ADVANCED REACTOR SAFEGUARDS

Framework for Microreactor Safeguards and Security

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Project overview

- The goal of this project is to develop a guide/rubric for domestic safeguards.
- Products will assist advanced reactor designers/vendors in producing evidence for the NRC of safeguards advantages and/or challenges and how either is being addressed.
- Step 1 of this framework involves identifying the safeguards and security considerations and potential gaps.
- Step 2 of the framework is the procedure to address each of these identified considerations.

- Status: We are currently finishing Step 2 report

Overview of Accomplishments in FY23

- Finishing the draft of Step-2 of our framework. This includes:
  - Laying out pathways to safeguards resolutions as a user-driven choice. (decision-tree graphics).
  - Explaining the graphics in short, concise and impactful dialogs.
  - Expanding these graphics to other non-microreactor concepts.
  - Identifying where areas could be focused on to decrease uncertainty and risk, while improving security outcomes.

Key Findings in Step-1 Report

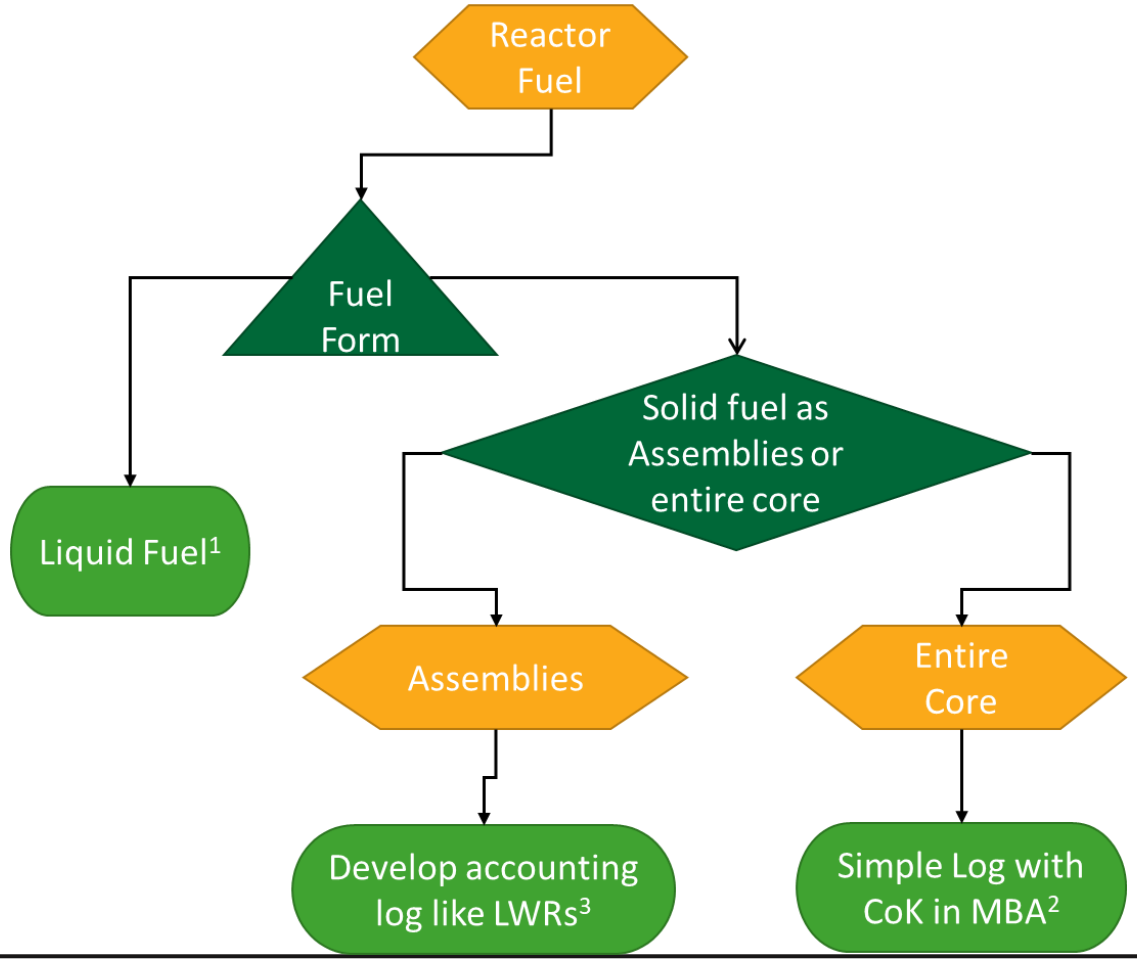
- Within the field of MC&A:
  - An operator will be able to use calculations, simulation and modeling, for spent fuel composition and its movement inter- and intra- facility;
  - We found what level of detail for inventory tracking of the material on site is necessary for continuity of knowledge;
  - We establish what MC&A practices are appropriate for the fueling concept (i.e., pre-loaded lifetime core or on-site fueling and refueling); and
  - Anomaly detection and resolution needed for a reactor in a remote environment, or when a sited reactor will have restricted access to the fuel.

