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Title: Second Line of Defense Radiation Inspection Equipment and Testing

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Second Line of Defense Radiation Inspection Equipment and Testing

Presentation for

Dubai Ports World

موانئ دبي العالمية
DP WORLD

SECOND LINE OF DEFENSE
International Security Program

Los Alamos National Laboratory

8 November 2012

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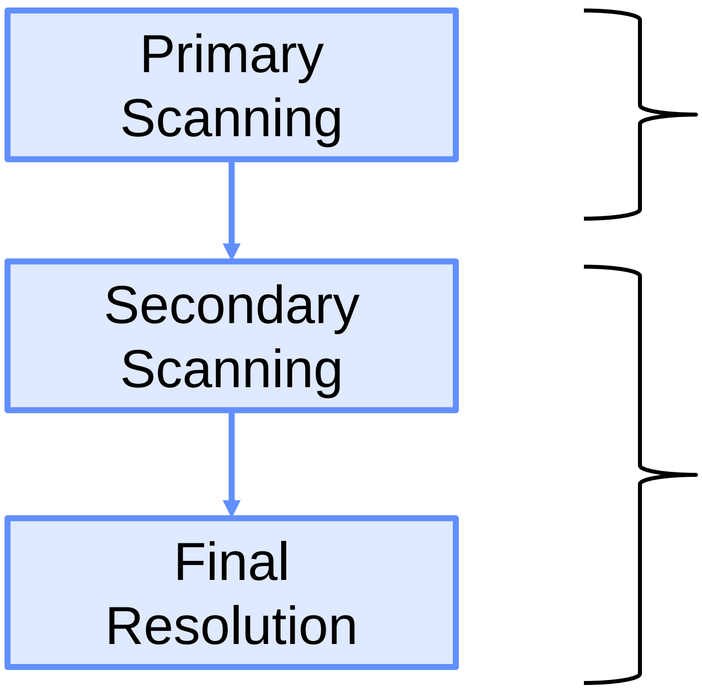
NNSA National Nuclear Security Administration

Topics

1. Equipment and Deployment Overview
2. Equipment Selection Process
3. SLD Testing Facility
4. Primary Screening Vehicle Monitors
   - Deployment
   - Concept of operations (CONOPs)
   - Background and suppression
5. Secondary Screening
   - Radioisotope identification devices (RIIDs)
   - Spectroscopic portal monitors (SPMs)
6. Other Systems
   - Radiation detection straddle carrier (RMDS)
   - Mobile radiation detection and identification system (MRDIS)
   - Spreader bar radiation detection system (SBRD)

Deployed Vehicle Monitor

SLD Radiation Detection Equipment Overview



Gross-Counting __Detection__ Systems

- Fixed or relocatable platforms
- Gamma and neutron sensitivity
- High throughput rate
- Low false alarm rate (FAR)
- Limited ability to prevent nuisance alarms through NORM discrimination and identification

Spectroscopic Isotope __Identification__ Systems

- Handheld search and RIID instruments
- Fixed spectroscopic portals
- Generally a slower, lower-throughput inspection process

A __multi-layered approach__ is critical to the overall inspection process.

Equipment Selection and Testing Process

1. Mission Basis
   - Threats
   - Operational bounds
2. Equipment Requirements, e.g.,
   - Detection sensitivities, FARs
   - Drive-through speeds, spacing, heights
3. Procurement and Acceptance Testing
   - Do systems meet program requirements?
4. Field Evaluation and Pilots
   - Do systems function in the field as specified?
   - Solving problems is often an iterative process
   - Solutions to field issues may require additional testing
5. Other Types of Testing
   - Characterization of performance and concept of operations (CONOPS)

