

USSSP-IAEA Workshop on Advanced Sensors for Safeguards



Celebrating 30 Years



*Atoms for Peace: The First Half Century
1957-2007*

JAEA-IAEA Workshop on Advanced Safeguards Technology for the Future Nuclear Fuel Cycle

November 13-16, 2007



USSP-IAEA Workshop on Advanced Sensors for Safeguards

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OUTLINE:

Workshop Logistics and Objective
Workshop Agenda
Technologies Presented
Summary of Brainstorming Sessions
IAEA Follow-Up Action Plan

Workshop Logistics

- Held April 23-27, 2007 in Santa Fe, NM
- Attended by representatives of USSP, IAEA, other IAEA MSSPs, national laboratories, companies and academia
- Sponsored by the U.S. Support Program to IAEA Safeguards
- Organized by the International Safeguards Project Office and Organizational Analysis Corporation
- Facilitated by Organizational Analysis Corporation

Workshop Objective

- Build on the October 2005 USSP Workshop on Safeguards Tools of the Future (Newport, RI)
- Uncover and discuss:
 - Capabilities required now and into the future
 - Technology solutions and the pros and cons of each
 - Prioritized technology recommendations – filtered through constraints
- Contribute to the objectives identified in the IAEA's Medium Term Strategy Goals for 2006-2011

Workshop Agenda

- Keynote Address by Leonard Weiss, Stanford University
“Nonproliferation and Safeguards: Then and Now”

- Presentations
 - IAEA (4)
 - Other Workshop Participants (22)

- Breakout Sessions (3 working groups)
 - Scenario #1: Clandestine enrichment activities at a declared location
 - Scenario #2: Clandestine production of plutonium at a declared nuclear research site that includes a research reactor

Technology Presentations

- Complete set of presentations is available on the ISPO website at www.bnl.gov/ispo (click on Agenda or Proceedings)

Technology Presentations

Speckle Photography or Speckle Interferometry

Stephen Mersch – Point Source, Inc.

Provides a means of detecting hidden underground structures or other non-visible items. The system uses subtle differences in surface response to light and requires significant interpretive analysis that is not yet well established.

Technology Presentations

Betavoltaic Energy Conversion and Storage

Larry Gadeken – BetaBatt, Inc.

Very efficient betavoltaic semiconductor devices capture energy from beta particles emitted by Tritium. A silicon wafer is chemically processed to produce deep micron-sized pores on the wafer. The energy conversion layer is fabricated in the pore space by diffusing $p-n$ junctions into the pore walls. The pores are subsequently infiltrated with a Tritiated polymer. Beta particles emitted by the Tritium strike the $p-n$ junctions resulting in the production of electricity continuously for 12 or more years.

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Technology Presentations

Boron Carbide Based Neutron Detectors

Shireen Adenwalla – University of Nebraska – Lincoln

Most materials have a tiny capture cross section for neutrons. Boron carbide is semiconducting with a large capture cross section and is a promising material for neutron detection. The technology is still under development with commercialization expected in two to five years. Boron carbide crystals are expected to cost ~10 USD.

Technology Presentations

Nuclear Magnetic Resonance

Robert Krause – Los Alamos National Laboratory

NMR provides a quantitative measure of the number of nuclei of a given isotope in a given sample. LANL developed a means for measuring the NMR signature of materials in ultra-low magnetic fields and at ultra-low frequencies. Applications include UF₆ flow monitoring, measuring U²³⁵ and U²³⁸ in enrichment monitoring, and UF₆ cylinder measurements. Benefits include non-intrusiveness and no source required.

Working Group Results

Scenario #1: Enrichment Activities

Challenges/Shortfalls:

- Existing tools too bulky and weight restrictions on carried equipment
- Inability to detect overproduction of LEU
- Limiting accuracy of existing monitoring
- Inability to detect remote piping to clandestine facility
- Need for continued training on new and existing equipment

Working Group Results

Scenario #1: Enrichment Activities

Recommendations:

- Accurately measuring the material balance is important in order to address diversion
- Nuclear Magnetic Resonance - revolutionary
- Other Sensors
 - Gamma Ray Tomography
 - Tunable Diode Laser
 - Sampling of vacuum system cold traps
 - Active Neutron Interrogation
 - Portable Swipe Monitor

Working Group Results

Scenario #2: Research Site with Reactor

Challenges/Shortfalls:

- Existing tools too bulky and weight restrictions on carried equipment
- Inability to track fresh, in-reactor and spent fuel
- Inability to detect undeclared fuel
- Site worker ability to defeat power monitors
- No means to look for irradiated targets
- Need for continued training on new and existing equipment

Working Group Results

Scenario #2: Research Site with Reactor

Findings:

- Clandestine production of plutonium is the major concern
- Existing technologies could help but are not acceptable to member states (intrusiveness, nature of data transmission)
- Advanced sensors should be smaller and detect unexpected materials and changes in the physical configuration

Working Group Results

Scenario #2: Research Site with Reactor

Recommendations:

- Portable mass spectrometer for detection of plutonium production
- Portable environmental sampling analysis and recording system
- High-resolution gamma system for on-site identification of actinides
- Portable information system/hand-held communication device

IAEA Action Plan

Following this Workshop, the IAEA will:

- Collect and collate the recommendations
- Conduct an Agency review
- Prioritize and include applicable and effective technical developments in the Agency's 2008/9 R&D Programme covering new and novel technologies
- Collaborate with Member State Support Programmes



*Celebrating 30 Years
of USSP Management*

2007 USSP-IAEA Workshop on Advanced Sensors for Safeguards

Santa Fe, New Mexico
April 23 - 27, 2007



IAEA

*Atoms for Peace: The First Half Century
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Presentations

- Simultaneous Beta Gamma Spectrometry
- Advancements in High Resolution Gamma
- Multi Isotope Process Monitoring in Reprocessing
- New Types of Unattended Systems for Enrichment Plant Safeguards
- Boron Carbide Based Neutron Detectors
- A Solid-State Hand-Held Neutron Radiation Sensor
- Improving the Accuracy of a Uranium Enrichment Monitor Based on a NaI(T) Spectrometer and Transmission Source

Presentations

- Development of SIC Schottky Diode Detectors as a Safeguards Verification Tool for Use in Chemically and Radiological Harsh Environments such as in Molten Salt Electrolytes
- Modern Safeguards System
- Ultra-High Resolution Gamma-Ray Spectrometers
- Long-life, Self Recharging Betavoltaic Microbattery
- Modern Electronics for Safeguards Application
- Speckle Interferometric Imaging for Site Evaluation
- Design for Stand-Off Radiation Detector System Using Compton Scattering

Presentations

- Novel Concept for a Directional Fast Neutron Detector
- Use of Acoustic Wave Analysis Technology for SG Applications
- Investigation of Ultra-Low-Field Nuclear Magnetic Resonance for UF₆ Flow Measurements
- Monitoring Solutions for Nuclear Materials Safeguards
- Advanced Fourier-Transform Infrared Sensors (FTIR)
- Study on Utilization of Satellite Imagery by Advanced Land Observing Satellite "DAICHI" for Nonproliferation Safeguards