

Advanced Reactors

Radiation Protection and Advanced Reactors



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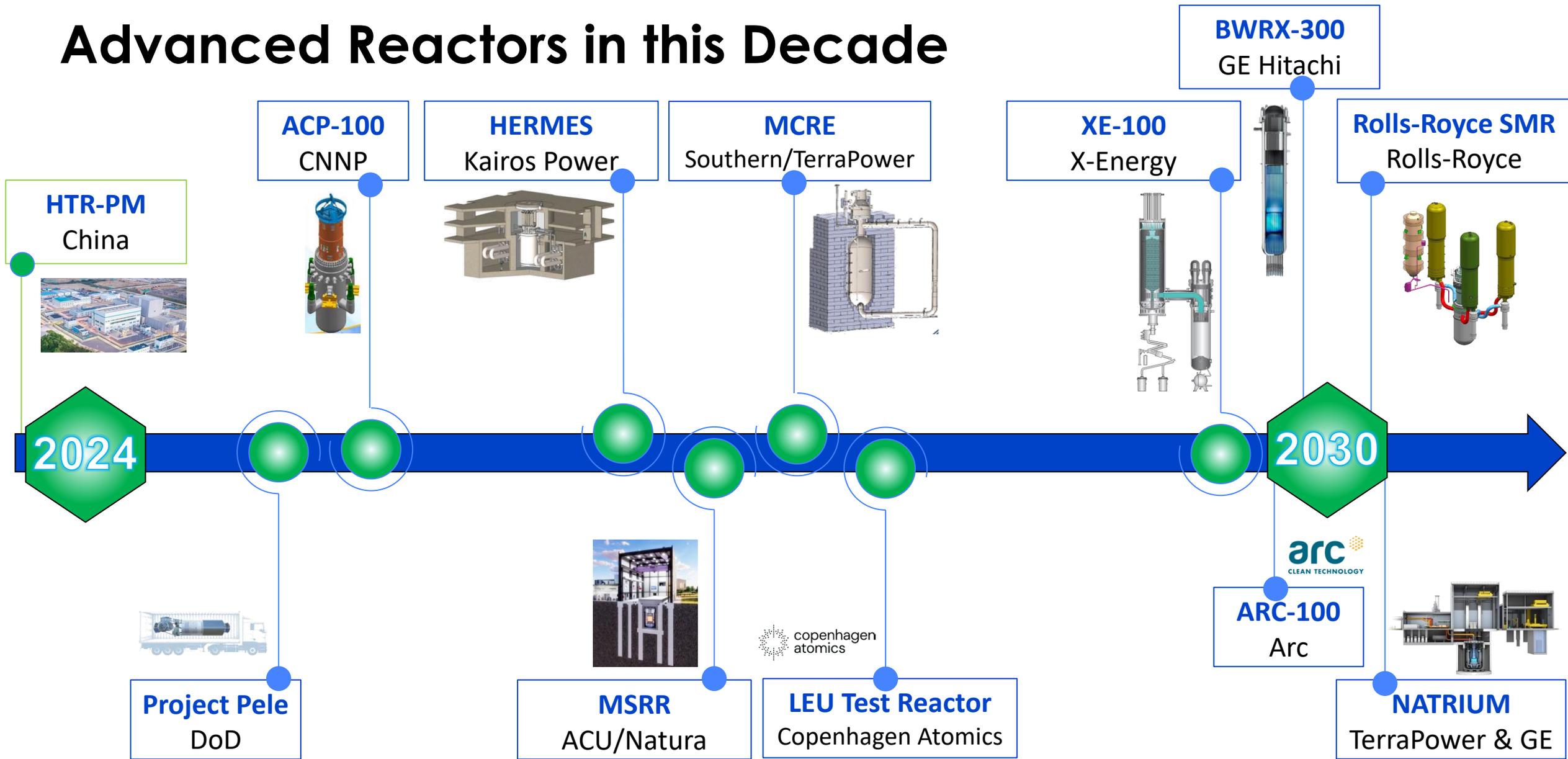
European ISOE Workshop
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With Support from

