U.S. DEPARTMENT OF ENERGY | Office of NUCLEAR ENERGY

Advanced Reactor Safeguards and Security Program Overview and Goals

National Nuclear Security Administration

U.S. DEPARTMENT OF ENERGY

Sandia National Laboratories

Advanced Reactor Safeguards and Security

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SAND2023-11557PE

Goals for this Working Group Meeting

- Discuss the reorg and inclusion of the cyber pathway.
- Present FY23 final results—why is your work important, why does industry care, and key results.
- Discuss collaboration within the program (moving toward 3S integration)
- Discuss external collaboration with vendors, stakeholders, and related program areas in DOE NE and NNSA.

Roles and Responsibilities

- Over the next year, I will continue to focus on management of the MC&A and PPS pathways.
- Katya will focus on management of the cyber pathway, but will be the deputy for the full program.
- Cheyenne provides admin support for the full program and will increasingly be tasked with communications and tracking in the program.
- Dan is our Federal Program Manager for 4-6 months on detail from NRC, and Savannah is transitioning to her new role managing NRIC.

ARSS Program Goal and Objectives

The ARSS program is addressing near term challenges that advanced reactor vendors face in meeting material control and accounting (MC&A), physical protection system (PPS), and cybersecurity requirements for reactors built in the U.S.

Material Control & Accounting

Systems Level

PBR MC&A Approach
MSR MC&A Approach
Vendor Engagements
International Coordination

Technology Level

Measurement Technologies
Process Monitoring
Statistical Evaluations

Physical Protection Systems

Systems Level

SMR PPS Design Approach
Microreactor PPS Design Approach
Vendor Engagements

Technology Level

Advanced Intrusion Detection
Advanced Delay Technologies
Advanced Response Tech/Tactics

Cybersecurity

Systems Level

Cyber-Informed Engineering
Defensive Cyber Architecture
Vendor Engagements

Technology Level

Secure Elements/Tokens
Supply Chain
Control System Component Testing

Interface with Safety

New Program Graphics

Outreach & Impact

- Our goal is to get the work in the hands of vendors and other stakeholders.
  - UUR reports will be posted to the program website:

    https://energy.sandia.gov/ars
  - CUI reports can be shared by the NTD or dNTD provided certain conditions are met.
- The website, program logos, and templates are currently being redesigned.

Outreach & Impact

- Cheyenne is going to be tracking vendor engagements more moving forward including key points of contact.
- We need to use established points of contact when interacting with the NRC—check with myself or Katya if unsure.
- We would like to engage more with NEI moving forward since they can be a key advocate for change.
- Vendor/Industry interactions are likely going to be more useful in 1:1 meetings moving forward.

