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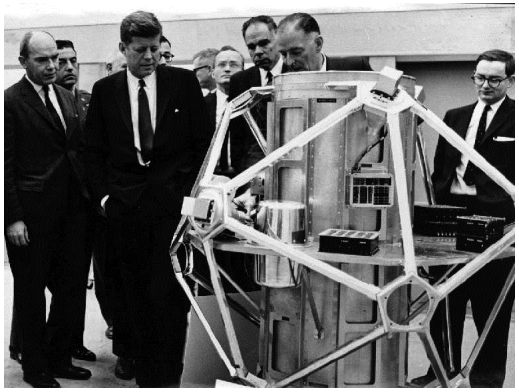

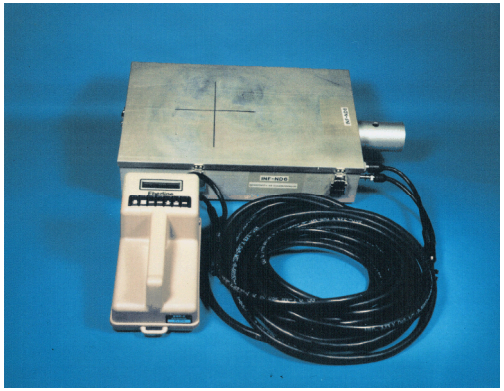

Nuclear Arms Control at Sandia

Sharon DeLand

Global Technology Engagement, Research and Analysis

U.S. DEPARTMENT OF ENERGY | NNSA National Nuclear Security Administration

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Outline

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  - Why Arms Control?
  - Verification Technology Design Objectives
  - Key Sandia Contributions
- Arms Control: Lessons for Life
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  - Do Your Homework!
  - Maintain a Work-Life Balance
  - Keep It Simple!
  - Live long and prosper!
- The Future Awaits
- What's In It For You?
  - Some Really Hard Problems
  - Interesting Places, Interesting People

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BACKGROUND

Arms Control: Motivation and Types

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- Historical rationales
  - Punish the vanquished
  - Preserve a status quo
  - Prevent/deter the outbreak of hostilities
  - Limit damage should hostilities occur
  - Minimize the economic impacts of defense
- Limits on
  - Spread of weapons and technology: NPT, CWC, BWC, MTCR
  - Use: Geneva Conventions, CWC, BWC, PNET, Radiological Weapons
  - Numbers: SALT I, INF, START, SORT, New START, CWC, BWC
  - Weapon Types: ABM, INF, Radiological Weapons
  - Deployment: Seabed, Antarctica, Tlatalolco, Outer Space, other weapons-free zones
  - Development/Testing: LTBT, TTBT, CTBT, CWC, BWC
  - Materials: FMCT
- Tension Reduction and Confidence Building: Hotline, NRRC, JVE, CTR, MPC&A, IPP, NCI, WSSX, Open Skies

Verification Technology Design Objectives

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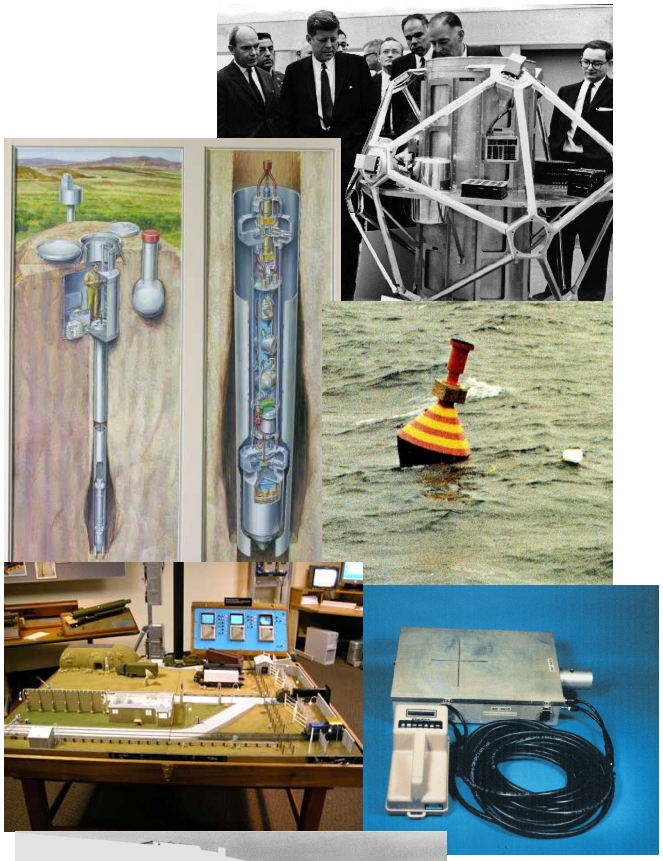
- Provide trusted evidence for compliance and/or detect non-compliance
  - Distinguish allowed activities from disallowed activities
  - Distinguish allowed weapons/equipment from disallowed weapons/equipment
  - Monitor dismantlement or destruction
- Protect sensitive information not related to the treaty
- Operate reliably, safely and securely within the environment
- Detect tampering or interference with monitoring
- Minimize impacts to operations
- Operate over extended lifetime (e.g., duration of the treaty)