Ms. Darcy Campbell, RP and LILW Team Lead

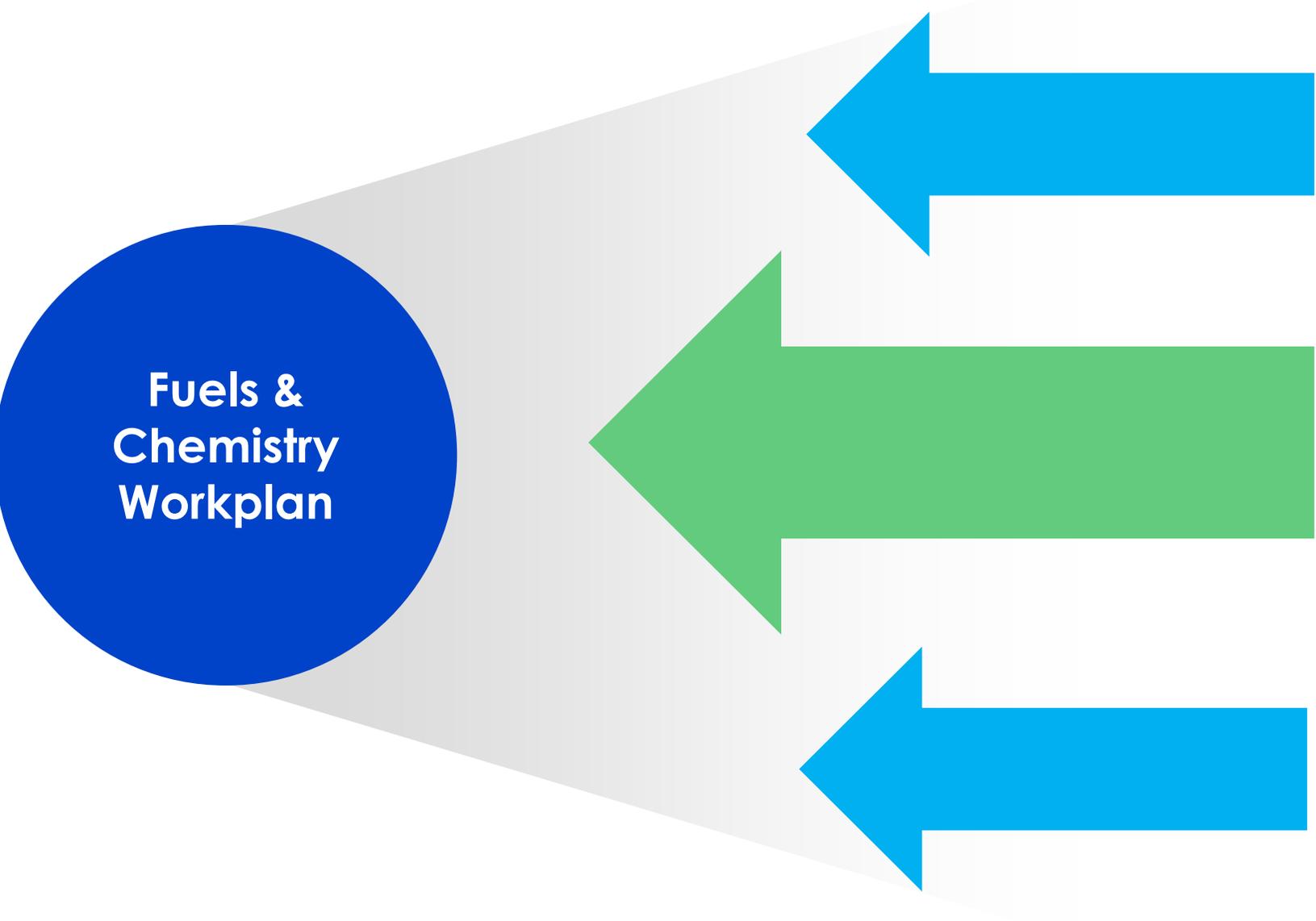
Ms. Karen Kim-Stevens, Groundwater and Effluent Team Lead

Advanced Reactors in this Decade



THE FUTURE OF THE ADVANCED REACTORS IS NOW

Identifying and Closing the Gaps



Fuels & Chemistry Workplan

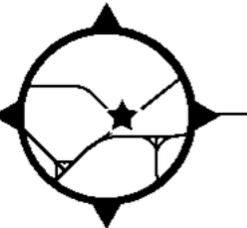
Initial Gaps

- Review the knowledge and technical gaps identified during 2022 review



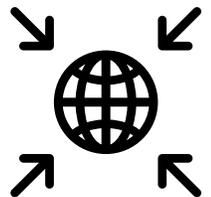
AR Roadmap

- Identify relevant AR roadmap actions to fuels & chemistry.
- Prioritize projects supporting the actions of the AR roadmap.



