VTR™

SOLVING ENERGY CHALLENGES THROUGH SCIENCE

Overview of the Versatile Test Reactor Safety Analysis

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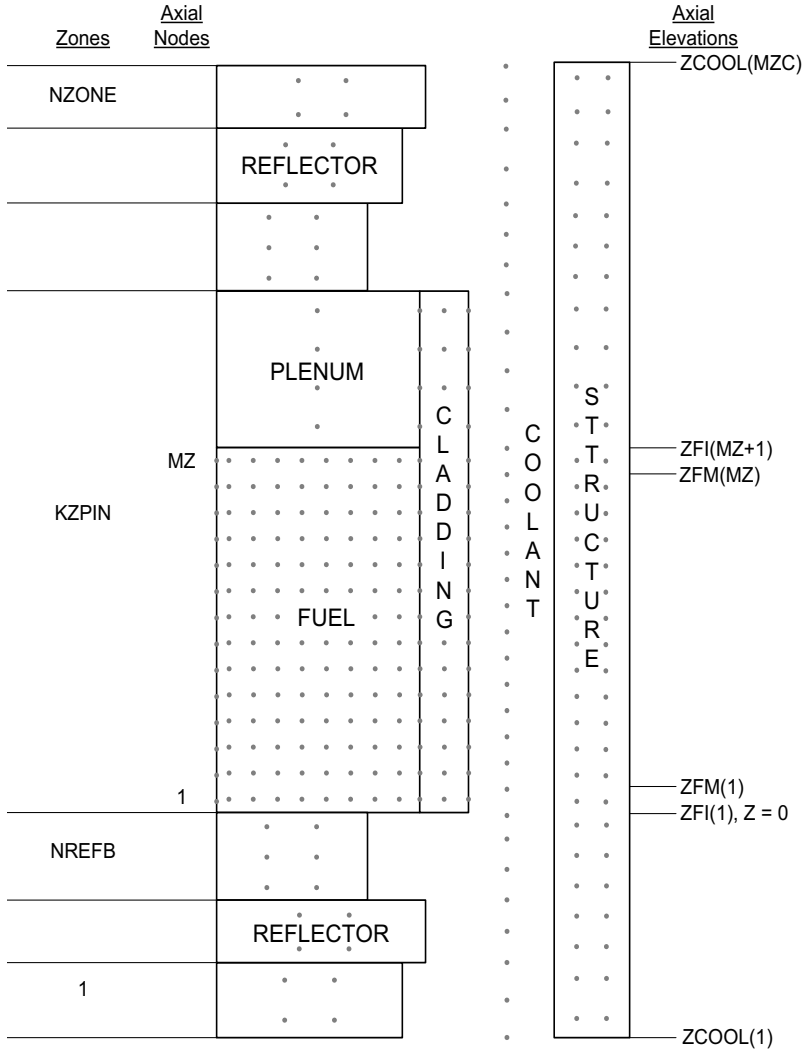
Note: Information regarding site location is **preliminary**. The decision for site location is determined via DOE acquisition processes that have not yet been completed.

