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Incorporation of a Risk Analysis Approach for Advanced Safeguards Analysis

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Outline

- Advanced Transparency Framework and Its Relation to Advanced Safeguards
- Project Scope
  - Incorporation of the Risk Analysis
  - Path Forward

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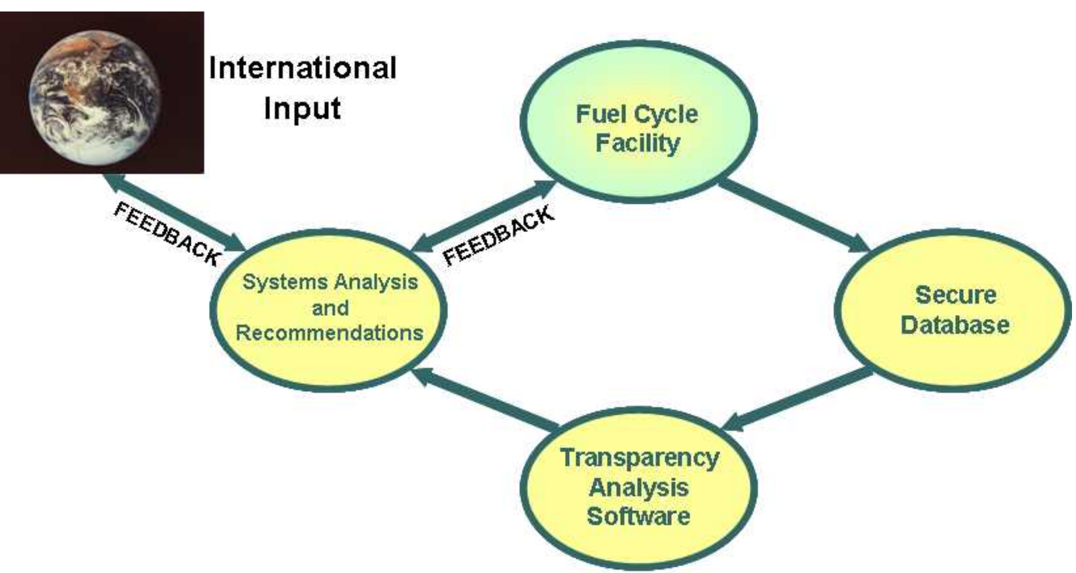
Transparency is a confidence building approach among political entities to ensure civilian nuclear facilities are not being used for the development of nuclear weapons

Nuclear fuel cycle transparency involves the cooperative sharing of relevant nuclear material, process and facility information among all authorized parties to ensure the *safe and legitimate* use of nuclear material and technology

A system is transparent when all parties feel that the proliferation risk is at an acceptable level. For this to occur, proliferation risk should be monitored in a continuous fashion.



Transparency vs. Remote Monitoring

- Transparency
  - The objective is verification of declared operations and to assess changes in terms of diversion risk
  - Capable of detecting host diversion, theft, and safety issues
  - Is a bilateral agreement between two (or more) parties
  - All data available is shared
  - All results of data analysis are shared

- Remote Monitoring
  - The objective is to verify operations and to make safeguard conclusions
  - Primary purpose is to detect host/state diversion
  - International requirement with regards to the NPT
  - All data collected is negotiated
  - Only final conclusions are shared with the applicable parties

REDEFINING TRANSPARENCY

OLD

Monitoring fuel handling activities by inspection
Slow and subjective

NEW

Increasingly automated fuel handling activities
Use of process data
Real-time quantitative analysis

A traditional transparency system involves:

- Use of external devices
- Comparison of recorded and declared activities
- Provides no feedback

An advanced transparency system MUST:

- Operate in real-time
- Utilize plant process and design data
- Utilize declared plant processes
- Conduct real-time, quantitative analysis of proliferation-risk
- Securely provide analysis to the facility and authorized parties

Project Scope

- Utilizing the framework developed by Sandia National Laboratories & Japan Atomic Energy Agency (JAEA)
  - Demonstrate advanced transparency at the Monju Nuclear Fuel Cycle Model at the International Nuclear Information Training Center/JAEA
  - Explore implementation at the Monju Fast Reactor
- New innovations:
  - Continuous, real-time monitoring of process and signal data internal to nuclear fuel cycle facilities to ensure safe and secure operations
  - Generation of an international *remote monitoring test bed* in support of an advanced transparency concept

Monju Nuclear Fuel Cycle Training Model





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Proliferation Risk & Diversion Risk

- Proliferation Risk:
  - Defined as the risk of materials acquisition, transformation and weapons fabrication.
  - We focus on the risk that a facility may be used for proliferation *by the host nation*.
  - Risk is assumed to be acceptable when the facility operates under normal conditions as declared by licensing and export control agreements.