Other Inputs

- Direct requests from members
- Interactions with AR developers at specialized workshops



Radiation Protection Aspects

What We Know

- Online Measurements Techniques
- Remote Monitoring
- Design best practices
- Source term Best Practices
- ALARA

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New Technology

- Advanced sensors and instrumentation
- Artificial Intelligence / Machine Learning
- Automation
- Recent modeling and simulations tools

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Advanced Reactors

Design Improvements
Staffing Optimization
Faster Deployment

Leveraging Our Current Knowledge to Accelerate the Deployment of AR

Radiation Safety of Advanced Reactor



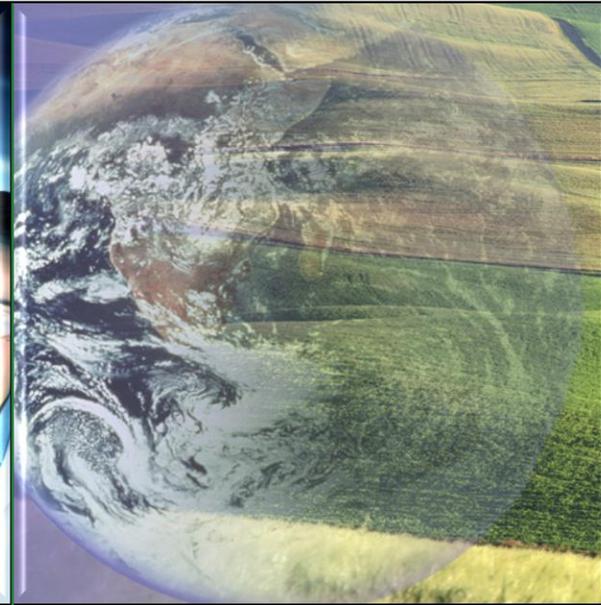
Objective

- Identify radiation safety technology and knowledge gaps related to non-LW Advanced Reactors.
- Identify and Prioritize R&D needs to meet advanced reactors deployment schedule
- Develop radiation safety strategies and practices for non-LW Advanced Reactors.



Short or Near Term

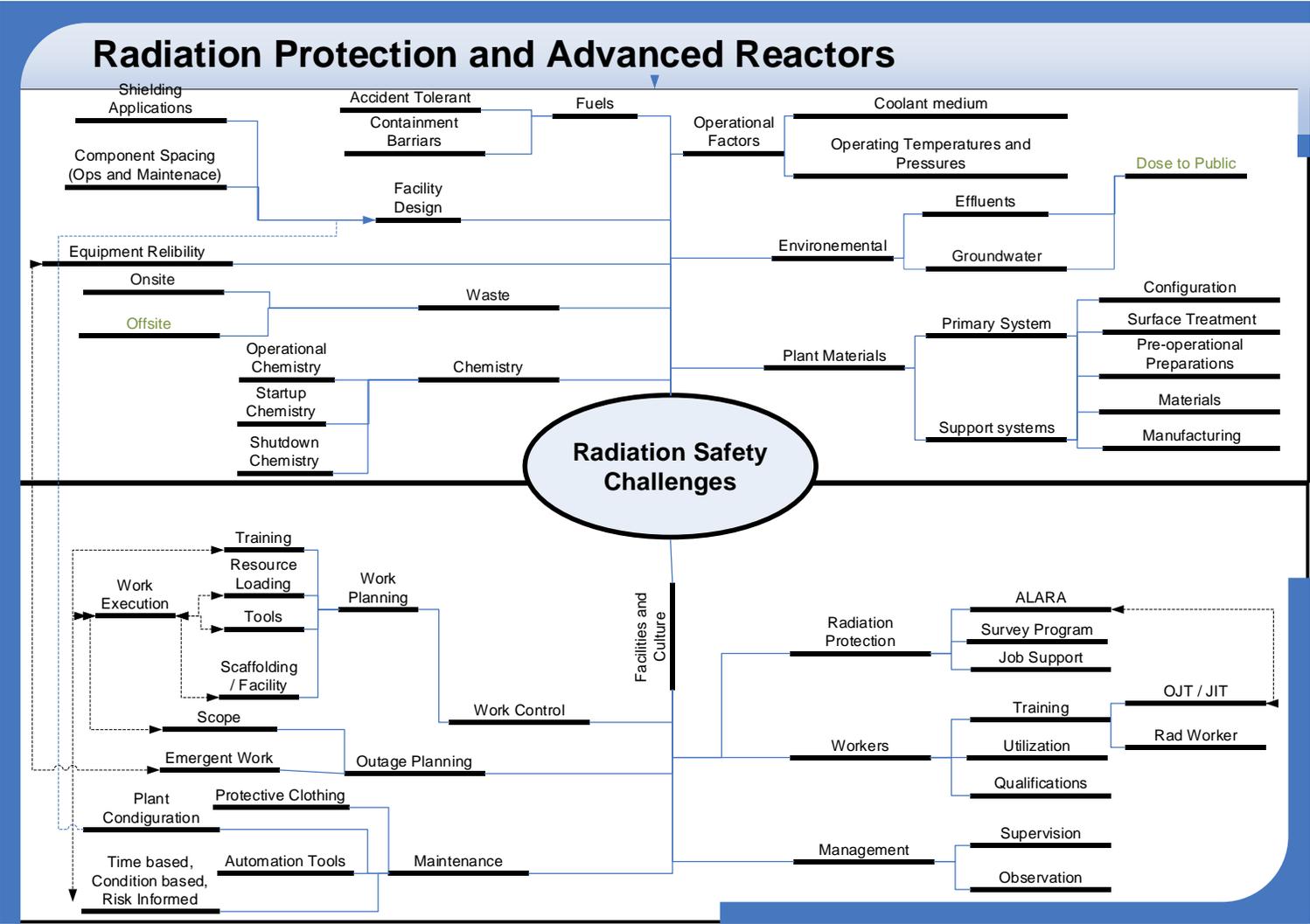
- Identify technical and knowledge gaps.
 - Identify and collect radiation safety data from the operation of past and present advanced reactors.



