flexible film	Tag placed on empty plastic bottle	8 inches
	Tag placed on plastic bottle filled with water	6 inches
	Tag placed on aluminium box	Zero inches

HF Technology

The HF tags do not allow long-range reads. The typical distance for HF systems is 12 inches. This distance is the same for tags in free-space as for tags on liquids; liquids do not interfere with HF systems. However metal is still a problem, reducing the read range to zero.

Tag	Environment	Read-Range
Tagsys HF Tag 2” long x 1 inch high. Printed on flat flexible film	Tag placed on empty plastic bottle	12 inches
	Tag placed on plastic bottle filled with water	12 inches
	Tag placed on aluminium box	Zero inches

Active Technology

The active tags performed exceptionally well, delivering a read range in excess of 300 feet. Water and metals do reduce the range slightly, but not a disabling level.

Tag	Environment	Read-Range
RF Code Active Tag 2” long x 1” high, ¼ inch thick. Case is rugged plastic.	Tag placed on empty plastic bottle	300 feet
	Tag placed on plastic bottle filled with water	300 feet
	Tag placed on aluminium box	200 feet

RFID for Chemical and Sample Tracking

Chemical Tracking

Currently PNNL utilizes a barcode scheme for tracking its chemical inventory. The term 'chemicals' in this context covers a wide range of products, from laboratory reagents used by the scientists to cleaning liquids used by maintenance staff. These chemicals are found in many locations and in many shapes and sizes.

The system in place today identifies these chemicals as they are received at PNNL, and marks each one with a unique barcode and a corresponding entry in a campus-wide database.

After subsequent distribution around the PNNL campus, periodic inventories are made using a handheld barcode scanner. Some chemicals require more frequent inventories than others, especially those that are deemed more valuable or more hazardous than others. Thus inventories may take place on a yearly basis for some laboratories, and as infrequently as every three years for others.

The purpose of the inventory is simple stock taking and accounting. A chemical exists in the campus wide database as either present or not, and is assigned to the room it was last inventoried in. There is no differentiation between a half-empty bottle and a nearly full one.

If chemicals are moved from one location to another, the database information will become stale and inaccurate until the next inventory is conducted.

It is hoped that RFID can assist in the chemical tracking mechanisms in the following ways:

- Dramatically decrease the time taken to perform manual chemical inventories
- Increase the accuracy of chemical inventories
- Automate some of the inventory process
- Detect and alert movement of specific 'high-interest' chemicals
- Provide electronic visibility of all chemicals around PNNL

Sample Tracking

The term 'samples' used in the PNNL context refers to physical samples obtained for analysis, or created by experimental procedure. For example, a sample may be 10 cubic feet of soil taken for analysis from a particular ground site. Alternatively a sample may be one of 20 similar samples obtained from a chemical reaction, each extracted at different times throughout the reaction.

In either case these samples are kept, archived and data about them recorded for future use. Currently this is a manual process, and somewhat ad-hoc in that there is no common numbering scheme for the samples. A scientist may mark his samples as 'A-1' through 'A-20'. Similarly a soil sample may be marked as '201-1'.

Sample numbers are typically written onto the sample container by hand.

It is hoped that RFID can assist in the sample tracking mechanism in the following ways:

- Establishing a common, system-wide sample-naming scheme, and sample database to improve the accuracy of sample inventories.
- Providing real-time electronic visibility to samples around PNNL.
- Eliminate the paper-based solution as the primary vehicle for documenting and tracking samples.

Application of RFID to Chemical and Sample Tracking

It is clear from the results listed earlier in this document that RFID will not enable the location of all things to be known at all time. While this may be a long-term goal for RFID, it is simply not a practical reality today. Too many issues arise that reduce the effectiveness of RFID as a long-range tracking tool. However RFID should in no way be dismissed: ***RFID is a highly effective tool that can add tremendous value, efficiency and accuracy to any tracking application.***

The following section identifies ways in which RFID can be used to add value to chemical or sample tracking in the PNNL environment.

Active RFID for High Value or High Importance Assets (Chemicals or Samples)

There are many high-value or high-importance assets through the PNNL environment ranging from radioactive samples to biological agents that cost thousands of dollars per ounce. All of these items require careful tracking today and would benefit greatly from an automated RFID system.

It is recommended that areas housing these assets be fitted with Active RFID readers, where each reader can typically cover an area of 100,000 square feet. In conjunction each asset should be assigned an active tag and have it physically and permanently attached. Further, important doorways or corridors should be fitted with Infrared signposts that interact with the tags to give them precise location information. Such a system would provide the following information:

- Real-time, instant inventorying of high-value / high-importance assets, indicating presence or no-presence of an asset within a building or 100,000 square feet area.
- With the addition of IR signposts, assets can be monitored in real-time as they enter or leave smaller coverage areas of approx 1000 square feet: i.e. doorways or corridor choke points.