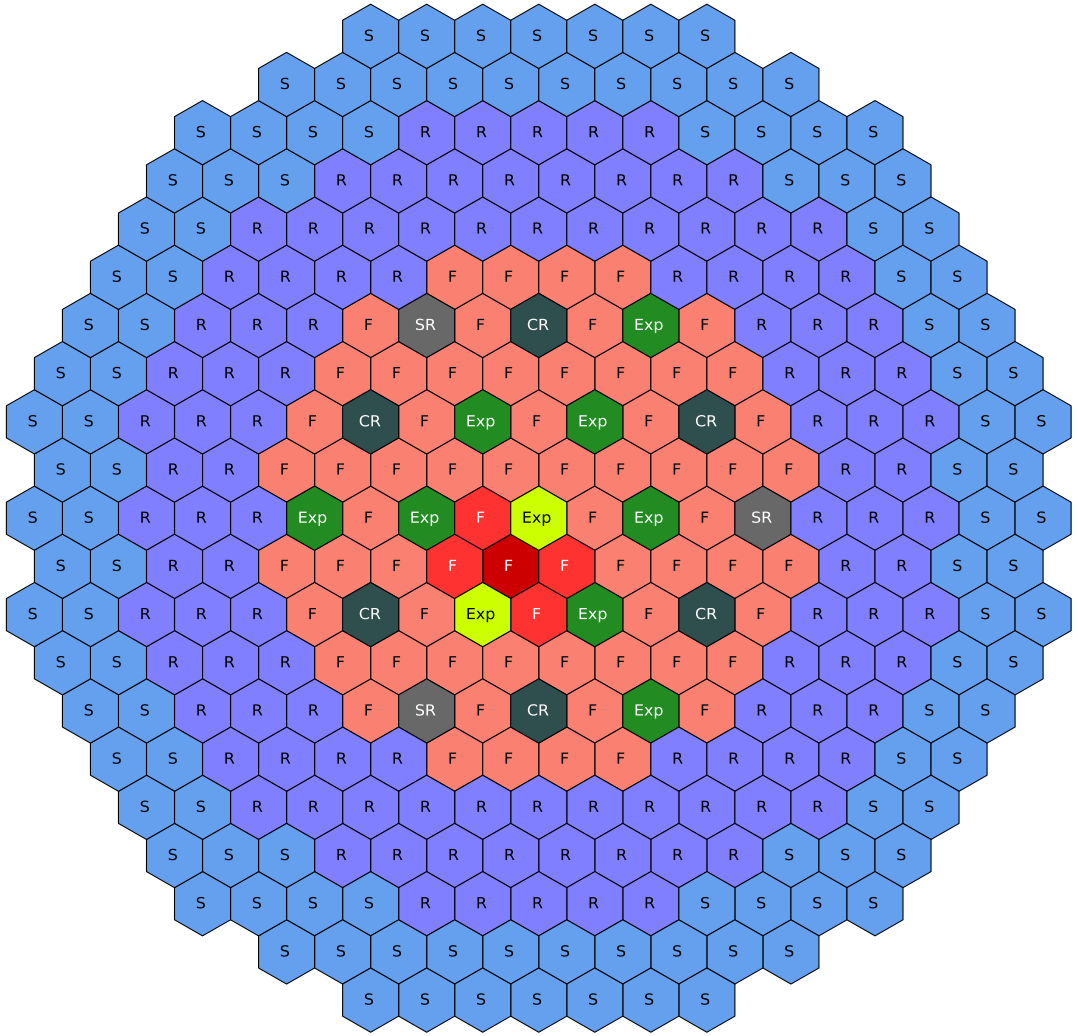
Argonne NATIONAL LABORATORY

Overview

- Versatile Test Reactor:
  - Fast spectrum test reactor design
  - 300 MWth
  - Sodium coolant
  - Metallic fuel
  - Pool type
- SAS4A/SASSYS-1 model represents:
  - Core
  - Primary heat transport system
  - Secondary heat transport system
  - Reactor vessel auxiliary cooling system
  - Reactor protection system
- Protected Transient Scenarios
  - Evaluated to demonstrate system's response to various initiating events
  - Protected loss of heat sink
    - PLOHS
  - Protected loss of flow/station blackout
    - PLOF/PSBO
  - Protected transient overpower
    - PTOP
  - Transient initiated at nominal full power, full flow conditions
  - BOC and EOC