Key Findings in Step-1 Report

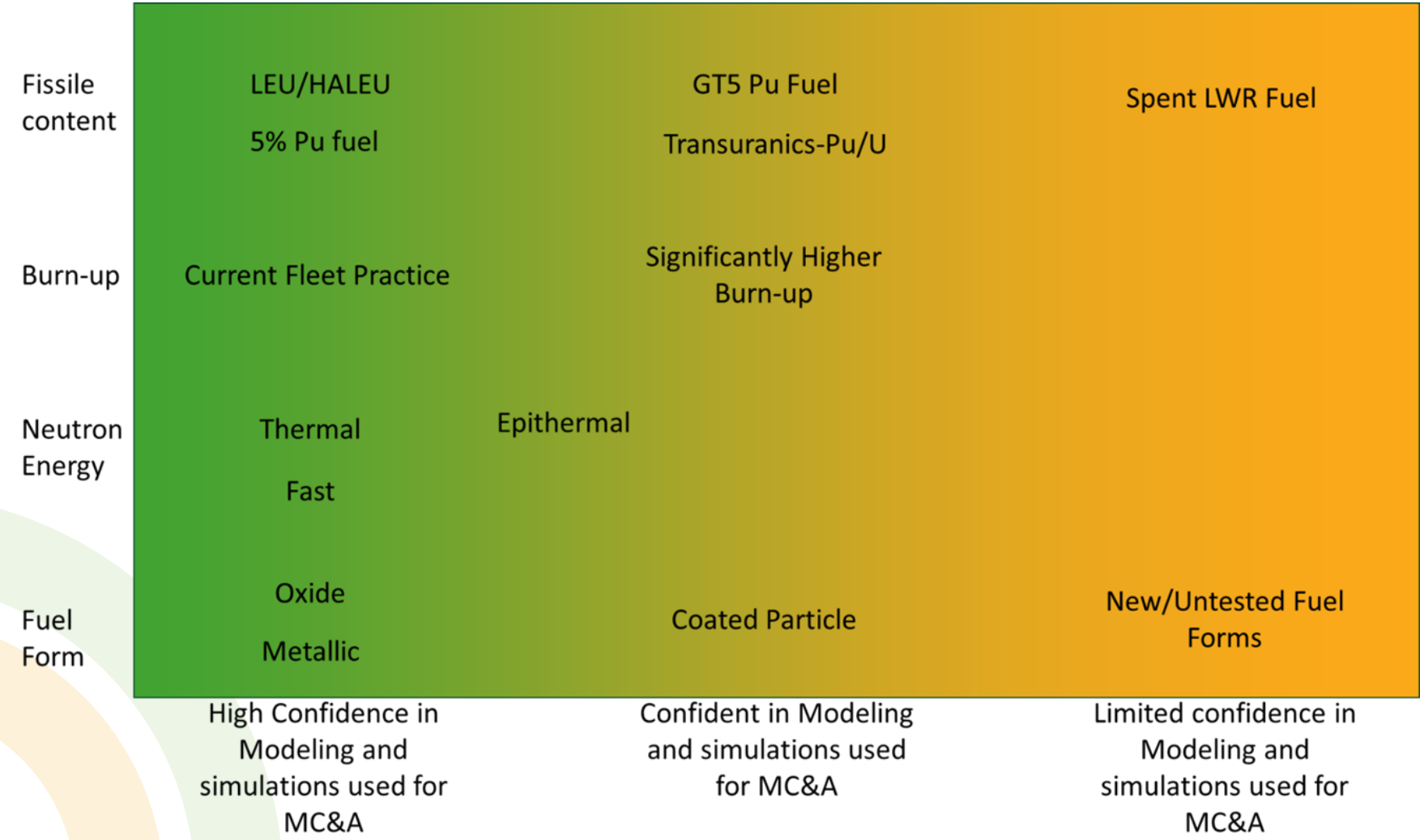
- Within the field of security:
  - We established what formal documentation is needed when a vendor uses reactor features to affect physical security scenarios
  - Addressed security concerns within the protected area, if smaller than conventional reactors
  - We identified possible improvements to gain quicker and higher confidence of threat vectors during site intrusion detection and assessments thereto,
  - We found that reducing access points to primary structures (i.e., the reactor building) will drive a refined force-on-force defense strategy.
  - Innovation in approval and authority to access areas of paramount security interest
  - Advanced force multiplier deployment for countering an intrusive force