Longer-term

- Prioritize the identified radiation safety gaps
- Develop a research plan to close these gaps.
- Execute to support fleet deployment

RP and Advanced Reactor – Radiation Safety Challenges



- New designs – new materials – new operating strategies
 - Regulations applicability
 - Public perspective and concerns
 - how well do we communicate?
- Engineering and ALARA
 - Lack of operating experience
 - Source term studies
 - Shielding, ventilation, and monitoring
- Facilities and Work Culture
 - Staffing operating experience
 - Maintenance programs and understanding new equipment

Radiation Protection for Advanced Reactors

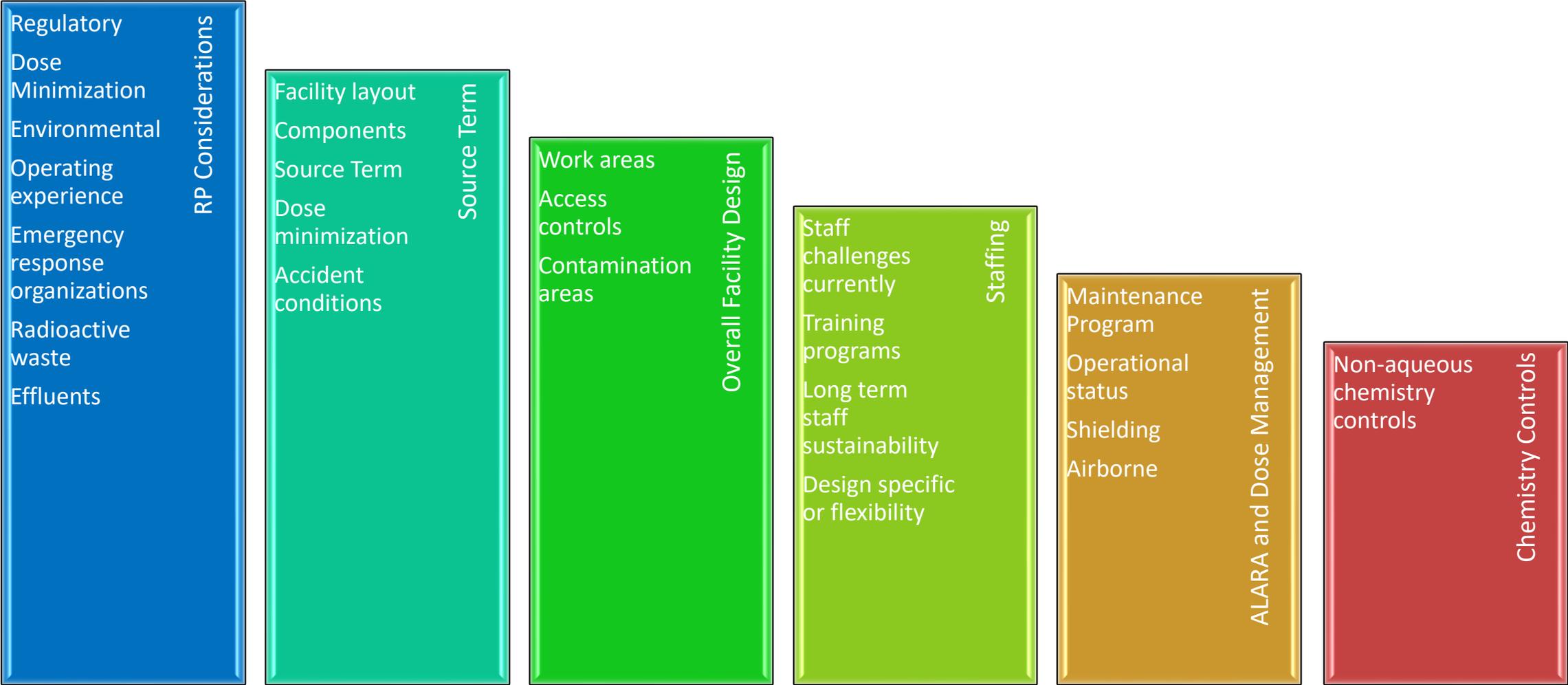
Radiation Safety starts during the design phase:

Radiation aspects identified early in the life cycle can be carried forward through decommissioning activities.

- Essential to integrate and engage with radiation protection early in the process.
- Focus Areas
 - Environmental:
 - ALARA:
 - Engineering:
 - Source term:
 - Expertise in system materials, activation and decay of materials, transport between systems.
 - Understanding the operations and maintenance of these systems.
 - Radioactive waste management



Radiation Protection – Building on the Pillars



Radiation Safety

Pillar / Area	Explain it	Objectives
Dose Reduction / ALARA Program (Radiation Exposure)	Radiological Protection practices, lessons learned, and technologies should be incorporated into these new designs to minimize worker and public dose over the life of the plant.	<ol style="list-style-type: none"> 1) How provide input into the design aspects 2) Source term <ol style="list-style-type: none"> 1) Application of lessons learned 2) Optimized materials and chemistry controls 3) Facility and component layout 4) Maintenance program management
Engineering	Understanding the site, facility, and component designs early in the design process and the adaption of technologies to address source term, ventilation, and the application of other engineering controls based on radiation protection and waste requirements.	<ol style="list-style-type: none"> 1) Review the essential programmatic aspects focused on: <ol style="list-style-type: none"> 1) Source term controls 2) Dose minimization 3) Shielding applications 2) Review the facility layout related to contamination controls, radiologically defined areas, egress points, and shielding application <ol style="list-style-type: none"> 1) Equipment, piping and rooms considering these differing areas. 2) Application and usage plan for remote monitoring equipment
Monitoring	<p>Reviewing the designs and the application of remote monitoring technologies.</p> <p>Online measurements, application of digital twin technologies, AI and other advanced technologies.</p>	<ol style="list-style-type: none"> 1) Facility setup related to permanently installed and portable instrumentation. 2) Incorporation of existing technologies and new technologies

