Detecting and Using Radiation in Security Application

Leticia Pibida, Ph.D.
leticia.pibida@nist.gov

Team members:
Fred Bateman, Paul Bergstrom, Heather Chen-Mayer, Jack Glover, Larry Hudson, Ronnie Minniti, Ron Tosh, Michael Unterweger, Peter Volkovitsky
Summary of NIST Efforts

• Testing of radiation detection instruments
  – Test design
  – Technical support during test execution
  – Data Analysis and Report

• Standard development
  – Consensus standards – ANSI/IEEE, IEC, ASTM
  – Technical capability standards – Government unique standards
  – Validation of standards

• Development of sources for testing

• Development of the Graduated Rad/Nuc Detector Evaluation and Reporting (GRaDER) Program
  – Develop components of the program – T&E protocols, NVLAP Handbook, review of testing labs capabilities, proficiency test, post-market surveillance
  – Review test results – provided test reports
Rad/Nuc Detector Standards Development

http://standards.ieee.org/getN42/

- **ANSI N42.32** (equivalent IEC 62401)

- **ANSI N42.33** (equivalent IEC 62533)

- **ANSI N42.34** (equivalent IEC 62327)
  - American National Standard Performance Criteria for Hand-held Instruments for the Detection and Identification of Radionuclides

- **ANSI N42.35** (equivalent IEC 62244)
Rad/Nuc Detector Standards Development

• ANSI N42.37  (training standards)
  – Training Requirements for Homeland Security Purposes
    Using Radiation Detection Instrumentation for Interdiction and Prevention

• ANSI N42.38 (equivalent IEC 62484)
  – Performance Criteria for Spectroscopy-Based Portal Monitors used for
    Homeland Security

• ANSI N42.39 (equivalent IEC 62534)
  – Performance Criteria for Neutron Detectors for Homeland Security

• ANSI N42.42  (applicable to all instrument standards)
  – Data format standard for radiation detectors used for Homeland Security

Information on ANSI N42.42: http://www.nist.gov/pml/div682/grp04/n42.cfm
Rad/Nuc Detector Standards Development

- **ANSI N42.43** (no IEC equivalent)
  - Standard for Mobile and Transportable Systems Including Cranes used for Homeland Security Applications

- **ANSI N42.48** (equivalent IEC 62618)
  - American National Standard Performance Requirements for Spectroscopic Personal Radiation Detectors (SPRDs) for Homeland Security

- **ANSI N42.49 A & B** (no IEC equivalent)
  - Performance Criteria for Personal Emergency Radiation Detectors (PERDs) for Exposure Control

- **ANSI N42.53** (equivalent IEC 62694)
  - Performance Criteria for Backpack Based Radiation Detector Systems Used for Homeland Security

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• **General tests:** display, weight, size, data format, alarms, user interface (depend on detector type)

• **Radiological tests:** exposure rate, background, false alarm, gamma and neutron response, (strongly depend on detector type)

• **Environmental tests:** temperature, humidity, sealing (similar for all type of detectors)

• **Mechanical tests:** mechanical shocks, vibration, drop test (strongly depend on detector type)

• **Electromagnetic tests:** external magnetic fields, radio frequency, conducted disturbances (burst and radio frequencies), surges and oscillatory waves, electrostatic discharges (similar for all type of detectors)
**ITRAP+10 Testing Against Standards**

Testing against IEC and ANSI standard:

- PRDs
- RIDS
- Gamma high sensitivity meters
- Neutron high sensitivity meters
- Backpacks
- Portal monitors – gross count and spectrometric
- Mobile systems
- SPRDs

Includes US and EU laboratories:

- JRC (Ispra)
- PNNL
- SRNL
- ORNL
Source Development and Calibration

- Produced, calibrated and supplied of gamma-ray and neutron sources to laboratories, for use in equipment testing against ANSI and IEC standards.

- Developed new $^{232}$Th (14 $\mu$Ci), $^{232}$U (14 $\mu$Ci - 100 $\mu$Ci) and $^{226}$Ra (8 $\mu$Ci) sources for use in testing against N42.38.