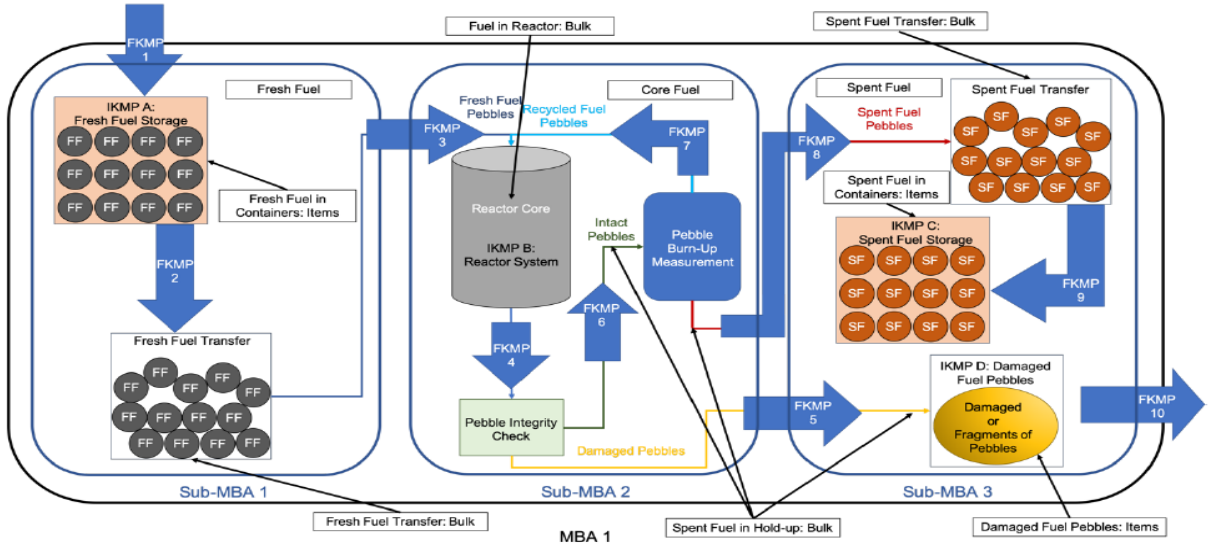
Final Reports

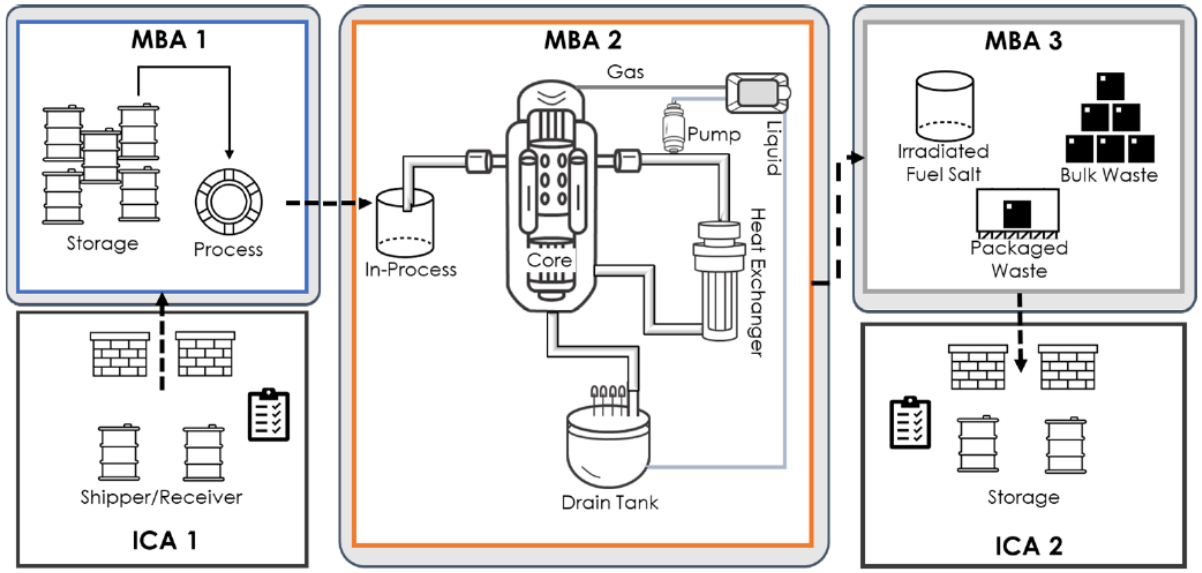
- All PI's need to put themselves in the shoes of the vendors when writing your final report – what does the vendor community take away from this?
  - If the report is more than 30-40 pages, need a good executive summary (NOTE that an executive summary should not just be a slightly longer abstract—you want to highlight your key technical results and include some figures/tables).
  - Have you provided results or performance testing to prove the use of the approach or technical concept?
  - Have you clearly articulated why this is important?
- In the traditional technical report structure, it often takes a long time to get into the "meat" of the report. Think about how to condense down intro, background, procedures sections to get to the main points/key results sooner.