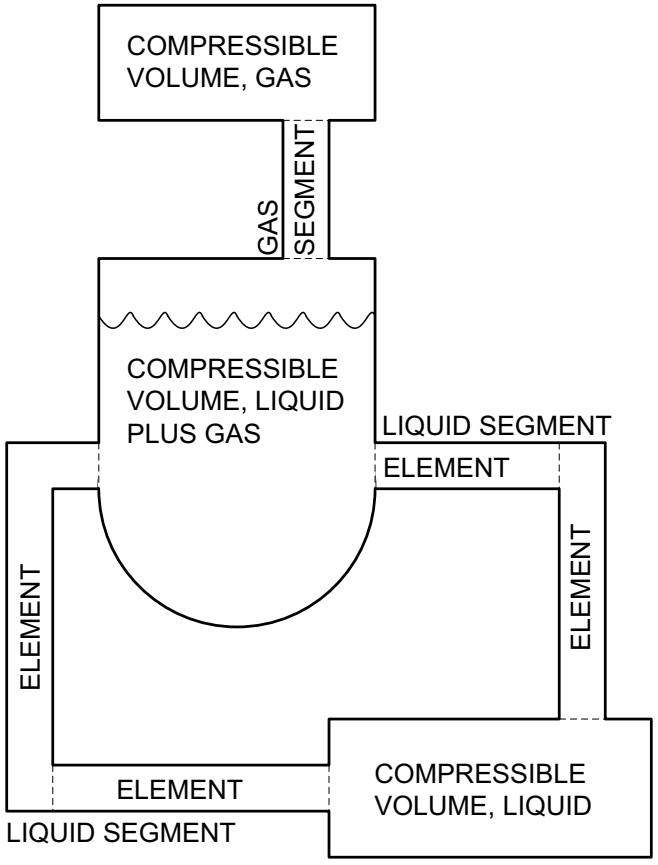
SAS4A/SASSYS-1 Core Model

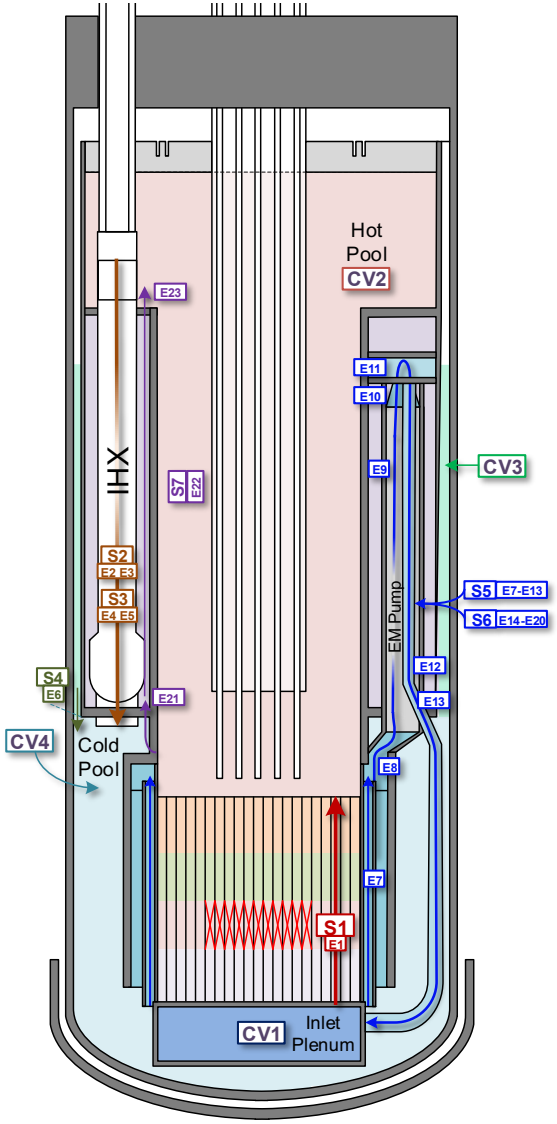


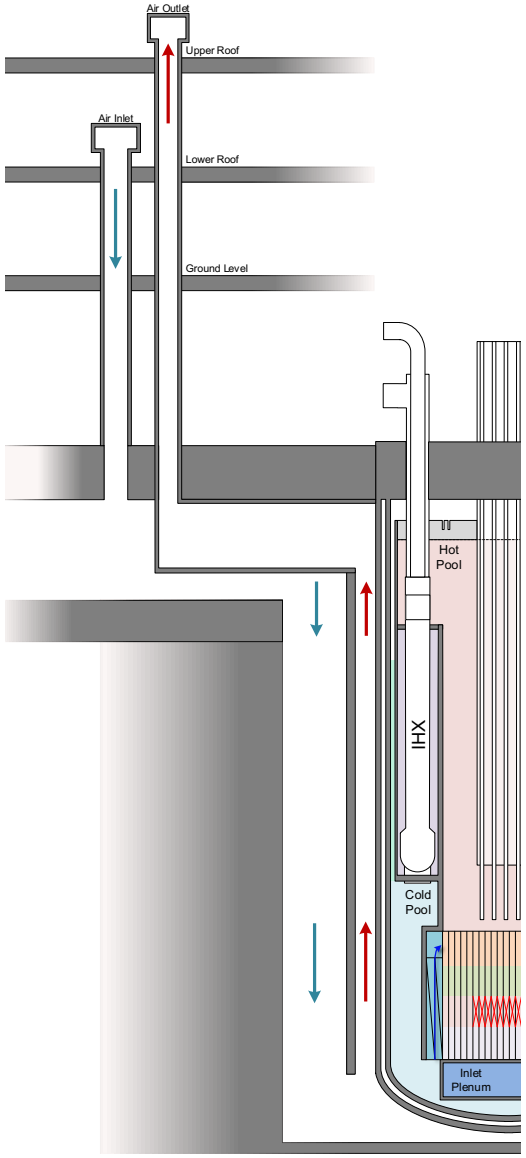


SAS4A/SASSYS-1 Heat Rejection System Model

- PRIMAR-4 module used to model VTR heat transport system
  - Primary, secondary, and RVACS systems







Metrics & Criteria

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Metrics

- Demonstrate safe shutdown of reactor
- Maintain coolable fuel pin geometry
- PTOP, PSBO, PLOHS
  - AOOs or DBEs?
  - Subject to PRA results
  - Tentatively assumed to be AOO
  - For PRISM PSID, would be evaluated against ASME Service Level B