Key Sandia Contributions



- Optical sensors (bhangmeter) and data processing for LTBT ban on atmospheric testing
  - Vela satellites
  - DSP satellites
  - GPS satellites
- Seismic monitoring stations for the TTBT
  - Downhole encryption for data authentication
- VELA Sierra – infrasound and radiological monitoring
- Portal-perimeter monitoring system for INF
- Radiation detection equipment for INF (and START and New START!)
- SAR System for Open Skies Treaty

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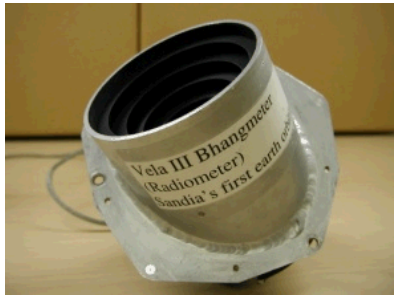
LIFE LESSONS FROM ARMS CONTROL

Just Do It!

Trinity Seismometer



- Limited Test Ban Treaty banned atmospheric tests
- Created need for a mechanism to detect atmospheric testing
- SNL and LANL collaborated in the development and deployment of VELA satellites, leveraging
  - NW knowledge and expertise
  - Experience in instrumenting and monitoring tests
- SNL charged with building complex electronic system
  - Same capabilities as room-sized IBM 704,
  - Put on rocket and blast into space where it
  - Must work perfectly in extreme temperatures,
  - Must distinguish natural radiation from nuclear-blast radiation
  - Can't weigh more than 500 lbs.

Technical capabilities created by NW mission and related nuclear security missions continue to be an important foundation for arms control technology development –and vice versa

Do Your Homework!
(even if it may never be used!)

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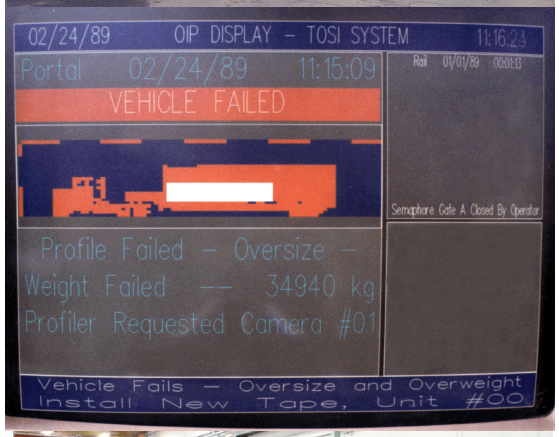
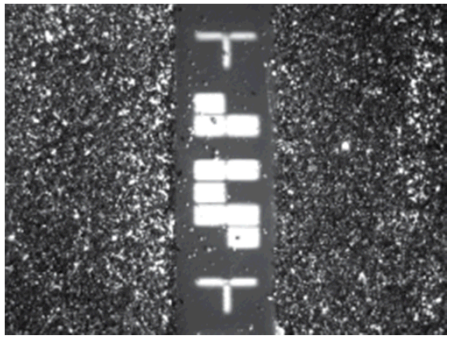
- The Intermediate Range Nuclear Forces Treaty banned all nuclear missiles with range 500-5500 km
- The USSR had two missiles with very similar dimensions – one would be allowed, the other banned
- Created need for a way to ensure banned missiles were not being produced
- The Portal Perimeter Monitoring System monitored the production facility
  - During concept development there was great skepticism that it would ever be used
  - When need identified during negotiations, team had 6 months to demonstrate concept

