Progress in Safeguards by Design
by the United States
National Nuclear Security Administration

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In 2008, the DOE/NNSA launched the Next Generation Safeguards Initiative (NGSI)

- A multi-year program to develop the
  - policies,
  - concepts,
  - technologies,
  - expertise, and
  - international infrastructure
- necessary to sustain the international safeguards system as it evolves to meet new challenges.
- A recent example of NGSI’s efforts to strengthen the international safeguards system was the third international Next Generation Safeguards meeting (NGS3), held in Washington in December 2010, which focused on Safeguards by Design (SBD).
Next generation Safeguards Initiative: Advancing Safeguards by Design (SBD)

- Developing and promoting an international understanding for **systematic use** of SBD
  - Hosted Third International Meeting on Next Generation Safeguards, 14-15 December 2010 (Washington, DC)

- Developing guidance for **ALL** stakeholders that will help enable **systematic** incorporation of safeguards early into facility design
  - Drafting facility-specific SBD **guidance documents**
  - Collaborating with IAEA, industry, and multiple other stakeholders
  - Incorporating **Lessons Learned** and **Best Practices** for **existing facility types based upon current designs**
  - Developing advanced concepts, incorporating recent technologies for **new facilities to be designed based upon LL and BP**
“international safeguards are fully integrated into the design process of a new nuclear facility from initial planning through design, construction, operation and decommissioning.”

---- IAEA definition

SBD is not a New Concept

- Concept researched in 1970s and 1980s – among other things, in those days, a term used was “Engineered Safeguards”
- SBD, or engineered safeguards, has never been broadly or systematically implemented
The NGSI program also takes into account successes that the NNSA has had with implementing safeguards into the design process of NNSA projects in the U.S., replacing old facilities or making upgrades.
Y-12 maintains 40 to 60 Year Old Cold War Facilities “Constructed by Operations”
Uranium Processing Facility (UPF)
In Oak Ridge, Tennessee
Current Y-12 Complex Footprint

UPF replaces 800,000 sq/ft of Cold War buildings
Protected Area will shrink 90% from 150 to 15 Ac
UPF (Processing) and HEUMF (Storage)
Highly Enriched Uranium Materials Facility (HEUMF)
Recent Y-12 Complex Aerial View
Future End State Aerial View of Y-12 Complex
• Weapons Dismantlement and U.S. Stockpile requirements
• Material to support U.S. Nuclear Navy Reactors
• Material for research reactor fuel
• Material for private industry to manufacture power reactor fuel

• Operations will best be described as metalworking and chemical processing
Schedule Profile
Currently about 50% design completion
U.S. Domestic Nuclear Safeguards – What is It?

- **U.S. Domestic Nuclear Safeguards** focuses primarily on the insider threat and requires the use of an engineered and integrated systems approach to prevent material from being intentionally or unintentionally diverted from within a process, Material Balance Area (MBA), or process room during active operational hours when personnel are present and actively engaged in material processing.

- Domestic Safeguards encompasses Material Control and Accountability (MC&A) programmatic elements (MBA, Process Unit, Key Measurement Points) along with Material Protection elements to provide assurance that material is where it is supposed to be ~ (IAEA Objective # 1).
DOE Standard 1189, *Integration of Safety into the Design Process*, was mandated to be used on the project.

- Developed to show how (1) project management, (2) engineering design, and (3) safety analyses can interact successfully
- The methods by which safety structures, systems, and components (SSCs) are selected and designated

- Because of inter-related nature of disciplines, the project was “DRIVEN FORWARD” to integrate MC&A/Safeguards into design. This is especially true because of the similarities of the measurement instrumentation of Criticality Safety and Radiological Engineering.
- Safeguards/MC&A SSCs were created as a direct result of Design Criteria reviews (inter-relationships of disciplines)
<table>
<thead>
<tr>
<th>SSC Selection Strategy for MC&amp;A -- in order of preference --</th>
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<tbody>
<tr>
<td><strong>Safeguards/MC&amp;A structures, systems, and components (SSCs) were created as a direct result of 3S relationships and DOE Standard 1189.</strong></td>
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1. Minimization of impact to personnel **safety** is the first priority (no conflict).

2. **Structures**, systems, and components (SSCs) i.e., physical features, (**walls**, doors, locks, alarms) are preferred over Administrative Controls. **seismic, security, safety**

3. Passive SSCs (**walls**) are preferred over active SSCs (laser alarms). **seismic, security, safety**

4. Active SSCs are complementary to passive SSCs (consider type of facility: storage or processing.) **safety, security**
5. Preventative measures (3S) are preferred over mitigative measures (i.e., security response, accountability).

6. Integrated facility safety SSCs are to be considered and can be complementary (i.e., Criticality Safety, Radiation Protection, and Accountability). — instrumentation similarity

7. Controls closest to the source (MBA or sub-unit, i.e., process unit, Criticality Safety Alarm Systems) may provide protection to the largest population of material.

