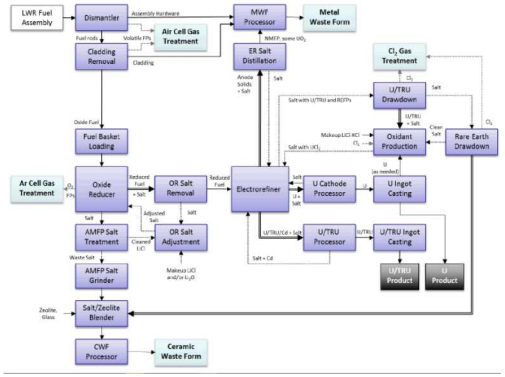
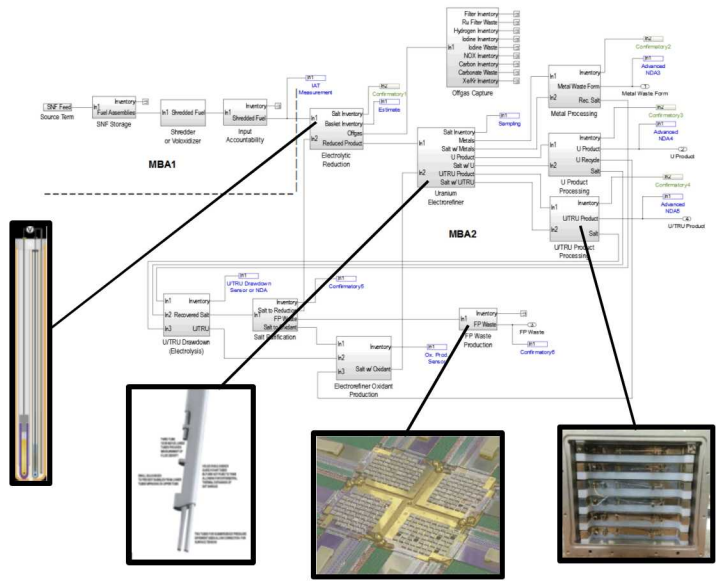
SAND2019-4375PE

Preparing for the MPACT 2020 Milestone





PRESENTED BY

Ben Cipiti

MPACT Working Group Meeting, April 2019
SAND2019-xxxxC

What is the 2020 Milestone Again?

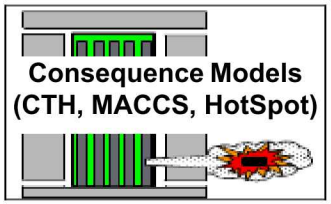
- **Develop and demonstrate the next generation of nuclear materials management for the peaceful use of civilian nuclear energy.**
- **Develop a Virtual Facility Distributed Test Bed that incorporates measurement technologies, data from field testing, analysis tools, and models currently under development to demonstrate Safeguards and Security by Design (SSBD).**
- **We will focus electrochemical processing plants, but the tools can be extended to other fuel cycle facilities.**

References:

1) "MPACT Implementation Plan: Lab-Scale Demonstration of Advanced Safeguards and Security Systems," INL/EXT-17-43112 (August 2017).
2) "MPACT Advanced Integration Roadmap," LA-UR-16-27364 (2016).
3) "MPACT Modeling and Simulation Roadmap," LA-UR-16-26045 (2016).

Virtual Facility Distributed Test Bed

High Fidelity Capabilities



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Measurement Models (NDA, MIP, etc.)

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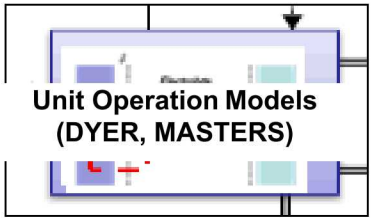
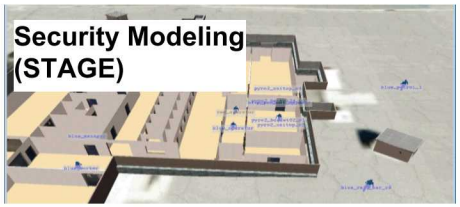
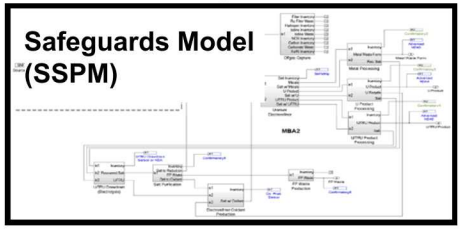
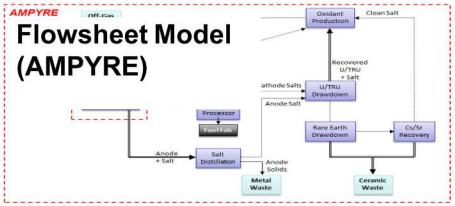