Work on Step-2 Report: MC&A example

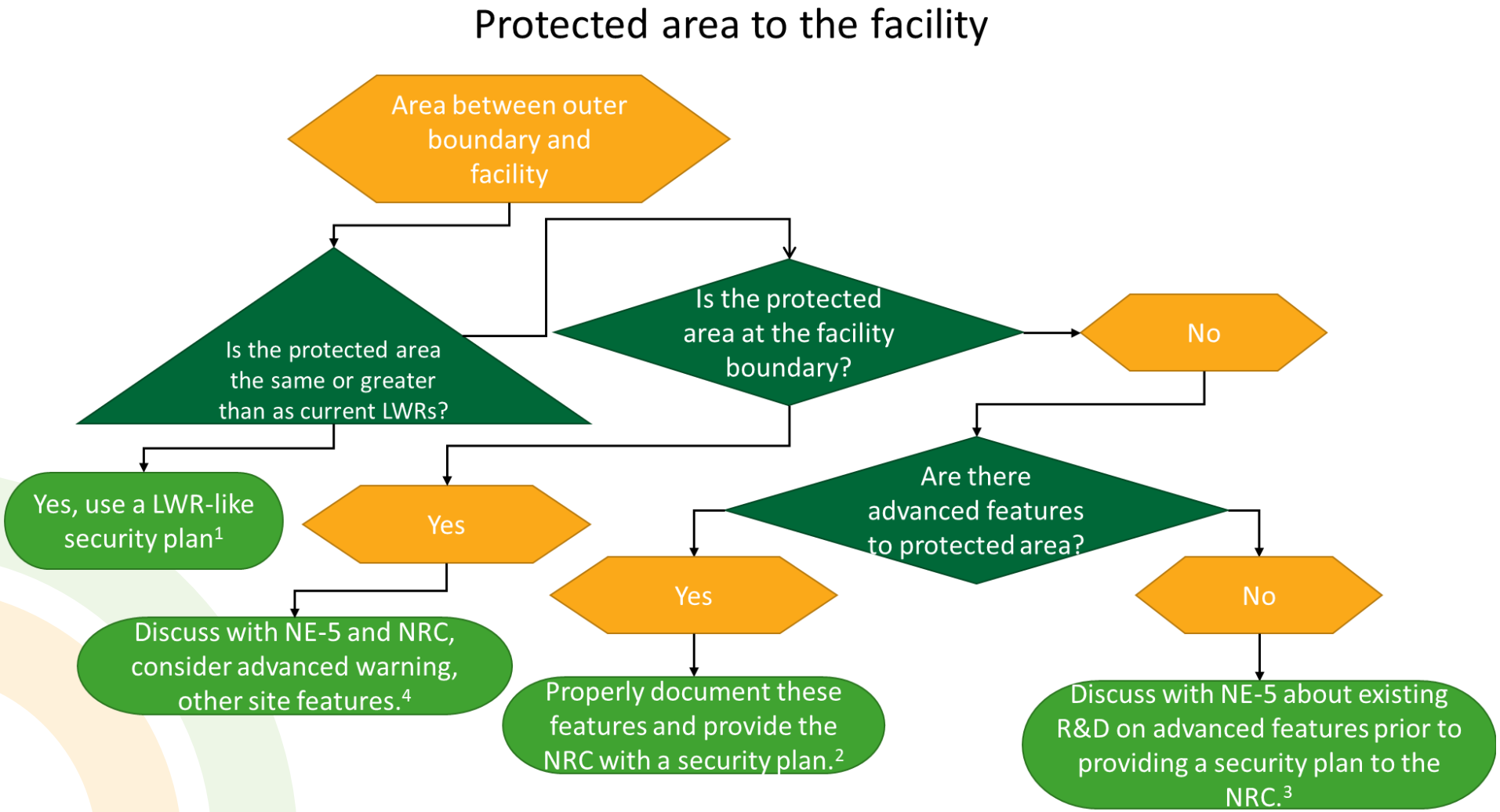
Fuel tracking in the facility



Work on Step-2 Report: MC&A example



Work on Step-2 Report: Security example



Work planned for Fiscal Year 2023:

- Microreactor domestic safeguards framework:
  - Work on completing Step-2 of the framework (addressing gaps and strengths).
  - Provide initial product to DOE-NE for initial feedback.
  - Report matrix and final products to DOE-NE by start of Q4.
- Provide support to NE-5 on advanced reactor/microreactor MC&A and physical security to end of FY.