TSA VM-250 RPM

SLD Test Facilities

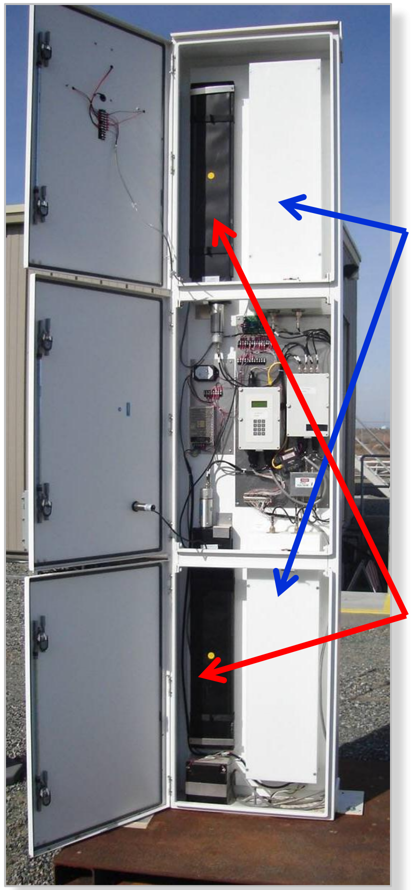
LANL TA-35 Test Facility

- Single drive-through lane
- Multiple test pads
- HEU, Pu, industrial sources
- Test in progress of Thermo and Canberra SPMs, TSA RPM

LANL TA-16 Test Facility

- 3 lanes, 1 with 5 test pads
- HEU, Pu, industrial sources
- Trenches for data and auxiliary power

List of Tested Primary Screening Systems



Inside a TSA VM-250 Primary Screening Panel

Deployed Primary Gross Counting Systems – TSA and Aspect Yantar

- Vehicle Monitor
- Mobile Van Monitor
- Pedestrian Monitor

Other ***Deployed*** Primary Systems

- TSA Mobile Detection System MD-134
- Radiation Detection Straddle Carrier (RDSC)
- Mobile Radiation Detection and Identification System (MRDIS)
- TSA Luggage Monitor

Other Tested Systems (***Not Deployed***)

- VeriTainer Spreader Bar Radiation Detection System (SBRD)
- IAT/Bromma SBRD
- Jersey Barrier ISCPM

List of Tested Secondary Systems

Deployed Radioisotope Identification Devices (RIIDs)

- ORTEC Detective
- FLIR identiFINDER
- Aspect MKC

Deployed Spectroscopic Portal Monitors (SPMs)

- Thermo-Fisher SPM
- Canberra SPM
- Totem Plus Radioactive Material Detection System (RMDS)

Other Tested Systems (***Not Deployed***)

- Smiths Detection RadSeeker RIID
- Raytheon SPM
- SAIC ST-20 SPM
- ORTEC Mobile Sodium Iodide

LANL TA-35 Testbed

Primary Screening

Gross-Counting Radiation Portal Monitors (RPMs)

- VM-250AGN and Yantar 1A meet SLD specifications for both gamma ray and neutron detection with nominal CONOPS and within specified background
- PVT plastic scintillator gamma detectors can detect but not identify radiological material

Nominal Concept of Operations (CONOPS)

- Pillar spacing 4.6 m
- Drive through speed 8 kph

Impact of Off-Nominal CONOPS on Minimum Detectable Quantity (MDQ)

- Increasing pillar spacing raises MDQ
- Increasing drive through speed raises MDQ

TSA VM-250 Master Pillar

Aspect (Dubna) Yantar 1A

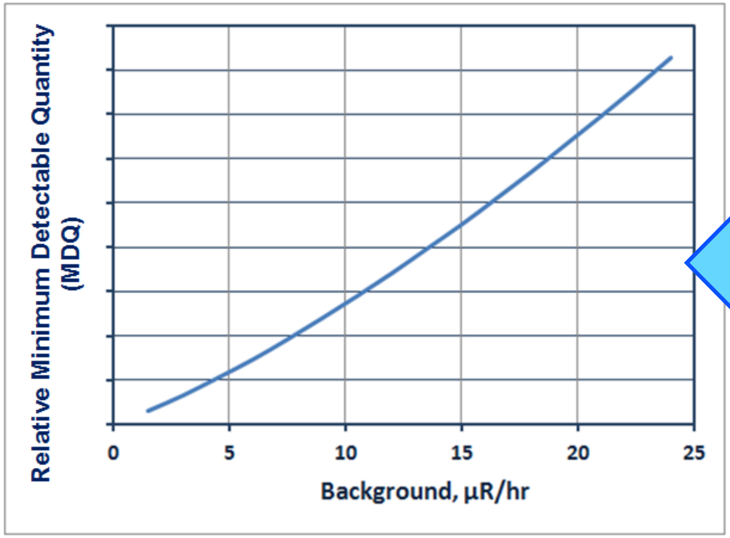
Neutron and Gamma Background

Neutron Detection

- Standard detectors use He-3 tubes to detect neutrons
- He-3 supply is limited; alternative systems are being developed and tested