Systems Level Models







Key Metrics

Probability of Success
Timeliness
Consequence

Facility Layout
Batch Timing

SEID (σ_{MUF})
Probability of Detection
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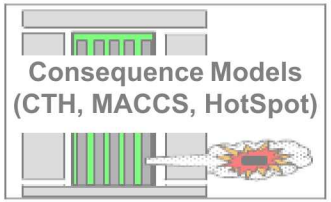
Flowrates
Inventories
Separation Efficiencies

Branding

- **We would like to showcase these capabilities and generate more visibility both domestically and abroad.**
  - Reaching out more to industry
  - Targeted presentations in U.S. and international venues
- **Nuclear facilities in the U.S. tend to be built without laboratory input, but cost overruns and overly conservative security designs do not help the industry.**
  - Contractors tend to follow what's been done in the past, one-size fits all approaches, with no budget for R&D or optimization.
  - Industry also avoids the labs due to high cost and limited ability to execute large-scale projects (with good reason).
- **We need to craft our message better. MPACT can be a one-stop shop for SSBD *consulting* to provide optimized safeguards and security designs.**

Flowsheet Modeling

High Fidelity Capabilities



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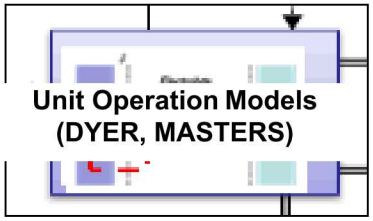
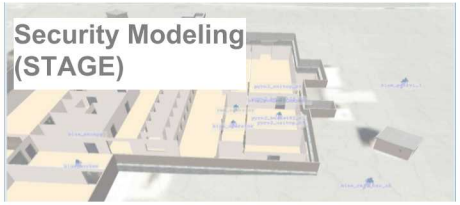
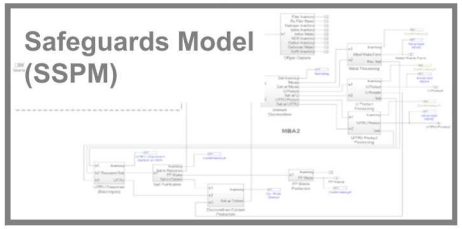
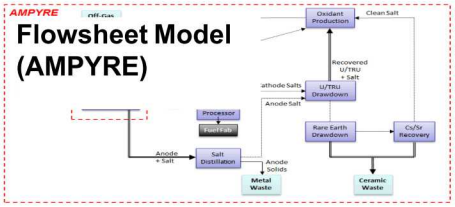


