SAFEGUARDS ENVELOPE THE FIRST STEPS

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Overview:

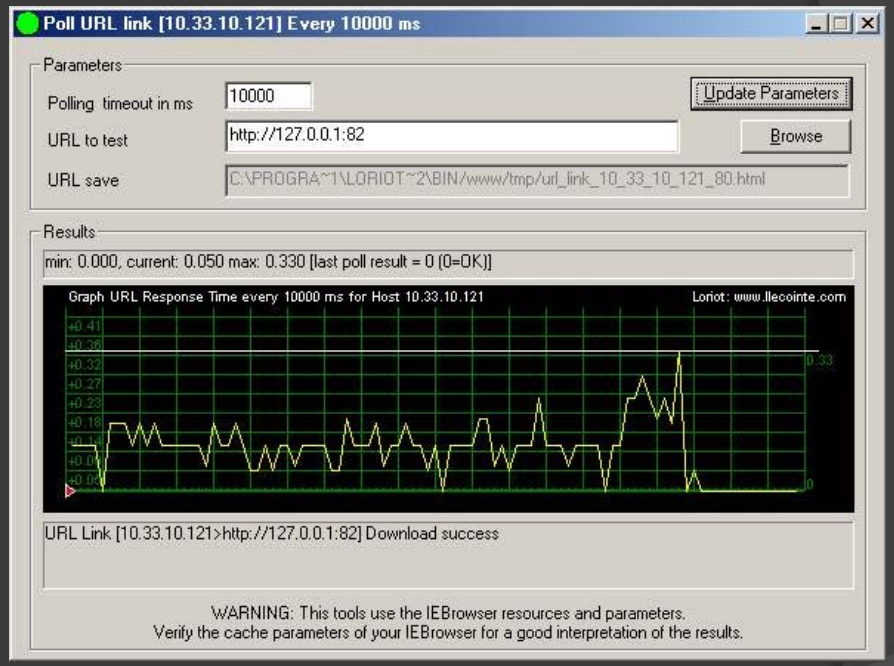
- What We Heard Yesterday
- Safeguards Envelope Final Goal
- Advantages to a Safeguards Envelope
- The Plan
- Example
- Recap
- Conclusion

What We Heard Yesterday

- If you do something new: make it cost effective – Baute (IAEA)
- Increase automation – Scheinman (USGOV)
- Move to Real Time – Scheinman (USGOV)
- NA-243: Use existing technology for safeguard applications – Whitaker (ORNL)
- Example technology: continuous fuel cell monitoring

Safeguards Envelope Goal

- Create a set of operational and safeguards parameters that will be used to establish the real time location and assay of nuclear materials in parallel to existing direct observation in reprocessing facilities
- Use already measured quantities to increase confidence
- Use existing proliferation resistance (PR) figures of merit methods (FoM)
- Use some theory developed by Safety



Advantages

- Inexpensive (math is cheap)
- Uses already measured parameters
- Some theory exists thanks to Safety Analysis
- FoM methods growing and can be utilized
- Allows for real time warnings
- Parallel value for operators and regulators
- Adaptable (can include new technology).
- Will increase safeguardability of the fuel

The Plan: Overview

1. Evaluate the Normal PR in each MBA:
    1. Determine Normal Operation Parameters
    2. Input Parameters into Method to find PR
2. Evaluate the “normal” Transient Conditions
    1. Determine PR for “normal” transients
    2. Refine Methods to determine Transient vs Normal conditions.
3. Evaluate several “expected” Diversions
    1. Refine Methods to determine Diversion vs Transient Conditions
4. Use the more standardized view of PR (on-normal, off-normal, diversion) to assign preliminary lower bounds to PR of the plant.

The Plan: Required Methods

- Local Proliferation Resistance (PR) evaluation based on real-time measured parameters.
  - Scalable over different MBAs
- Diversion Detection FoMs to detect, in real time, transient conditions and differentiate between “all clear” and “requires inspection.”
  - Using normally not-considered operations data such as pH, NOx concentrations, flow rates, etc. Also should include the new ideas for flow monitoring.
- Both steps will likely employ a multiplicative multi-attribute utility analysis decision method (MAUA)

Example: PWR Power Plant

- Assume PR between 0 (bad) and 1 (perfect)
- 3 MBAs: Fresh Fuel, In Reactor, Spent Fuel
- Assume the following PR Model (Additive)

Attribute	Function	Weight
Fuel Access	% of time accessible	0.1
Radiation in Dose	x/5	0.4
Movement Detection	% detection	0.5

- Assume the Following Diversion Detection Model (higher is bad, threshold of 0.5 for alarm)

Attribute	Function	Weight
Fuel Moved?	Binary (1/0)	0.1
Crane in Motion?	Binary (1/0)	0.3
Pressure Vessel Seal?	Binary (1/0)	0.2
Off-normal alarms?	Binary (1/0)	0.4

Example:

- Now the value of the Base PR

Attribute	Weight	Fresh Fuel	In Core	Spent Fuel
Fuel Access	0.1	0.25	1	0.75
Radiation in Dose	0.4	0	1	0.75
Movement Detection	0.5	0.5	1	0.8
	Final Score	0.275	1	0.775

- And a Transient: Refueling PR

Attribute	Weight	Fresh Fuel	In Core	Spent Fuel
Fuel Access	0.1	0.25	0	0.75
Radiation in Dose	0.4	0	1	0.75
Movement Detection	0.5	0.4	0.8	0.6
	Final Score	0.225	0.8	0.675

Example:

- Compare the Normal Transient to a Real Diversion: Stealing 1 Fuel Rod
- Assume the Proliferator spoofs 1 of the Off- normal detection systems (crane in bad motion), but fails to spoof the radiation alarms well enough

Attribute	Weight	Normal Refuel	Diversion
Fuel Moved?	0.1	1	1
Crane in Bad Motion?	0.3	0	0
Pressure Vessel Seal?	0.2	1	1
Off-normal alarms?	0.4	0	1
	Final Score	0.3	0.7

Example:

- At this point:
  - The Operator is notified, with a detailed analysis of the PR of the plant as well as the reason for a tripped alarm
  - The Regulator may be notified that there may require an inspection and a less detailed explanation of standard MBA PR
    - For respect of proprietary information: this may be a green light/red light scenario

Recap

- Cost Effective
- Increases Automation
- Real Time
- Uses existing technology

- IAEA, US Government, National Labs should all be happy now

Conclusion

- First Steps are being made for fully integrated Safeguards Envelope
- This is an addition, not a replacement
- Allows for real time evaluation of plant PR
- Benefits plant operators and regulators alike
- Uses existing technology and already measured values