- Note: These metrics are preliminary
  - Based on expectation that these are bounding events
  - Will depend on results of PRA & uncertainties

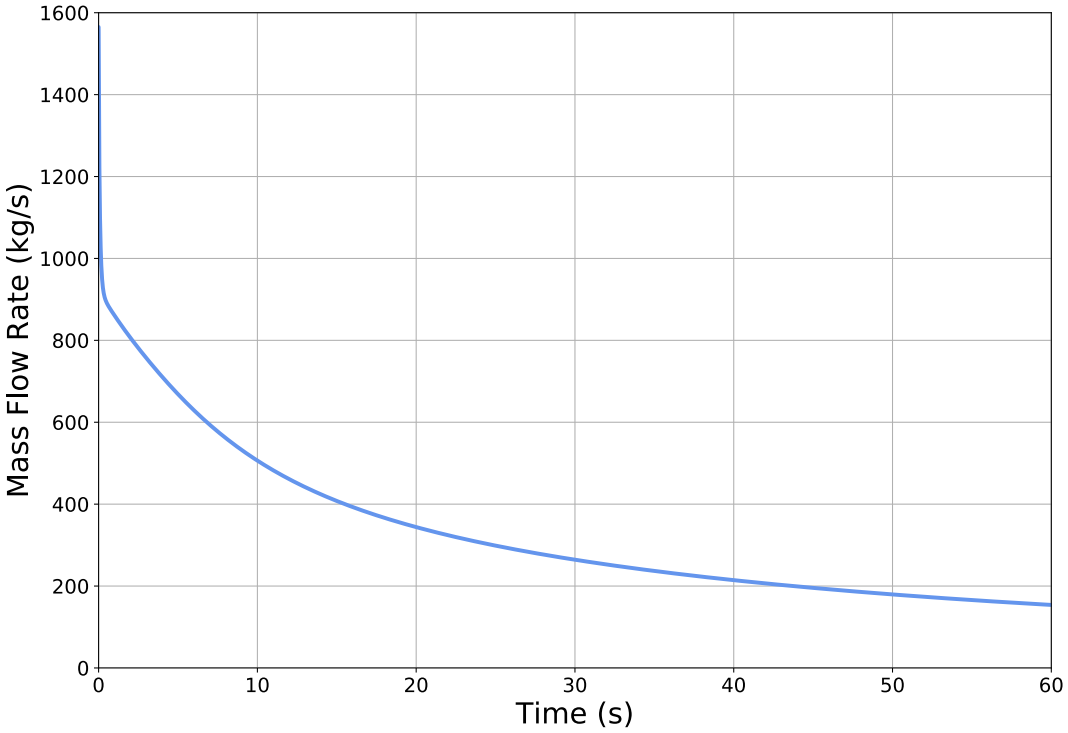
Criteria

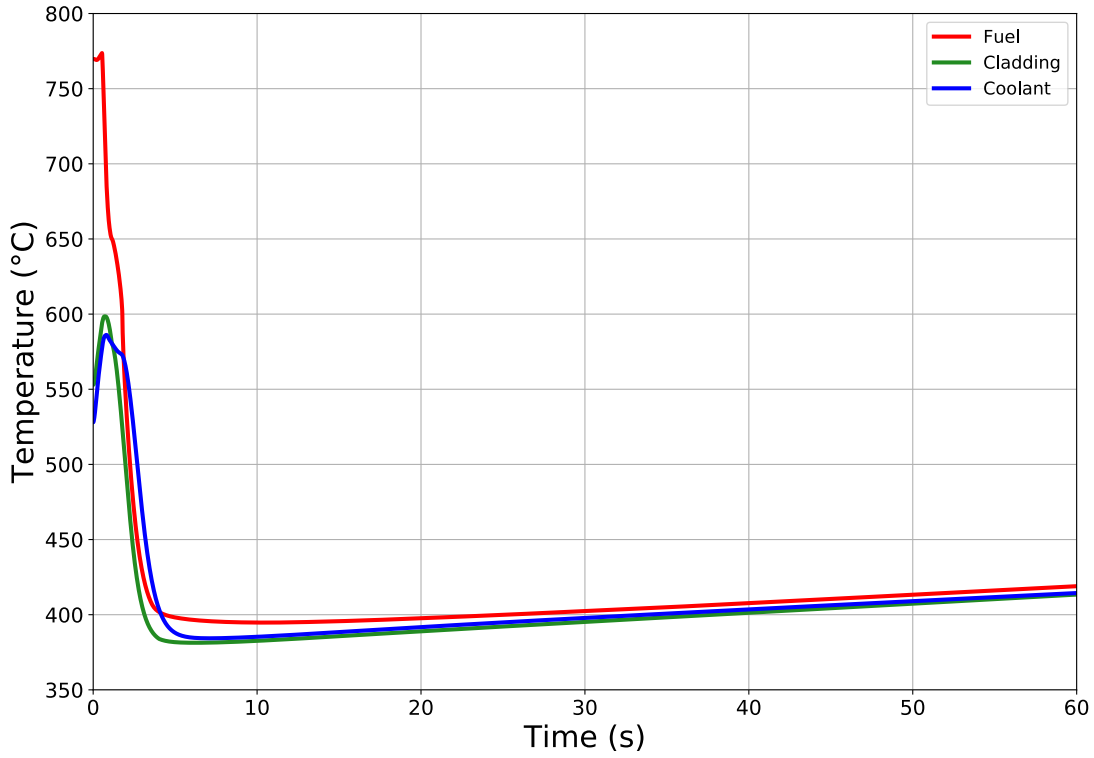
- Control Rods:
  - Establish and maintain subcriticality
- Cladding:
  - Cladding temp below 649°C
  - Service Level B limit
  - Both peak and long-term
  - Precludes eutectic formation
- Coolant:
  - Pools remain below 649°C
  - Service Level B limit
  - Both peak and long-term
- Fuel melting and coolant boiling margins also assessed
  - But specific limits not defined