Systems Level Models







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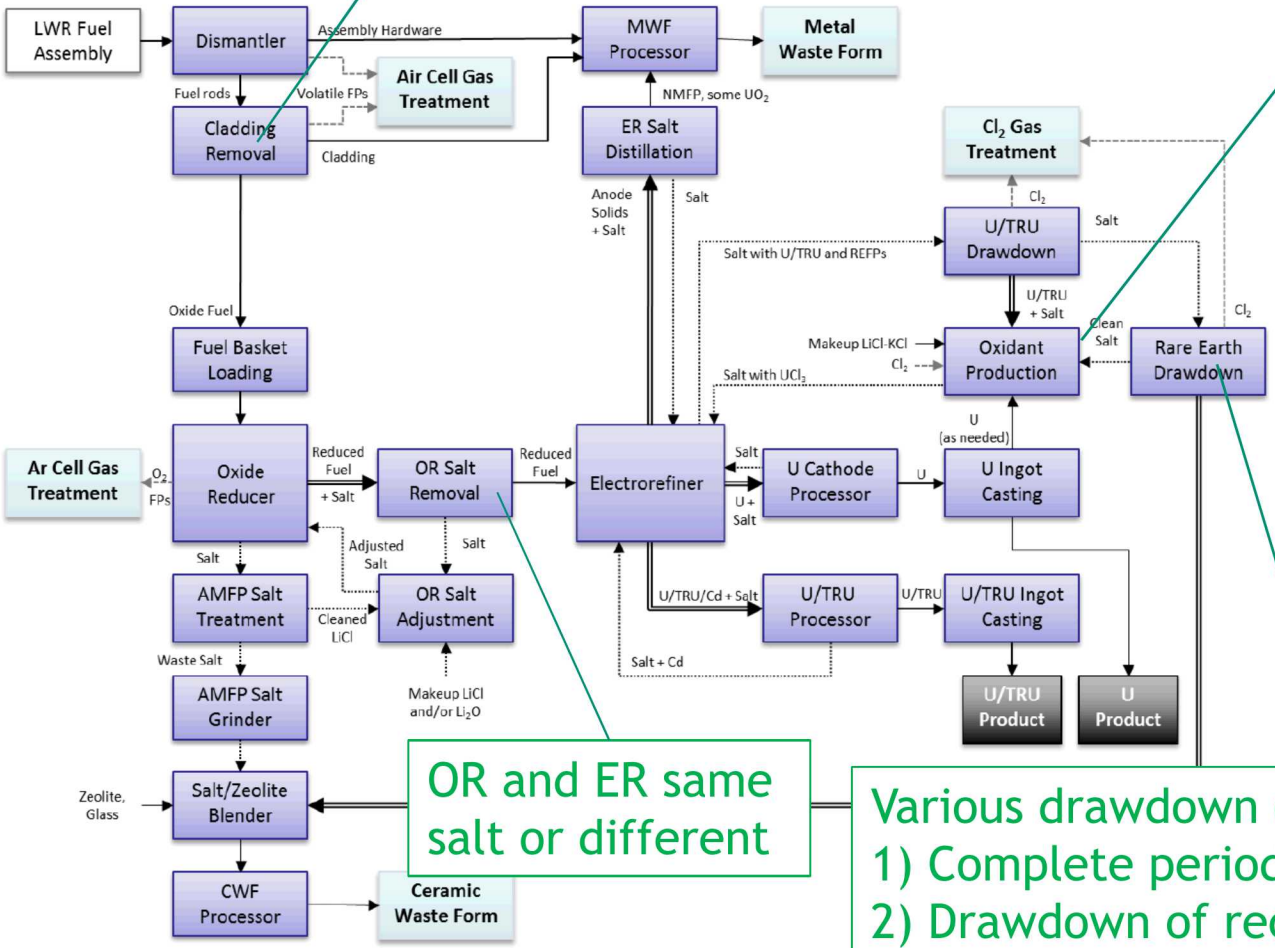
Flowsheet Options and Effect on SSBD

Various front end options:
1) Decladding is an option
2) Voloxidation is an option
3) Variations in input accountancy

Recycle U/TRU and U for oxidant production, or DU feed?

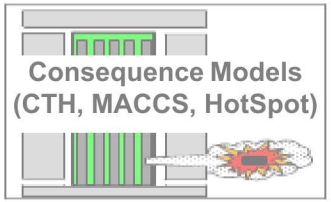


OR and ER same salt or different

Various drawdown options:
1) Complete periodic drawdown of ER salt
2) Drawdown of recycle stream

Safeguards Technologies & Modeling

High Fidelity Capabilities



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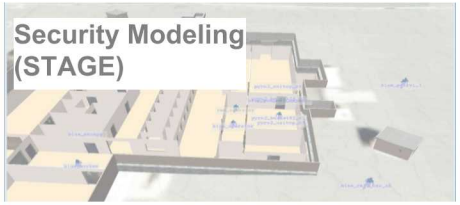