Radiation Safety

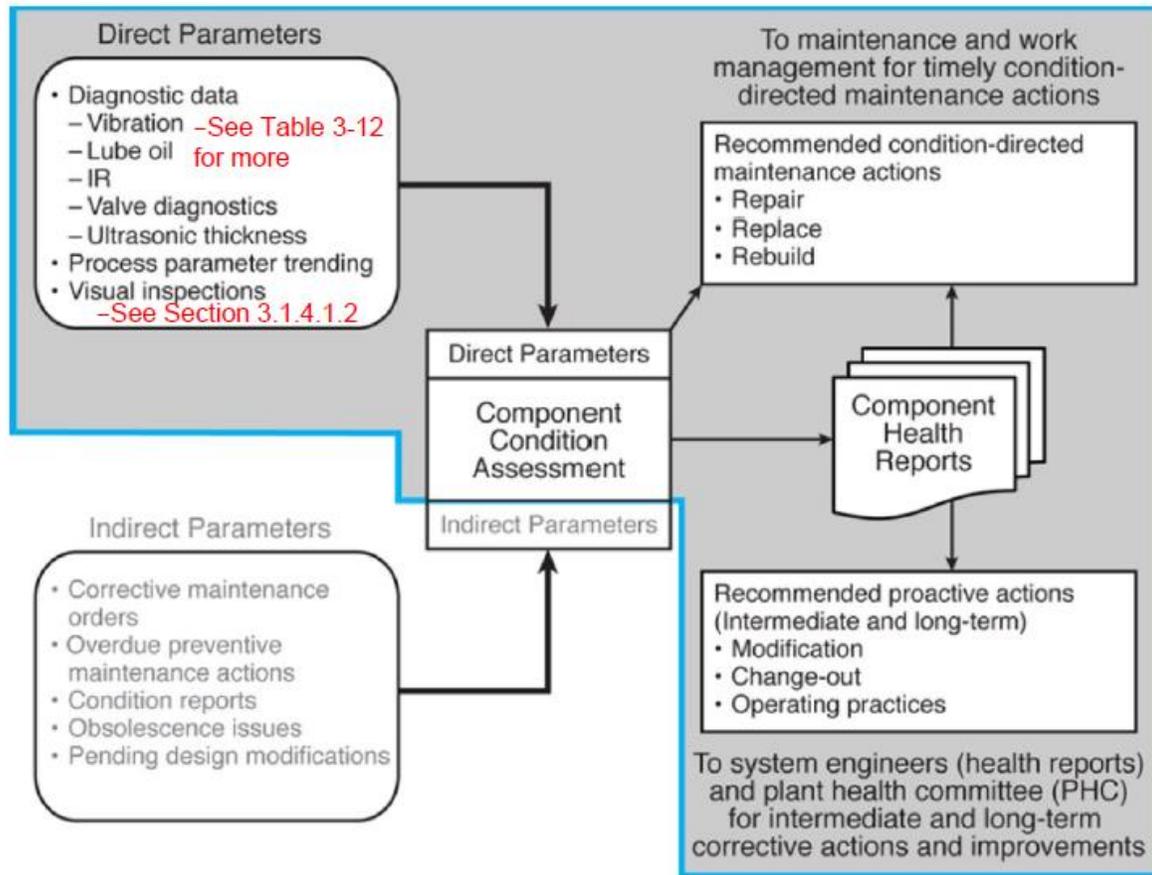
Pillar / Area	Explain it	Objectives
Radioactive Waste	It is important to understand that no matter the design, we will have radioactive waste. The EPRI project is focused on low and intermediate level waste and the identification of these pathways and management.	<ol style="list-style-type: none"> 1) Identification of waste streams and minimization of radioactive waste. 2) Long-term storage opportunities. 3) Facility and component layout for waste processing. <ol style="list-style-type: none"> 1) Depending the reactor design – these facilities may be required to deal with short-lived radionuclides and very high dose rates.
Environmental	Effluents – Plant effluents from non-LW Advanced Reactors designs are going to be different. This step is to review and identify the gaps in monitoring Life of plant challenges	<ol style="list-style-type: none"> 1) Review vendor designs to better understand: <ol style="list-style-type: none"> 1) Offgas streams 2) Waste streams variances and changes 3) Recovery processes (i.e., lithium and chloride recovery and differences) 2) Review the facility layout related to contamination controls, radiologically defined areas, egress points, and shielding application <ol style="list-style-type: none"> 1) Equipment, piping and rooms considering these differing areas with the application and usage plan for remote monitoring equipment

Radiation Safety – Source Term

- Do we need to change our mindset?
 - With a new design, the opportunity to provide feedback and input is essential.
- Typical source term considerations by the designers
 - Areas outside of the core region (reactor building and structures)
 - Source – neutron and gamma presence outside of the reactor vessel
 - In-reactor regions
 - Activation of corrosion products
 - Activation of coolant impurities (dissolved and suspended)
 - Activation of chemical additives
 - Nuclear fission - fuel and tramp
- Source term can be a challenge for any design.
 - Early engagement with engineers is the key to understanding source term



