Modern Safeguard Systems

Chris A. Pickett and Zane Bell

Nuclear Security Technologies Group

Nuclear Science & Technology Division

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Agenda

- **Why Modernize Safeguard Systems?**
- **Sensor Technologies & Deployments**
  - **Weight**
  - **Radiation**
  - **Portable equipment**
  - **Tracking**
- **Some System Requirements for Unattended Remote Monitoring**
- **Concluding Remarks**

Why Modernize?

- Other than better measurement technology and computerized accounting systems there has not been much improvement in the way a site performs the Safeguards function in more than 25 years!

- Labor and site overhead costs have grown exponentially in that time frame as operational budgets have decreased; making the need greater than ever to introduce technologies and methodologies that improve Safeguards!

Process Outputs- The Realities

The good, the bad ,and the ugly!

Move, Measure, and Move again

Bringing the measurement to the process can save labor and time and improve safety & security!

Process Holdup: The Situation

Systems not designed for measurement.

Hard to get to areas!
Radiation Background problems

Process Holdup over 2300 points to measure every 2 months!

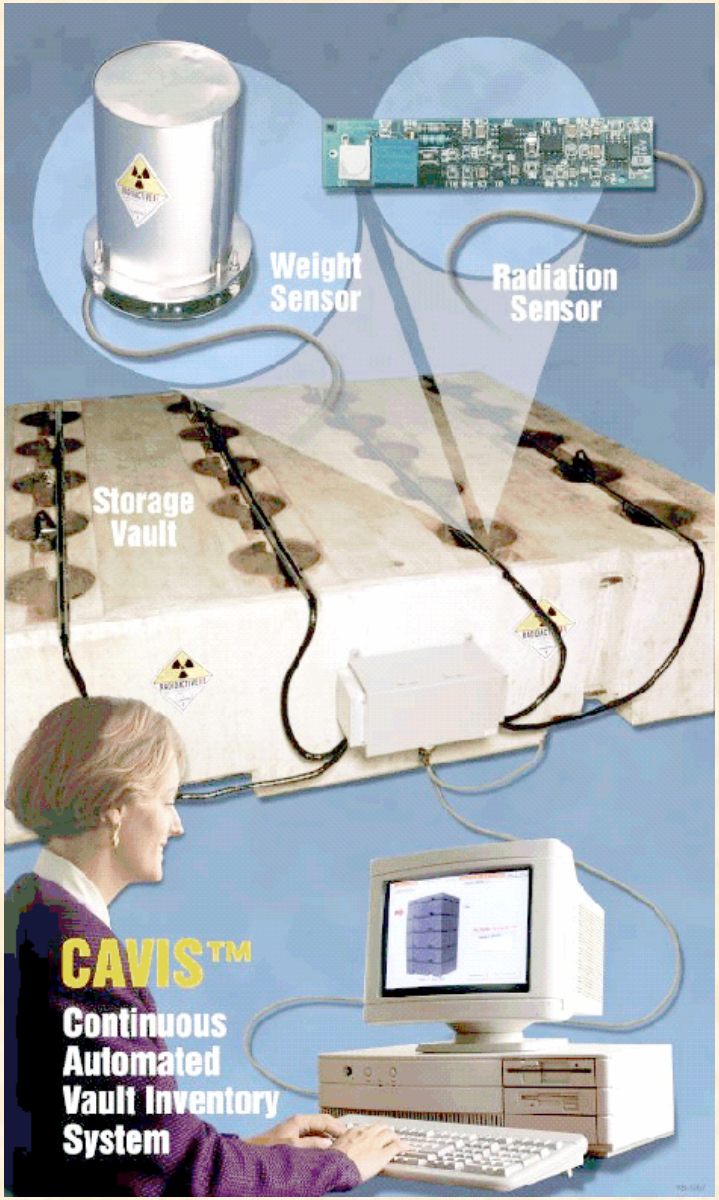
GOALS to Achieving Modernized Safeguards

- **Reduce the labor associated with performing safeguards functions.**
- **Reduce the down time associated with SNM inventories.**
- **Move toward instantaneous, continuous SNM accountability systems with automated data collection.**
- **Design Safeguard systems into the processes/facilities/equipment.**
- **Reduce and improve post-security event actions and assessment.**

Technical Path to Achieving Modernized Material Control & Accountability

- **Instantaneous Inventory Systems with automated data collection.**
- **Real-Time Tracking and Surveillance of People and Materials.**
- **Remote, Unattended Monitoring and Measurement Systems.**
- **In-Process Measurements.**
- **Improved System Integration**

The Vision: "Unobtrusive Surveillance with Instantaneous Accountability"