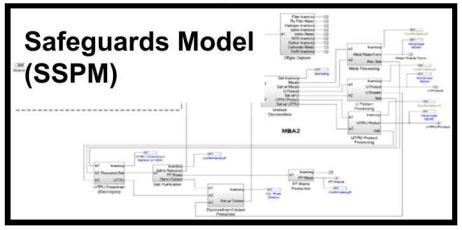

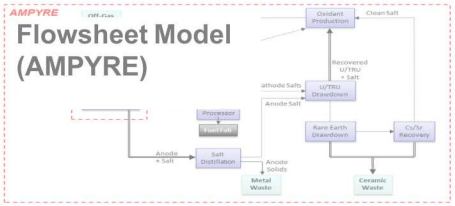

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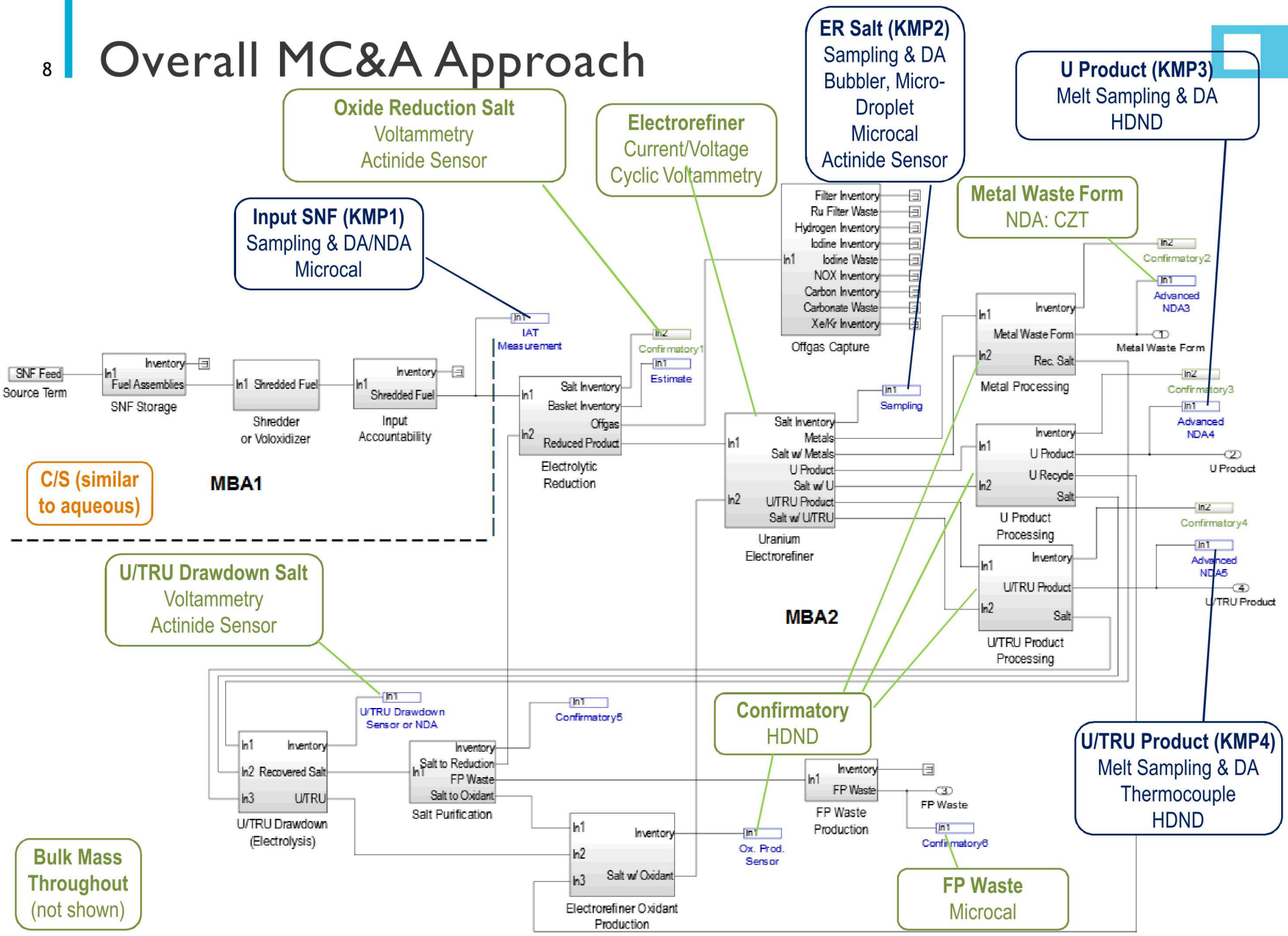
Overall MC&A Approach