Neutron Background

- Near 5 counts per second (cps) in TSA and Yantar vehicle monitors at sea level, moderate latitudes; increases up to 30 cps at altitude and farther north
- FAR is very low, so best CONOPS for neutron alarm is to drive container through RPM again to verify presence of neutron source



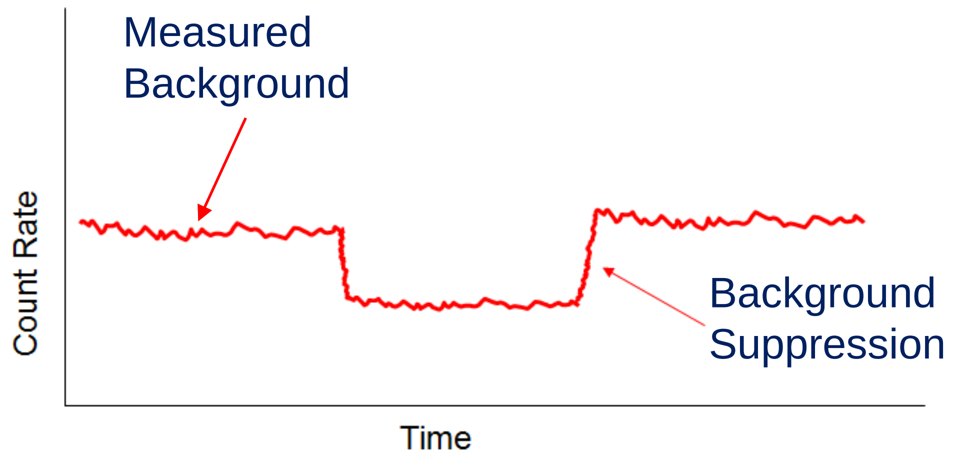
SLD Gamma-Ray Background Specification

- 20 μR/h (equals 2600 cps in VM-250)
- Most seaports have lower background
- MDQ increases as gamma-ray background increases

Background Suppression

Gross-counting RPM operation

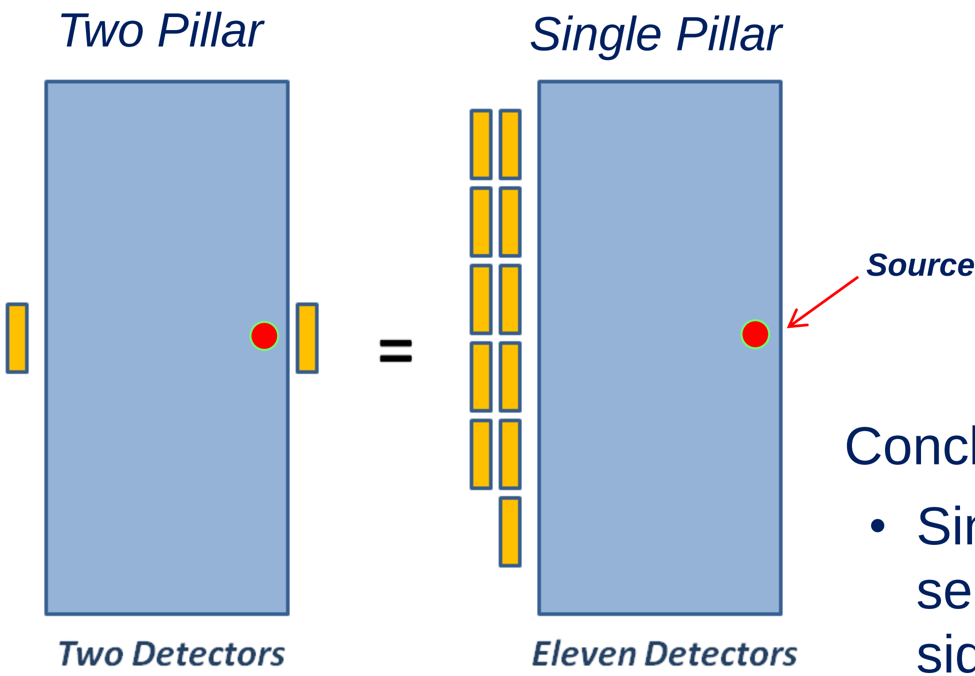
- RPM measures background when no container is present
- This background is compared with signal during occupancy
- But background during occupancy is suppressed because tractor, trailer, container, and container load absorb background radiation from the ground

