Instrument Standards Used in Security Applications

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Summary of NIST Efforts in DHS/DNDO Work

- **Standard development**
  - – Consensus standards – ANSI/ IEEE, IEC, ASTM
  - – Technical capability standards – Government unique standards being developed by DHS/DNDO
  - – Validation testing of standards
- **DHS/DNDO Testing of radiation detection instruments against standards**
  - – GRaDER®
  - – ITRAP+10

Rad/Nuc Detector Standards Development

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

- **ANSI N42.32 (IEC 62401)** **under revision**

– American National Standard Performance Criteria for Alarming Personal Radiation Detectors for Homeland Security




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

– American National Standard for Portable Radiation Detection Instrumentation for Homeland Security




- **ANSI N42.34 (IEC 62327)** **under revision**

– American National Standard Performance Criteria for Hand-held Instruments for the Detection and Identification of Radionuclides



- **ANSI N42.35 (IEC 62244)** **under revision**

– American National Standard for Evaluation and Performance of Radiation Detection Portal Monitors for Use in Homeland Security




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Rad/Nuc Detector Standards Development

- **ANSI N42.37**
  – Training Requirements for Homeland Security Purposes Using Radiation Detection Instrumentation for Interdiction and Prevention

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

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

- **ANSI N42.42 (IEC 62755) applicable to all instrument standards** **revision balloted**
  – 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)**
  - Standard for Mobile and Transportable Systems Including Cranes used for Homeland Security Applications

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

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

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

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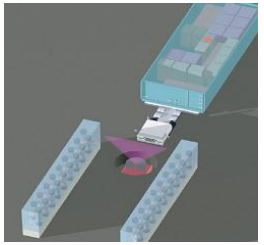
X-Ray Screening/ Active Interrogation Standards Development

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



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

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

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

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

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IEC Standards Under Development WG B15

- SPRDs: **IEC 62618**
  - It is out as a CDV
- Backpacks (BRDs): **IEC 62694**
  - It is out as a CD3
- Imagining x-ray and gamma-ray systems for security screening of humans: **IEC 62709**
  - It is out as a CDV
  - The radiation safety part was developed in the IEC 62463 under WG B9
- Data format standard: **IEC 62755**
  - It is out as a CDV
  - Applicable to all radiation detection instrument standards

Rad/Nuc ANSI N42/IEC Standards Tests Types

- 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)

Applicable Standards/Technologies for Cargo Screening

- **RIIDs** **ANSI N42.34** **(IEC 62327)**
  - Main use: CBP, Coast Guards, ports, borders, security
- **RPMs** **ANSI N42.35** **(IEC 62244)**
  - Main use: CBP, ports, borders, security
- **SRPMs** **ANSI N42.38** **(IEC 62484)**
  - Main use: ports, borders, security (outside the US)
- **Mobile and Crane Systems** **ANSI N42.43**
  - Main use: CBP, ports, borders, security
- **BRDs** **ANSI N42.53** **(IEC 62694))**
  - Main use: Coast Guards, security, law enforcement
- **Cargo and vehicle imaging** **ANSI N42.46** **(IEC 62523)**
  - Main use: CBP, aviation, ports

