SAFEGUARDING THE PLUTONIUM FUEL CYCLE

Verification Systems
- Integrated Spent Fuel Verification System
- Integrated Head-end Verification System
- Integrated Canister Assay Verification System
- Integrated Uranium Assay Verification System
- Integrated Plutonium Assay Verification System
- Integrated Passive Preparation System
- Integrated Passive Measuring System

Shirley J. Johnson, Consultant Tucker Creek Consulting
Lessons Learned
Safeguards Approach
Safeguardability
Process Monitoring
Measurement and Monitoring Equipment
Data Management
LESSONS LEARNED

- West Valley Reprocessing Plant
- Barnwell Nuclear Fuel Plant
- Wiederaufarbeitungsanlage Karlsruhe (WAK)
- Tokai Reprocessing Plant (TRP)
- Rokkasho Reprocessing Plant (RRP)
1969 - early 1980s

Safeguards instrumentation and methodology development
1971 - 1990

- Attention to undissolved solids in samples,
- First attempt at routine (manual) solution monitoring,
- First attempt at in-field computerized data storage, calculation and evaluations,
- Development/testing of the K-edge and Hybrid K-edge Densitometers for in-field measurements, and
- Open access to operating records.

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TOKAI REPROCESSING PLANT (TRP)

- **Tokai Advanced Safeguards Technology Experiment (TASTEX):** late 1970s - US/Japan
- **TRP Improvement Plan:** late 1980s - IAEA/Japan
  - Continuous DIE/DIV,
  - Solution measurement and monitoring systems,
  - Sample integrity and handling,
  - Waste measurement and monitoring systems,
  - Shipper-receiver difference (SRD) evaluations,
  - Near-real-time-accountancy (NRTA),
  - Timely and continuous provision of operator data, and
  - Formalized approach to Other Strategic Points (OSP) for ‘operations as declared’.

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ROKKASHO REPROCESSING PLANT (RRP)

- Large Scale Reprocessing (LASCAR): 1988-1992
  - General design and operating features,
  - Capabilities for and ease of design examination and verification,
  - Design in a nuclear material accountancy system,
  - Design in measurement and monitoring systems,
  - Design in sampling and analytical capabilities, and
  - Design in system security and authentication.
PIV: 1/year after clean-out; shut-down with small in-process inventory.

Inventory changes: 100% verification on main flows; Medium or low random on others.

IIV for timeliness: May have flowing inventory; High sampling requirement; high uncertainties in both operator declaration and verification measurements.

OSP for:
- Continuity of knowledge during IIV,
- Added assurance to high uncertainty measurements, and
- Confirmation of ‘operations as declared’.
Safeguards activities in Pu processes in Europe and Japan, when in operations, require ~30% of total inspection effort.

Could be reduced with introduction of Short Notice Random Inspection (SNRI).
‘SAFEGUARDABILITY’ REQUIRES:

- A verifiable physical design;
- Transparent operations and operating procedures;
- Highest quality, timely and verifiable facility accountancy measures and data management;
- Accommodation for inspection activities and accessibility for inspectors; and
- A safeguards culture that is supported by the plant administration.

SAFEGUARDS BY DESIGN
CAPABILITY for and EASE of DESIGN EXAMINATION and VERIFICATION

- Early and continuous provision of design information (GOV/2554/Attachment 2/REV.2);
- Access to and transparency of design:
  - Pre-construction and testing of demonstration equipment,
  - Synergies between safeguards, safety and security;
- Minimization of and provisions for sensitive technology and equipment, and proprietary information.
- Development of verification tools:
  - Maintaining continuity of knowledge (CoK),
  - Installation of independent vessel calibration systems;
DESIGNING in NM ACCOUNTANCY (NMA) and DATA MANAGEMENT SYSTEMS

- Clearly defined inventory areas and material transfer boundaries (MBAs and KMPs),
  - Batch operations and transfers, where possible,
  - Minimization of Un-Measureable Inventory (UMI),
    - Pipes, pumps, pots, evaporators, separators, etc.;
- Optimized NM accountancy and verification,
  - Vessel design - internal structures, homogenization systems, environmental controls, sampling systems,
  - Unattended, joint-use measurement/monitoring systems;
- Transparent and minimized recycle processes;
- Well defined waste treatment and handling; and
- Inspector access to operations and operating records.

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Assurance that the selected vessel is being sampled and there is no tampering;

Capable of sampling multiple vessels simultaneously;

Consideration of IAEA On-Site Laboratory (OSL),
- Improved sample control;
- Timely analyses;
- Reduced cost of sample preparation and shipping;
- Waste recycled to process;
- Joint-use with State requires well defined roles and responsibilities and assurance of independent results.
The collection and evaluation of data on the flow of nuclear or other material, or on the status of a nuclear facility or equipment.
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Normally continuous and unattended.
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Normally continuous and unattended.

May be transmitted to a central on-site location or back to head-quarters.
WHERE AND WHY USE IT?

- CoK of flows, storages, DIV;
- Determination of in-process hold-up and “UMI”; 
- Added assurance to high uncertainty measurements;
- Optimization of measurement plans;
- Measurement data any-time/on-demand (SNRI);
- Support Near-Real-Time-Accountancy;
- Timely detection of process disruptions or equipment mal-function;
- Assurance that operations are as declared;
- Reduction of inspection effort.
LOADING/UNLOADING MATERIAL
IN-PROCESS INVENTORY
IN-PROCESS ‘UMI’
GLOVEBOXES INVENTORY
Can monitoring contribute to the safeguards evaluation of a facility?
If so, can it be given a quantitative value?
What is the ‘goodness’ factor of monitoring?
WHAT PM TOOLS DO WE USE?

- Radiation sensors
  - Gamma and neutron

- Solution monitors
  - Flow, volume, density, levels, temperature

- Combination of radiation and surveillance

- Nuclear material or chemical component analyses

- Portal monitors
Need - reliable, robust, on-line/in-vessel measurement systems with improved sensitivity;

Remote, unattended systems with data transmission capabilities;

In-field diagnostics with modular design for maintenance/replacement;

Access for data retrieval and servicing.
Assurance that data originated from a known source and has not been altered, removed or substituted; Difficult and expensive if not addressed in the design, Independent, solely owned and operated verses Joint-Use; Methods can be: Technical - hardware and/or software, Procedural - cross correlation, random secondary measurements, no-notice inspections of equipment; Data sharing: Assurance that operator/State cannot use data to influence accountancy/operational declarations or to defeat the implementation of reliable IAEA safeguards.
Operator Nuclear Material Accountancy

- Must meet domestic requirements;
- Optimized measurement capabilities,
  - Low uncertainties, on-line, rapid and timely;
- Must have real time access to operating and in-plant accounting data;
- Operator declarations (OPD) to the IAEA must be timely and should be automated;
- OPDs must also include operational information,
  - Schedules, operating status, non-routine activities.
Verification data should be remotely transmitted from unattended measurement/monitoring systems;
System should collect, store, calculate, evaluate and report verification results;
Data transmission must be secure, both on-site and off-site;
Handling of operator’s proprietary information must be addressed early.
Operator, State and IAEA Data Management Systems

- Integration and compatibility of all systems;
- Physical connection between operator and inspector data systems, should be avoided;
- Remote transmission of relevant data and system Statement of Health (SoH) to central computers;
- IAEA policy on data sharing must be addressed;
- Design of both the operator NMA and the inspector DC&E systems MUST START EARLY!!!!
Effective
Efficient
Safeguards

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