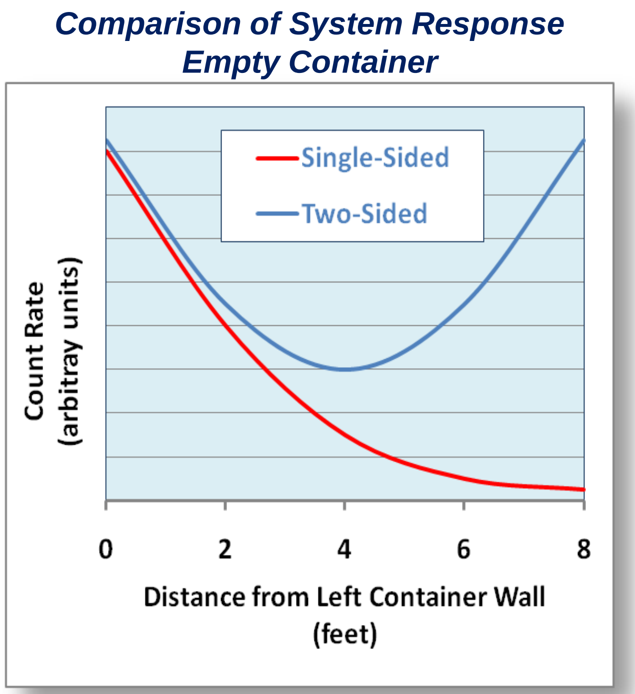


- Average suppression is ~20% but can be as high as 40% - 45%
- So RPM “oversubtracts” background
- Therefore, background suppression requires greater signal from source to alarm RPM
- Background suppression for neutrons is negligible

Single-Pillar vs Two-Pillar Deployment

- Two-pillar deployment is always preferred
- If a single-sided system can *barely* detect a source at the center of a uniformly loaded container, to detect a source on the other side requires one of these two configurations:





Conclusion:

- Single-pillar deployment reduces sensitivity to sources on the far side of loaded container

Secondary Screening with RIIDs

General Observations and Comments

- Small detector size → long measurement time
- High-resolution HPGe detector had reasonably good overall performance
- Neutron detectors on RIIDs are too small to be useful
- SLD is working with vendors to improve performance

These RIIDs were tested at LANL:

ORTEC Detective
(used by SLD)

FLIR identiFINDER
(used by SLD)

Aspect MKC
(used by SLD)

Smiths Detection
RadSeeker

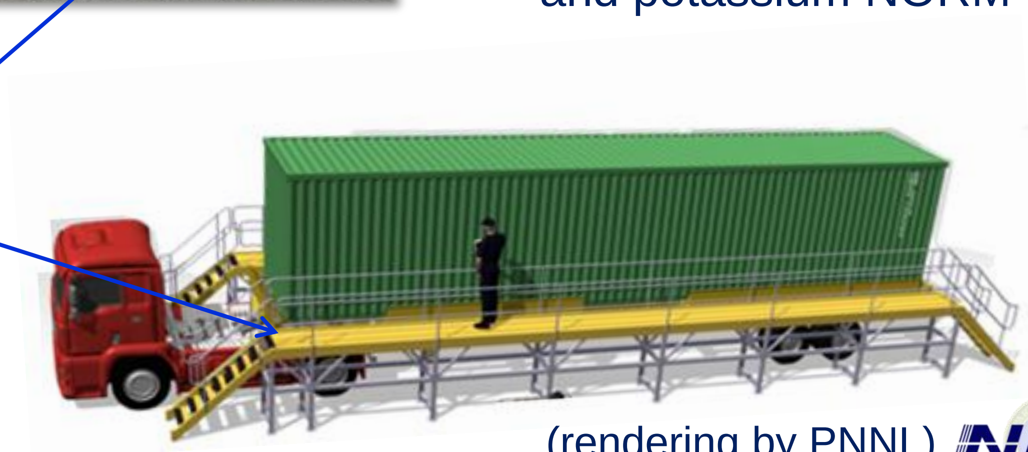
LANL RIIDs Tests

- Tests were performed at LANL TA-35 testbed
- Some tests were repeated at ORNL, which has lower background

