LRS: INL/MIS-26-91857

Molten Salt Reactor PROGRAM

Technology-Based Licensing MSR Evaluation Models for Safety Analyses

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Scope, motivation, and modeling mission

1. Rapid evaluation of molten salt reactor concepts across core, loop, and plant scales.
2. Enables consensus on safety, security, and safeguards for molten salt reactors in general.
3. Bridges benchmark models, design screening tools, and transient studies into one evaluation workflow.
4. Needed to better define experimental bounds and needs.
5. Supports both mechanistic physics models and faster surrogate layers for iteration and communication.

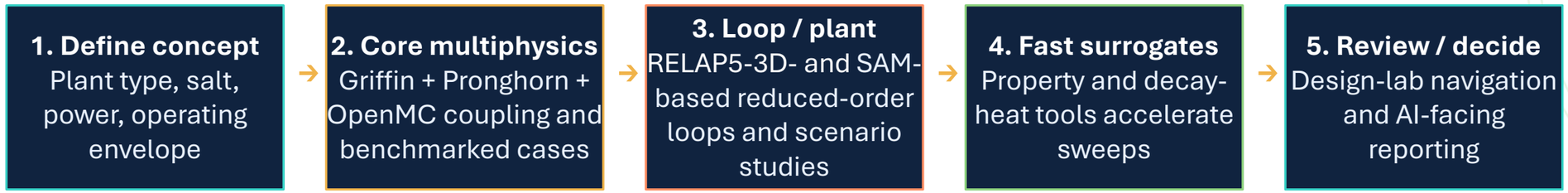
Key Issues

- Large variety of MSR designs (fluoride vs chloride, moderated vs fast, power production, breeder, burner, …)
- MSR concept, key operational challenges, and safety bounds will be vary depending on the related MSR function
- The are many MSR vendors proposing different concepts with different scopes and applications

- **Solution**: Create a tool that leverages DOE-codes (NEAMS, MELCOR, etc.) to enable the development of evaluation models

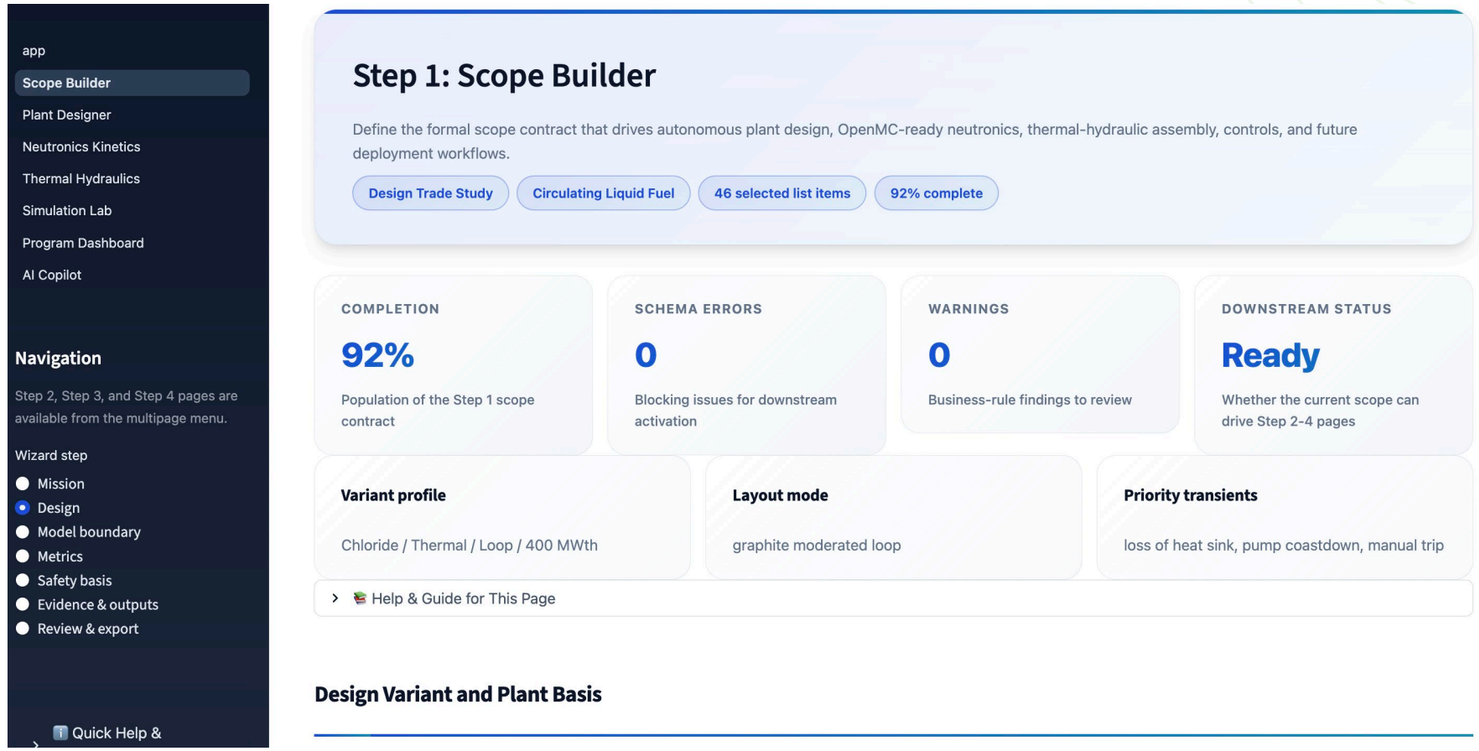
Key Features of the Evaluation Model Development Tool