Maintain a Work-Life Balance



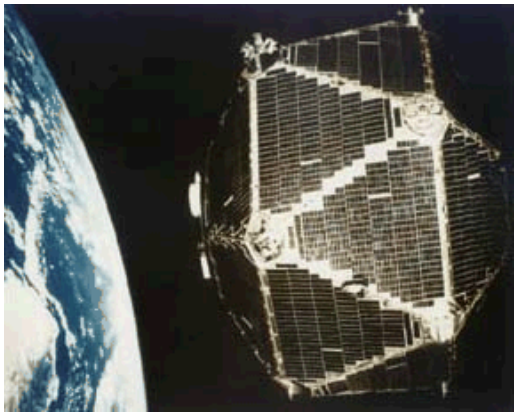
- Monitoring will impact operations at facilities
  - How can systems be designed to provide confidence and minimize impact?
- Design of the Portal Perimeter Monitoring System for Votkinsk used:
  - Break beams to measure 2-D profile of vehicles exiting facility
  - Vehicles too small to contain a prohibited missile could pass without further inspection
  - Vehicle large enough to carry a missile were inspected
    - X-Ray system (CargoScan)
    - Stage Measuring Device

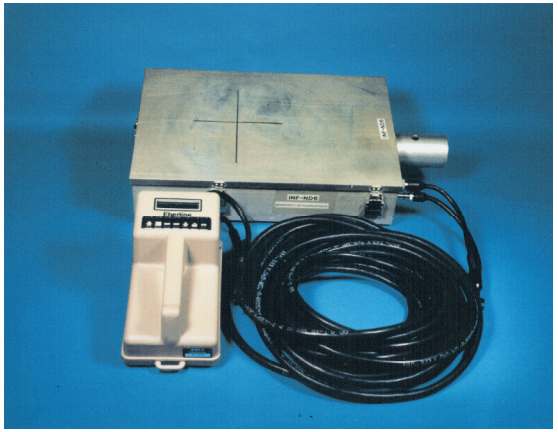
Keep It Simple!!



- Equipment typically operated by designated inspectors
  - DTRA OSI for US
- Equipment may have to be maintained in the field
- Both host and inspecting party need to be sure equipment performs designated monitoring function – and nothing else
  - Best if hardware and software are simple

Live Long and Prosper





- Treaty monitoring requirements can run for decades
- Monitoring technology can be difficult to replace
  - Remote locations e.g., space environments
  - Extensive negotiations specify what technology can be used
- Durability has been a hallmark of Sandia systems
  - Vela satellites launched from 1963 – 1970; last one deliberately turned off in 1984
  - INF portal perimeter monitoring at Votkinsk ran from 1988 until 2010
  - The INF radiation monitoring equipment was used for START I and now New START (almost 30 years ….)

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THE FUTURE AWAITS

Further Reductions Will Bring New Challenges

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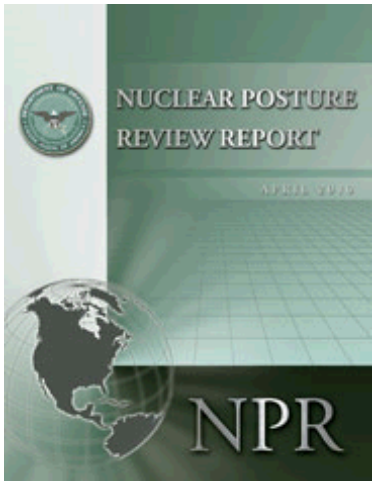
… and we will seek to include all nuclear weapons states in this endeavor."

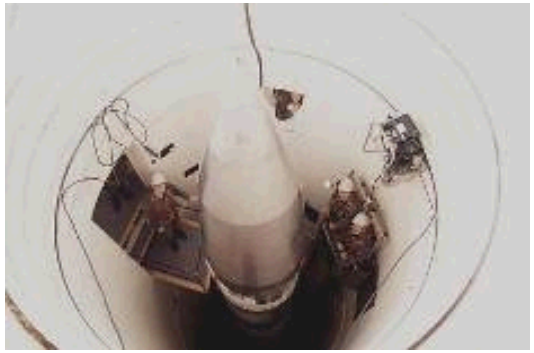
President Obama, Remarks in Prague, April 2009

"*Non-strategic nuclear weapons*, together with the *non-deployed weapons of both sides*, should be included …"

Nuclear Posture Review, April 6, 2010



What if a future treaty placed limits the total number of nuclear warheads?



Potential Future Verification Needs

- Limitations on warheads
  - Confirm that an item declared to be a nuclear warhead is as declared
  - Inspect, confirm and account for declared warheads of various types
  - Confirm the declared number and status of non-deployed warheads
  - Maintain chain of custody for warheads during transportation, storage, and retirement
  - Confirm dismantlement / destruction of retired warheads
  - Disposition of components
- Comprehensive Test Ban Treaty
  - Improved coverage and sensitivity
  - Utilizing technology during on-site inspections
- Fissile Material Cut-Off
  - Establishing baselines
  - Forensics of operational facilities

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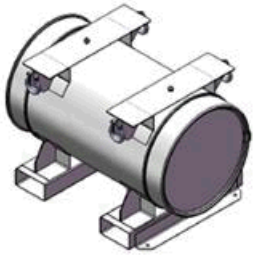
Hard Problems!