LANL tests included

- HEU
- Plutonium
- Empty container
- Containers with thorium and uranium decay chain NORM and potassium NORM

Providing stair steps on wheels or a platform (illustrated) is very helpful to operators



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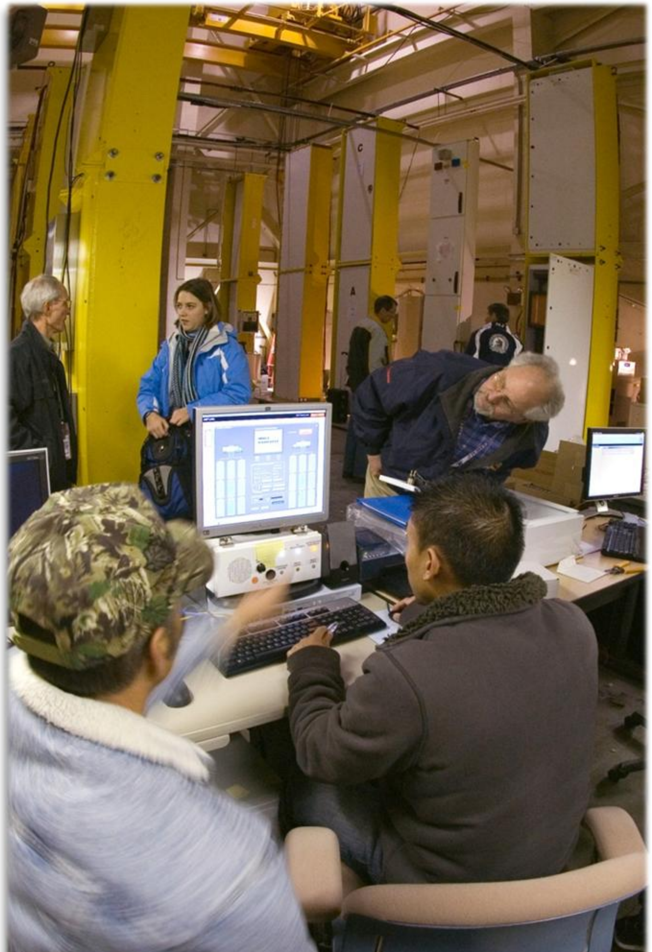
Secondary Screening with SPMs



LANL SLD-DNDO High Bay Test

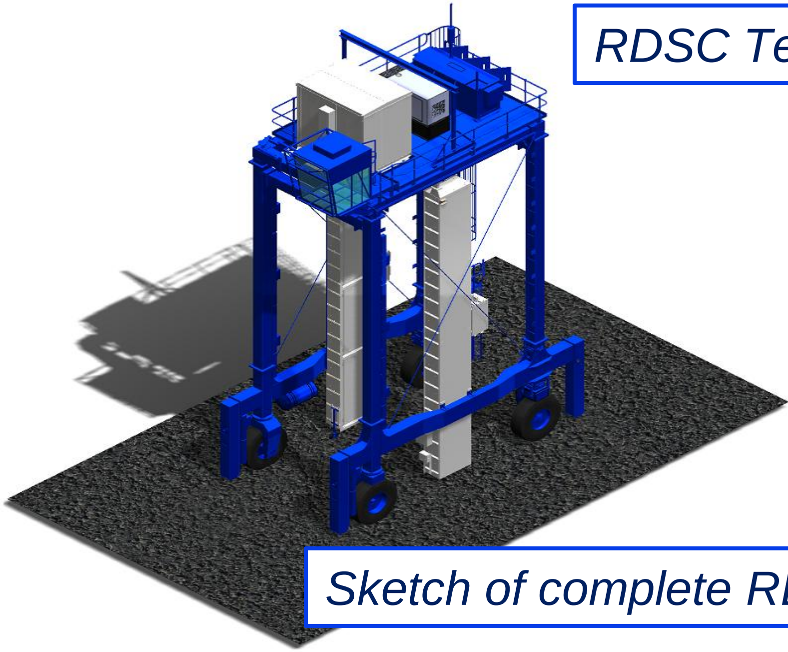
SPM advantages over RIIDs

- Much larger gamma and neutron detectors
- Drive-through scan may find streaming paths
- Full coverage of container
- Scan in 30 seconds or less at 5 kph
- Can identify threat source against NORM masking at high levels of NORM activity in commerce