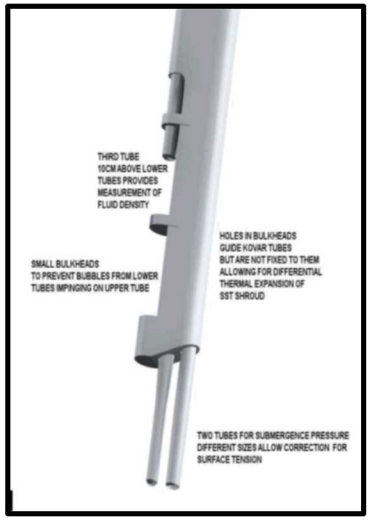
Advanced Integration

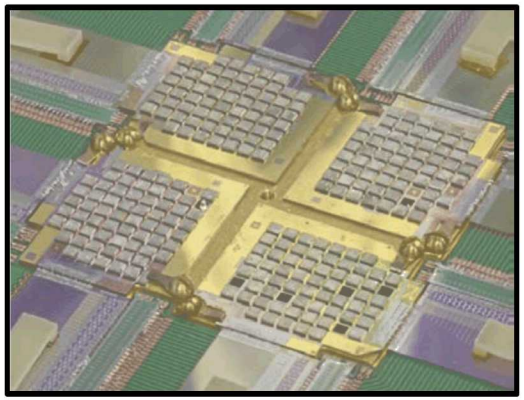
- **LANL is providing a key role by evaluating the use of individual measurement technologies in various locations in the flowsheet.**
  - Transition experimental results in the laboratory setting to expected performance in a commercial scale facility.
  - Also helps to narrow down the choice of technology in various locations.
- **To date, have analyzed:**
  - Microcal, HDND, Voltammetry
- **Future work:**
  - Microfluidic sampler, U & U/TRU NDA measurements, and other MPACT-supported technologies.

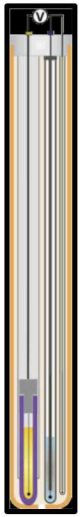
Process Monitoring

- **SNL & UTK are evaluating alternative analytical approaches for echem safeguards.**
  - It is useful to consider some alternatives due to concerns about the measurement uncertainty of MC&A measurements.
  - This work is also exploring a different approach to safeguards.
- **The approach assumes more use of NDA measurements to reduce reliance on DA.**
  - Bulk measurements can be used to detect direct material loss
  - NDA measurements can provide indicators of substitution loss (the uncertainty for detecting Pu loss may be high, but we maybe able to detect that a substitution has occurred with lower uncertainty.)

Measurement Technologies



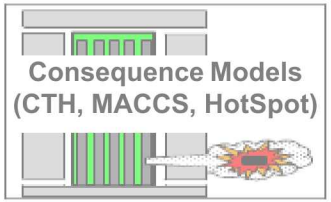




- Measurement technologies have been a key focus of the MPACT program for the past decade, and include the vast majority of the experimental work.
- Performance of measurement technologies (uncertainties) on relevant solutions/materials are passed to the systems level models.

3D Facility Modeling

High Fidelity Capabilities



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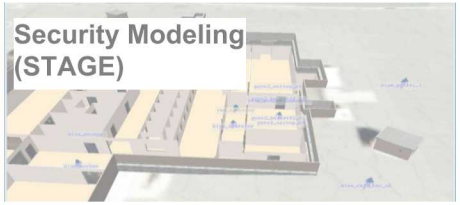

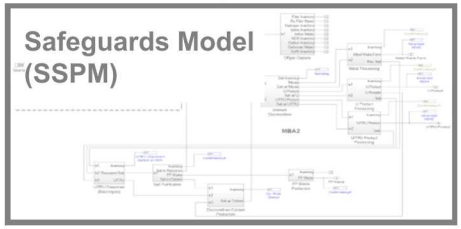

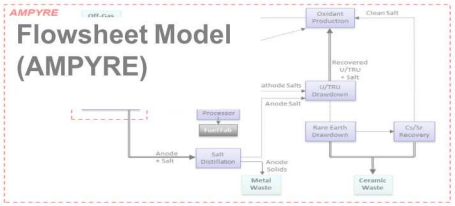

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Security Modeling

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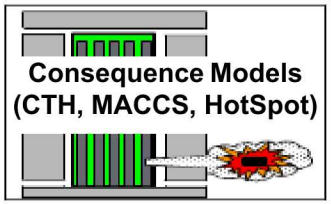

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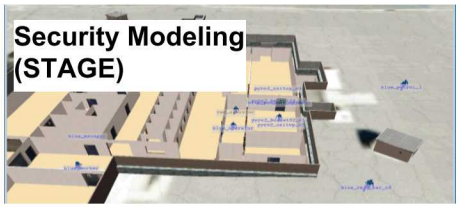