PICS:NE

- We will be implementing some additional tracking and requirements to help meet milestones on time.
- Monthly PICS status is important for program tracking—these inputs all roll up to a report to DOE NE.
  - We want to see an input in accomplishments every month.
- Our main challenge with the budget is the monthly or quarterly distribution of money—we all need to take that into account when planning spending and any contracts.
  - If you do need to make a big purchase, let us know so we can adjust the lab allocations.
- International Travel Requests – DOE NE needs to see detail in these requests. In the future, note that there should be a good paragraph for both the Purpose/Scope and Justification tabs. These should be submitted when ARSS work is involved, even if funded from another source.

Material Control and Accounting (Systems Level)

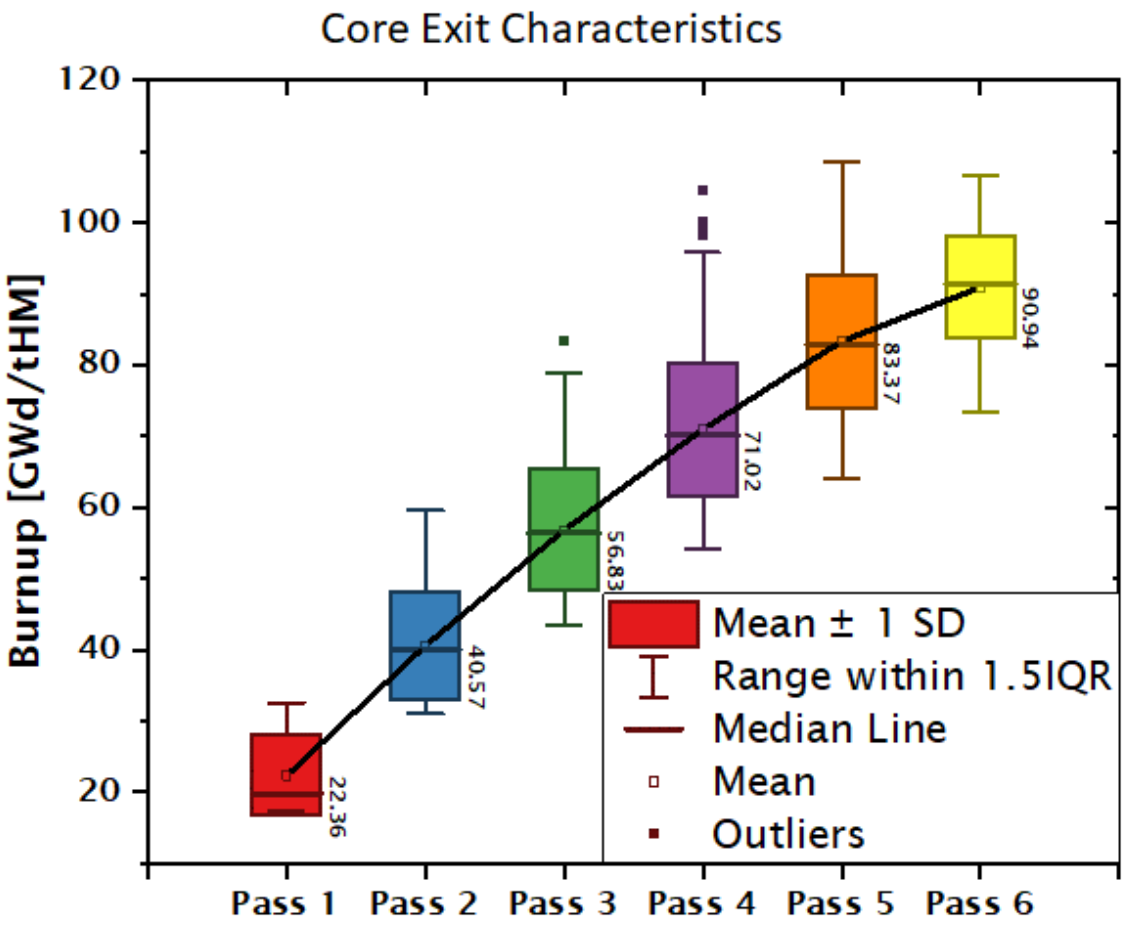