- The workflow moves from plant definition to traceable decisions, with high-fidelity models and lighter-weight surrogates used where they add the most value.



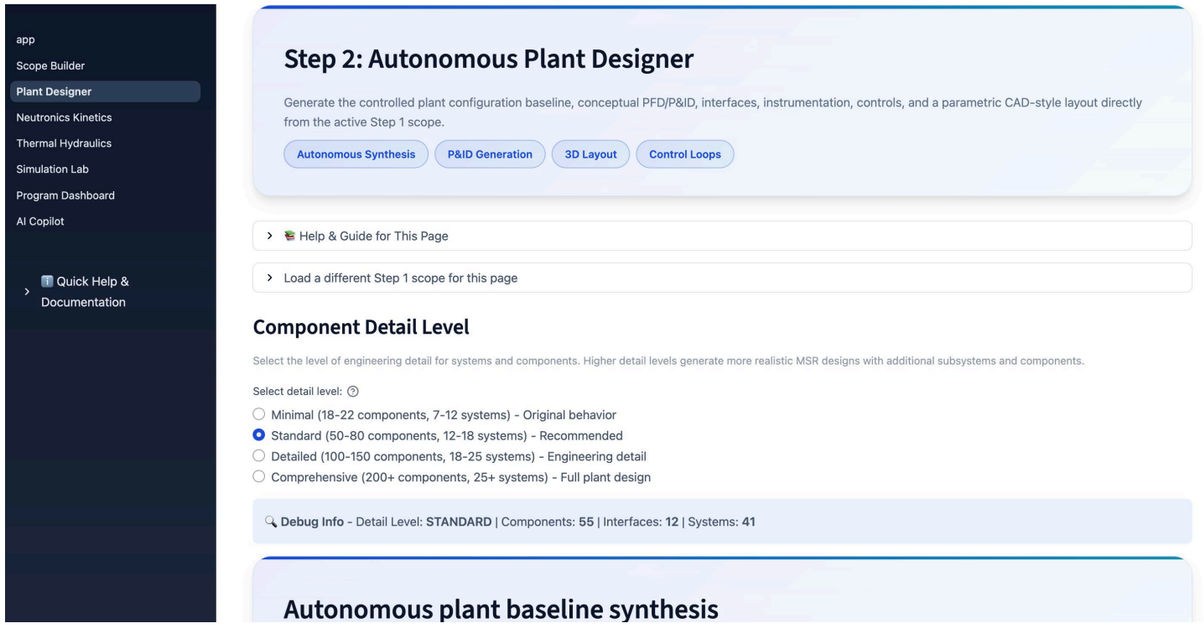
1. Defining the Concept: Scope Builder

- Select parameters related to mission, design, model boundaries, metrics, safety basis, controls, and validation requirements