Results

Protected Station Blackout: Definition

- Loss of electrical power to all plant systems
- Primary pumps trip
- Secondary pumps trip
- SAHX heat rejection lost





Protected Station Blackout: Short-Term

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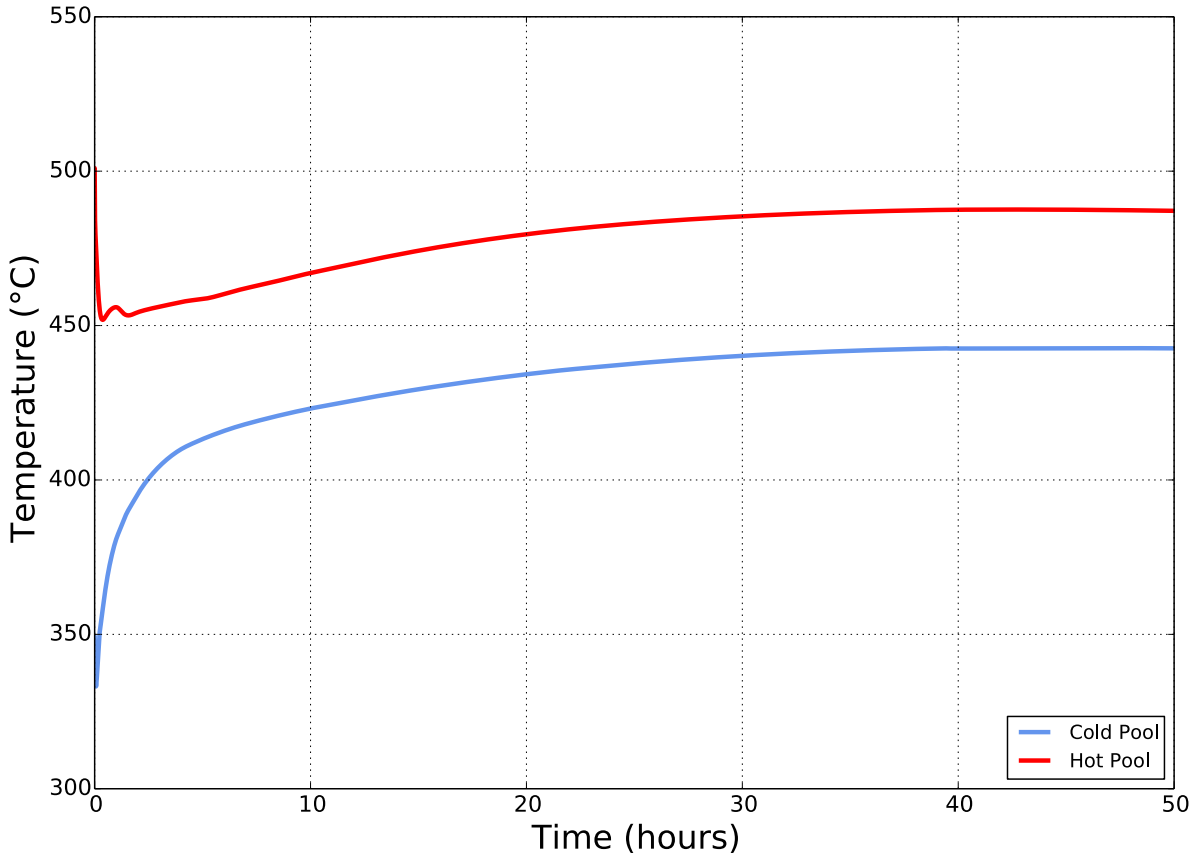
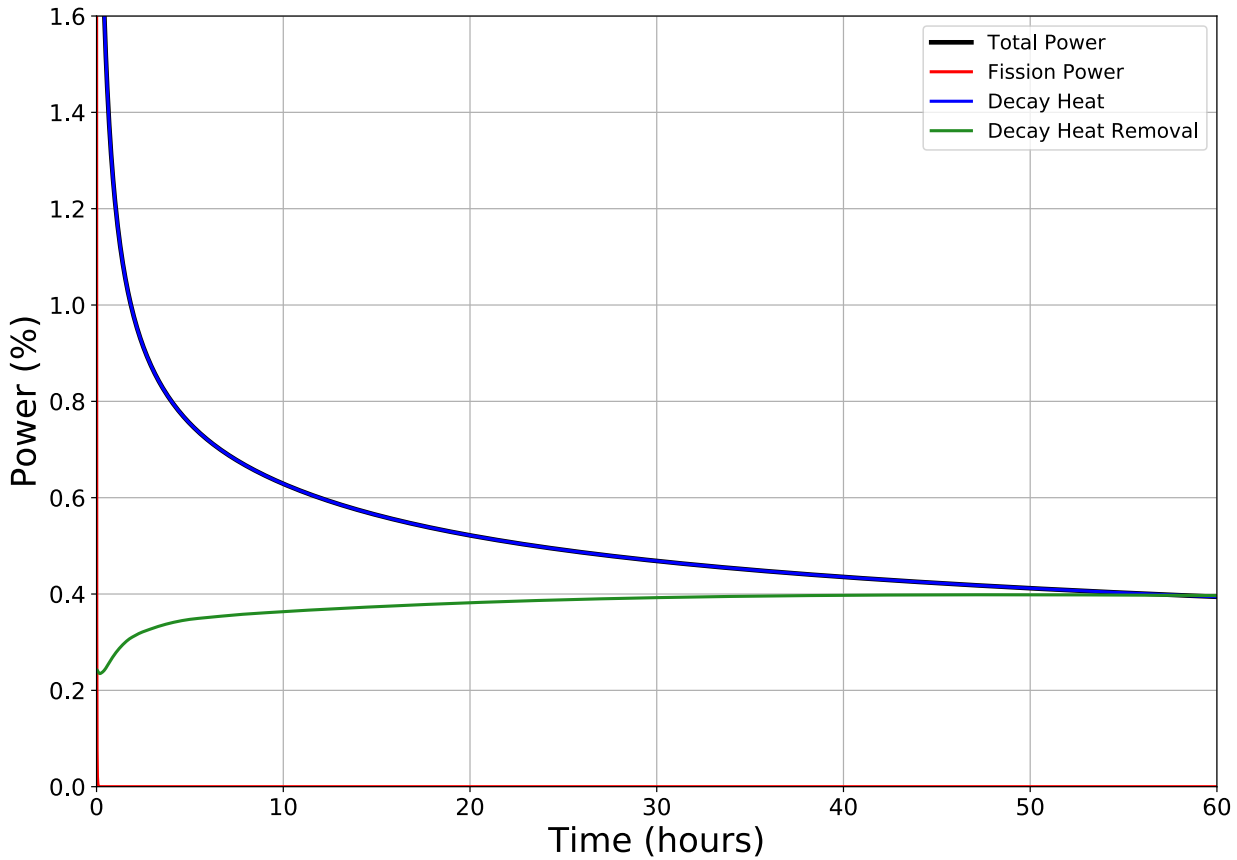
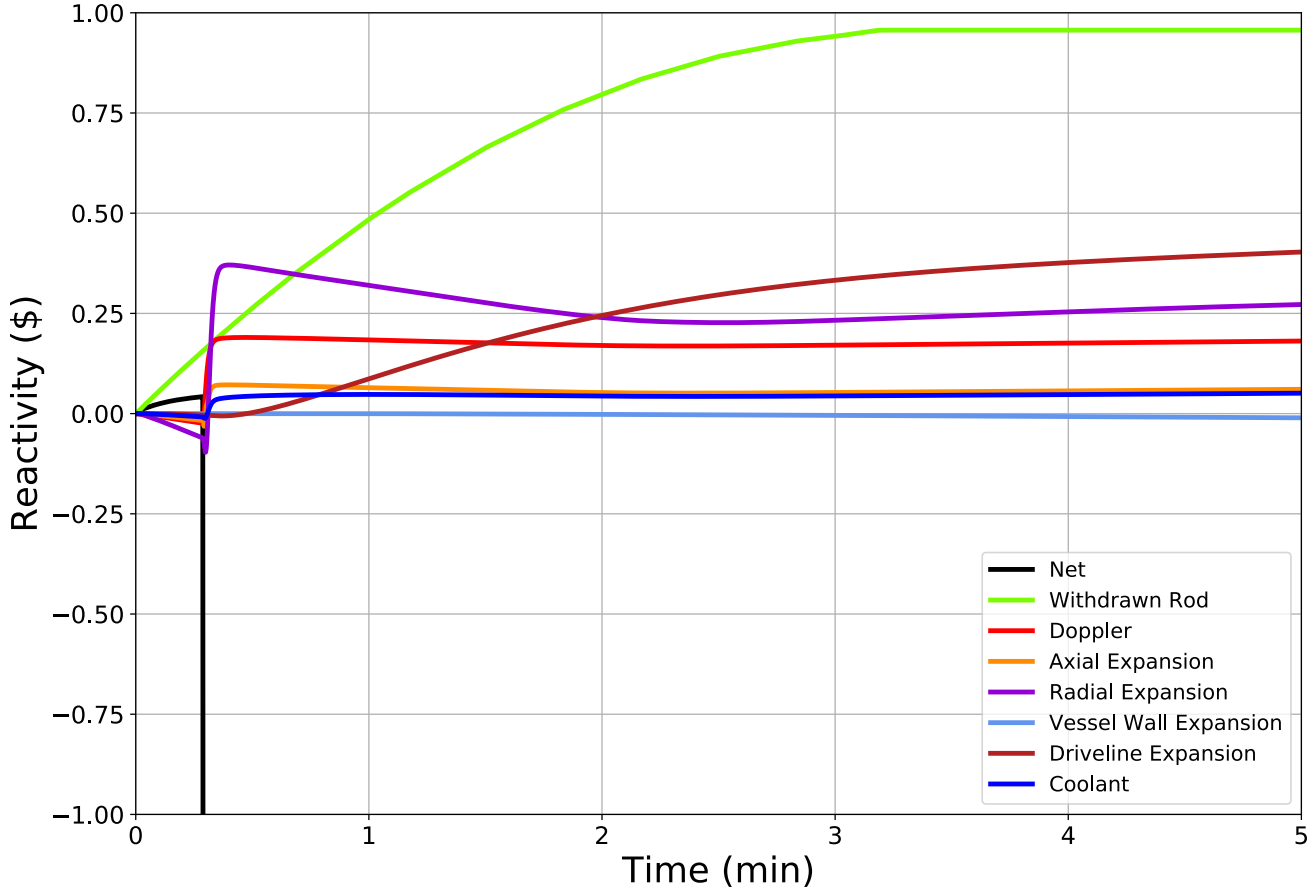


