Separation and Safeguards Performance Model

SAND2014-19385PE

- The SSPM was designed for evaluating advanced safeguards concepts, improved measurement instrumentation, and diversion scenario analysis of reprocessing plants.
- Currently PUREX, UREX+, and E-Chem models have been built using Matlab Simulink. Material flows are tracked throughout the plant and measurements are simulated for safeguards.
  - Spent fuel source term library for user-defined runs
  - Mass tracking of elements 1-99, bulk solid & liquid (or salt), heat load & activity
  - Customizable measurement points with user-defined measurement error
  - Automated calculation of material unaccounted for (MUF) and error propagation in real-time.
  - Alarm conditions and statistical tests
  - User-defined diversion scenario analyses
  - Integration with process monitoring and physical protection systems.

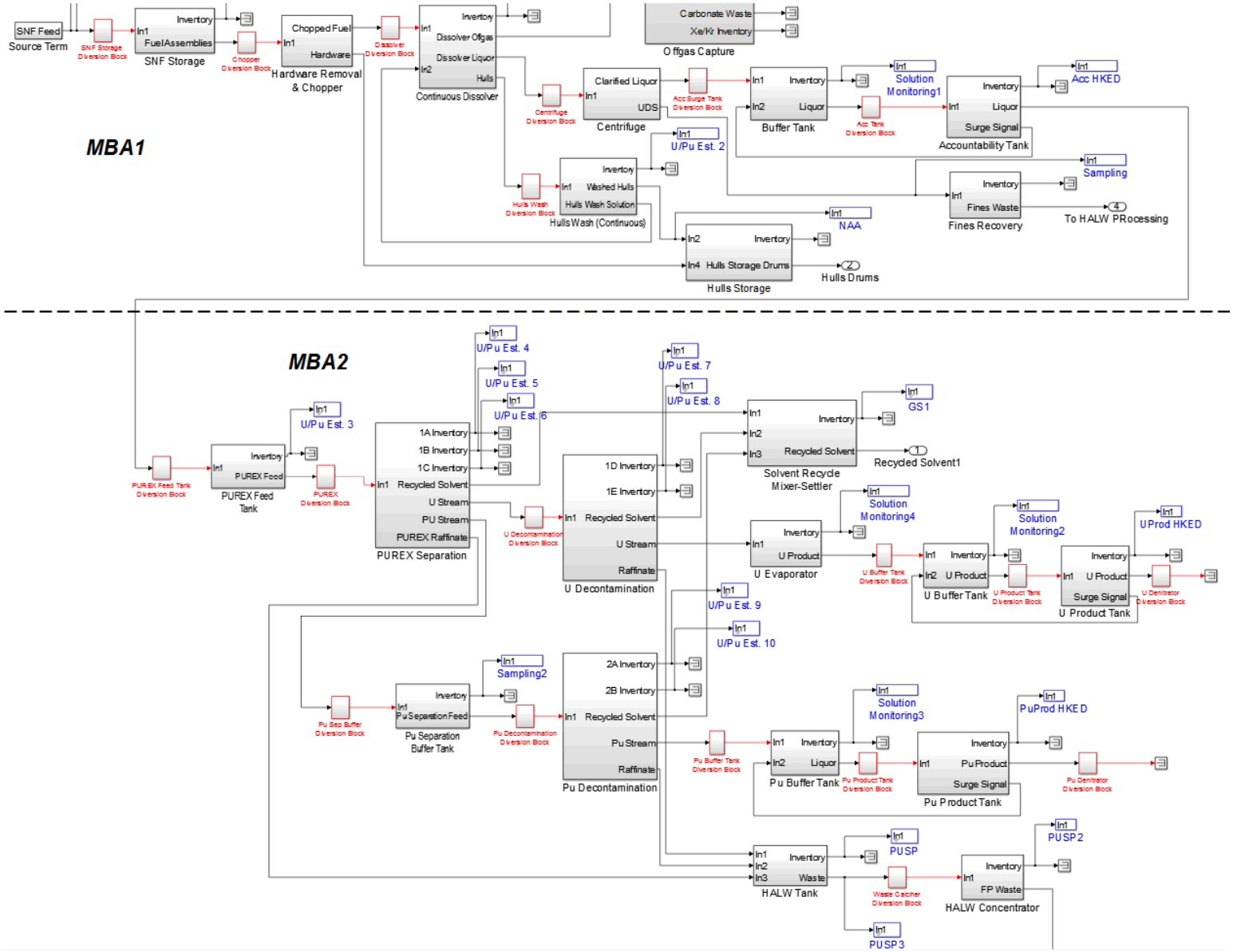
SSPM Demonstration

- The SSPM will be used as part of a one-day training module on traditional nuclear materials accountancy vs. process monitoring measurements in existing reprocessing plants.
  - Examine typical process steps in aqueous reprocessing
  - Examine material balance area structure
  - Perform example inventory difference calculations
  - Examine error propagation and statistical tests
  - Discuss how to incorporate process monitoring
  - Run through notional material loss scenarios