- Diversion Risk:
  - Is the risk of diverting nuclear material *through the declared operations*.
  - Incorporates the probability and consequences of a *host nation* diverting nuclear materials *from a commercial facility*.
  - Quantified in terms of significant quantities (SQs) of nuclear material potentially diverted.
  - Our project calculates diversion risk in real-time from process data.

Components of Risk

- The risk of an event occurring is calculated as the product of two components:
  - the probability that the event will happen and
  - the consequences of such an event if it did occur.
- The diversion risk model assesses the probability of diversion by interpreting the set of observed signals for an operation.
  - Probability of sensor malfunction is considered in this calculation.
- A "significant quantity" (SQ) is used as the measure of consequence to account for material attractiveness and other related factors.

Expected vs. Observed Risk

- "Expected risk" is the risk introduced by the existence of the facility based on planned and declared operations.
  - Represents the normal baseline risk.
  - Is dependent upon plant design and processing capabilities.
  - Plant design should have the goal of making this risk as small as possible.

- "Observed risk" is measured in real time during plant operations and is based on the signals transmitted by sensors.
  - Calculated at every process step via a comparison of actual operations to planned and declared operations (the foundation for expected risk).

"Incorporation of a Risk Analysis Approach for the Nuclear Fuel Cycle Transparency Framework,"
Sandia National Laboratories, Albuquerque, NM. 2007 Sandia-Report 2007-3166

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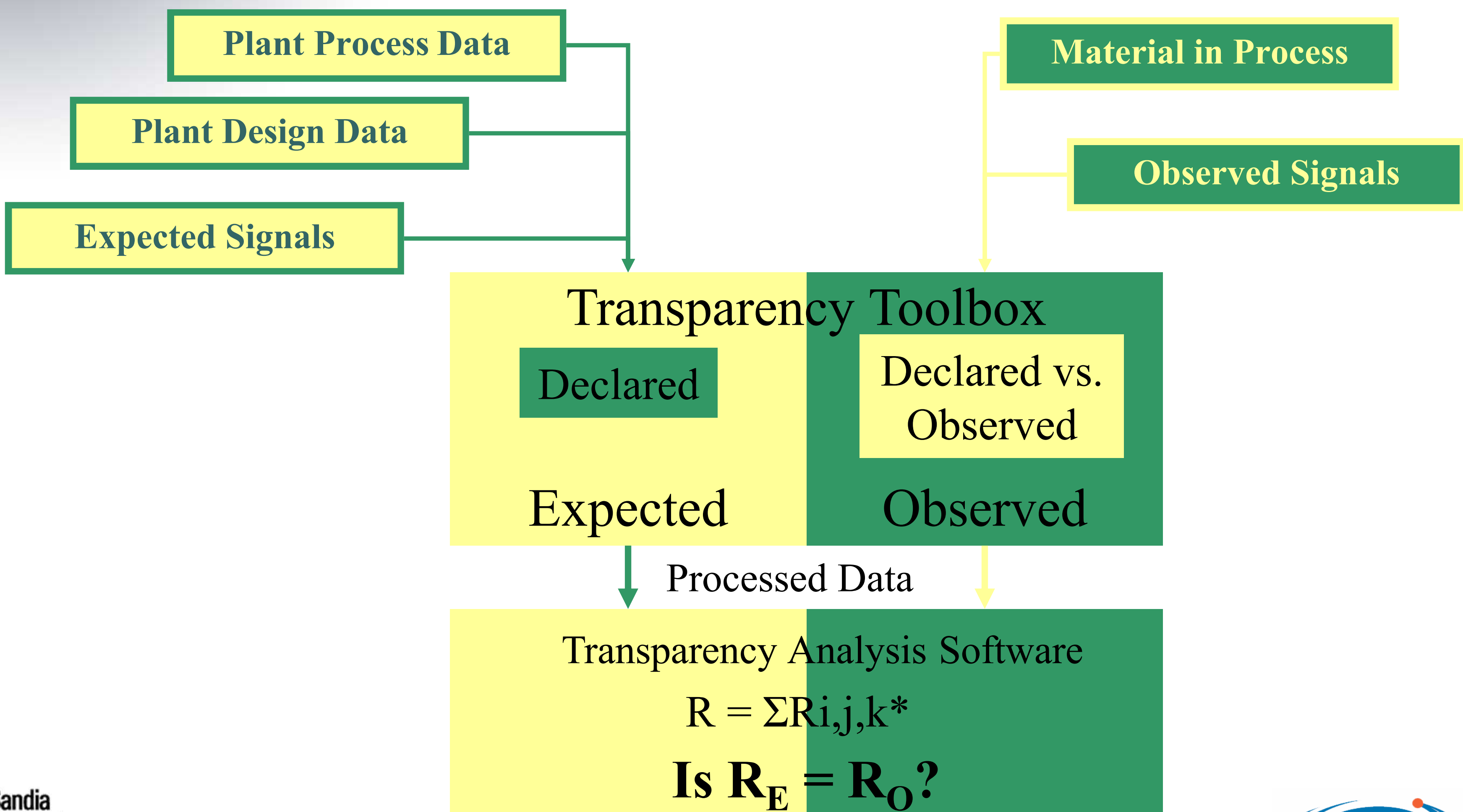
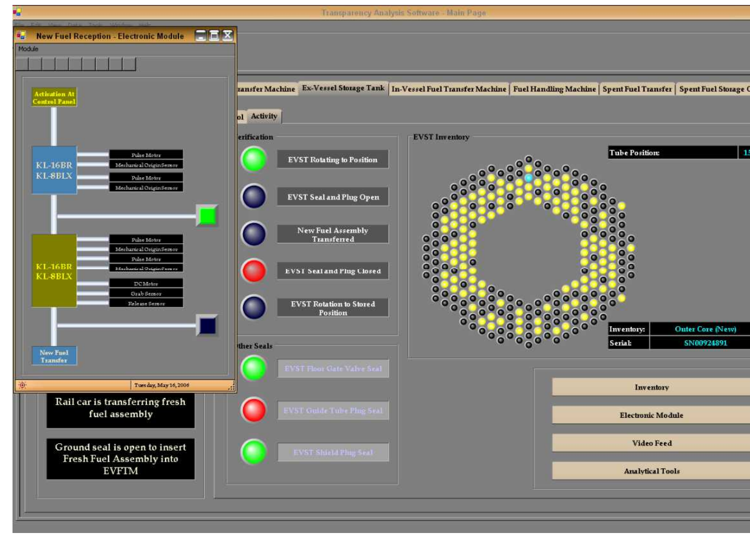
Diversion Risk Analysis