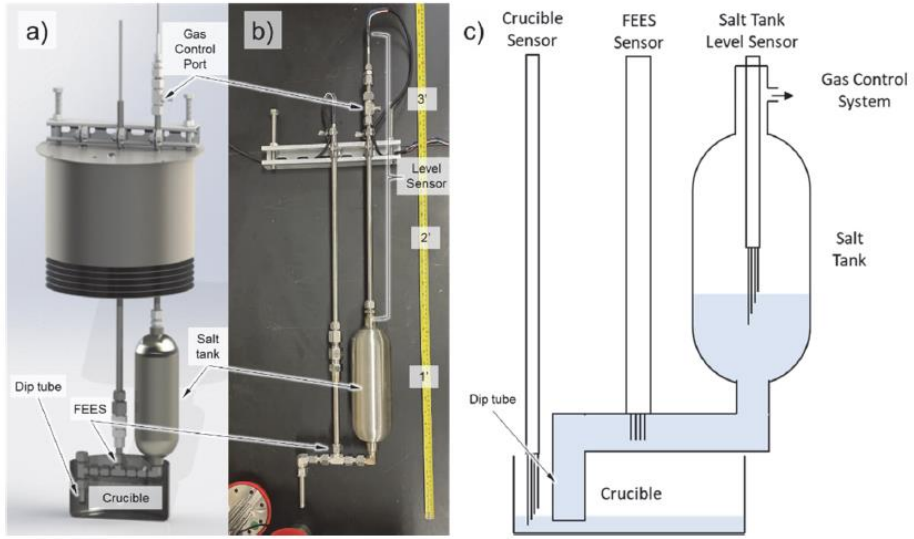
- Completion of the two M2 milestones on the MC&A approach for PBRs and MSRs should allow us to transition to different work moving forward.
  - The overall concepts are beginning to be validated through vendor engagements.
  - Continue deep dives on specific technical issues that have been identified.
  - Move toward more integrated 3S approaches moving forward.

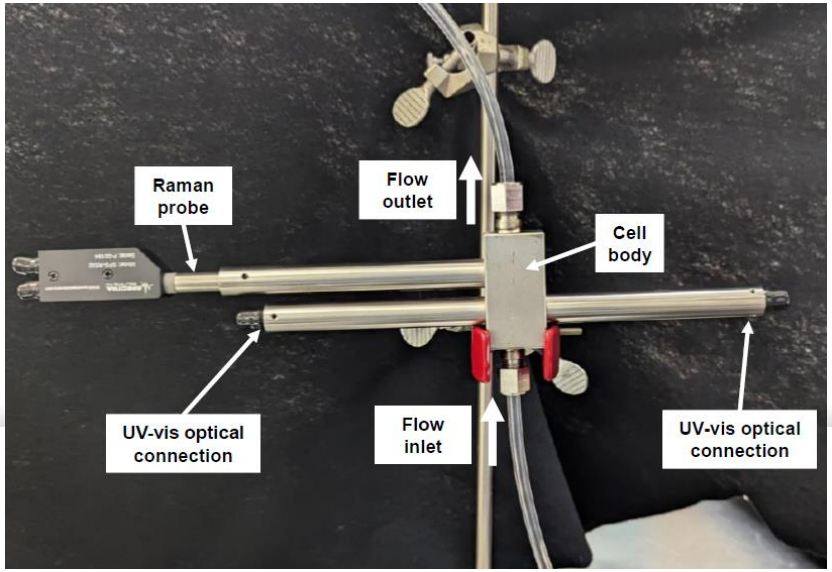
Material Control and Accounting (Technology Level)

- Currently funding a deep dive on the pebble handling system for PBRs.
- NDA measurement campaign on TRISO fuel will help the community to better understand the limitations of burnup measurements of discharged pebbles.
- Examining batch and defect measurements of pebbles.
- Beginning to examine acquisition path analysis which is an integration of MC&A and PPS.



