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Savannah River National Laboratory
Overviews of Department of Homeland Security Test and Evaluation Programs Conducted by SRNL

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Agenda

- Overview/Summary of SRNL Counterterrorism and Homeland Security Areas of Support
- Descriptions of Major Test and Evaluation (T&E) programs executed by SRNL
  - Provide overviews of the technology being evaluated
- Testing Process Description for two example programs (IPRL and SORDS) from SRNL
  - Technology evaluated
  - Team make-up and structure
  - Test parameters
  - Logistics and Test Equipment

SRNL Counterterrorism and Homeland Security Support Areas

Radiation Detection Test and Evaluation

Training

Forensics

Radiological Response

Maritime Technical Support

Unmanned Vehicle Platform Development

Acronym City

Department of Homeland Security (DHS)

Domestic Nuclear Detection Office (DNDO)

Defense Threat Reduction Agency (DTRA)

Commercial Off The Shelf (COTS)

Government Off The Shelf (GOTS)

Department of Defense (DOD)

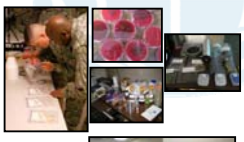
Intelligent Personal Radiation Locator (IPRL)

Standoff Radiation Detection Systems (SORDS)

Training

SRNL's experts train law enforcement, emergency management, and government agency personnel to perform detection and quantification for criminal mishandling or criminal misuse of chemical, biological, and radioactive materials

- Training includes
  - The threat
  - Concepts of chemical and biological agents, and of radiation and radioactive material
  - Detection devices
  - Proper search techniques including safety techniques
  - Hands-on activities, practical exercises and realistic scenario
  - Customs and Border Protection (CBP) Weapons of Mass Effect Training is example with up to 30 classes per year.



Federal Bureau of Investigation

- Radiological Crime Scene Investigator Training
  - Over 600 federal agents trained in collection of hazardous evidence
- Investigative Case Support
- Hazardous Evidence Packaging
- Dedicated Laboratory Examination Space
  - $20M renovation underway for dedicated FBI forensic laboratory

Special Agent Instruction Book

TRUPAC I Shipping Container

Phase I Forensic Lab Renovation Completed

Maritime Security Support

- Maritime Background Radiation Program (MBRP)
- Mapping Surveys of Ports, Harbors and Marinas
- Vulnerability Assessments
- In-Land Waterway Analyses
- Off-Shore Inspection Strategies

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Domestic Nuclear Detection Office (DNDO) is Major SRNL Customer

DNDO Mission

The DNDO is a jointly-staffed, national office established to improve the Nation's capability to detect and report unauthorized attempts to import, possess, store, develop, or transport nuclear or radiological material for use against the Nation, and to further enhance this capability over time.

DHS's DNDO is major customer for SRNL, in particular, their Transformational and Applied Research Directorate which has this mission:

Develop break-through technologies that will have a clear and demonstrable positive impact on capabilities to detect nuclear threats through an aggressive and expedited R&D program.

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Radiation Detection Test and Evaluation

- US Government working to develop improved rad detection capabilities for DHS / DTRA / Others
- Objectively evaluate developmental and COTS equipment in operational environments
  - Nevada Test Site
  - Savannah River (SRNL / SRS)
  - Other DOE National Labs
- Radioactive material detection
  - Variety of short and long lived materials
  - Special Nuclear Material
  - Further advancement of technical capabilities
  - Equipment validation prior to purchase

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Detection Technical Challenges

- Radiation monitoring on air, land, and sea borders between points of entry
- Mobile or re-locatable radiation detection and monitoring
- Passive and active detection at larger standoff distances
- Widespread and/or networked radiation detection sensing systems

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Test & Evaluation Programs

- Major DHS program element
  - Developmental systems
  - COTS equipment
- Multiple environments
  - Lab-scale, automated
  - Maritime
  - Terrestrial
  - Aerial
  - Mobile ops.

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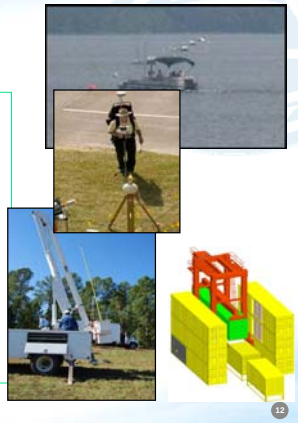
T&E Programs

Conducted by SRNL

- Crawdad Maritime – completed Summer 2008 at L-Lake
- Intelligent Personal Radiation Locator (IPRL) – completed in 2009
- Stand-off Radiation Detection Systems (SORDS) – Completed February 2010
- Dolphin Maritime – Completed March 2010 in San Diego
- Graduated Rad/Nuc Detector Evaluation and Reporting (GRaDER) – in progress
- On-Dock Rail – in progress



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T&E versus ATD

Test and Evaluation (T&E) applies to tests of developed equipment (COTS and GOTS) to evaluate performance and to inform acquisition decisions.