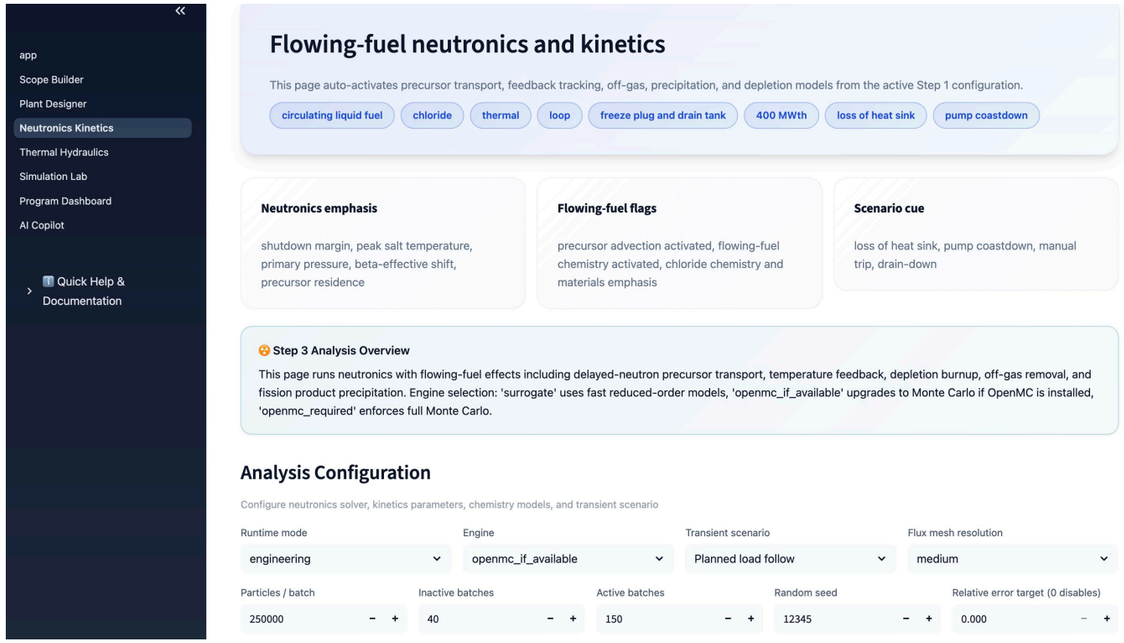
2. Autonomous Plant Design

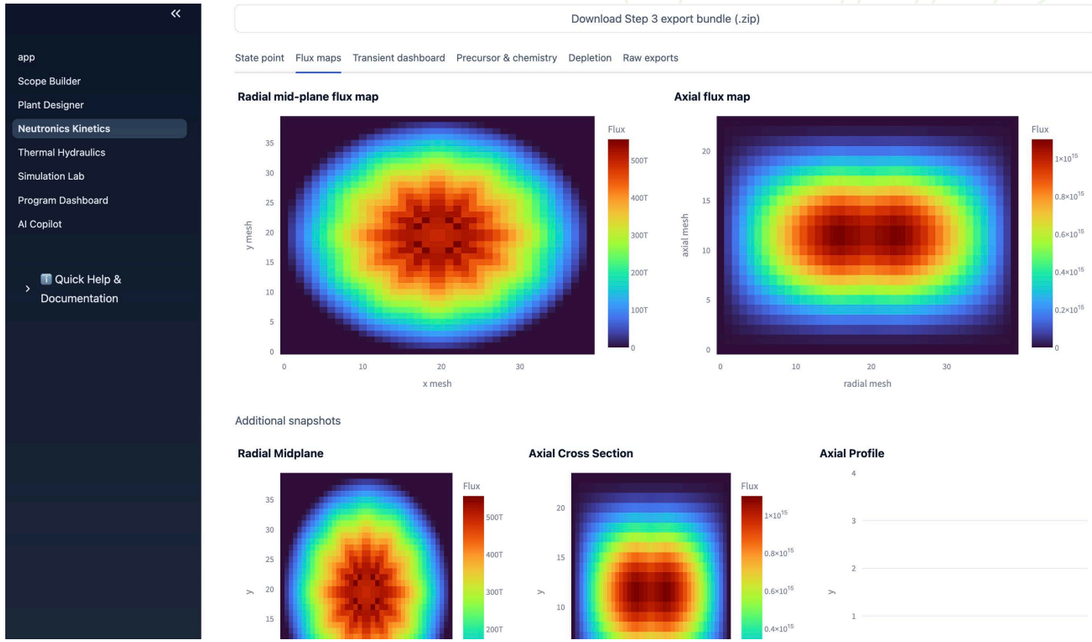
- Develops conceptual layout and BIM models, systems & controls, PFDs, P&IDs, and data tables for the plant
- User selects the required level of complexity for the evaluation model