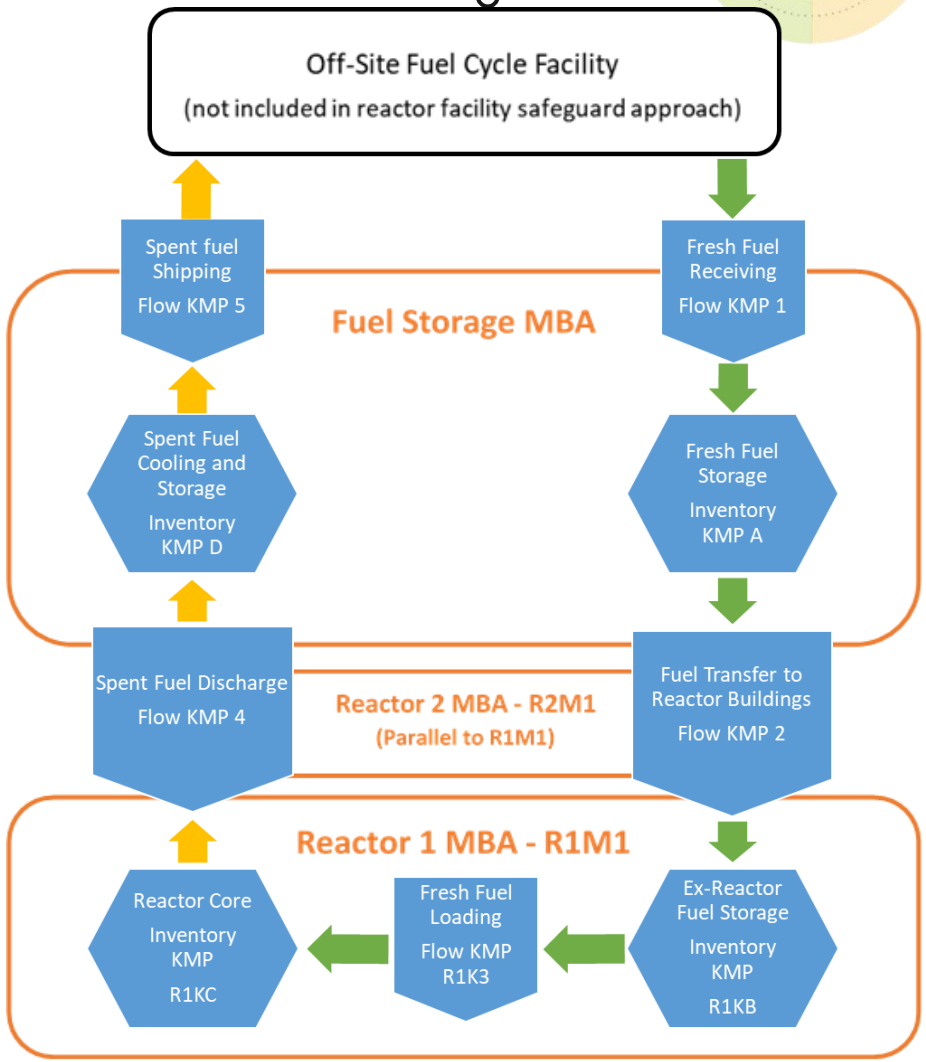
Conclusion

- From the items identified in Report 1 on MC&A and Physical Security to microreactors, we moved forward to addressing those in Report 2
- Two flowsheets from Report 2 were presented at the last NE-5 Program Review last year and we incorporated reviewer feedback from other PIs, the sponsor and from our own reviewers at ANL.
- Finishing Report 2 is our highest priority.