Advanced Technology Demonstration (ATD) applies to evaluation of new or improved technologies by evaluating prototypes.

DNDO funds and supports both but under different groups

SRNL supports both T&Es and ATDS

- Tend to use T&E as term for both

Characterization versus Testing

- Characterization term most applicable to ATD
- Testing most applicable to Test and Evaluation programs

Difference is?

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T&E Example Names– Named Alphabetically to Address Test Venue and/or Type completed in sequence.

Anole -	Handhelds, Backpacks
Bobcat -	Pagers
Crawdad –	Maritime SRNL supported and completed at L-Lake
Dolphin -	Maritime SRNL supported – completed at San Diego
Eland -	Vehicle Mounted Systems
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Gryphon –	Airborne detection system test –possible characterization for SRNL
H?	
I?	

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Dolphin in San Diego as a follow-up to Crawdad that used L-Lake at SRS.

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Detector Mounting for Dolphin in San Diego

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Unpaid Observers for Dolphin Test

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Advanced Technology Demonstrations

- Technology concept previously demonstrated
- Develop and test in simulated operational environment to generate performance data for cost-benefit decision to transition to commercial system development
- Goal for 2-3 ATD's per year
- Intelligent Personal Radiation Locator (IPRL) – FY06 start (Completed at SRS in 2009)
- Stand-off Radiation Detection System (SORDS) – FY07 start - 2010 end.
- Shielded Nuclear Alarm Resolution (SNAR) – FY08 start
- Intelligent Radiation Sensor System (IRSS) - FY09 Start
- Advanced Modules for Radiation Detection (ARMD) – FY10 Start

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ATD Development Path

Solicitation process, 6-12 mos

Contract award

Vendor development Typically 24 mos

Government Characterization and Analysis, 6-8 mos

Transition to Development and Acquisition cycle

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Intelligent Personal Radiation Locator ATD: (SRNL Conducted Characterization)

IPRL goal to build prototypes of small hand-held/wearable detectors with capability to distinguish benign from threat materials, indicate direction from which radiation is coming, and communicate wirelessly peer to peer

Program Results (Examples):

Cadmium Zinc Telluride Technology:

- CZT materials and packaging are mature technologies
- No significant difference in CZT material from two different foundries
- Directionality determination, < 20 deg, demonstrated via two different techniques

Energy range of operation 30 - 3000 keV demonstrated

Handheld unit with self-location (GPS), orientation determination, and communication capabilities achievable

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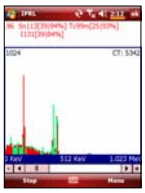
System Features

Isotope ID
Threat or Medical Isotope?

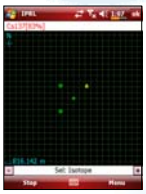
Location Finding
Which direction is radiation coming from?

Situational Awareness
Where was source found? Where are my teammates?



Spectrum Display

Direction Display



GPS Display

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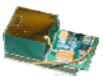
Major Hardware Components

^{3}He Neutron tube



CZT Modules

PDA

Wireless

High Voltage Power Supply

Orientation sensor

Battery Pack

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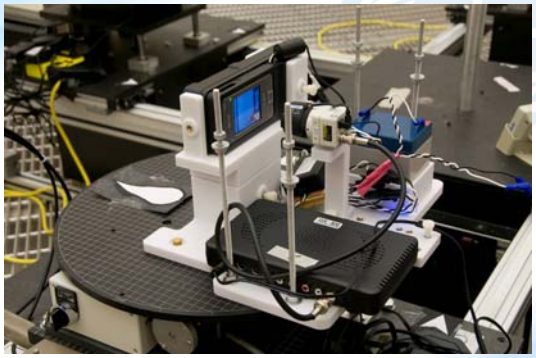