CAVIS™

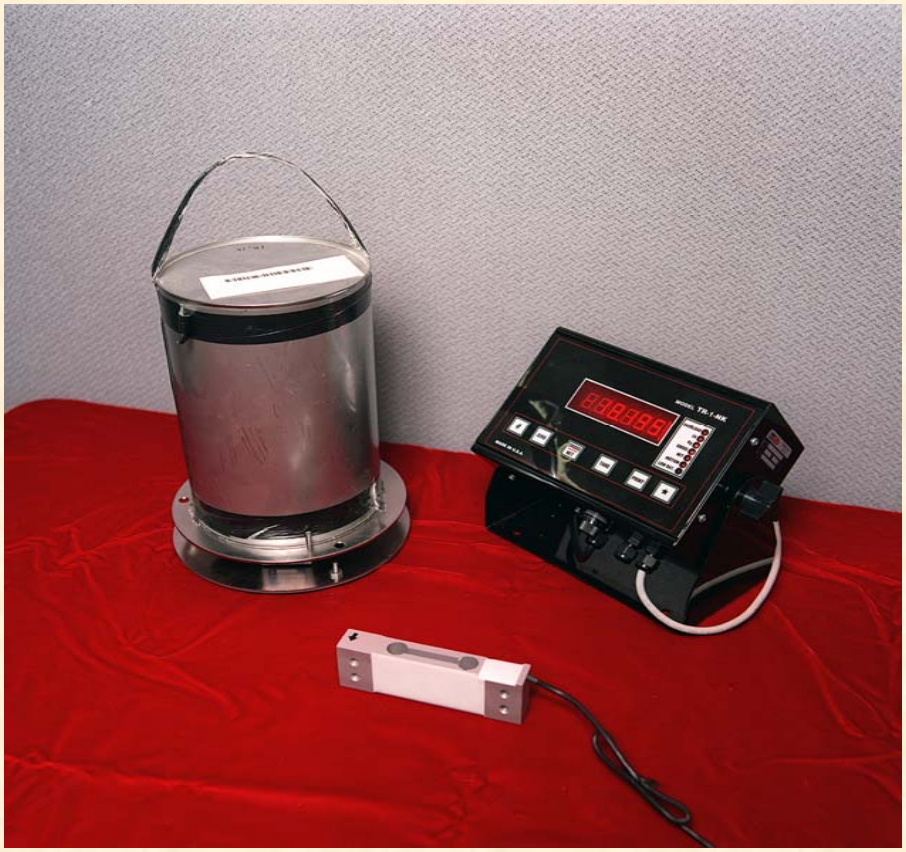
- Continuous Automated Vault Inventory System
- An embedded sensor system that continuously monitors the physical attributes associated with stored nuclear materials.
- Allows Remote Unattended Monitoring
- Provides timely detection that can be used to initiate appropriate response(s).

Early CAVIS™ Technology installed at VNIIEF in 1997-98

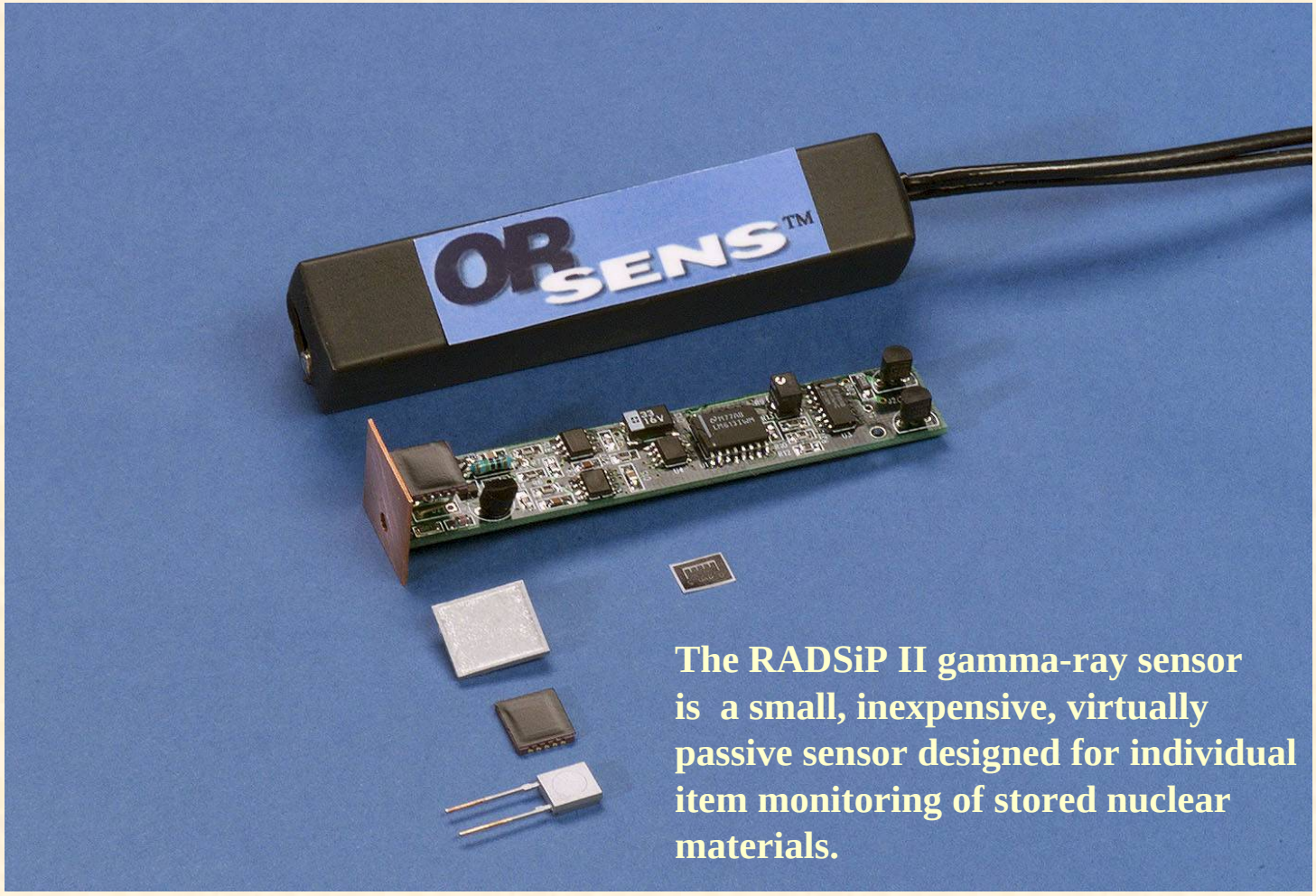
VNIIEF System monitoring Radiation, Weight , and Serial Number