Material Control and Accounting (Technology Level)

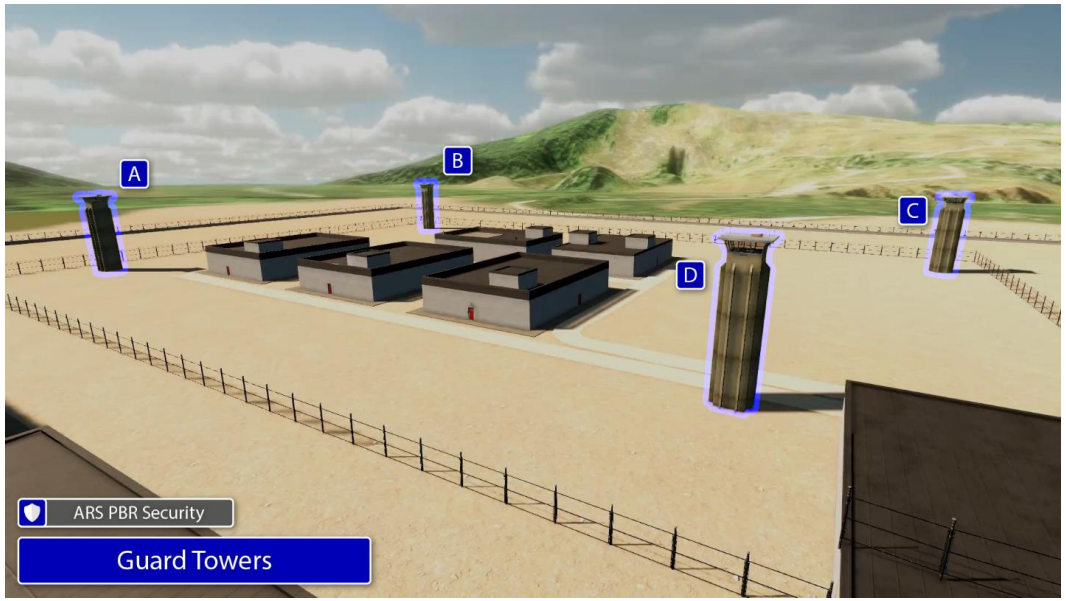




- Continuing to develop both voltammetry and spectroscopy techniques for measuring actinide content in molten salts.
- Laboratory work is moving toward more actinide species and more complex molten salt solutions.
- Work will transition toward piloting with vendors and gathering lessons learned about deployment, maintenance, and performance.

Physical Protection (Systems Level)