But SPMs are costly

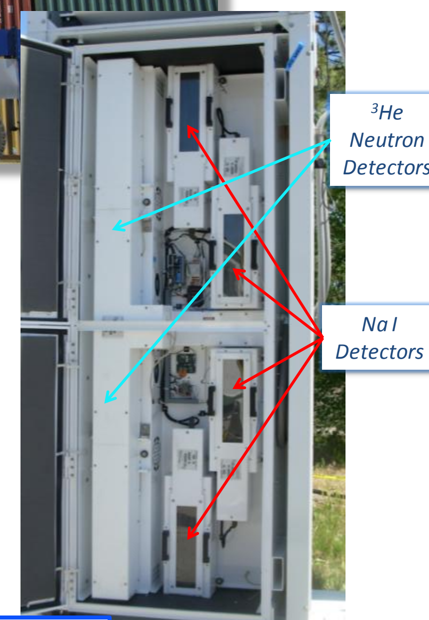
- 20x the equipment cost of gross-counting vehicle monitors
- Operational costs are higher
- SPMs are complex
- Operators need greater training

RDSC



Sketch of complete RDSC

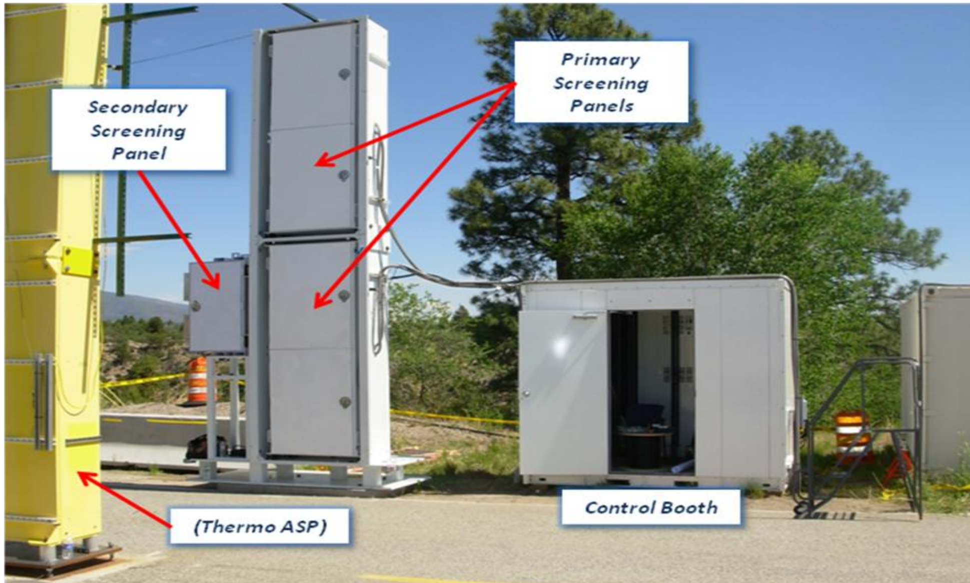
RDSC Testing at Freeport

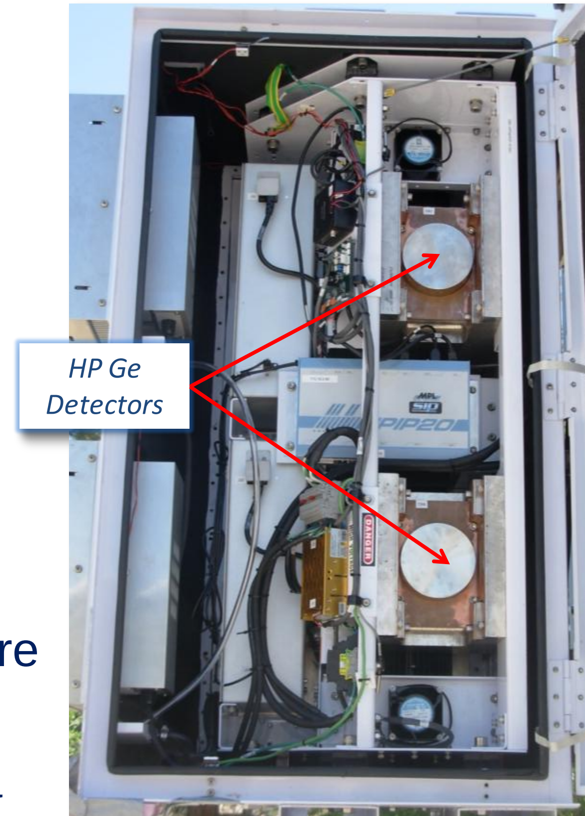


RDSC Primary Screening Panel

- The RDSC is useful for scanning transshipped containers
- It can scan container stacks up to 3 high
- Primary scan at 5 kph
- RDSC returns to alarming container for secondary scan
- Secondary scan time ~ 5 minutes for 20-ft-long container

RDSC Tests at LANL





RDSC Secondary Screening Panel