IPRL Test Station for Health Physics Instrument Calibrations Laboratory

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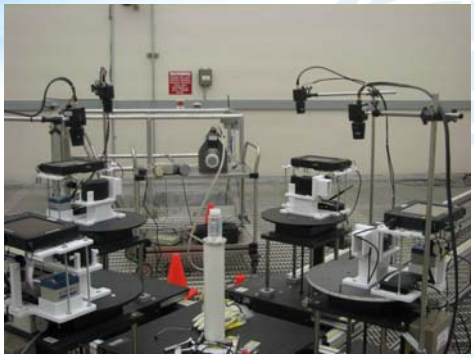

IPRL Laboratory Testing – IPRLs, Ground Truth Detectors, and Source in the Middle (Ground Truth = Reference Measurements)

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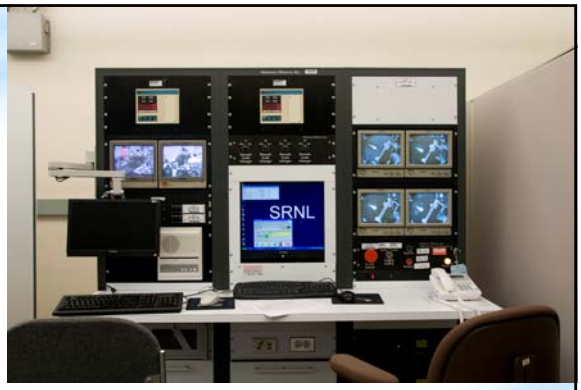

Console for IPRL Laboratory Testing

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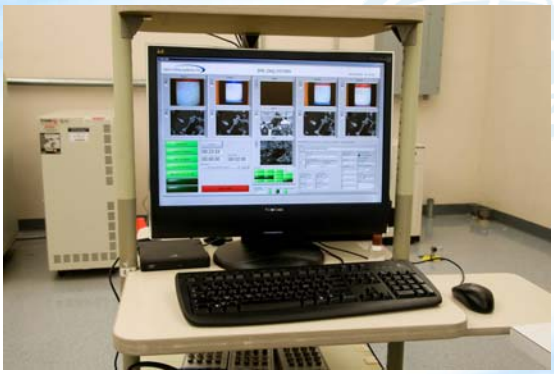

IPRL Data Acquisition Center (Vendor Developed)

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IPRL Data Collection Station for Data Review and Validation – (Flashview)

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IPRL Field Scenario Test Area

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IPRL Field Testing – Pulling Sources past IPRL Stations.

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IPRL "Wedding March" to the Source

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IPRL - Two Meter Distance Approach to Source

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Stand-Off Radiation Detection (SORDS)

Standoff Radiation Detection System (SORDS) second Advanced Technology Demonstration (ATD) for DNDO

Goal to demonstrate detection, identification, and localization of small radiation sources (1 mCi) at large distance (100 m) from moving platform

Units from four vendors completed characterization at SRS

- Analysis activities to complete in Spring 2010

SORDS will enable larger areas to be quickly searched and allow much more sensitive systems to be mobile

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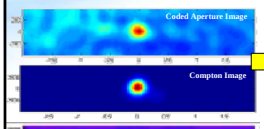
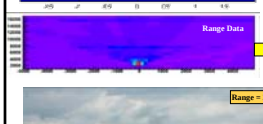
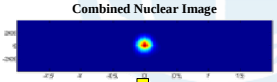
Fuse Nuclear Image with Optical Image

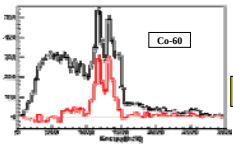




Combined Nuclear Image



Isotope ID



Overlay

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GE SORDS

- Design features investigated through characterization and analysis activities included:
  - Active coded mask
  - Curved vs. Linear mask
    - Investigate complexity of image reconstruction
    - Investigate gains in system field of view
  - Use of commercial health-care detectors (with some modification)
  - Compact design

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GE SORDS Detectors

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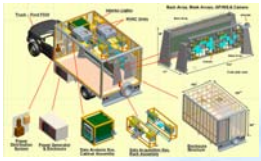
Raytheon SORDS

Design features investigated through characterization and analysis activities included:

- Combined coded aperture and Compton imaging technique
  - Increased Field Off View
  - More sensitive at higher energies
- Linear active coded mask
  - Efficiency gains over passive mask



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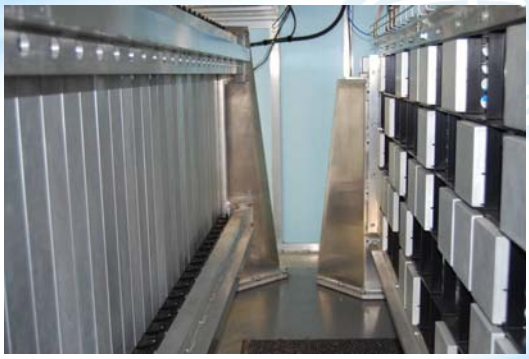