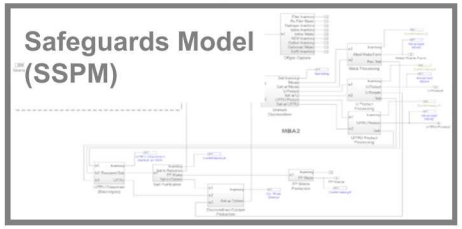

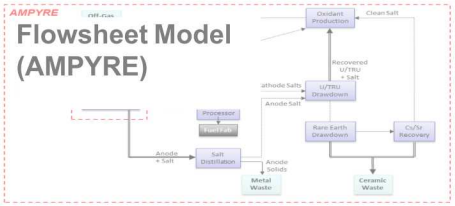

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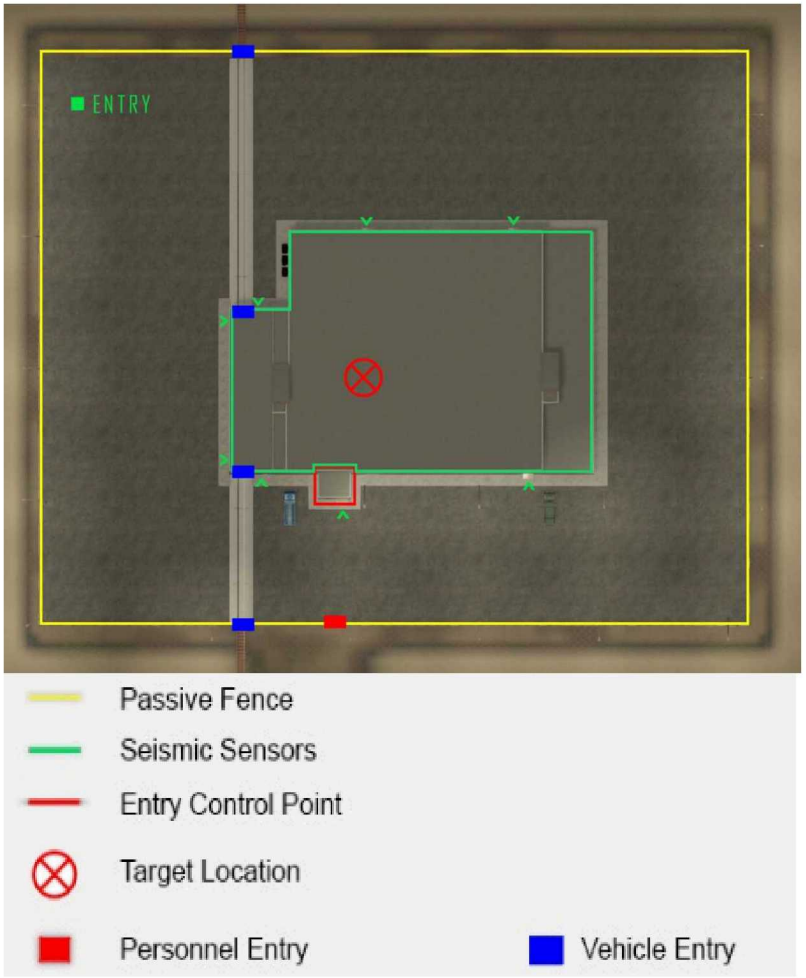
Security by Design Focuses More on Cost Optimization

- **Modeling tools like Scribe3D allow a single analyst to optimize a security design to meet regulatory requirements while minimizing cost.**



JNMM Special Issue

- **A special issue of JNMM could be a very visible way to showcase the milestone.**
  - Have talked with the managing editor about this.
- **The idea is to have one overview paper followed by 4-8 supporting papers.**
  - "MPACT 2020 Milestone: Safeguards and Security by Design"
  - "Flowsheet and Facility Design to Support SSBD"
  - "Safeguards and Security Modeling"
  - "Advanced Integration of Electrochemical Safeguards Measurements"
  - "Electrochemical Safeguards Measurement Technologies"
  - "Process Monitoring for Electrochemical Facility Safeguards"
- **Papers would serve as our PICS:NE milestones and would be submitted in Fall, 2020 (Issue likely in early 2021).**