8. Integrated protective mechanisms that are effective for multiple control measures (i.e., containment, surveillance, access. CSA) can be resource-effective.
Enclosures for Safe Handling (reduce internal collective dose)
example: containment with alarm

“old” operations
Approximately 2000 linear ft of glovebox enclosures and similar workspace to specifically contain nuclear material for health and safety reasons. Gloveboxes also provide a containment enclosure with pressure alarms.

“new” operations
Accountancy Basis  
-- graphical representation --  
MBA sub-unit (Process Unit)

Relevant to any nuclear material processing or handling facility where measurements are made

Key Measurement Point (KMP) at MBA Boundary

Process Monitoring Measurement Point (MP); (more measurement points in a process through an MBA). Provides assurance that the material is within the process (accountancy).

Instrumentation for certain processes used in collaboration with Criticality Safety for Material Tracking Database.
Process Monitoring Measurement Points

MBA Representation

Input: [Input – Output – (In process inventory)] ~ 0

Output
Near Real-Time Accountability
aka Dynamic Inventory System
(with time delay elements)
IAEA Relevancy
- Information-Driven Safeguards
- Remote Transmission of Accountancy Data to IAEA
- Information Driven Inspections (timing)
- Verification of Accountancy Data or shipments by on-site Inspectors
- Potential diversion
Safeguards Successes
Early in Design Examples

- Rokkasho Reprocessing Plant and Safeguards (LASCAR)
- Centrifuge Enrichment Plant Safeguards (Hexapartite Safeguards Project)
- Geological Repository and Encapsulation Plant Safeguards (SAGOR/ASTOR)
- CANDU Reactor Designs

“What is needed is a structured process” – Bruce Moran, Division of Concepts and Planning Department of Safeguards, December 14, 2010
Project management is the discipline of planning, organizing, securing, and managing resources to achieve project-specific goals. A project is a temporary endeavor with a defined beginning and end. (usually time-constrained, and often constrained by funding or deliverables), undertaken to meet unique goals and objectives, typically to bring about beneficial change or added value such as construction projects. The temporary nature of projects stands in contrast with business as usual (or operations), which are repetitive permanent, or semi-permanent functional activities to produce products or services.

In practice, the management of these two systems (design and operations management) is often quite different, and as such requires the development of distinct technical skills and management strategies. This was a significant Lesson Learned by operational managers placed on design teams.
• The primary challenge of project management is to achieve all of the project **goals and objectives** while honoring the preconceived constraints.

• **Typical** constraints are: **scope, time, and budget**.

• **Typical** project stages are:
  • Planning or (Conceptual Design)
  • Preliminary and Final Design
  • Construction
  • Operation

• And internationally, meeting the IAEA needs and requirements of the **Safeguards Agreements**

• Systems Engineering methodology integrates all information, including wants, needs, and requirements of **ALL stakeholders** into workable solutions during the preliminary design stage
Technical and management issues on the UPF project have direct relevancy to IAEA Objectives and Long-Term Strategy.

- Large design and construction projects requires the use of a structured process that integrates ALL disciplines. The Project Management System does that.
- Significant Lesson Learned is that co-location of UPF design team in a user facility led to a cohesive design minded unit responsible for getting the project done. Everyone was dependent on the others for information. A very functional team.
- MC&A/Safeguards was considered just like any other discipline.
- A chapter of requirements was incorporated into the Systems Requirements document (SRD) and the Design Criteria (DC).
- UPF project was forced into integrating safeguards/MC&A along with safety and security (3S) due to discipline needs, costs and efficiency.
- Design reviews were initially held daily. CAD System drawings could be updated during reviews affecting multiple drawings. Comment documents were obtained from all disciplines during the reviews that affected multiple other systems. These changes were made and subsequently brought into those design review meetings.
• Early and regular cost accounting methods utilized by the Project Management System assured that efficiencies and optimized technical decisions were being made.

• Extensive amount of in-process measurement instrumentation needed to be developed for measurement (isotopes) of nuclear materials. Extensive quantity of computerized manufacturing equipment is available for industry in chemical and mechanical processing that integrates with computerized processors. What has been sorely lacking are the direct measurement capability for nuclear materials along with the computerized systems that integrate the in process capability with an IT architecture.

• Project management requires the development of distinct technical skills and management strategies. In general, operational “type” managers that are placed on design teams because of their expertise, need to develop the mindset to function in a analytical/engineering setting where optimizing solution sets is the goal.
Closing Comments and Comparison to IAEA Objectives

- Increase the IAEA’s ability to provide credible assurances of non-diversion of nuclear material and the absence of undeclared activities (*Strategic objective 1*):
  - Nuclear material *accountancy remains the basis for deriving a conclusion on the non-diversion of nuclear material*, so the IAEA will continue to conduct robust NM accountancy verification while also seeking efficiencies;
    - *(Near Real-Time Accountancy System - basis for Safeguards)*
  - Increasingly invest in strengthening its capabilities to *detect undeclared nuclear material and activities*;
  - Rely on presence in the field, capitalizing on the IAEA’s unique rights of access to information and locations.