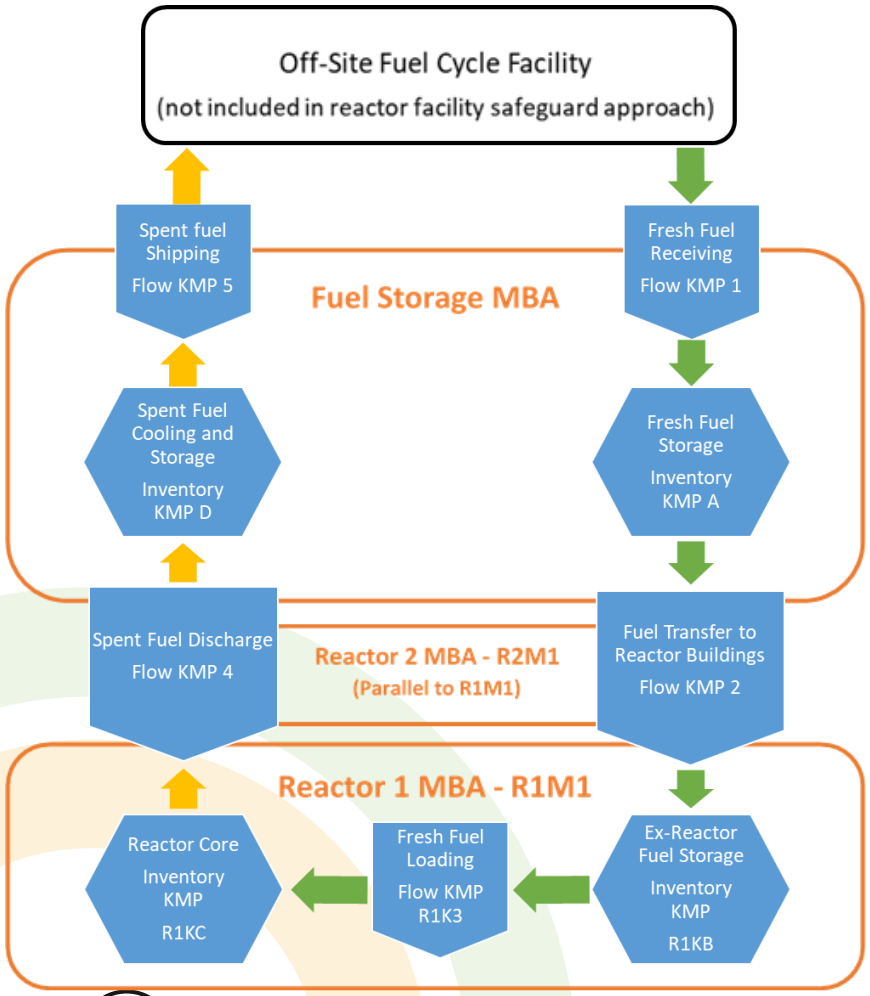
Back-Up Slides

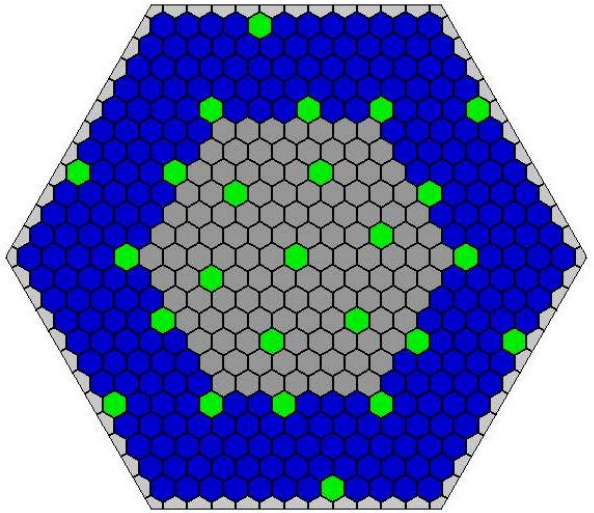
Material Control and Accountancy

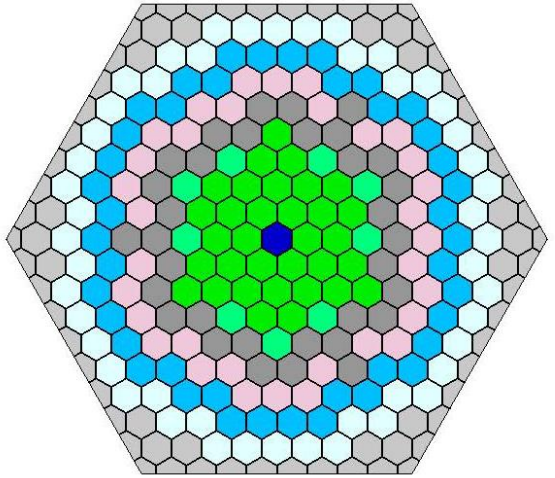
- The material control and accountancy (MC&A) for microreactors will depend very much on how the reactor will receive, transfer, arrange, eject, and cool fuel.
- The microreactor concepts all rely on reducing the number of fuel “items”.
- If it can be demonstrated that reliable accounting, recordkeeping, identification, and continuity of knowledge can be kept on each item, at the same level of confidence or greater than the current domestic reactor fleet, then the reduced number of fuel items will make MC&A less burdensome at the reactor site.
- This last point is very much dependent on the MC&A plan that will be employed.



Material Control and Accountancy







- Calculations suggest that material control and accountancy (MC&A) for microreactors, using conventional practices adapted to microreactors, does not need significant changes to meet requirements.
- Burn-up confidence is high, experiments to confirm calculations might be a smaller effort.
- HALEU does not seem to affect the implications of the MC&A approaches adapted.