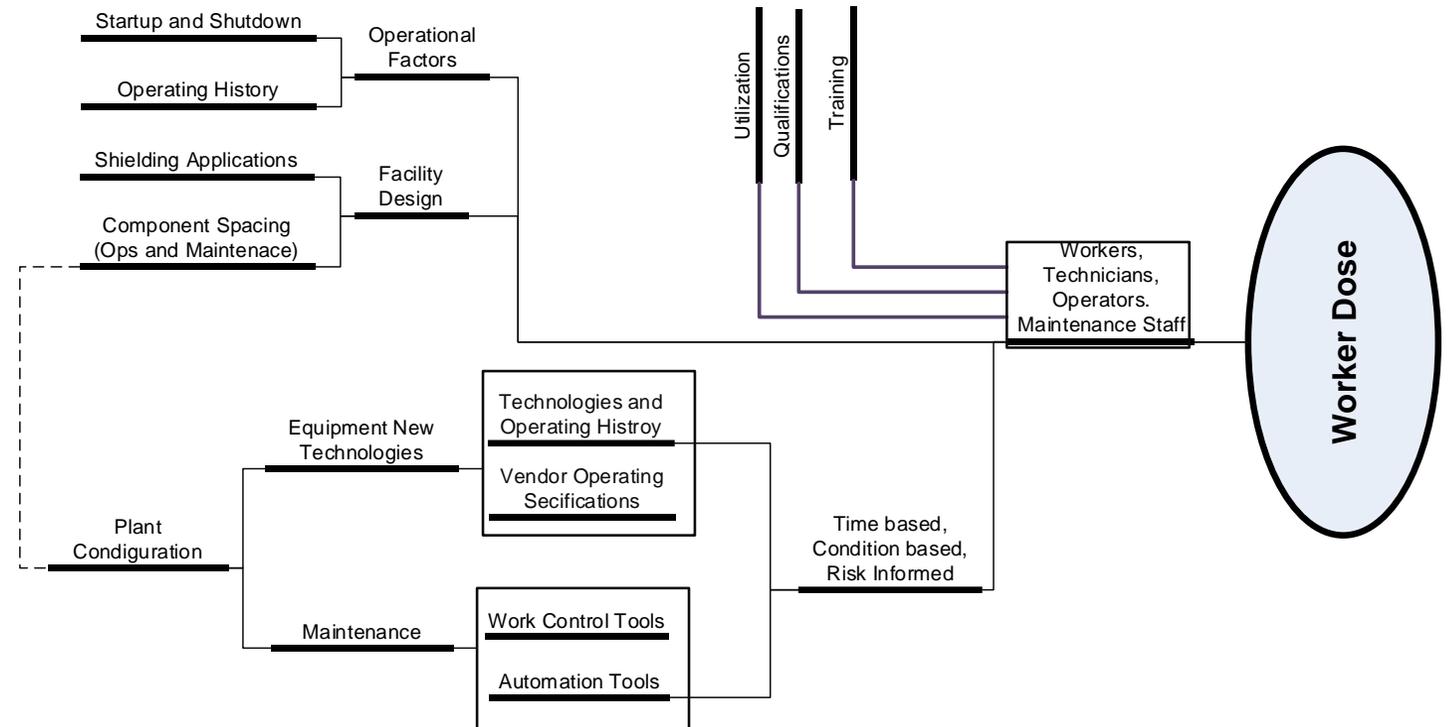
Radiation Safety – Maintenance and ALARA



- Connecting Radiation Protection with Maintenance
 - Condition based maintenance program (left)
 - Understanding the maintenance history and repair
 - Understanding the component health reports
 - Input into the design, maintenance, and replacement processes.
 - Integration of monitoring parameters
 - Identify the key online monitors for planning.
 - Application of digital twin with and around components

RP and Advanced Reactors – Worker Dose

- Individual components and configuration
 - Component spacing for workers, shielding configurations, component layout
 - Materials applied, optimal configuration for inspections and maintenance
- Facility configuration
 - Site layout (primary or containment areas)
 - Room and area spacing and distance and how shielding is applied
 - Waste storage areas
- Maintenance and Monitoring
 - New technologies and optimal maintenance programs – time-based, condition-based, or risk-informed based.
 - ALARA work planning tools