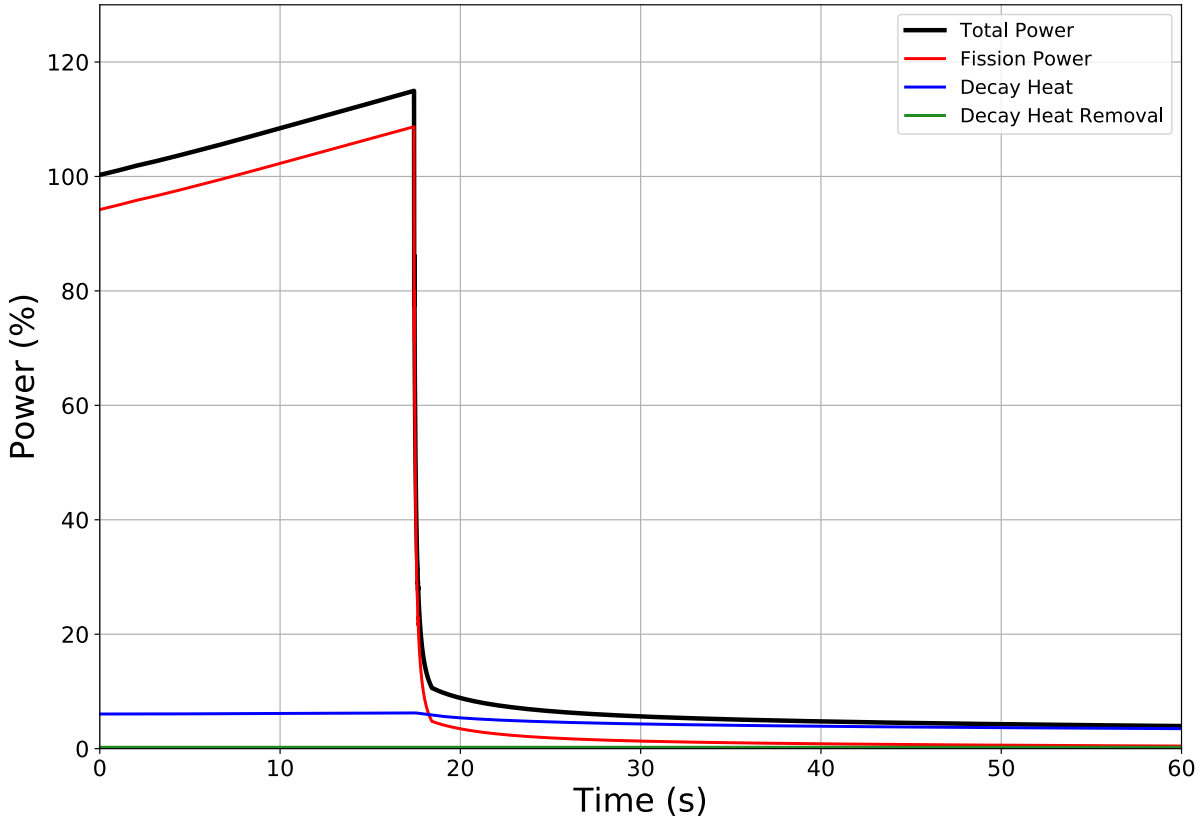


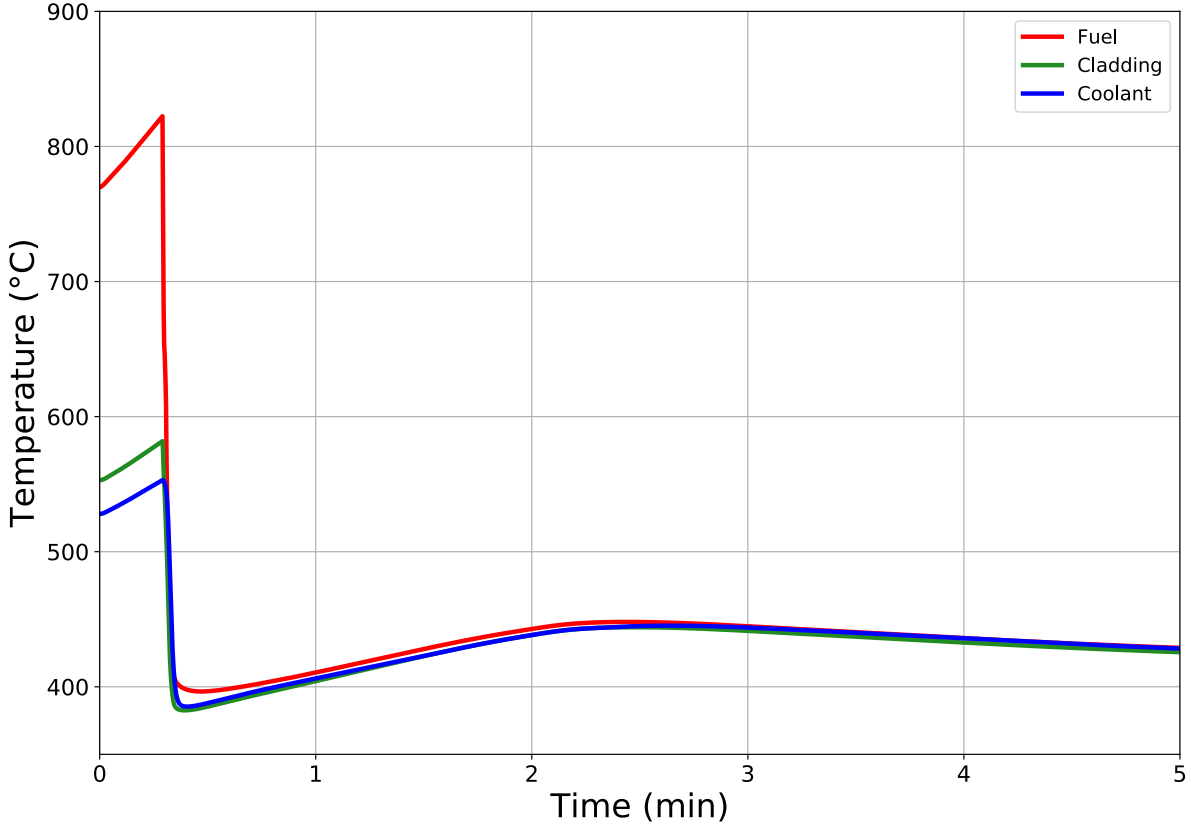
Protected Transient Overpower: Definition