3. Neutronics and Kinetics Studies

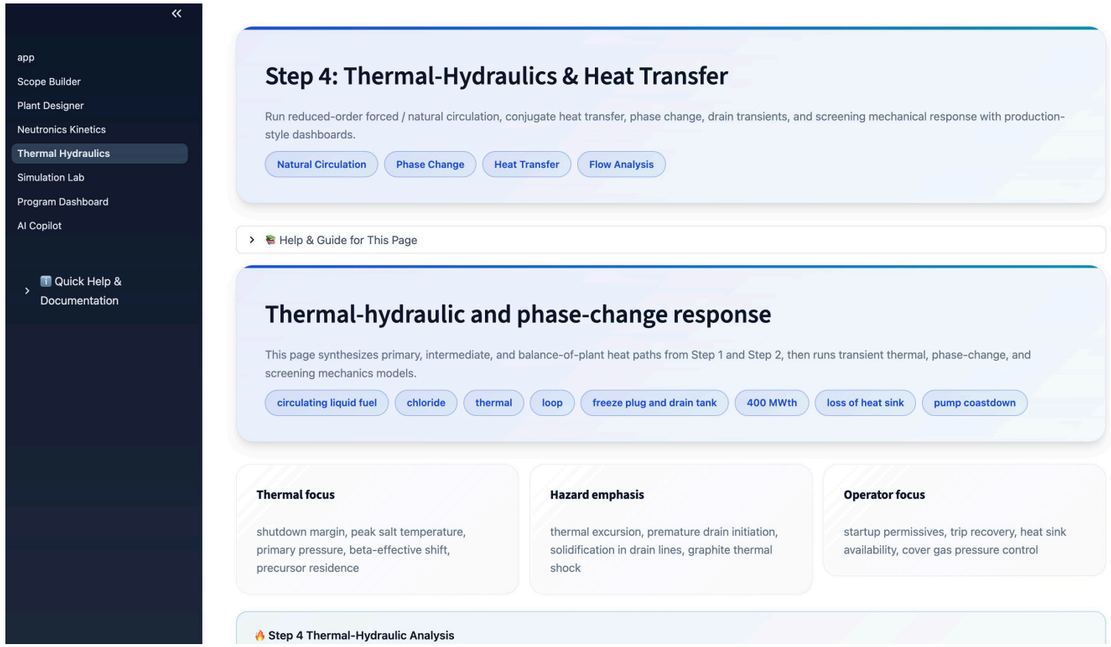
- Creates steady-state flux maps and kinetics neutronics models for the selected configuration
- Develop flux distribution and short- and long-term transient studies including depletion and speciation