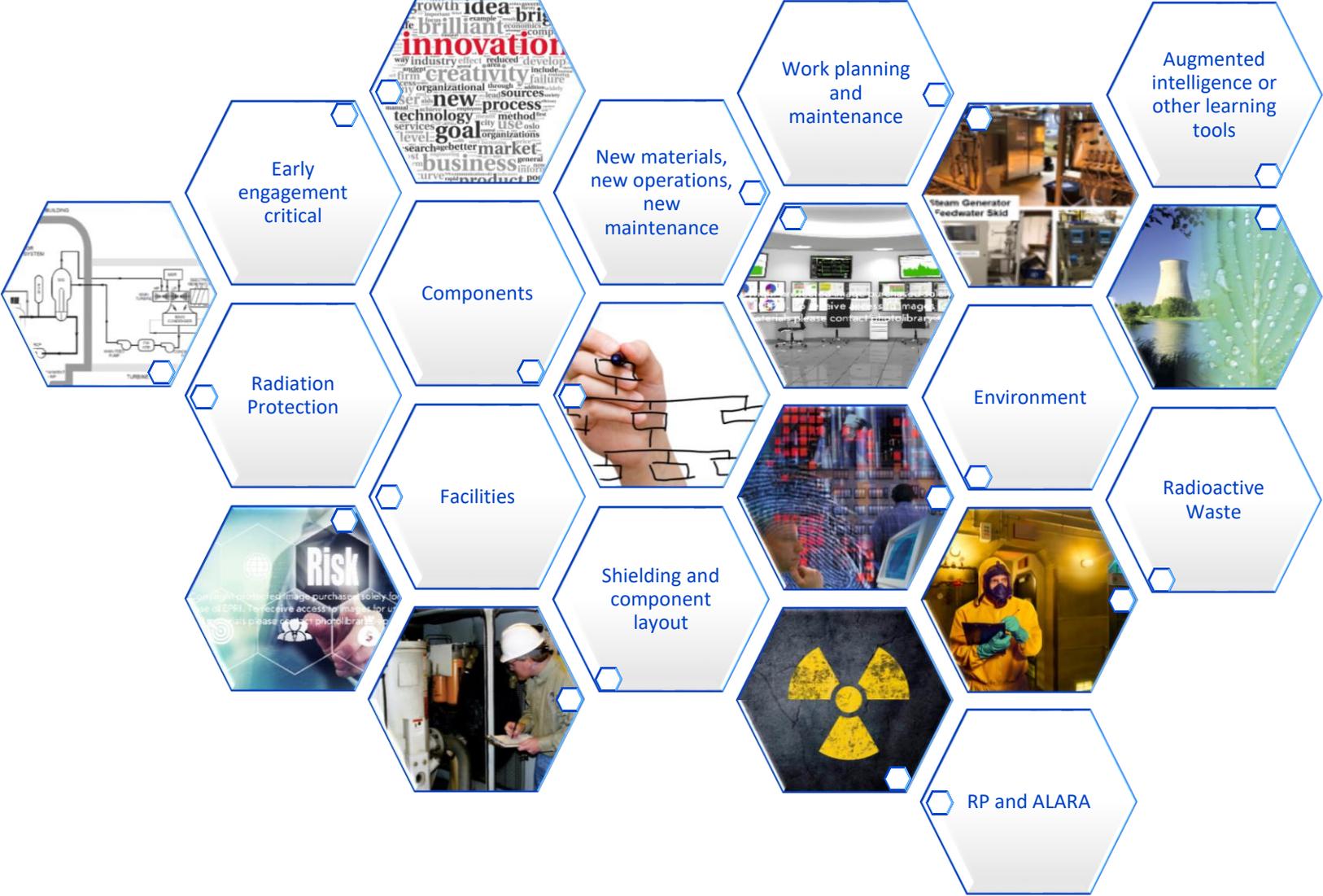


Radiation Safety and Advanced Reactors

- Task 1 - Document existing knowledge and experience
 - Where available, capture the existing knowledge and experience base from prior years of the operations
- Task 2 - Plan and engagement with advanced reactor developers
 - Develop an engagement strategy/plan and interact with the developers
- Task 3 - Identify gaps
 - What are the gaps from Task 1 and 2
- Task 4 - Prepare a plan for gap closure
 - Develop a roadmap to gap closure
- Task 5 – Final report

RP and the Future

Connect the Dots





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