CAVIS™ Weight sensors at Kurchatov Institute in use since 1997

Current CAVIS™ (Load Cell) Weight Sensors

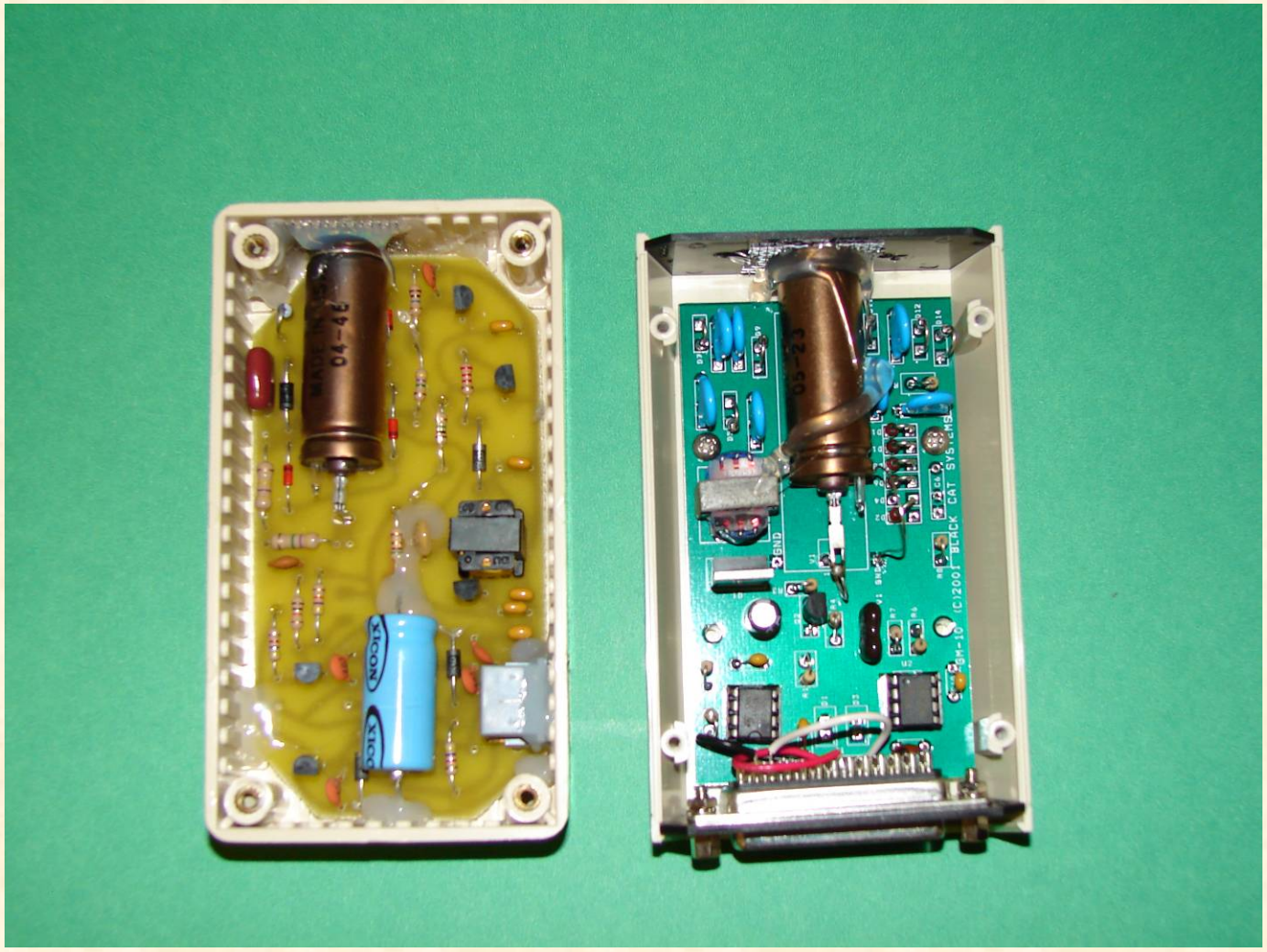


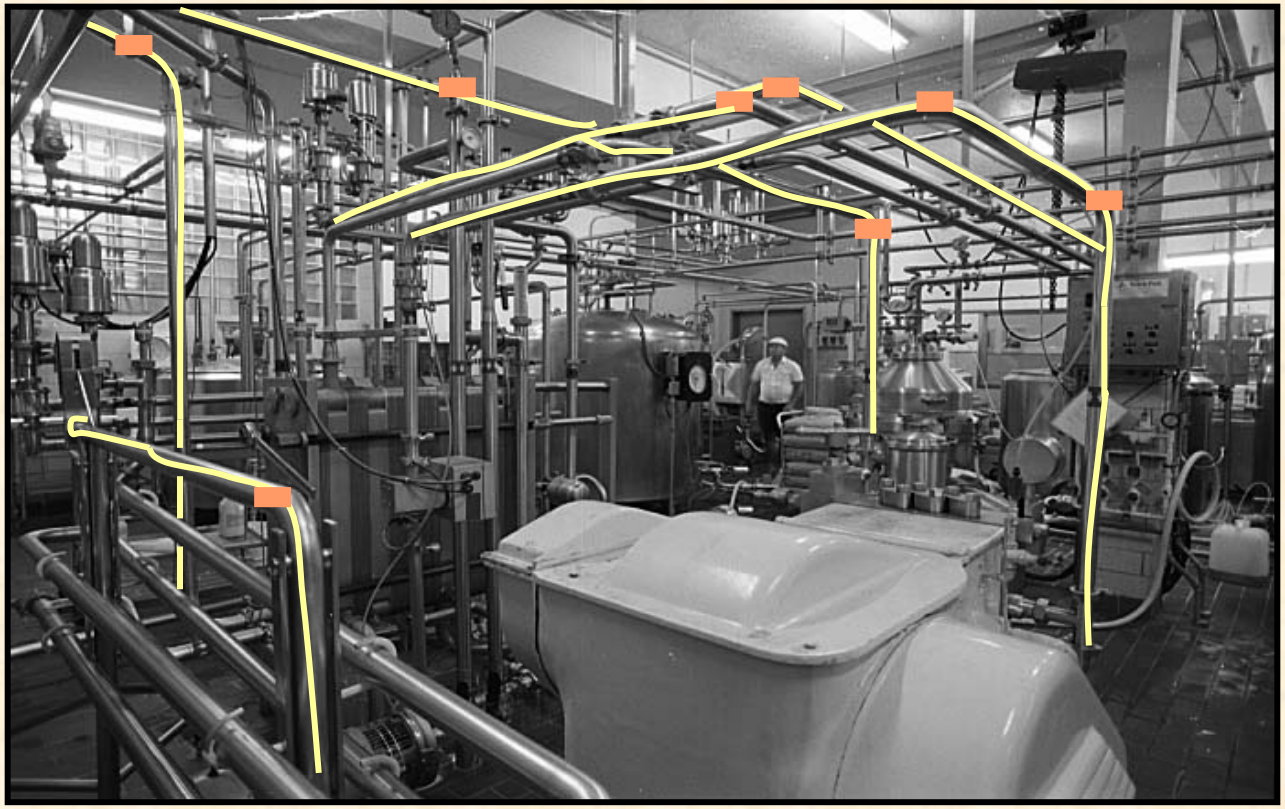
RadSiP II Solid State Radiation Sensor