- RDSC primary and secondary screening panels were installed at LANL testbed; only one side was tested
- Detectors: Primary gamma NaI, secondary gamma HPGe, neutron ^{3}He tubes in polyethylene moderator
- The panels were stationary, and the source was moved – opposite of RDSC operation

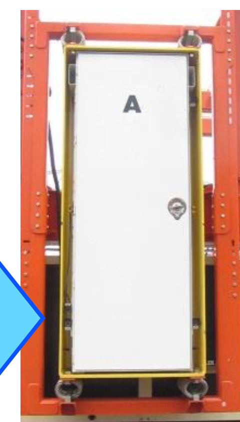
(The Thermo ASP was not used in the tests)

MRDIS*

RPM-MRDIS (Primary)

SPM-MRDIS (Secondary)

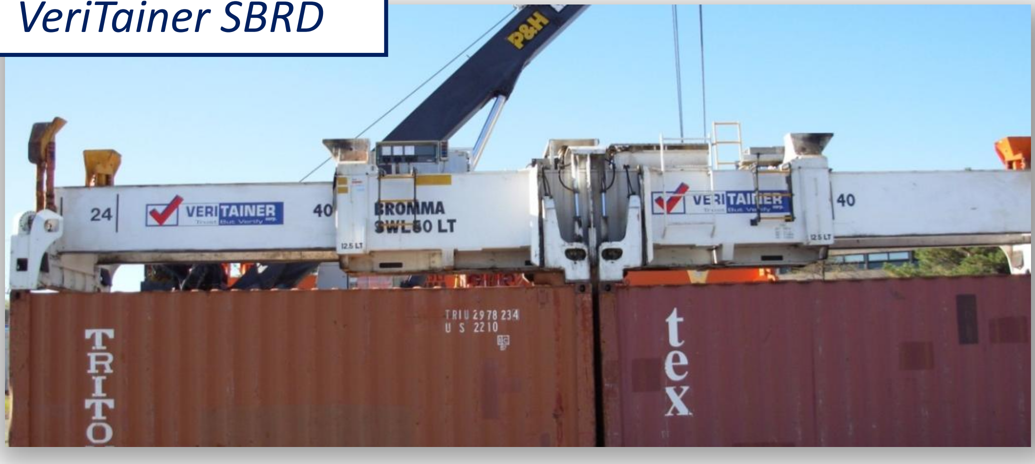
- MRDIS can be driven and parked in response to needs of yard operations
- MRDIS can be used for transshipment
- Full TSA vehicle monitor RPM deployed on MRDIS for primary screening
- ½ of a Thermo SPM system deployed on MRDIS for secondary screening