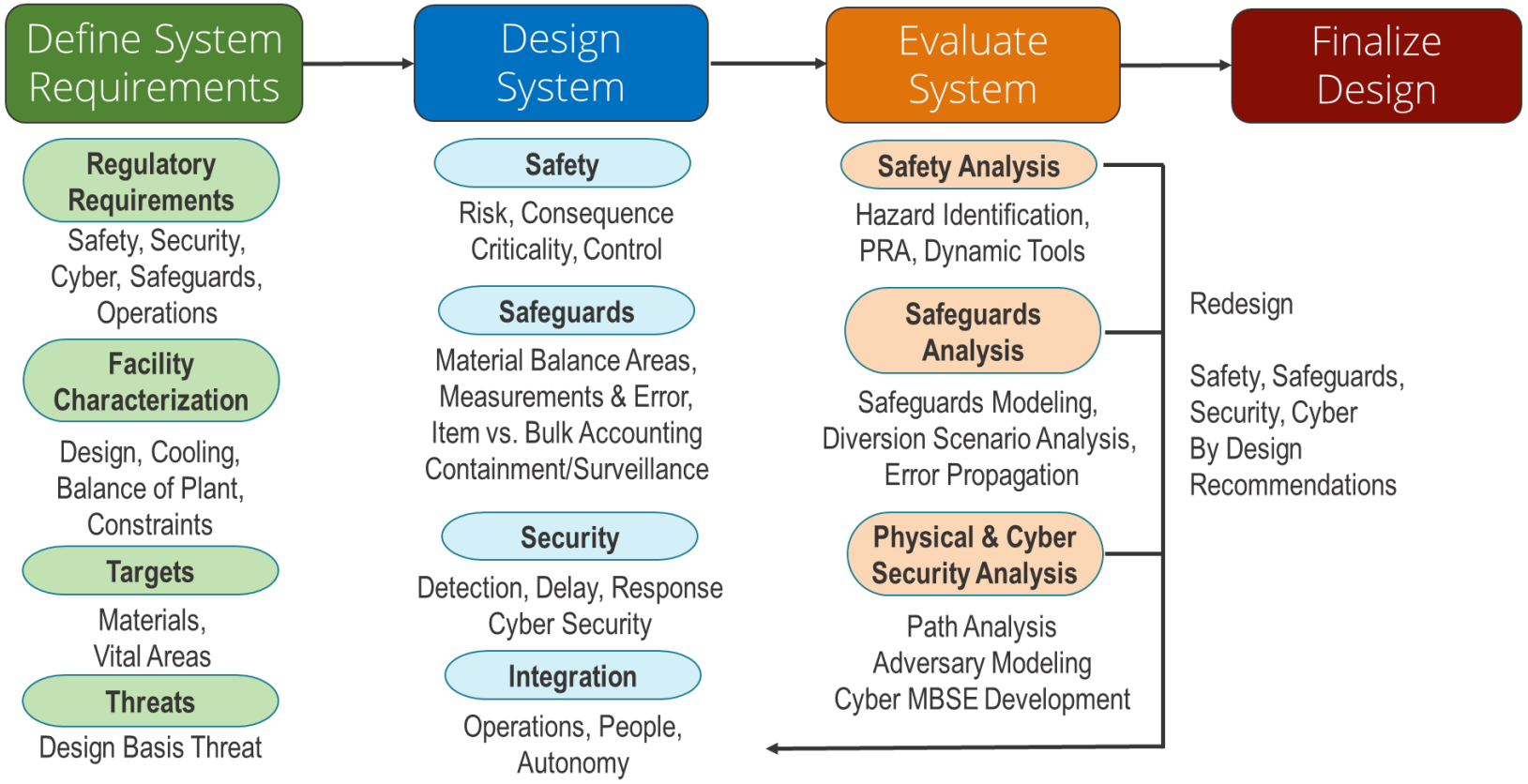
- The AR vendors would like to reduce the PPS footprint and number of on-site security staff
  - Marketing aspect to show that these reactors are smaller and safer.
  - Cost aspect to keep overall plant economics competitive.
- Systems level work has focused on minimum numbers of staffing required for different reactor types and where those minimum numbers may be reduced through exemptions/alternatives.



- Vendor engagements are being used to validate PPS design recommendations

Physical Protection (Systems Level)

- Work in FY23 started to examine the interface between cyber and physical attacks.
- Future work should continue to expand a 3S integrated approach to protection of advanced reactors with increasing linkage between the cyber and PPS pathways.