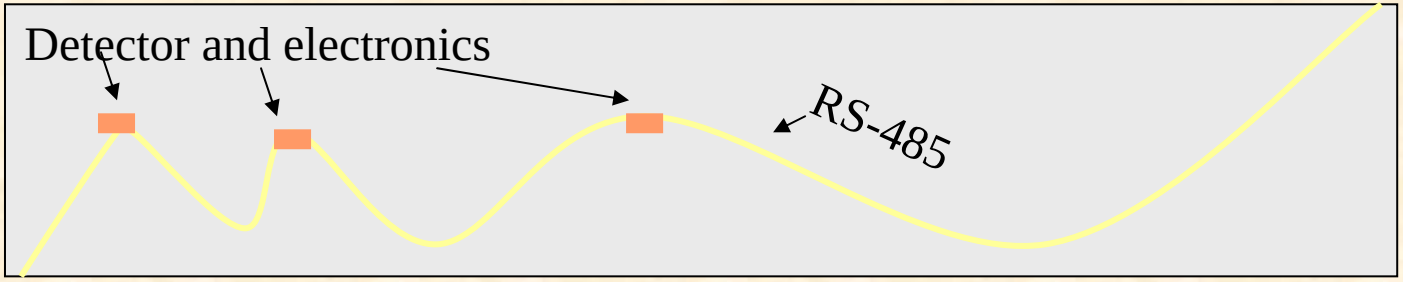


The RADSiP II gamma-ray sensor is a small, inexpensive, virtually passive sensor designed for individual item monitoring of stored nuclear materials.