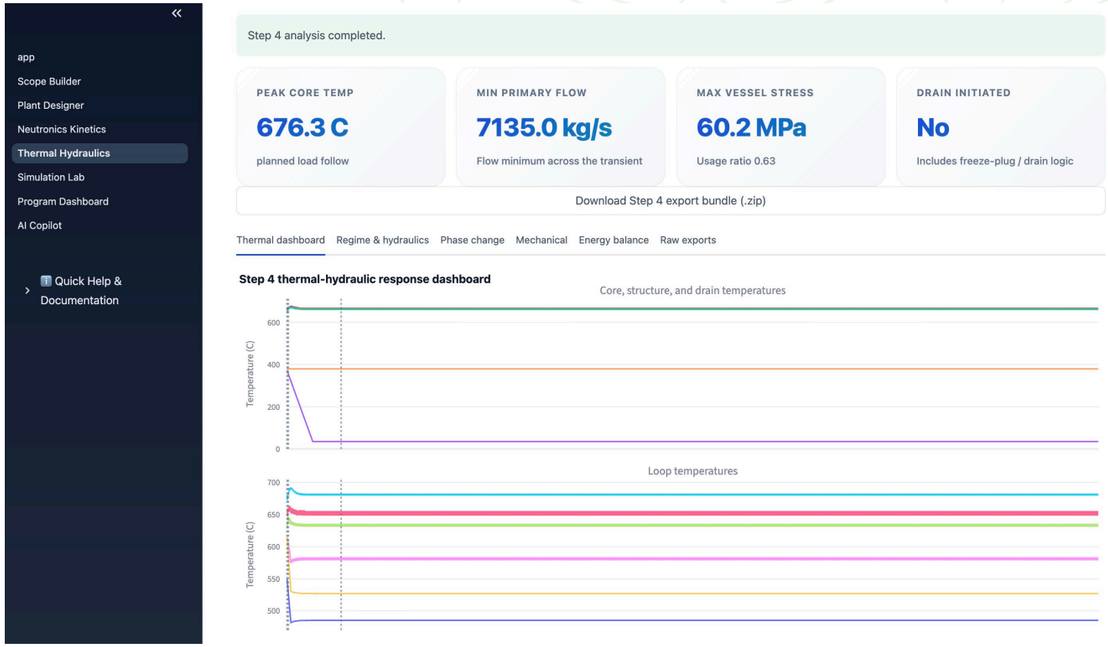




4. Thermal-Hydraulics Analyses

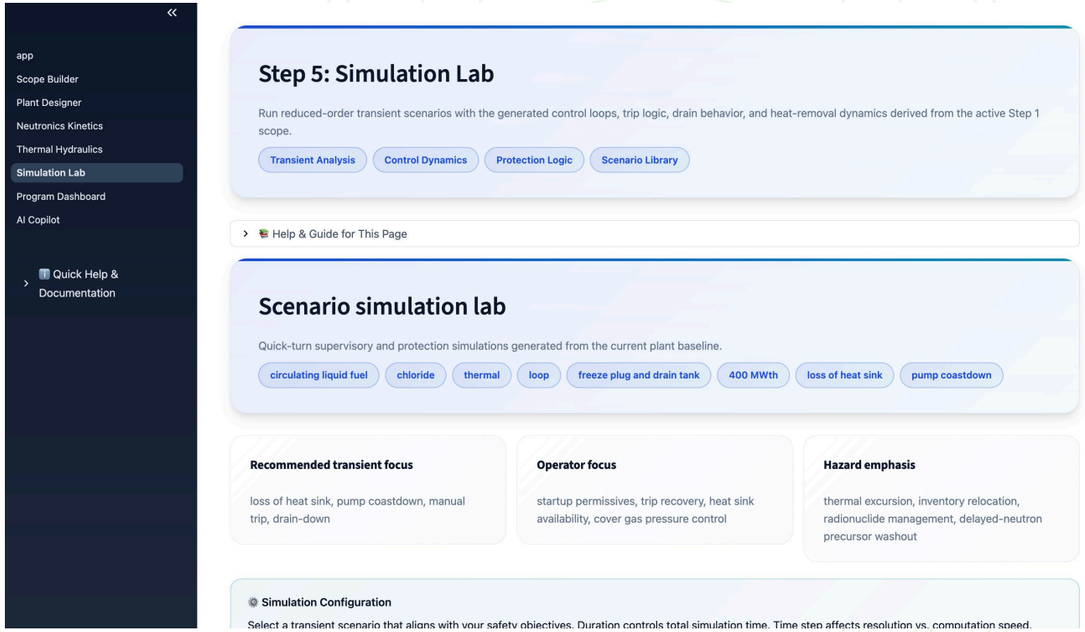
- Runs reduced-order plant-scale thermal-hydraulics models for the steady-state operation of the MSR model