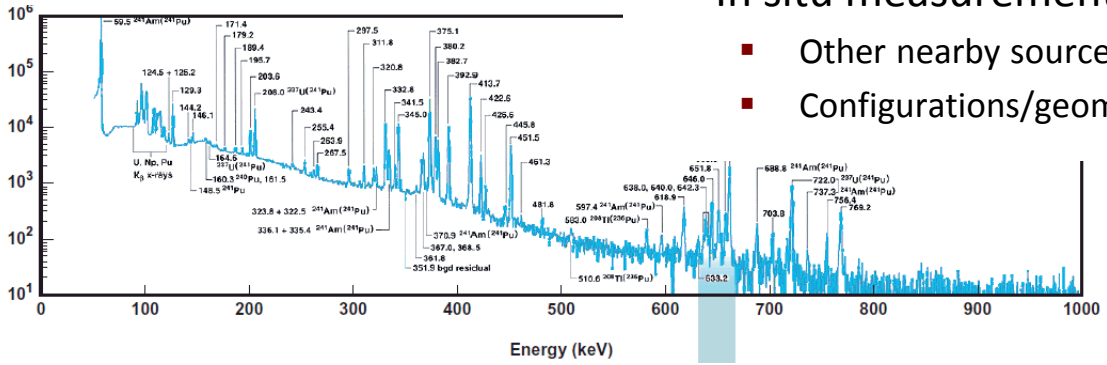
Interesting Places and People!

WHAT'S IN IT FOR YOU?

Hard Problems: Accountability of Non-Deployed Warheads

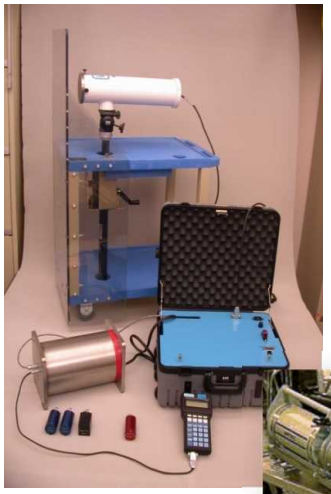


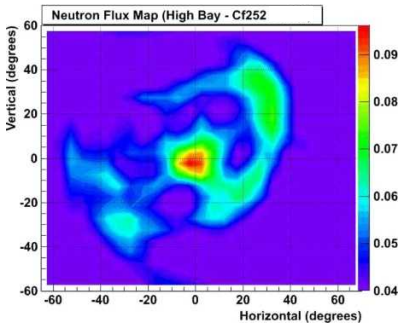
- Non-deployed warheads are stored in a variety of containers and configurations
  - Containers
  - Bolsters (single and double-stack)
  - Rotary launchers
  - Pylons
- Lower limits may require more stringent verification
  - Confirmation that a declared item is a warhead
  - Monitored dismantlement
- Technology introduces risks and complexity
  - Authentication
  - Certification
  - Protecting sensitive information, e.g., design information
- In situ measurements challenging
  - Other nearby sources
  - Configurations/geometry may change



Source: S. J. Luke et al., Verification of the Presence of Weapons Quality Plutonium in Sealed Storage Containers for the Trilateral Initative Demonstration," IAEA-SM-367/17/08

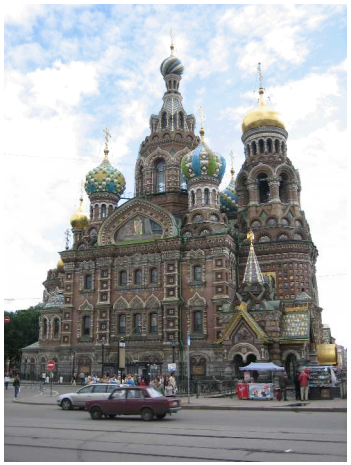
Hard Problems: Warhead Authentication





- How to be confident that a declared item is a warhead?
  - Attributes: presence of SNM, SNM mass, isotopic composition, geometry
  - Templates – comparison to a warhead with a known provenance
  - Which set of measurements is sufficient?
- Operating within constraints
  - Measurement times
  - Measurement geometries
  - Background and presence of other sources
  - Changes to fissile material over time
  - Protecting sensitive information

Interesting places and people



Questions?

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- Remember
  - Just do it
  - Do your homework
  - Maintain a work-life balance
  - Keep it simple
  - Live long and prosper