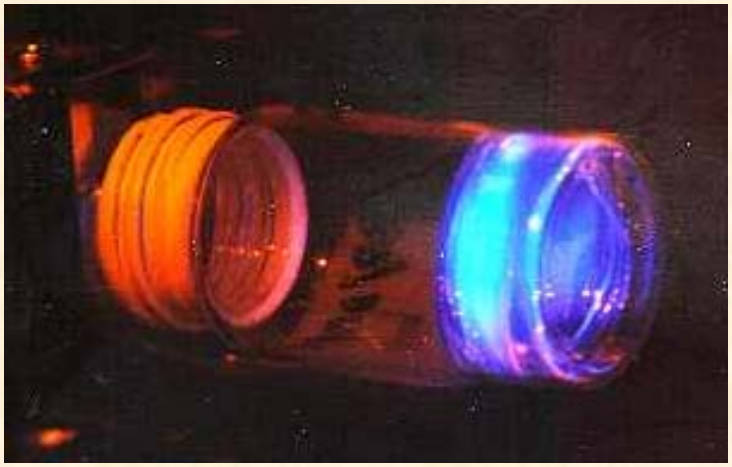
Geiger-Mueller Gas Tube Detectors






Detector and electronics
RS-485

Silicone Rubber Scintillator



Scintillator sample glowing blue when exposed to x-rays

- Dimethyl diphenyl silicone polymerized with UV and blue-emitting phosphors
- Shows better gamma ray sensitivity than does hydrocarbon plastics because of presence of Si
- 1 cm thick piece generates photopeak at 60keV(^{241} Am); thicker pieces should work at commensurately higher energies
- Starting materials are inert liquids; requires catalyst to initiate polymerization
- Can be cast in large pieces and odd shapes at room temperature in presence of air; can be cast in plastic or metal molds
- Net assembly cost is less than plastic; requires no machining; ready to use right out of the mold
- Can be handled

SmartShelf™ - Active tag Technology

System for tracking nuclear material in dynamic storage

Electronic item identification tag

Inventory Verification/Confirmatory Cart

Technology Description

Cart provides a scale (up to 50Kg), NDA equipment, barcode reader, and computer for in-situ inventory assessments. The built-in power supply provides up to 8 hours of power.

Brings the inventory measurement technology to the materials. Reduces the labor, time, and risk associated with SNM material moves during inventories by 50 percent.

Security Benefits:

Assets are not changing locations as frequently.
Inventories cycle times are reduced
Less lifting by employees

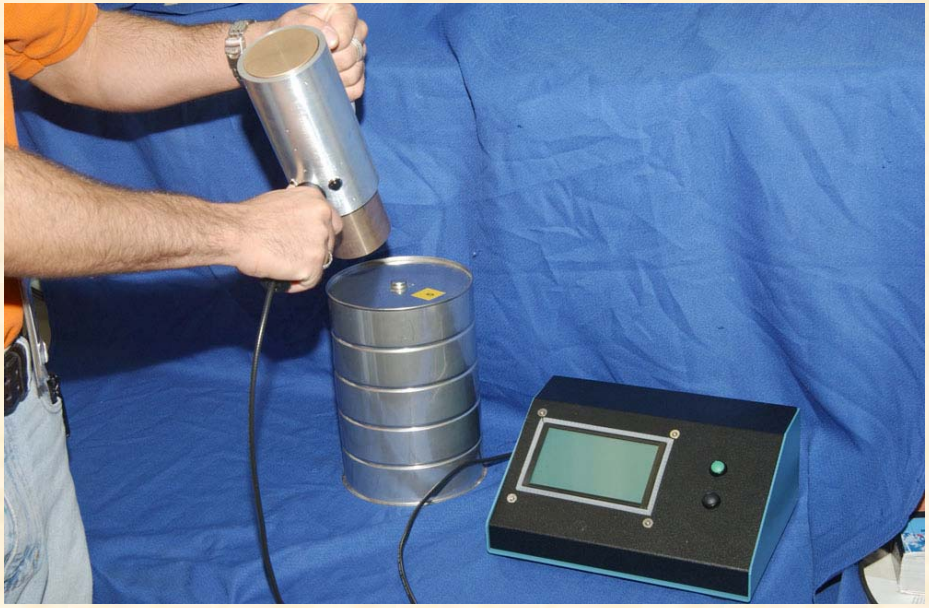
Operations Cost Savings (est.)