Raytheon SORDS Detector System

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NRL MISTI

- Design features investigated through characterization and analysis activities included:
  - Hybrid detector using enhanced spectral resolution HPGe detection array
  - 2-D coded aperture mask with NaI backplane for gamma-ray imaging

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NRL SORDS Detector System

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SAIC SORDS

- Design features investigated through characterization and analysis activities included:
  - Coded aperture passive mask/ anti-mask configuration
  - Cesium Iodide detectors offer slightly improved energy resolution over NaI
  - Dual sided imaging with one detector bank

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SAIC SORDS Detector Unit

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SORDS Units

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Representative Test Structure via SORDS

Team Approach

Personnel at Test Site

- DNDO Program Manager
- Characterization Scientist/s (DNDO or Contractor)
- Data Analysts – DNDO and DNDO Contract Personnel
  - Lawrence Berkeley National Laboratory &NASA/Goddard
- Vendor SORDS Operators and Technical Support
- Data Collection System team (SRNL and DNDO Contractor)
- Characterization Director and Deputy (SRNL)
- Source Handlers (SRNL)
- Radiological Control (SRNS when needed)
- SORDS Drivers and Logistics Support (SRNL and SRNS)
- QA – SRNL

25-30 Personnel per week when all SORDS units tested

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Test Process

Multiple measurements defined in advance for two major sets – static and dynamic measurements –

Static Measurement Variables

- Angle relative to determined effective detector center for each SORDS Unit.
  - Field of View (FOV) determinations (Correct imaging across a wide angle).
- Source type, activity, and distance from detector.
- Source elevation relative to effective detector center
- Number of measurements
- Minutes per measurement from 1-30 minutes with 3 most typical.

- Process to change and document measurements based on performance
  - Test Observation Reports (TORS) – electronic system/process to document changes and issues.

"Current measurement results inform future measurements"

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Dynamic Measurement Variables

- Speed as an important consideration (5-55mph)
- Source type, activity, and distance from detector.
- Source elevation relative to effective detector center.
- Number of measurements to obtain desired statistics for given measurement set. Number of measurements assigned typically range of 10-40 measurements for given setup.
- Orientation of SORDS unit relative to source – i.e., straight line, inside curve, outside curve, 90 degree turn, etc.

Total of nearly 2000 measurements per SORDS Unit

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Test Process Continued

Daily Schedule

- Provide a set of daily a.m. and p.m. measurements required and completed each day with same parameters as part of start up and shutdown
  - Backgrounds (static and moving)
  - Source measurement –Cs-137 1 mCi at 25 meters
- Provides data to determine system changes over time
  - Validate readiness of all systems
  - Validates data is being received in proper formats and all units and infrastructure are performing.
- Start of day and end of day team briefings.

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SOURCE Examples

Americium 241

Cobalt-57 and Cobalt-60

Cesium-137

Barium-133

Tin-113

Strontium-90

Cadmium-109

Yittrium-88

Germanium-68

Medicals (I-131, Tc99m, Ga-67) - local supplier.

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Quantities varied for isotopes – distances and speeds.

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Source Pole Used to Raise and Lower Sources to Desire Height –

Uneven terrain meant height adjustments needed as source was moved around static arc.

Static Testing 25 Meter Arc

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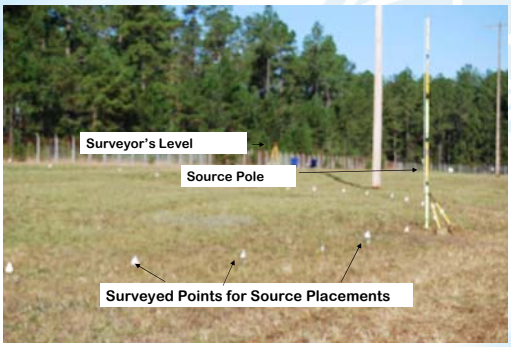

Source Pole and Surveyor's Level Used to Validate Proper Height and Surveyed Points marked with bar-coded flags

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Surveyor's Level to Validate Source Height with Detector Center

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Depleted Uranium Source Mounted on Aluminum Ladder (Little Giant)

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Use of "Bucket" Truck for Elevated Field of View Measurements

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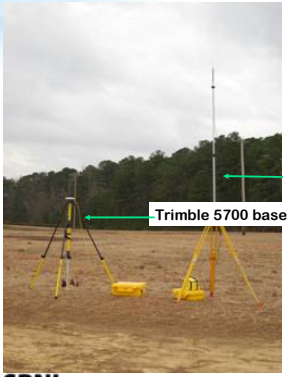

Trimble transmitter sends base signal to GPS units in field.