Main Differences Between ANSI and IEC Standards - RIIDs

- **Warm-up/stabilization time:** IEC 10 min of power on. ANSI 2 min from dead start or standby.
- **Data format:** IEC provide list of elements required. ANSI adds ANSI N42.42 data format requirements
- **Battery life:** IEC 5 h. ANSI 2 h.
- **Alarms:** IEC requires an ambient dose equivalent rate indication (gammas and neutrons). ANSI requires a personnel protection alarm it does not specify if it is gamma and/or neutron.
- **Explosive atmospheres:** IEC no requirement. ANSI requires certificate if claimed by manufacturer
- **Response time gamma:** IEC gamma alarm within 3 s and ambient dose equivalent rate indication (±30% of 0.5 μSv/h) within 5 s. ANSI alarm within 2 s 50 μR/h (Cs-137) and exposure rate indication (±50% of 50 μR/h) within 5 s.
- **Response time neutron:** IEC within 10 s for Cf-252 20,000 n/s at 25 cm. ANSI within 2 s same source.
- **Dose/Exposure rate indication:** IEC ±30% 5 μSv h–1, 20 μSv h–1, 80 μSv h–1. ANSI ±30% for 0.1 mR/h, 5 mR/h, and 80% of the manufacturer-stated maximum response.
- **ID radiation quantity:** IEC uses ambient dose equivalent rate. ANSI uses exposure rate
- **Radionuclide ID:** IEC 1 min unshielded ^{111}In, ^{133}Xe, ^{99m}Tc, ^{201}Tl, ^{67}Ga, ^{125}I, ^{123}I, ^{131}I, ^{18}F. ANSI 2 min unshielded ^{40}K, ^{57}Co, ^{60}Co, ^{67}Ga, ^{99m}Tc, ^{125}I, ^{131}I, ^{133}Ba, ^{137}Cs, ^{192}Ir, ^{201}Tl, ^{226}Ra, ^{232}Th, ^{233}U, ^{235}U, ^{238}U, Pu [Reactor grade plutonium (>6% ^{240}Pu)], ^{241}Am. Shielded source: IEC has 3 mm and 5 mm steel. ANSI has 5 mm steel different set of sources.
- **Mixed radionuclides:** IEC has ^{137}Cs + HEU, ^{131}I + HEU, ^{57}Co + HEU, and ^{133}Ba + RGPu. ANSI has ^{133}Ba + RGPu.
- **Interfering ionizing radiation (beta), FWHM, efficiency:** IEC no requirement. ANSI has requirements.
- **Impact (microphonics):** IEC no requirement. ANSI 50 g peak acceleration, each applied for a nominal 18 ms in each of three mutually orthogonal axes

Main Differences Between ANSI and IEC Standards - RPMs

- **Gamma sources:** IEC uses Am-241 17 MBq, Cs-137 600 kBq, Co-60 150 kBq and ANSI uses Co-57 185 kBq, Ba-133 518 kBq, Cs-137 592 kBq, Co-60 259 kBq, Th-232 518 kBq, Am-241 1.74 MBq.
- **Neutron source:** IEC uses Cf-252 unscattered fluence rate of 0.04 n/cm^2/s at face of RPM (equivalent to 20000 n/s 2 m). ANSI uses a 20000 n/s Cf-252 the distance to the RPM depends on type of portal (can vary between 1 and 5 m)
- **False alarm rate:** IEC no alarms in 100 h. ANSI 1 alarm in 1000 occupancies or 1 alarm in 2 h.
- **Response:** IEC 49 alarms in 50 trials. ANSI 59 alarms in 60 trials
- **Over-range:** IEC uses air-kerma 100 µGy/h. ANSI uses exposure rate 10 mR/h.
- **Background effects:** IEC has a step change over 5 s (uses Cs-137). ANSI the source moves at 0.08 km/h from a distance of 8 m (uses Cf-252 and Cs-137).
- **Magnetic fields:** IEC 30 A/m 50 Hz or 60 Hz, 2 orientations. ANSI has no requirement
- **Radiated emissions:** IEC has no requirement. ANSI 100 µV/m 30-88 MHz,150 µV/m 88-216 MHz, 200 µV/m 216-960 MHz, 500 µV/m >960 MHz.
- **Mechanical shocks:** IEC half-sine from all directions at an acceleration of 300 m/s^2 over a time interval of 6 ms. ANSI has no requirement
- **Temperature:** IEC –25 °C to +55 °C (±15% from –25 °C to +40 °C, ±50% from +40 °C to +55 °C) ANSI –30 °C to +55 °C (±15% full range)
- **Sealing:** IEC has moisture (same as ANSI). ANSI has moisture and dust (IP54)