Reduce V/C inventory costs by a factor of 2 or more.
Annual site wide productivity gains

Handheld HEU Enrichment Monitor

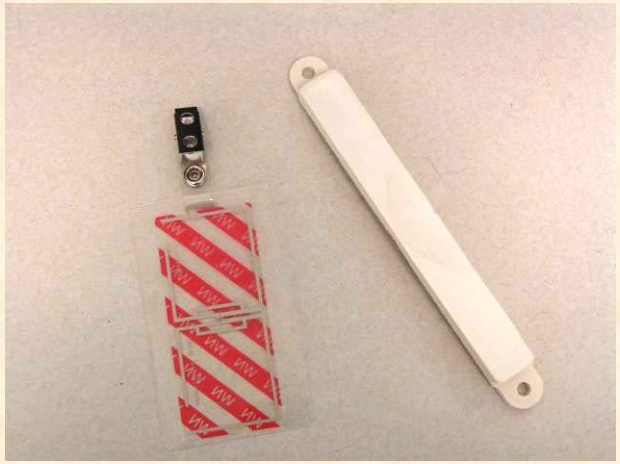
- Based on CdWO4 Scintillator (smaller crystal)
- Miniaturizes size/weight of detector, thereby reducing or eliminating operator fatigue
- 1/5 the cost of COTS equipment

- Single cable (multiple conductor) carries control signals and analog signal
- HV generated in handset
- Removable protective cap to keep debris out of collimator



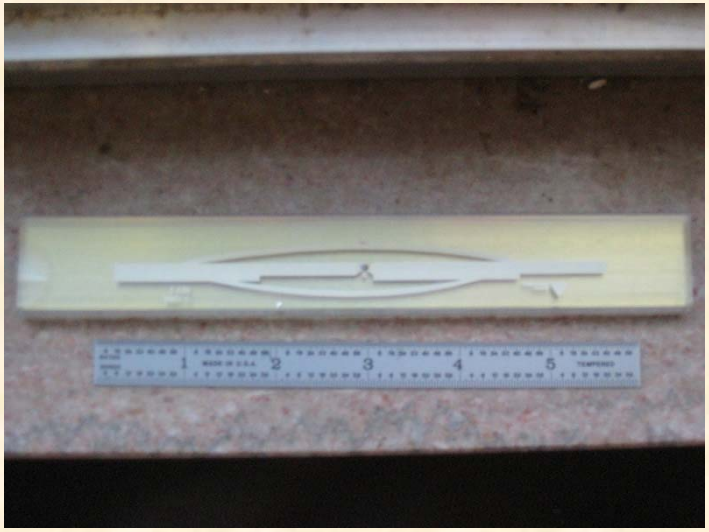
In-Process Material Transfers

Examples of Passive Tag Technologies



Passive Tags

- Range in size from about two to seven inches in width/length
- Short read distances (a few meters)
- Most are adhesive-based and metal tags that have stand-offs or are potted in rubber
- Tag size, orientation, antenna type, and environment all affect readability
- Wearable tags for personnel



Example of Passive RFID Portal for Tracking Materials and Personnel

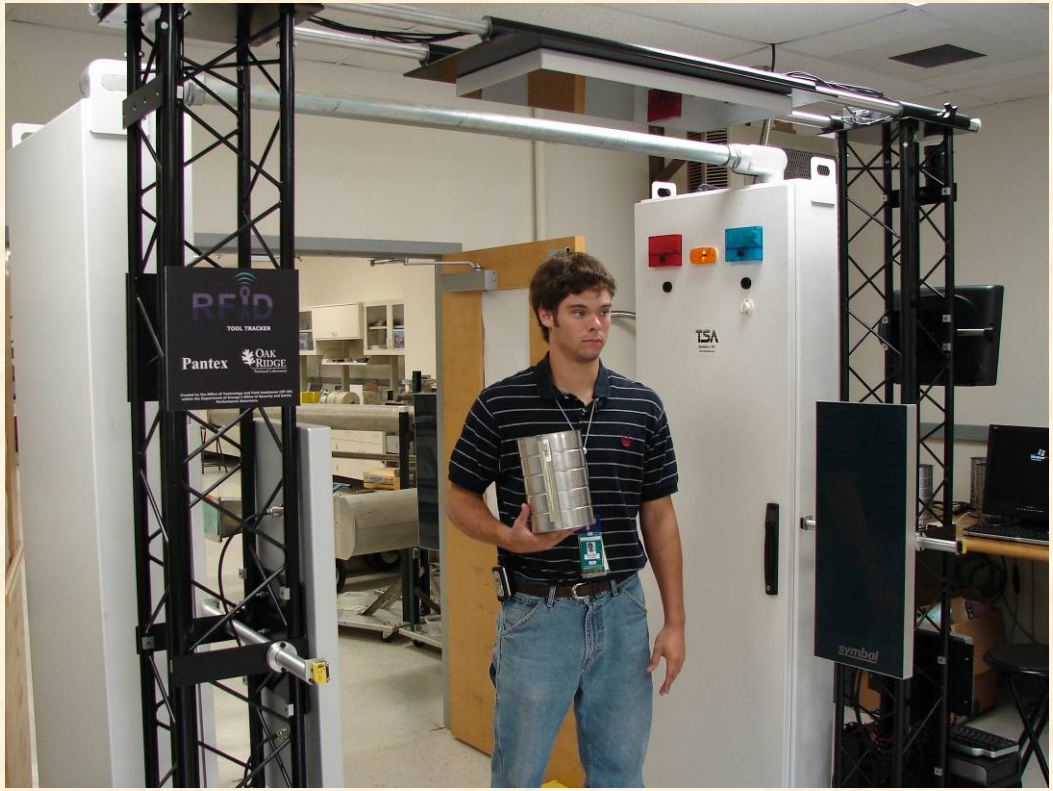
Directional RFID portals that inventory throughput traffic including cameras for event confirmation