- Withdrawal of one control rod
- RPS functions as designed
- SAHX heat rejection eliminated following plant trip
- Simulation Transient Initiator:
  - 95.7¢ reactivity insertion (BOC)
  - Average insertion rate: 0.5¢/s
  - Insertion speed: 2.1 mm/s



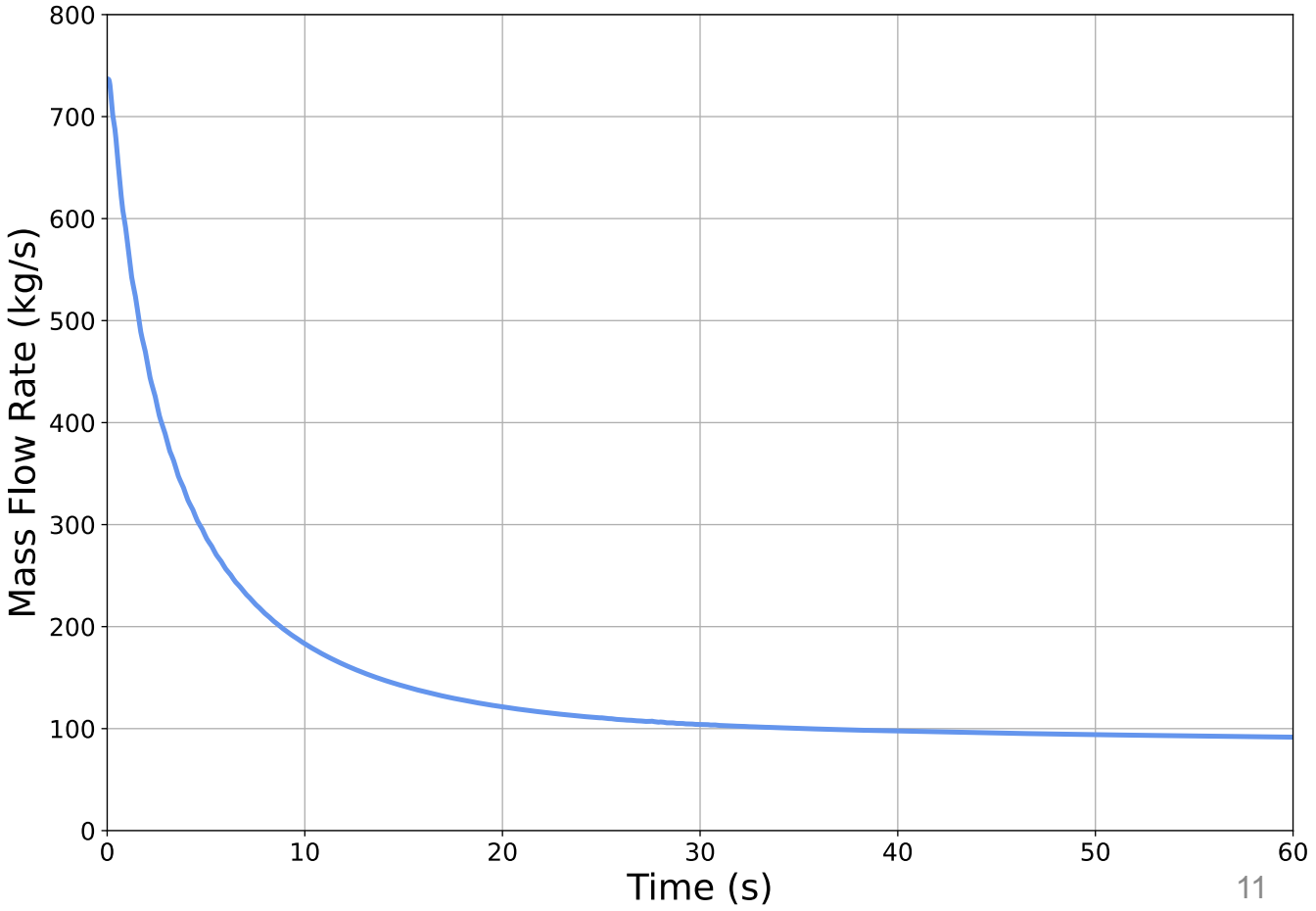
Protected Transient Overpower: Short-Term