- While focusing on strengthening its capabilities to successfully execute existing mandates, also maintain its preparedness to carry out further verification missions, as requested (*Strategic objective 2*).

- Continually *improve the way it works* to deliver high quality, *cost-effective services* to its stakeholders (*Strategic objective 3*). *(in-facility analytical lab)*
• Further develop the **State-level concept** for the planning, conduct and evaluation of safeguards activities, making safeguards more **information-driven, focused and efficient, in the field and at HQ**

• Develop and implement **State-level approaches for all States**, taking into account a broader range of State-specific factors, to apply an optimized combination of safeguards measures for each State

• Provide guidance and **training to States - particularly those introducing nuclear power - on the implementation of their safeguards obligations**

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States must ensure that specific accountancy / safeguards elements are designed into their facilities or be subject to intrusive measures.

*excerpt from* Department of Safeguards Long-Term Strategic Plan, 2012-2023
Jill N. Cooley
Director, Division of Concepts and Planning

**IAEA Symposium on International Safeguards:**
‘Preparing for Future Verification Challenges’

1 November 2010
Closing Comments and Comparison to IAEA Strategies

- Employ modern and **integrated safeguards information architecture** to store and make information available in a secure and user-friendly manner.
- Make optimum use of unattended monitoring and **remote transmission**.
- Deploy information and **communication technologies** to improve interconnectedness between inspectors in the field and at HQ.
- Maintain technical readiness (e.g. expertise) to respond to requests for technical input to, or verification of, **nuclear arms control and disarmament related arrangements and agreements**.
- Strengthen **technical tools** for the search, collection, analysis and processing of safeguards relevant information.

Seismic requirements establish support walls that easily provide the natural barriers that are part of inspection regimes.

*excerpt from* Department of Safeguards Long-Term Strategic Plan, 2012-2023

Jill N. Cooley
Director, Division of Concepts and Planning

IAEA Symposium on International Safeguards: ‘Preparing for Future Verification Challenges’

1 November 2010
Q&A

Your Opportunity?

Thank You
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Systems Engineering Process for all Stakeholders in design

- Transform customer and stakeholder needs into engineering termed requirements
- Generate effective decisions from various alternative evaluations
- Provide input to next level of INTEGRATED design development
- Determine effective design solution
Modelling provides decision support throughout the life-cycle of the facility.
FREDERICK, Md., December 16, 2010 - Bechtel will provide design and project management support services for the first commercial nuclear power plant in the Middle East. The plant will be one of four that a consortium headed by the Korean Electric Power Corporation (KEPCO) will build and manage in the United Arab Emirates.

“This project continues Bechtel’s tradition of working on first-of-its kind projects around the world,” said Carl Rau, president of Bechtel’s nuclear division. “We have worked with KEPCO since the 1950s, when it first commissioned Bechtel to build the DangIn-Ri power plant in Korea. We believe the strength of that relationship will contribute to the success of this project.”

Bechtel will provide project support to KEPCO subsidiary KEPCO E&C both in Seoul, Korea, and at the project site in Braka, which is in the western region of Abu Dhabi. Bechtel has served the nuclear power market for more than 60 years and has worked at more than 150 nuclear plants worldwide. It currently has more than 3,000 employees working globally on nuclear projects.

The first UAE nuclear power plant is scheduled to be completed in 2017.
Develop instrumentation and methods to determine local balances based upon process input and output > integrates to facility balance.
Recommended Areas for Technology Investigation to Support Information-Driven Safeguards at the State / facility level

- Support the evaluation and potential modification of (1) programmable (process) logic controllers (PLCs), (2) process measurement, and (3) Human Machine Interface (HMI) Instrumentation for nuclear material processes and equipment for use within nuclear facilities.

- Support the development of integrated information technology / manufacturing execution systems (IT/MES) to enhance facility safeguards data gathering and reporting to the IAEA.

- Determine indicators for “Information-Driven Inspections (IDI)” to increase effectiveness and efficiency of verification activities based upon reported State activities and transmitted accounting data.
As part of the preparations for the 2012–2013 TC program cycle, 16 training workshops were held to strengthen project design capacity in Member States, streamlining the language and approach used. A training package for TC programme planning and design, using the Logical Framework Approach (LFA), as well as orientation materials for Agency staff, was prepared. Extensive internal training on the preparation of Programme Notes, project design and use of the LFA was delivered to technical and country officers and orientation workshops were held for National Liaison Officers, National Liaison Assistants, counterparts and regional experts in all regions. In total, 436 participants were trained, 366 of whom were from Member States. The training was managed by TC’s Division for Programme Support and Coordination in close coordination with the Regional Divisions. The overall evaluation of the workshops was very positive, with requests that they become regular, ongoing activities.

Technical Cooperation Report for 2010

Technical Cooperation Report for 2010
Report by the Director General
GC(55)/INF/2
Printed by the
International Atomic Energy Agency
July 2011

9 This section relates to operative paragraph 13 and 16 of resolution GC(54)/RES/9 on strengthening TC activities and on providing MSs with adequate information on project development according to the logical framework methodology.