Protected Asset Tracking System (PATS)

- **Directional Sensing**
- **Supports RuBee RFID tag formats**
- **Eliminates Metal issues**
- **Provides real-time automated inventory reconciliation**
- **Supports integration of other layers of S&S technology**

RF & RAD Portal Integration

–The System provides automated detection of



- **Direction**
- **Occupancy**
- **Gamma/ Neutron levels**
- **Item ID**
- **TID Status**
- **Camera**

The RF-Base TID (enabling technology)

- Single-use plastic strap passive RFID E-seal with reusable electronics.
- Records data when it is armed, last time read, tamper event information.
- Real-time clock; Temperature sensor.
- Operating battery life: 1 year
- EPC Global Generation 2, Class 1+ tag
- Operating frequency range: 860-960 MHz
- Read range: 21 feet
- Operating temp: -40°F to 158°F
- Humidity: 95% non-condensing at 158°F

Passive RF-based Seal

Zone Tracking – Examples of Active RF Tags

Active RF Based Seal

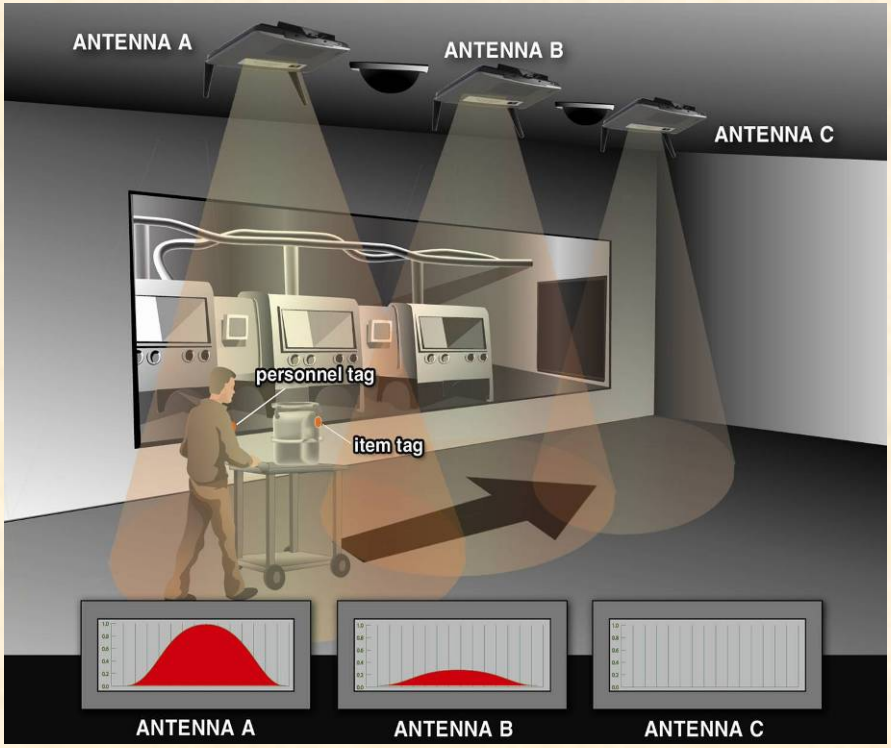
Active RF-Tags

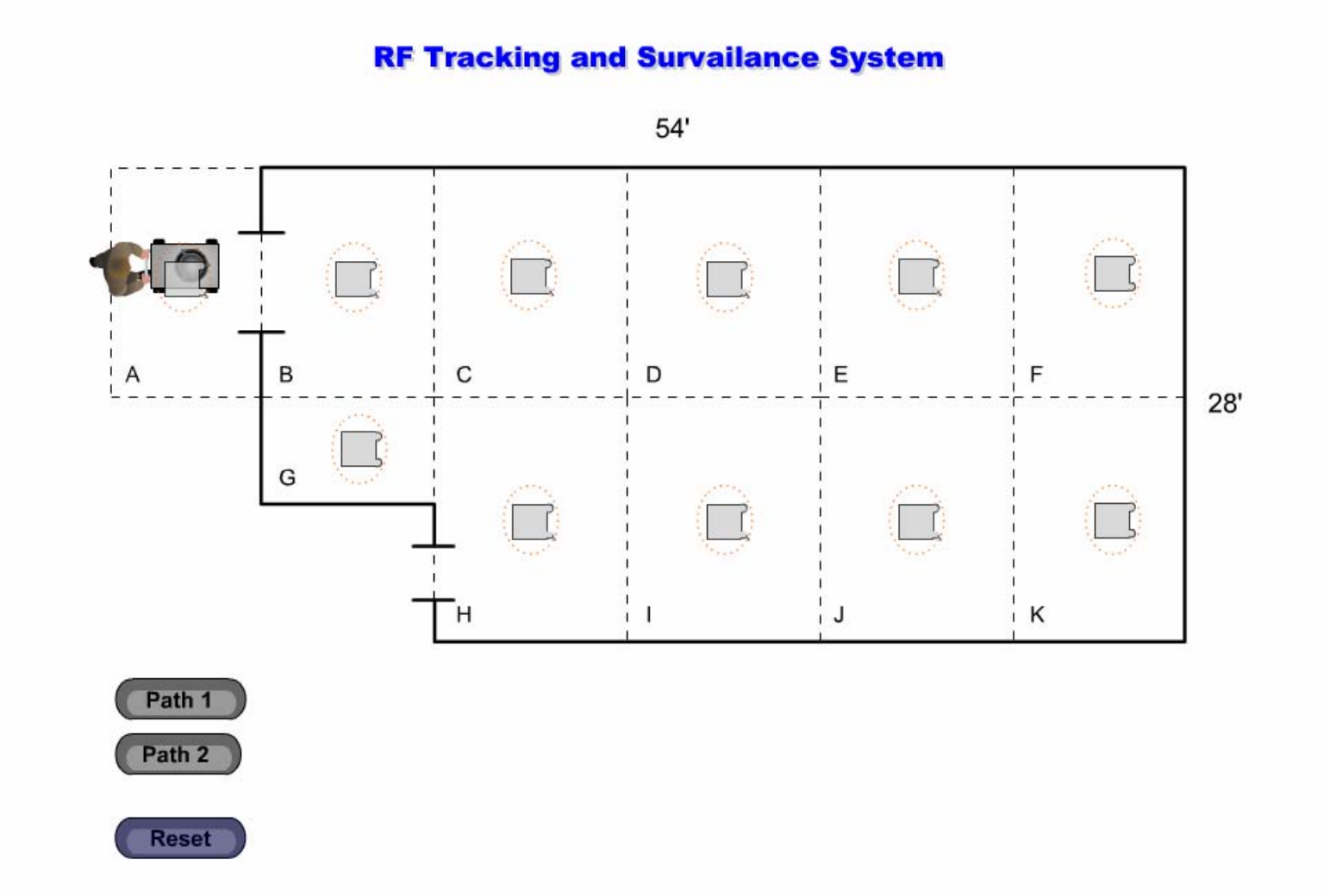
Active RF-Tag (433 MHz)

Active RF-Tags with motion detection

Zone Tracking

- Wireless technology for tracking personnel and assets.
- Provides near real-time detection of attempts to steal or divert protected assets.
- Supports rules based operation.




RF Tracking and Survailance System
54'
28'
A
B
C
D
E
F
G
H
I
J
K
Path 1
Path 2
Reset

Some Typical Design Criteria for Unattended Monitoring Systems

- **Provide information "equivalent" to what inspectors would be able to ascertain from a site inspection.**
- **Reliable**
- **Tamper resistant components**
- **Redundant system design**
- **Verifiable**
- **Appropriately Integrated (layered)**
- **Customized for application**

Some basic system design goals

- **Data authentication and encryption**
- **Tamper indicating Enclosures**
- **Continuous real time data collection**
- **Redundant and Integrated Layers of Technologies**
- **Site specific and remote Performance testing**

Some of the things that influence system designs

- **Level of perceived threat**
- **Resources**
- **Need to Protect State Secrets**
- **Culture “negotiate with adversary”**
- **How much is enough?**

Benefits of Real Time Monitoring

- Reduce time to inventory
- Reduce data transcription errors (human error typically ~10%)
- Faster reconciliation of anomaly events
- Improve timeliness (don't have to wait for human transaction to occur)
- Rules can be applied to information (e.g., ensuring right items are stored in the right place, etc.)

Some Final Remarks

- **Advanced Sensors will need to support data authentication.**
- **Protocols for wireless devices and communications need to be developed.**
- **Protocols for validating and remote verification of unattended remote monitoring systems will need to be adopted.**
- **The gains in timely detection, response, and labor savings will be significant.**