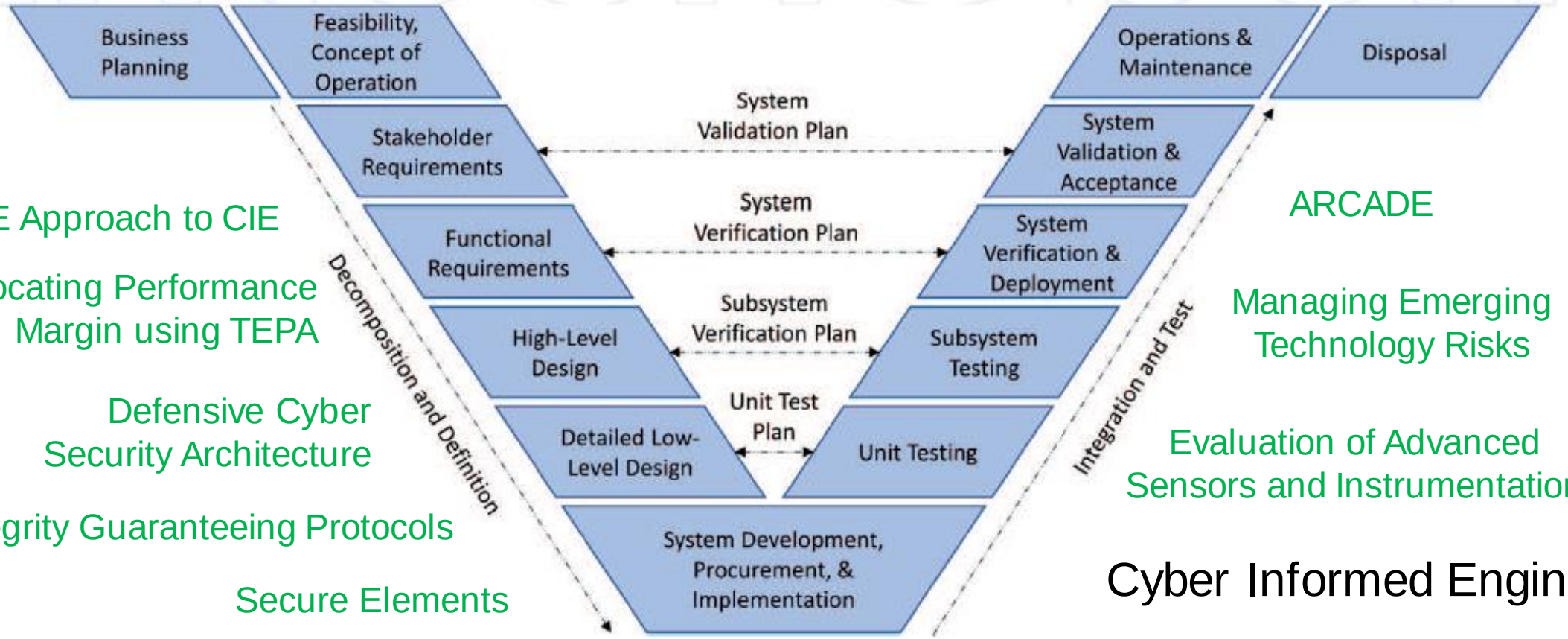
Physical Protection (Technology Level)

- Continuing to evaluate Deliberate Motion Analytics (DMA) to detect both land and air incursions as a potential replacement of a costly PIDAS around a nuclear facility.
- The ARSS program is also leveraging work from other programs on active denial (remote operated weapons systems).
- Current challenges include the high number of potential exemptions/alternatives required for NRC licensing.

FLIR Radar – capable of detection up to 700m

Visible Wavelength and Thermal Imagers with Video Analytics

Cybersecurity (Systems Level)



MBSE Approach to CIE

Allocating Performance Margin using TEPA

Defensive Cyber Security Architecture

Integrity Guaranteeing Protocols

Secure Elements

Wireless

Cyber Supply Chain Risk Analysis

ARCADE

Managing Emerging Technology Risks

Evaluation of Advanced Sensors and Instrumentation

Cyber Informed Engineering

Cybersecurity (Systems Level)

