Incorporation of a Risk Analysis Approach for Advanced Safeguards Analysis[1]

Virginia D. Cleary and Gary E. Rochau
Sandia National Laboratories
P. O. Box 5800
Albuquerque, New Mexico 87185-0748

Carmen M. Méndez
Sociotecnia Solutions, LLC

Naoko Inoue, Takuya Kitabata, Tsutomu Irie, and Masato Hori
Japan Atomic Energy Agency

ABSTRACT

Proliferation resistance features that reduce the likelihood of diversion of nuclear materials from the civilian nuclear power fuel cycle are critical for a global nuclear future. A framework that monitors process information continuously can demonstrate the ability to resist proliferation by measuring and reducing diversion risk, thus ensuring the legitimate use of the nuclear fuel cycle. The automation of new nuclear facilities requiring minimal manual operation makes this possible by generating instantaneous system state data that can be used to track and measure the status of the process and material at any given time.

ADVANCED TRANSPARENCY FRAMEWORK

The term "transparency" is used in many different applications. In the context of the nuclear fuel cycle, we define it as:

> "…a high-level concept, defined as a confidence building approach among political entities, possibly in support of multi-lateral agreements, to ensure civilian nuclear facilities are not being used for the development of nuclear weapons. Additionally, 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 considered ***transparent*** when the parties involved feel that the ***proliferation risk*** is at an acceptable level. For this to occur, proliferation risk should be monitored in a continuous fashion." (Love et al., 2006)

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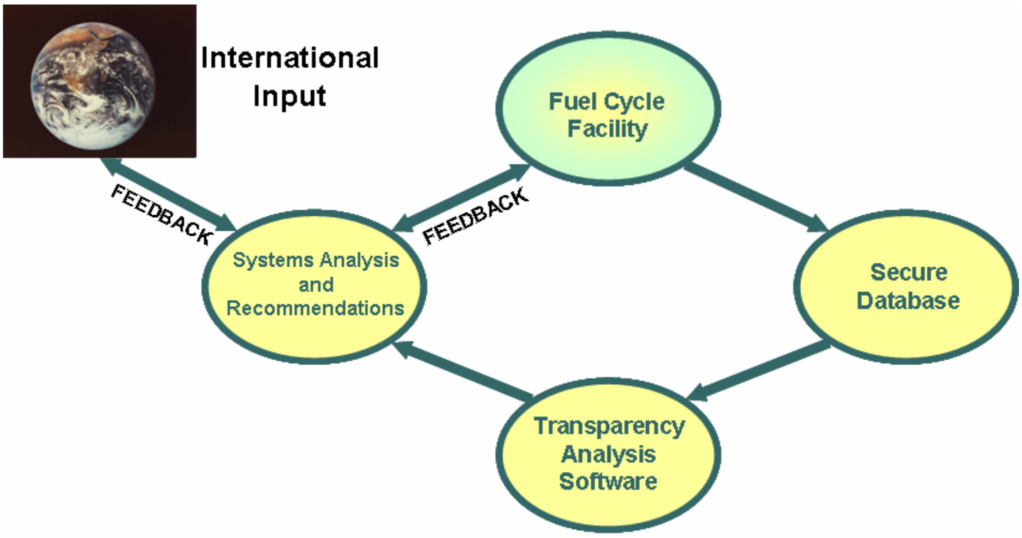

TRANSPARENCY VS. REMOTE MONITORING

The objective of Advanced Transparency is verification of declared operations and calculation changes in diversion risk, whereas the objective of Remote Monitoring is verifying and obtaining safeguard conclusions. In addition, the primary purpose of Remote Monitoring is detecting host diversion. The Advanced Transparency Framework proposed by Sandia National Laboratories not only detects host diversion, but also identifies theft and safety issues. Moreover, Transparency is a bilateral arrangement between two parties, meaning there is complete agreement to sharing all data available from the plant. On the other hand, with remote monitoring, all the data that collected is negotiated (with the facility, government entity, etc) and observed only by the inspectors.

REDEFINING TRANSPARENCY

In the past, the term "transparency" has meant monitoring fuel handling activities through the use of devices such as video cameras. However, given a rapidly increasing need for power generation and an increased automation in fuel handling capabilities at nuclear facilities, current transparency techniques are no longer an efficient means of building confidence in peaceful use. Often, inspections that occur at nuclear facilities take months to assess proliferation potential, and provide no feedback to facilities or other involved parties.

To support a proliferation resistant fuel cycle, the following tasks must be performed:

1) Increase confidence among nations and regulatory agencies that nuclear materials are used in a peaceful manner.
2) Design a system to support non-proliferation efforts during and following global deployment of nuclear power.
3) Optimize time required for inspections.
4) Optimize the cost involved with inspections.
5) Better enforce the current regulations (and agreements among nations) regarding the nuclear fuel cycle.

A redeveloped transparency system could perform all of the tasks listed above, but must include the following capabilities:

1) Operate in real-time,
2) Provide a final quantitative assessment of proliferation-risk,
3) Utilize plant process and design data,
4) Utilize declared plant processes, and
5) Have a secure link among the facility and authorized parties.

RISK ANALYSIS APPROACH FOR TRANSPARENCY AND APPLICATION TO SAFEGUARDS

The automation of new nuclear facilities requiring minimal manual operation provides an opportunity to utilize the abundance of process information for monitoring proliferation risk. A framework that monitors process information continuously can lead to greater transparency of nuclear fuel cycle activities and can demonstrate the ability to resist proliferation associated with these activities. Using the process data inherent to the plant, we have developed a methodology for calculating the diversion risk of the plant based on a comparison of expected and observed operations.

The "expected risk" is the risk introduced by the existence of the facility based on planned and declared operations. This risk represents the normal baseline risk and is dependent upon plant design and processing capabilities. The "observed risk" is measured instantaneously when the plant is operating and is based on the plant process data transmitted by sensors during the completion of declared operations.

The diversion risk would be applied to safeguards analysis of nuclear facilities under voluntary offer agreements (VOA) and provide end use verification of nuclear process equipment. Application of this framework to nuclear fuel cycle facilities within countries possessing nuclear weapons under VOAs offers a lower cost alternative to full-scale IAEA safeguards. Export control requirements need verification of the proper use of exported nuclear equipment according to agreements.

CONCLUSION

Sandia National Laboratories (SNL) and the Japan Atomic Energy Agency (JAEA) are working in cooperation to develop an advanced transparency framework capable of assessing diversion risk in support of overall plant transparency. The "diversion risk" quantifies the probability and consequence of a host nation diverting nuclear materials from a civilian fuel cycle facility. This framework is currently being demonstrated at the Monju Fuel Handling Training Model at the International Nuclear Information and Training Center in Tsuruga City, Japan.

The final stage of this work is to verify and validate the plant process data used in our methodology. Verification and validation of this data will allow the methodology to be used for safeguards analysis. The benefits of this methodology allow for instantaneous safeguards conclusions to be made based on plant process data. In addition, since plant process data is used for the analysis, the conclusions made are completely objective; thus, subjective conclusions, based on video monitors, are eliminated and the resulting analysis is independent of human interpretation.

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