*where i,j,k = step, process, plant

Technical Developments

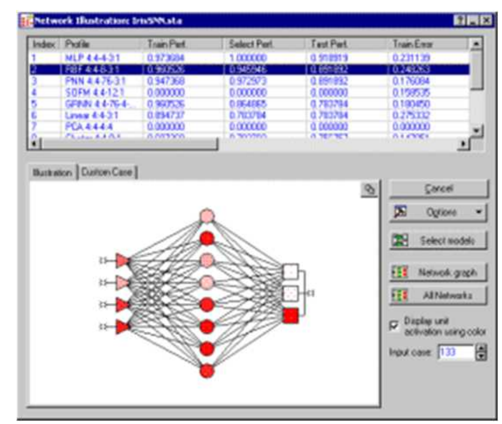
- Accurate collection of signals internal to the Monju Nuclear Fuel Cycle Model
- Live collection and transfer of these signals from the Monju Database Server (in Japan) to Sandia
- Accurate interpretation of signals in accordance with model operations
- Detection of "manual override events" or interruptions in automated processes



Data Security, Verification and Validation

- Transparency systems can be constructed that restrict access of sensitive information to only authorized regulatory parties.
- Through verification and validation techniques data transmitted from the nuclear facility via the advanced transparency framework can be guaranteed as secure and reliable.