Trimble 5700 base station acquires Satellite position

SRNL GPS Units for Ground Truth Location Documentation

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Wireless Access Point for Data Transmission to transmit SORDS Unit Data

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Computer Tablet Example – For Wireless Data Transmissions

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Trailers for Data Collection, Command and Control, and Vendors. Antenna is for Vendor Reachback (Mobile Operations)

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Data Collection Trailer – Computers for Data Receipt and Transmission, Monitor for Weather Monitoring, Network Time Display

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Command and Data Analysis Trailer – Also for QA

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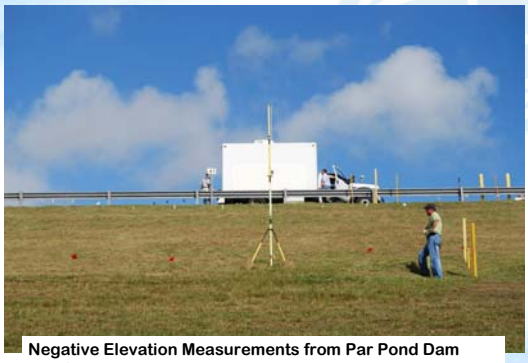

Negative Elevation Measurements from Par Pond Dam Road

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Leveling NRL Vehicle and marking effective Detector Center for Static Measurements

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SORDS Vehicles – Dynamic Testing around Rail yard 1.6 mile loop.

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D-Area – Urban Environment Measurements

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Adjusting to Technical Difficulties

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SAIC SORDS Trailer Moving Past Source

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PreHoliday Luncheon

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SORDS Team on last Characterization Day with Four Units

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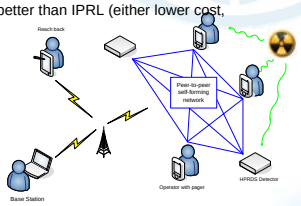
Future DNDO ATDs (Examples) – Intelligent Radiation Sensor System ATD

- IRSS ATD will demonstrate advanced technology required to improve ability to detect, localize, and identify radiological sources by integrating data from multiple radiation detectors.
- Demonstrate system performance better than IPRL (either lower cost, improved detection, or both)



Technical Approach

- **Detectors –** Use available portable detectors to form distributed sensor system.
- **Wireless Network –** Develop robust communications for fielded detector hardware.
- **Data Structure –** Implement well-defined data structure.
- **Algorithms –** Integrate advanced algorithms to provide enhanced ability to locate and identify sources.
- **Sensor System –** Develop distributed sensor system with performance superior to a system of individual detectors.

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Future: Advanced Radiation Monitoring Device (ARMD) ATD

- ARMDs new generation of handheld instruments
- To address balance between high sensitivity and small size
- Can assess/compare to COTS units

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Underway: DNDO Graduated Rad/Nuc Detector Evaluation and Reporting (GRaDER)

- Formal process to evaluate rad detectors to support purchases
  - Identify radiation detection products that satisfy standards and Homeland Security mission requirements
  - Help purchasers make informed acquisition decisions
  - Can't purchase without GRaDER acceptable evaluation
  - SRNL to be one of three approved GRaDER sites via Health Physics Instrument Calibrations Laboratory in partnership with Global Testing Lab (GTL) from Tenn.

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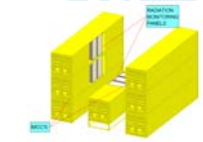
Project Underway for SRNL in 2010

On-Dock Rail Straddle Portal Prototype

Scope

SRNL On-Dock Rail scope to design, fabricate, integrate, install and test prototype radiation portal monitoring system to be used with straddle carriers transporting Intermodal Cargo Containers to rail cars at Port of Tacoma, Washington.



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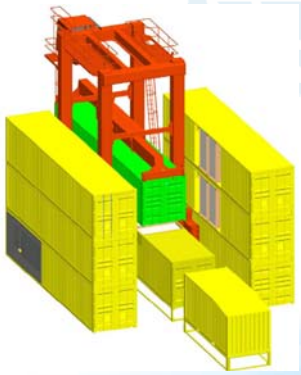
Straddle Carrier in the Portal



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End

Questions, Comments, Suggestions?

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