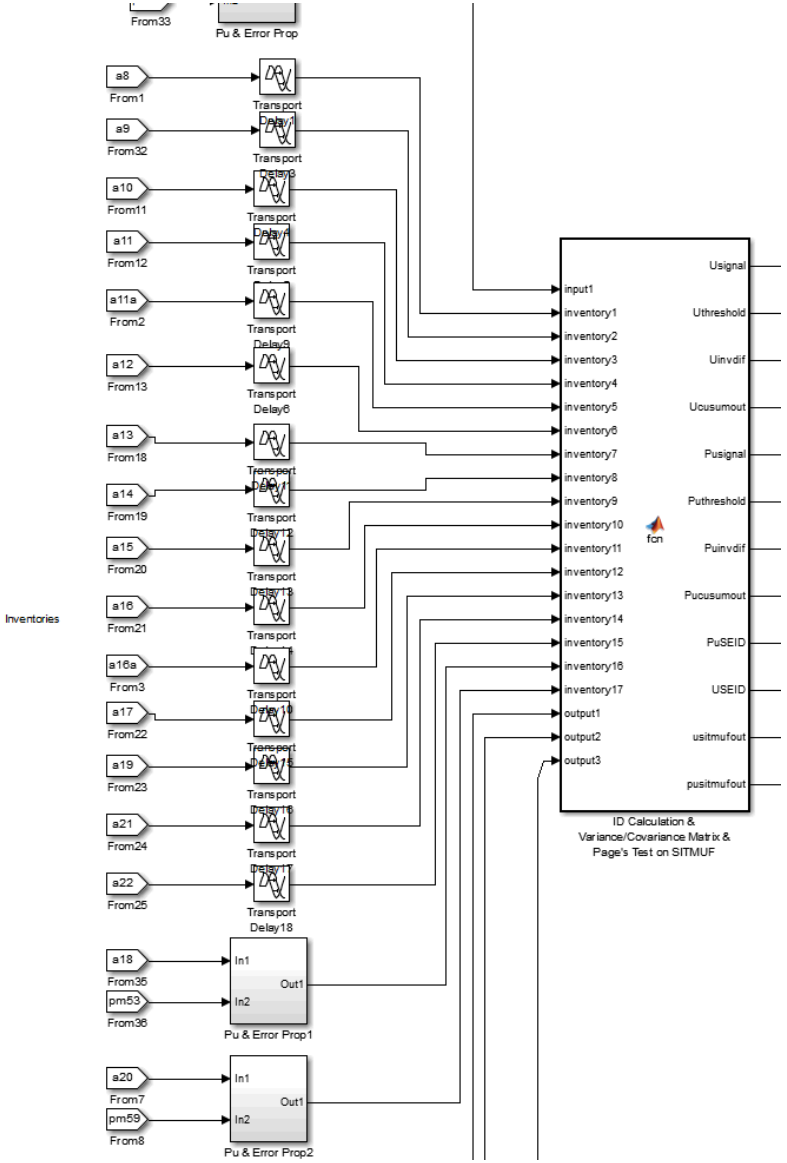
SSPM Data

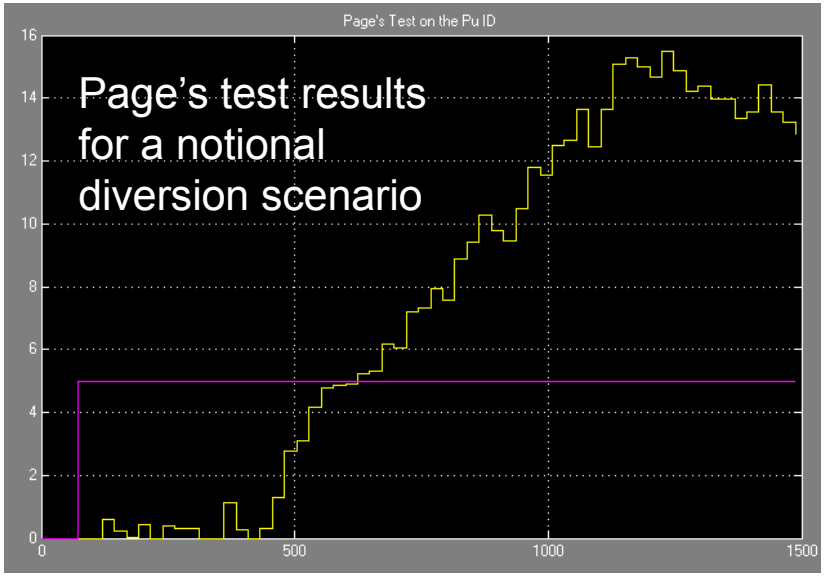
- Diversion scenario results can be OUO or higher depending on if the plant is representative of existing plants.
- The goal of this work is to modify the model to create a plant design that is representative of PUREX and based on open literature, but not any specific plant design.
- Any demonstrations of measurement error and diversion scenarios will be notional just to teach the concepts.
- Statistical tests are available in the open literature.
- Process monitoring is in the R&D phase, and so will be a discussion of new ideas.