This RFID system would feed into a system-wide database. Such a database would list the last-known location of all tagged assets, in real-time. If the tag was taken out of the RFID coverage zones, the database would be aware of tags leaving an area, and alerts could be triggered within 30 seconds of the event.

The only two restrictions on deploying this system for all chemicals and samples are:
- Cost – Each tag costs approximately $30, which limits the deployment to high-value or high-interest assets
- Size – Each tag has dimensions approximately 2” x 1” x 0.5”, which limits the size of the sample to be monitored.

The battery life for each asset tag is approximately 5 years. The batteries are replaceable.

Note: Active tags are supplied with pre-programmed ID numbers. These numbers are guaranteed unique worldwide but are not subsequently reprogrammable.

Wireless 802.11b Active Tags

Active tags are actually available in two flavors: those that use their own proprietary over-the-air protocol, and those that use 802.11b as their over-the-air protocol.

The tags that use their own protocol are typically the least expensive ($20-$25 per tag in volume), but the system requires the deployment of a number of readers, typically $2000 each.

The 802.11b tags use existing 802.11b wireless networks. There is no other infrastructure required. However the tags are usually more expensive, in the range $80-$100 each.

Short-Range Passive RFID for Chemical and Sample Inventorying

Both HF and UHF technologies can be used for short-range chemical and sample inventory systems. Tags of both types can be attached to the majority of samples and be read by RFID readers. This includes water-based samples. The only caveat is metal boxes – tags cannot be applied directly to the metal, but workarounds can be found (such as tying a 'luggage-label' style tag to the sample)

A typical chemical or sample tracking deployment would result in the following workflow:

1. **Tag commissioning:**
   Pre-programmed and pre-printed RFID tags would be applied to chemicals / samples as they enter the PNNL system. The tag ID would be noted in a system-wide database along with information about the sample. Tagged chemicals and samples would then be distributed around the campus in the usual fashion

2. **Tag Inventorying:**
   Due to the limited read-range of the tagged chemicals / samples (most are likely <12 inches), a manual inventory process will still be necessary. This process will involve passing a handheld reader over the chemicals at short-range, typically within a few inches of the RFID tag on the chemical. At this point the handheld reader will record the tag ID and combine this with location information before storing in a campus-wide database. To ensure this process is as fast as possible, the handheld reader will 'beep' on reading each tag. This gives the operator an audio clue that his inventory is proceeding correctly.

   If the handheld reader is waved over a tag that does not respond, no beep will be heard. This might indicate an unreadable tag, and require the operator to use the built-in barcode reader and scan the chemical's printed barcode.

   The process of scanning a typical shelf or cabinet of chemicals in this way is expected to be quick, taking just a few seconds. This is in contrast to the current method of reading each barcode, which can take a considerably longer time.

Long-Range Passive RFID for Chemical and Sample Inventorying

UHF tags offer a second approach to tracking chemicals and samples; this is a long-range approach utilizing read ranges of up to 30 feet. Such read ranges are well beyond the capability of HF systems.

Being able to track items up to 30 feet away opens up a whole slew of possibilities such as walking into a room and simply scanning the contents from a doorway. However it is clear from testing the 30 feet range is by no means guaranteed. When a UHF tag is placed on an empty bottle or cardboard box, these long ranges can be realized. But placing the same tag on a water-based liquid sample can reduce the read range to just inches.

Likewise it has been envisioned this long range can be used to track chemicals and samples moving through RFID equipped doorways. While this may work for many products, those that drop the read range to less than 12 inches will not be detected. Likewise, humans are composed mainly water. If a person carries an RFID tagged sample through an RFID doorway, with his hand covering the RFID label, the tag will likely go undetected.

Thus to talk about inventorying chemicals and samples using ONLY long-range passive RFID is to invite failure into the system. Any long-range solutions should be used to augment the baseline short-range readability.

HF vs. UHF for Short Range Passive Tracking

There is an ongoing debate, especially in the pharmaceutical world regarding the best technology for passive RFID tagging: UHF or HF.

Simply put, when tagging water-based liquids, both systems will perform about the same. They will both offer a read range of up to 12 inches and typically no more. Given this baseline equality, other factors need to be considered when making a choice between the two:

- **Cost Per Tag**
  The typical cost per RFID tag is equivalent. In high volumes (>1,000,000 tags) tags will cost in the range of $0.10 - $0.20 each

- **Cost Per Reader**
  The reader and associated hardware costs are also equivalent, ranging in the $1,000-$3,000 bracket depending on functionality.

- **Size of Tag**
  The newest breeds of UHF tag are smaller than their HF counterparts. The smallest UHF tag, the Button tag is 0.5 inches in diameter, allowing very small samples to be tagged. The smallest HF tag is 1 inch square.

- **Availability**
  HF systems are more prevalent in Europe than the US (for various historical reasons). Subsequently the majority of HF systems are manufactured by European companies, leading to some problems with supply and support. Conversely, US companies dominate the UHF systems.