- Helped source manufacturers with design, calibration and development of new sources – Commercialized by Eckert and Ziegler (E&Z) - Provides private sector participation
Source Development for Maritime Testing

Develop new sources for use during testing (special geometry)

Sources are design to:
- Float
- Spherical symmetric emission
- Mimic $^{60}$Co irradiators
- Mimic $^{137}$Cs density gauges
- Surrogates for SNM

<table>
<thead>
<tr>
<th>Radionuclide</th>
<th>Emission Rate</th>
<th>Comments</th>
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<tr>
<td>$^{57}$Co</td>
<td>$1.46 \times 10^6 \gamma/s$</td>
<td>5% for 122 keV, Equivalent to bare source</td>
</tr>
<tr>
<td>$^{60}$Co</td>
<td>$10.18 \times 10^6 \gamma/s$</td>
<td>5% for 1332 keV, Equivalent to irradiator</td>
</tr>
<tr>
<td>$^{133}$Ba</td>
<td>$7.15 \times 10^6 \gamma/s$</td>
<td>5% for 356 keV, Equivalent to bare source</td>
</tr>
<tr>
<td>$^{137}$Cs</td>
<td>$34.2 \times 10^6 \gamma/s$</td>
<td>5% for 662 keV, Equivalent to density gauge</td>
</tr>
<tr>
<td>$^{252}$Cf</td>
<td>$2 \times 10^4 n/s$</td>
<td>20%</td>
</tr>
</tbody>
</table>
NORM Measurements and Characterization

• Samples measured
  – Tiles
  – Cat Litter
  – Ice Melt
  – Roofing tiles
  – Hay
  – Coal
  – Granite

• Samples measured
  – Australian Zircon Sand
  – Diammonium phosphate (DAP)
  – ISG Pye
  – CEMEX type FC
  – Monocalcium phosphate (biofos)
X-Ray Screening/ Active Interrogation Standards
Development

- **ANSI N42.41**  (no IEC equivalent)
  - Performance Criteria for Active Interrogation Systems used for Homeland Security

- **ANSI N42.44**  (no IEC equivalent)
  - Performance and evaluation of checkpoint cabinet x-ray imaging security-screening systems

- **ANSI N42.45**  (no IEC equivalent)
  - Evaluating the image quality of x-ray computed tomography security-screening systems

- **ANSI N42.46**  (equivalent IEC 62523)
  - Measuring the performance of imagining x-ray and gamma-ray systems for cargo and vehicle security screening

- **ANSI N42.47**  (equivalent IEC 62463/62709)
  - Measuring the performance of imagining x-ray and gamma-ray systems for security screening of humans

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Test Objects for Testing X-Ray Screening

Standard test objects, test methods, T&E protocols, and minimum performance requirements
High Energy X-Rays Dosimetry Standard

- Ionization chamber to measure AIR KERMA from systems with peak voltages between 6 MV and 10 MV
- Leakage currents stable $< 5 \times 10^{-15}$ A
- Operating voltage is optimized at 300 V
- Chamber response is linear with increasing x-ray fluence
- Charge-collection efficiencies are of the order of 99%
- Monte Carlo calculations for estimating wall correction (about 8%); etc.
- Testing at both NIST Clinac megavoltage x-ray source and $^{60}$Co beams

![Prototype brass-wall ion chamber to measure high-E beams (cargo)]
Results are based on a pass/fail criteria set by the standards.
Laboratories are accredited for each section in the standard

The handbook has an annex that includes a list of questions for the NVLAP assessors for laboratory on-site assessment.
Test Campaigns – DNDO/NIST

- Advance Spectroscopic Portal Monitors (ASP)
- Anole – RIDs, Backpacks, Mobile
- Bobcat – PRDs
- Crawdad – Maritime Baseline (lake)
- Dolphin – Maritime (open sea)
- Eland – Mobile systems
- Gryphon – Aerial systems
- PaxBag – Airport systems
- International General Aviation (IGA)
- Straddle Portal Monitors

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Thank you for your attention

Questions?