Encrypted Tamper Resistant Virtual Network



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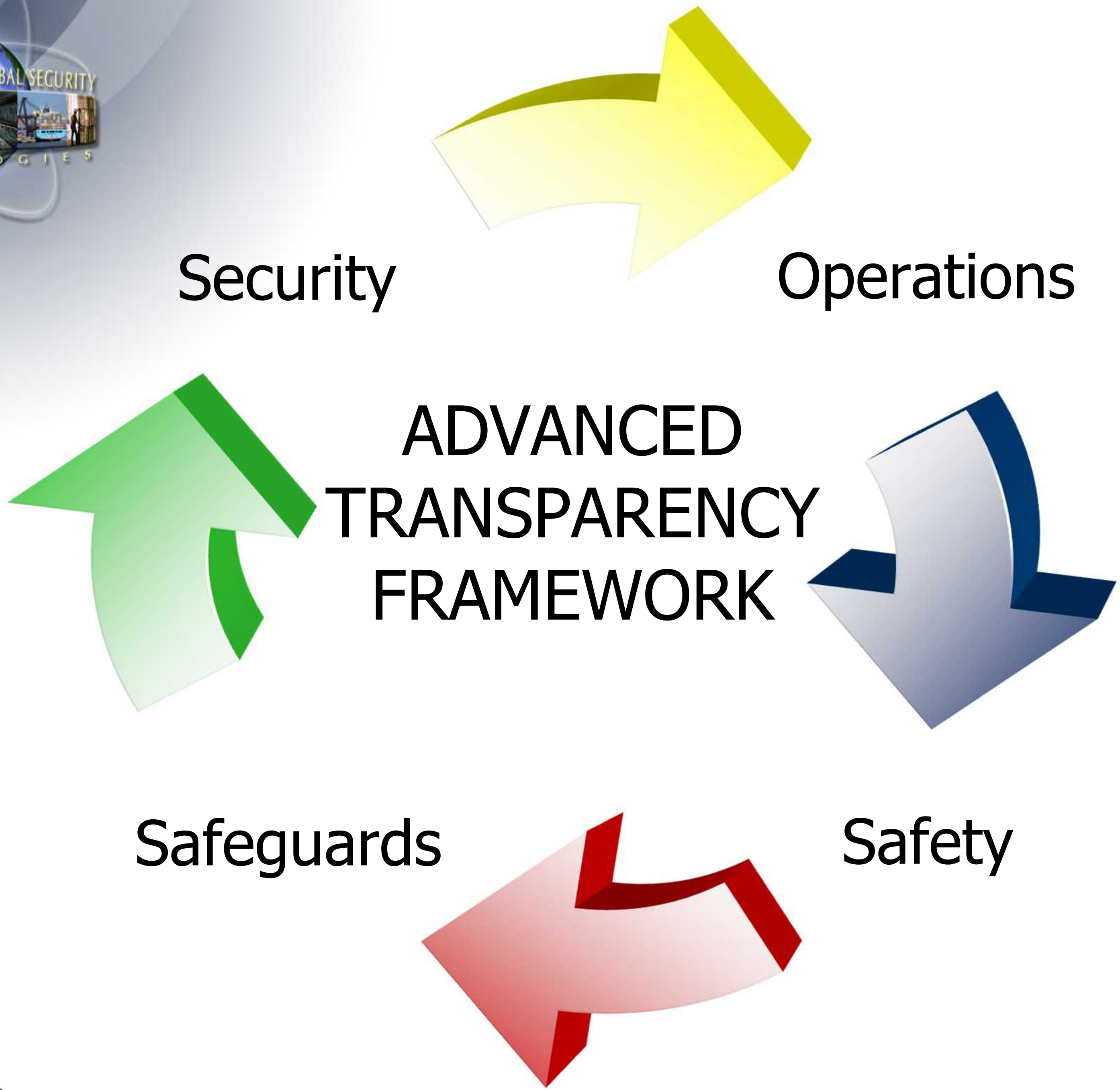
Security
Operations
ADVANCED
TRANSPARENCY
FRAMEWORK
Safeguards
Safety

Future Applications

- The diversion risk would be applied to safeguards analysis of nuclear facilities under
  - Voluntary offer agreements (VOA)
  - Provide end use verification of nuclear process equipment.
  - Lower cost alternative to full-scale IAEA safeguards.
- The transparency framework would:
  - Provide secure data to the IAEA for independent verification and validation
  - Eliminate the need for a secondary monitoring system

Conclusions

- Augmentation of the current transparency ideology can support the IAEA mission to ensure safe and peaceful use of nuclear technology.
- A real-time analysis is important due to the speed at which proliferation can occur.
- New ideas for fuel cycle transparency can result in increased confidence and optimized resources.
- A new paradigm can be utilized to facilitate deployment of nuclear technology to developing nations, optimize inspections, and enforce agreements.