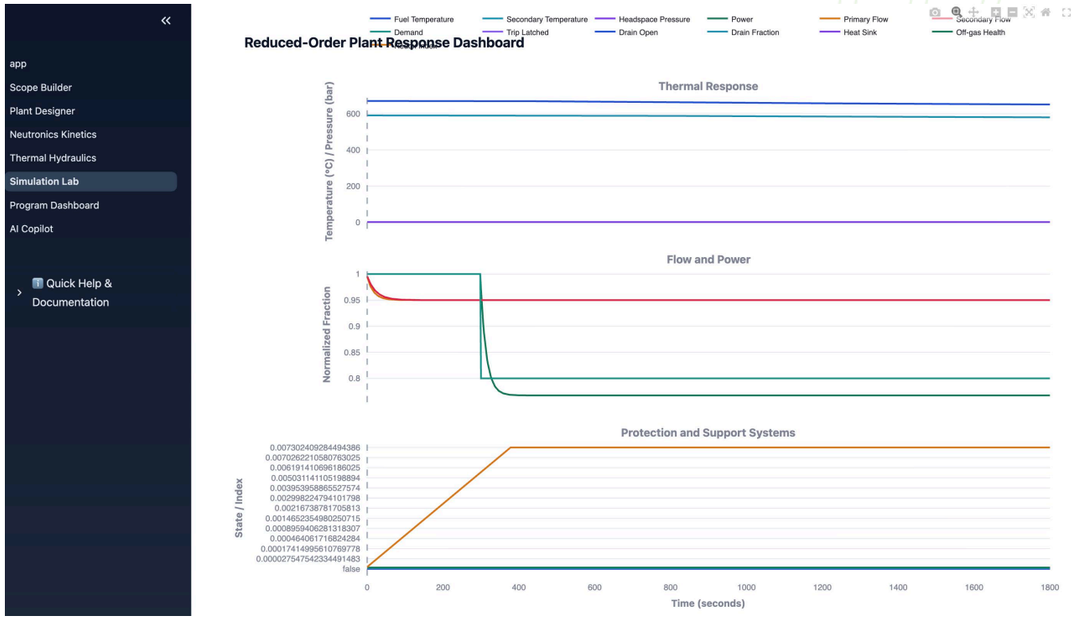




5. Simulation Lab

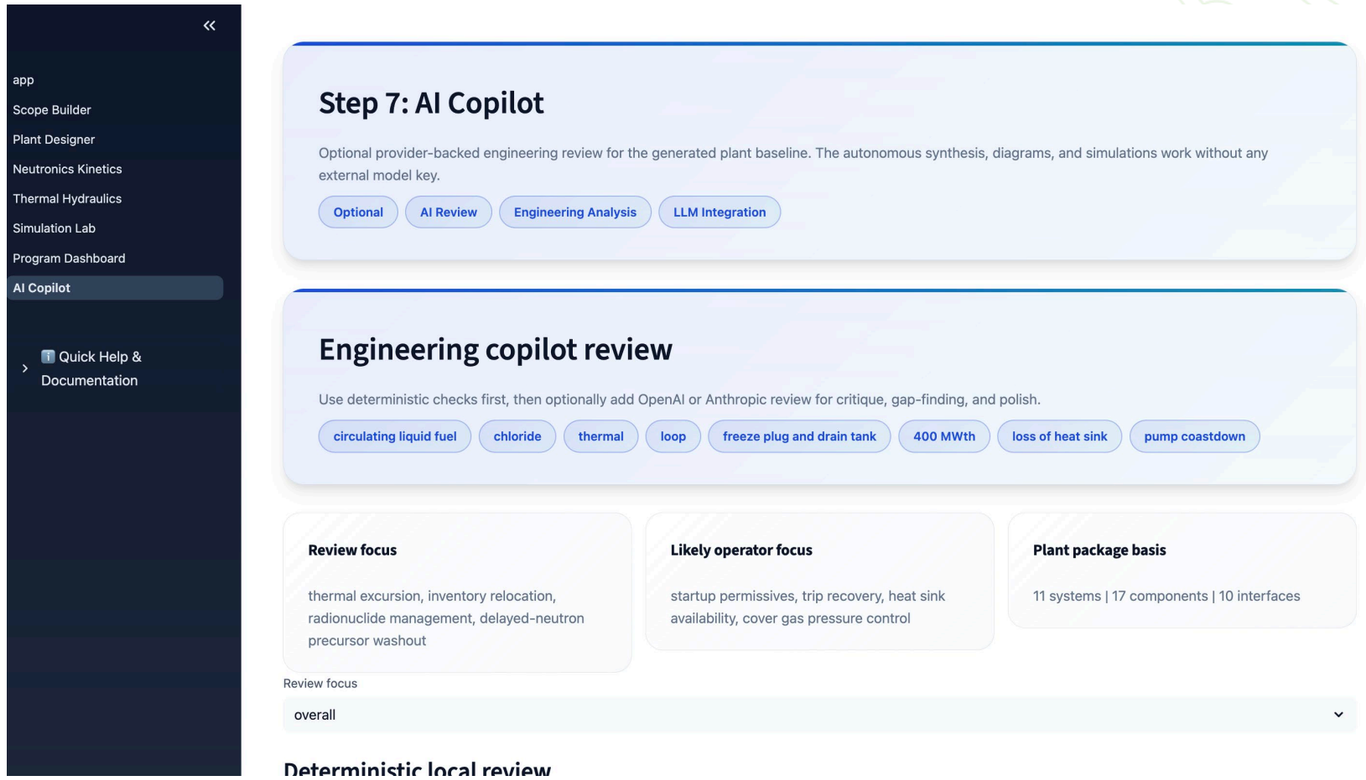
- Runs reduced-order models for plant transients with incorporated trips, controls, and auxiliary systems
- Allows the user to study the plant dynamics and better understand its behavior in characteristic operational transients





6. AI Co-Pilot

- Enables model auditing, report writing, results explanations, etc. via the integration of the platform with leading Large Language Models



Platform Demonstration

Next Steps

- New additions will include:
  - Increased transient and accident scenario evaluation sets
  - Integrated balance of plant modeling
  - Improved fidelity for corrosion and platting estimates
  - Extended model validation against MSRE and experiments
- Upcoming improvements will integrate:
  - Improved traceability to the sources of the models
  - Improved QA and configuration control
- Continue collaboration with French CEA

Thank you for you attention!

Questions?

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