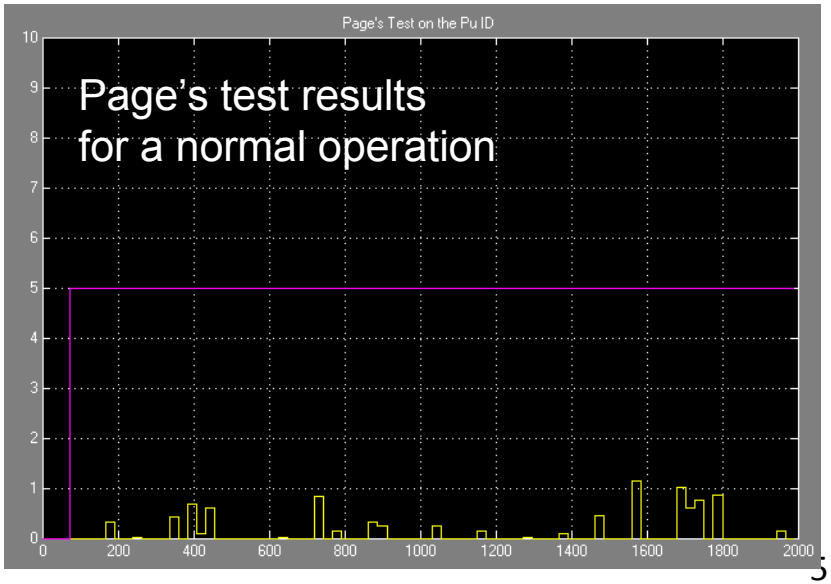
PUREX SSPM in Simulink



Monitoring Subsystem







Process Monitoring Integration

- The SSPM simulates standard plant monitoring data (bulk flow, mass, density, etc.) along with traditional safeguards measurements (Pu content).
- Bulk material balances have been setup for every processing unit in the plant, and the Page's test is used to detect bulk material loss.
- The Pu accountancy system is balanced across an entire MBA.
- When running a diversion scenario, the process monitoring system looks for bulk material loss; while the Pu accountancy system looks for Pu loss from MBA1 and MBA2.