- **Maturity**
  The HF systems have been available in Europe for at least 10 years. There are many applications especially for item and on-shelf tracking. Equipment is varied and mature. Conversely, the UHF systems are only 3 or 4 years old, and the majority of equipment is aimed at long-range supply-chain tracking. Equipment for UHF close-contact item level tracking (i.e. handheld with wands) is not yet available. To date there is only one supplier for short-range, near-field UHF tracking hardware, although many more are expected in the years to come.

Redundancy Systems: RFID, Barcodes and Printed ID Numbers

100% success of RFID inventory systems should never be expected. There will undoubtedly be occasions where the RFID tag does not work, either for interference reasons, or mechanical failure at the chip level, or even times where the RFID reader does not work (for example, battery too low).

Thus redundancy should be built into any inventory system. Redundancy in the RFID world simply involves two pieces: Barcodes and Printed ID Numbers.

The same ID number programmed into the RFID tag should be represented as a printed barcode on the RFID tag, and as a printed numeric.

All handheld RFID readers should be fitted with barcode readers, so the operator can try the RFID tag first and on failure, then read the barcode number. Similarly, all RFID readers should be fitted with a numeric keypad that will enable the numeric ID number to be typed in if required.

The chemical tracking system today uses a barcode system, and this should be continued. RFID tags can be programmed with the same existing barcodes and hence an RFID version of the chemical tracking system be rolled out in stages with no disruption to the majority of operators.

Label Stock

The majority of self-adhesive tags available today are designed for the supply chain, where tags are applied to cardboard boxes. This has resulted in tags embedded in plain paper, and coated on one side with an adhesive suitable for corrugate.

These tags are not suitable for chemical and sample tracking at PNNL. Tags should be prepared with the following properties:

- Tags should be made using a vinyl cover instead of plain paper. The vinyl (or similar) should provide some basic protection from the chemicals being tagged. It is inevitable the tags will be splashed with some the chemicals, and / or washed and hence should be protected if possible.
- The adhesive should be resistant to splashing and washing to stop the tag from peeling off the sample.
- Tags should be pre-encoded, with matching printed barcode and ID number.

PNNL does have the option to encode and print labels itself. However if the label requires special protective vinyl it will be difficult to print permanent ink on top of the label. Therefore it is recommended the label be programmed and printed before the protective vinyl is applied.

Requests for specially designed tags to suit the PNNL environment should be addressed to Label Converter Companies. These are the companies that source raw RFID tags and embed them into adhesive label stock. Some of these label companies can also provide serialization services, printing ID numbers, barcodes and pre-encoding the tag.

Metal Shelving vs. Glass or Acrylic Shelves

Both HF and UHF systems fail to work well when the tags are placed very close to, or directly onto metal. Given the majority of chemicals and samples are currently stored in metal cabinets using metal shelves, this can cause some problems for an inventorying system.

Therefore consideration should be made to replacing metal shelves with more RF-friendly shelves going forward. Hence as buildings are constructed and fitted, thought should be given to RFID in the planning stages.

Smart Shelves

Industry efforts are currently underway to develop Smart Shelves. These are cabinets and shelving systems with RFID antennas built in. With such a system, an instant, real-time inventory of all chemicals and samples on such a shelf could be obtained. These shelves would no longer need to be manually inventoried.

While such systems are not currently available for mass-rollout, a number of test units are available for purchase from different suppliers. It is recommended that PNNL revisit this topic in 12 months.

Radio Frequency Interaction with Chemical and Biological Samples

There may be concern from the scientists that radio-energy aimed at a sample may damage it at a chemical or biological level. This concern has been echoed throughout the RFID industry, especially by the pharmaceutical companies. To this extent a number of tests and trials have been held, all of which have shown no interaction between the RF and the sample. Furthermore the Federal Drug Administration (FDA) has approved the use of UHF and HF RFID tags on pharmaceuticals.

Recommendations for RFID Chemical & Sample Tracking at PNNL

It is clear that RFID can add tremendous value and efficiency to the current chemical inventorying system at PNNL. It is also clear that a similar system should be established for the tracking of samples.

Given these two simple statements, the following is a recommendation of how to proceed with RFID:

1. Active Tagging

Active tags should be used for accurate, real-time inventory of high-value or high-importance assets. Similar systems are already in use throughout many hospitals for tracking equipment and patients. There are very few barriers to successful deployment and the technology is mature and readily available.

2. Passive Tagging

Short-range passive tagging should be used to greatly improve the efficiency and timeliness of manual chemical and sample inventories.

Long-range passive tagging should not be relied on for the majority of chemical and sample inventories. However there are exceptions, for example stock rooms containing pallets or large cases of products that are RF friendly and will benefit from this technology.

Thus it is recommended to adopt UHF systems around PNNL. This will allow both short-range and long-range tracking with just one investment in hardware and tags.

Although some of the hardware is not available today for effective short-range inventorying, it is expected that this situation will change over the coming 12 months. In particular a handheld-wand device, similar to the HF solution is required for UHF.