Main Differences Between ANSI and IEC Standards - SPRMs

- **ID radiation quantity:** IEC uses ambient dose equivalent rate. ANSI uses exposure rate**.**
- **Gamma response:** IEC uses 320 kBq ^{133}Ba and 550 kBq ^{57}Co. ANSI uses 111 kBq ^{133}Ba and 185 kBq ^{57}Co.
- **Neutron response:** IEC requires bare and moderated (8 cm HDPE) ^{252}Cf. ANSI requires bare ^{252}Cf.
- **Radionuclide ID:** IEC and ANSI same list of radionuclides, activities are slightly different (there seems to have been some rounding of the numbers in the IEC standard)
- **Simultaneous ID:** IEC ^{99m}Tc+ HEU and 1^{31}I+ RGPu. 0,05 μSv·h^{-1}. ANSI ^{40}K + ^{226}Ra + ^{232}Th + RGPu, ^{40}K + ^{226}Ra + ^{232}Th + DU, ^{99m}Tc+ DU, ^{131}I+ RGPu based on same activities as single radionuclide ID test.
- **Masking:** IEC ^{40}K + ^{226}Ra + ^{232}Th + RGPu, ^{40}K + ^{226}Ra + ^{232}Th + DU, ^{99m}Tc+ DU, ^{131}I+ RGPu (3:1 ratio based in dose rate). ANSI has no requirements
- **Radionuclide not in library:** IEC requires testing with ^{90}Sr/^{90}Y. No requirement in ANSI.
- **FWHM and Efficiency:** No recommendation in IEC. Measurement required in ANSI.

Main Differences Between ANSI and IEC Standards

- **BRDs**
  - For ID radiation quantity: IEC uses ambient dose equivalent rate. ANSI uses exposure rate
  - Very similar: the IEC is still in a draft form

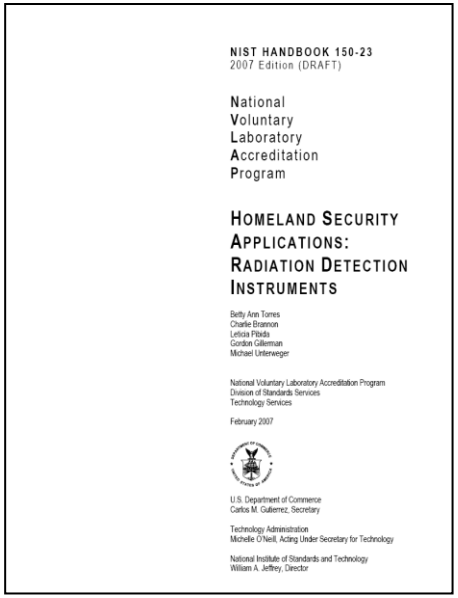
- **Cargo and vehicle imaging**
  - Testing objects are not exactly the same
  - ANSI standard has no radiation safety considerations (are being added in the revision)

GRaDER® Testing Against Standards

DHS/DNDO Project Manager Cheri Hautala-Bateman

Testing against IEC and ANSI standard:

- PRDs
- RIDS
- Backpacks



NIST HANDBOOK 150-23
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HOMELAND SECURITY
APPLICATIONS:
RADIATION DETECTION
INSTRUMENTS

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National Voluntary Laboratory Accreditation Program
Division of Standards Services
Technology Services

February 2007

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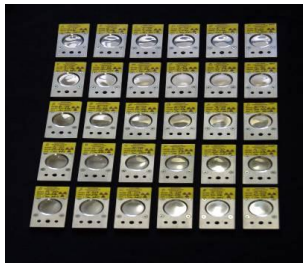
Includes US laboratories:

- PNNL/Northwest EMC
- SRNL/Global Testing Laboratories (GTL)
- ORNL



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ITRAP+10 Testing Against Standards

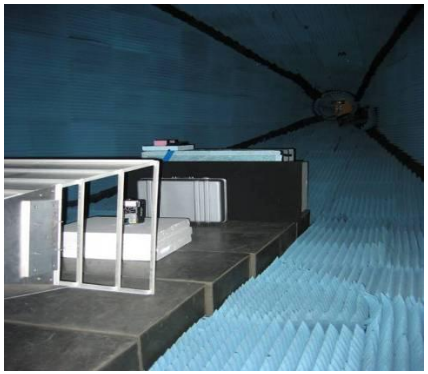
Joint program between the DHS/DNDO and EU (US Project Manager Luc Murphy)

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



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Thank you for your attention

Questions?