*Mobile Radiation Detection and Identification System

Spreader Bar Radiation Detectors

VeriTainer SBRD



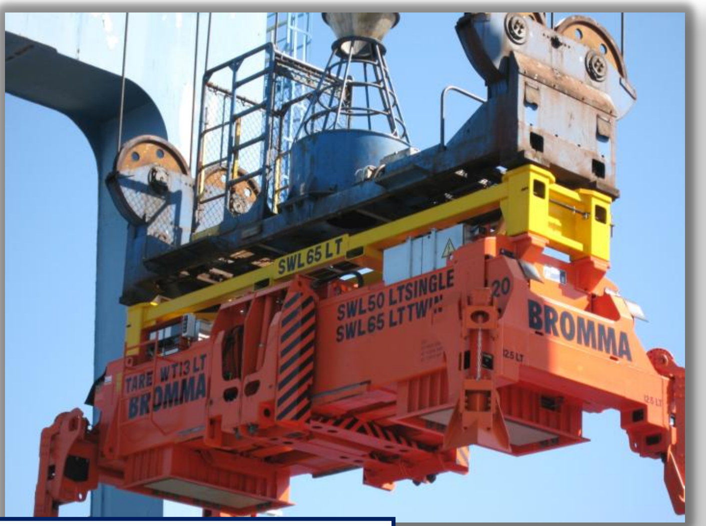
These systems are spreader bars instrumented with NaI gamma and He-3 neutron detectors

Concept

- Long-dwell measurement made during transfer from ship to dock

Problems

- One-sided measurement and nonuniform detector distribution
- → very limited coverage of container volume
- Background changes during measurement



Bromma-IAT SBRD

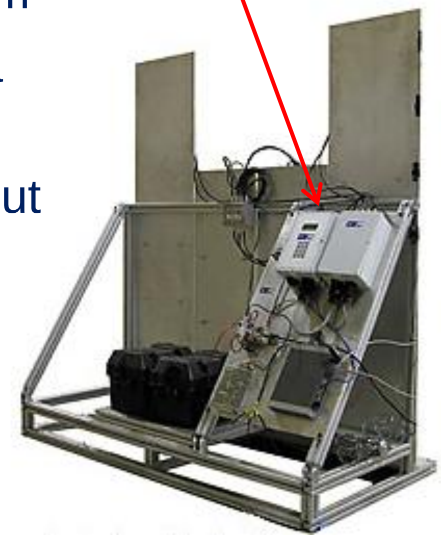
Background Information

Mobile Detection Systems

Rapiscan TSA MD134

- Skid-mounted detection system
- PVT plastic scintillator gamma detectors
- Gross-counting – can detect but not identify source
- He-3 neutron detectors
- Trailer with second skid available but usually deployed as single-sided system

Controller



Gamma Detectors

Neutron Detectors

Cutaway View of Skid in Van

Test Results and Issues

LANL Test Results – MDS stationary

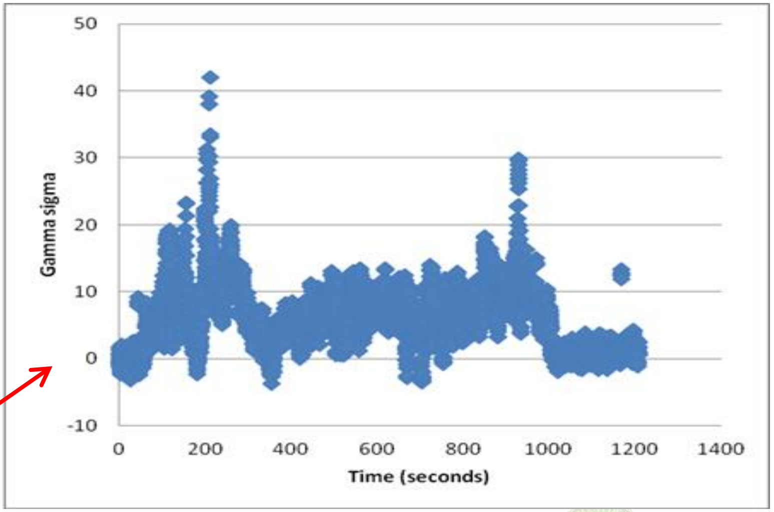
- Tested with test source in moving minivan
- Not tested with containers
- Performance similar to TSA vehicle monitor but degraded because of single-pillar limitations

Stationary Mode

- Can detect sources best in near lane
- And at low velocities – 8 kph nominal

Moving Scan Mode

- Rapid background variation creates high false alarm rate (FAR) in moving mode



Background along roadway