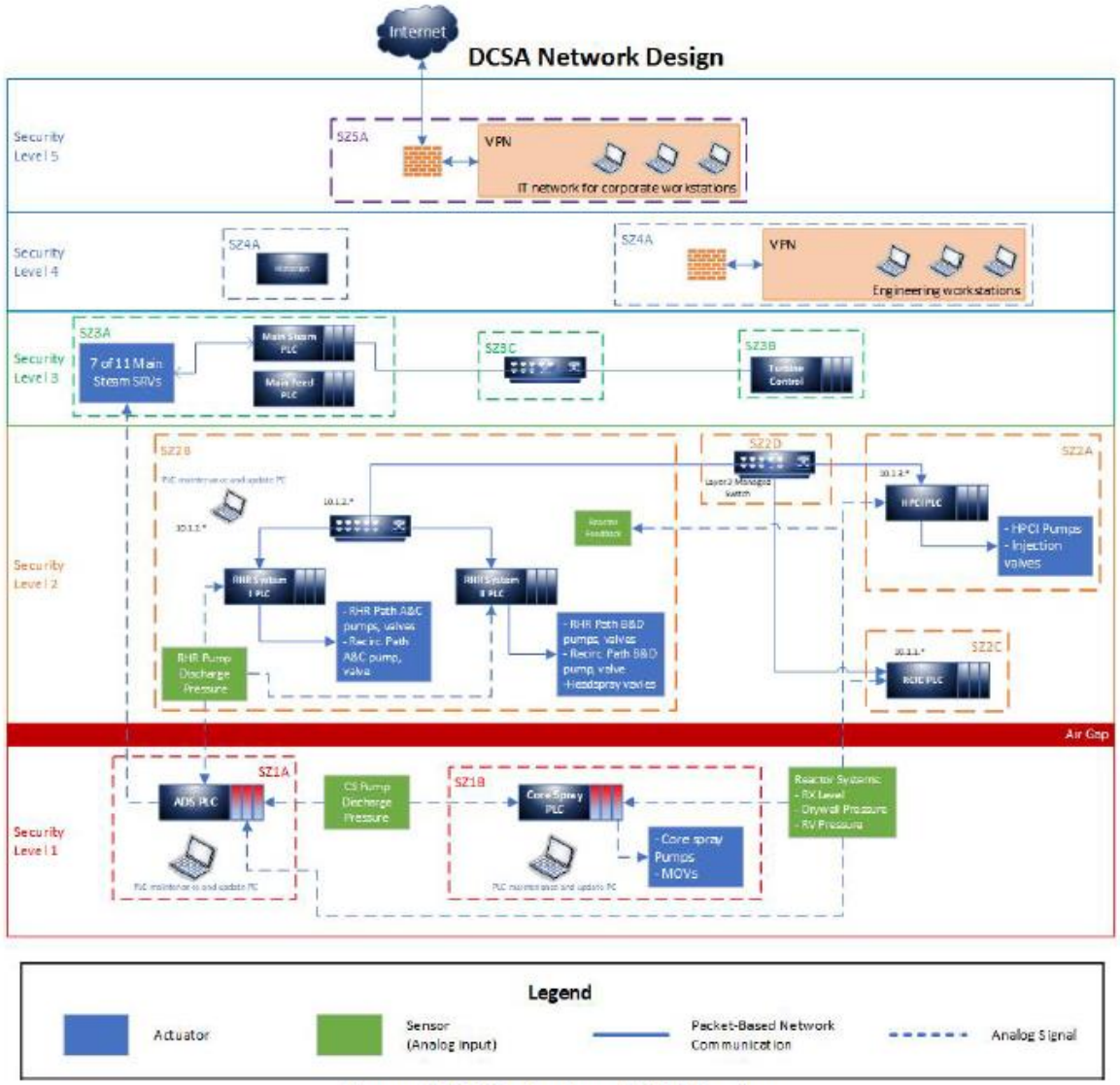


Figure 7. DCSA design of RHR System

Defensive Cyber Security Architecture

- Our goal is to define a DCSA for each class of advanced reactor.
- The DCSA is used to develop the network design, system components, and flow of information.
- The goal here is not to design the system for the vendors, but rather provide recommendations and develop the technical basis for components that may be used.

Cybersecurity (Technology Level)

- The ARSS program is also testing and providing recommendations for specific technologies that may be used as part of the engineering design (for example secure elements and tokens.)
- Wireless is a strong ask coming from the vendors, but we need to prove when and where wireless may be used and how it can be used securely.
- We expect more future work on red-teaming of systems and components as the recommended designs progress.

Vision and Path Forward

- 3SBD (Safety, Security, and Safeguards by Design) is a key overarching principle in the work of the ARSS program, and advanced reactors in particular will benefit from a 3S approach to minimize costs.
- Program work of the past few years has focused on vendor needs in the separate areas.
- We expect future work to be much more integrated across the different pathways while also taking safety into account with the goal to develop reactor class specific guides on an integrated MC&A, Physical Protection, and Cyber approach to overall plant design.

Save the Date

- The ARSS Spring Program Review will be held in-person at INL the week of May 13, 2024 (Tuesday-Thursday).