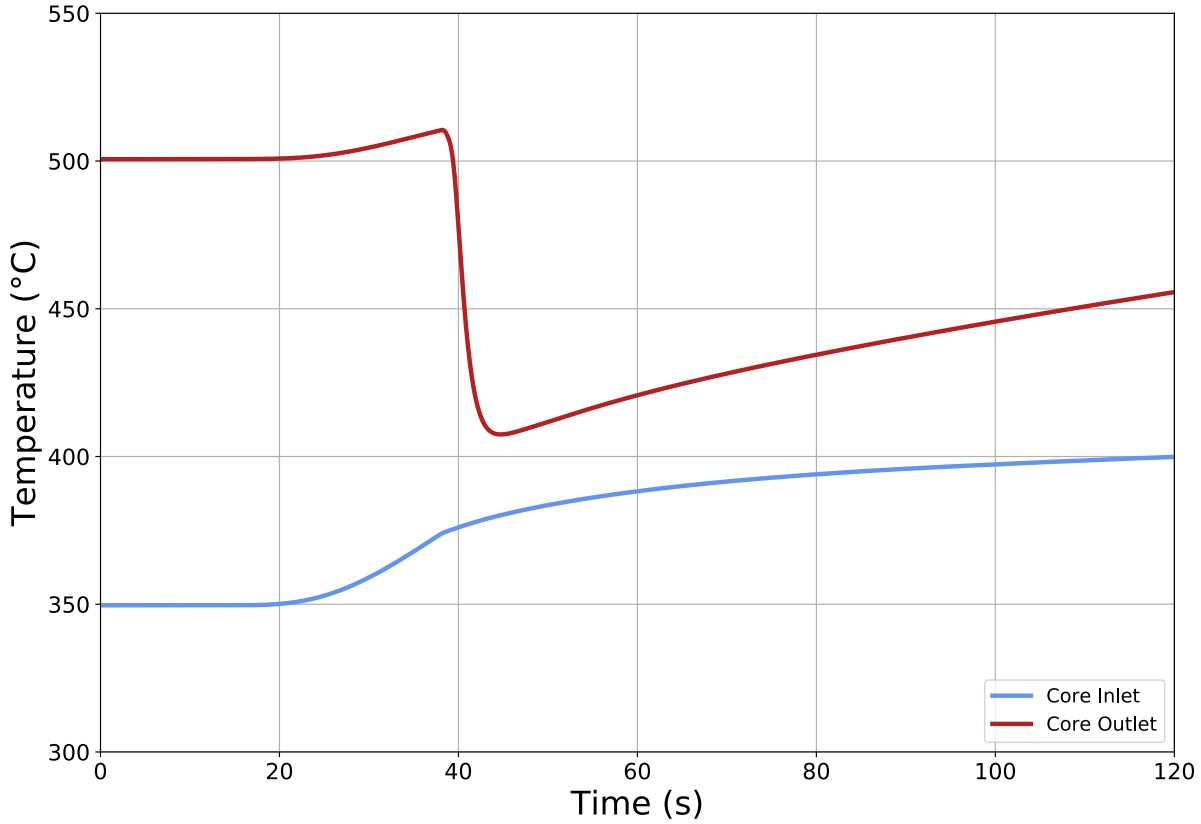


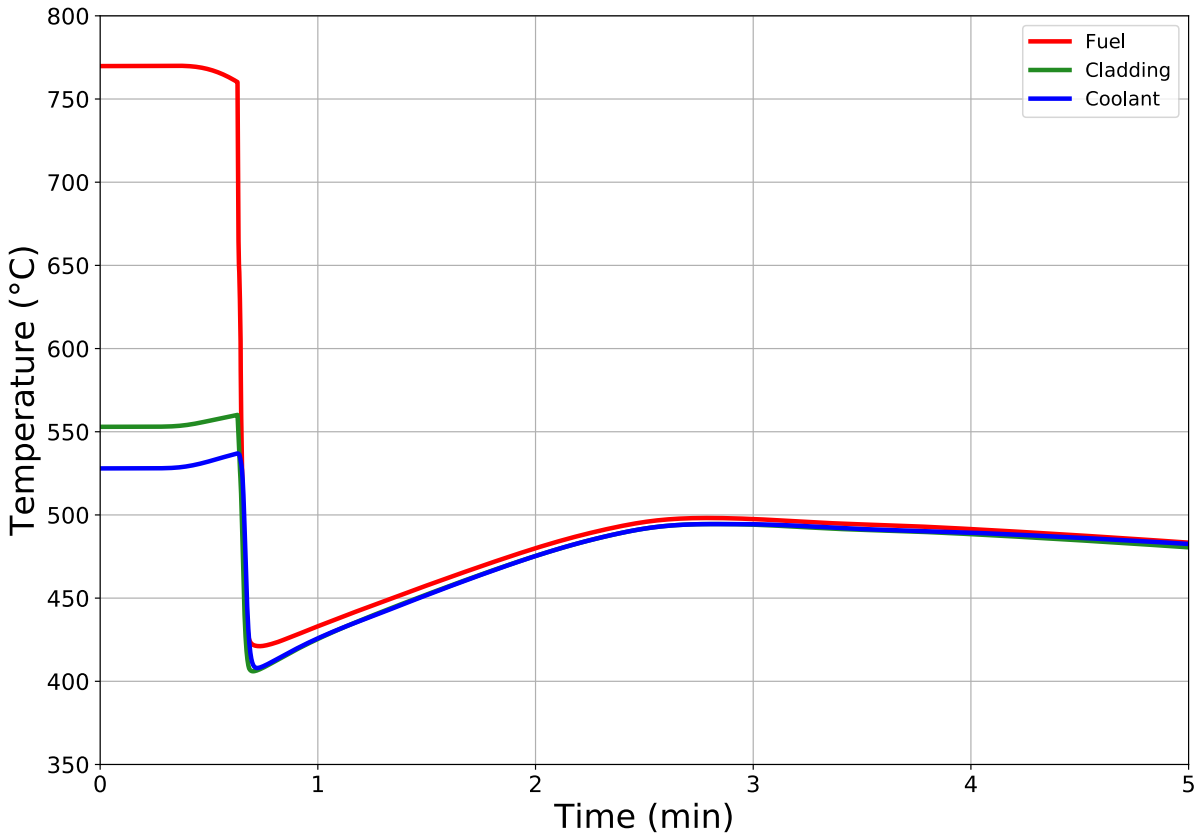
Protected Loss of Heat Sink: Definition

- Simultaneous trip of all secondary pumps
- RPS functions as designed
- Simulation Transient Initiator:
  - Secondary pumps trip
  - SAHX heat rejection assumed lost as well



Protected Loss of Heat Sink: Short-Term





Summary & Conclusions

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Beginning of Cycle

	Initial Value	PTOP Value	PLOHS Value	PSBO Value
Peak Fuel Temp.	769°C	822°C	769°C	774°C
Peak Cladding Temp.	553°C	582°C	560°C	599°C
Peak In-Core Sodium Temp.	528°C	553°C	537°C	588°C
Peak Bulk Sodium Temp.	500°C	503°C	501°C	501°C
Fuel Melting Margin	350°C	297°C	350°C	345°C
Sodium Boiling Margin	430°C	396°C	410°C	383°C
Bulk Coolant Margin	149°C	146°C	148°C	148°C
Cladding Margin	96°C	67°C	89°C	50°C

End of Cycle

	Initial Value	PLOHS Value	PSBO Value
Peak Fuel Temp.	751°C	751°C	756°C
Peak Cladding Temp.	547°C	555°C	591°C
Peak In-Core Sodium Temp.	520°C	530°C	578°C
Peak Bulk Sodium Temp.	500°C	501°C	501°C
Fuel Melting Margin	368°C	368°C	363°C
Sodium Boiling Margin	438°C	411°C	393°C
Bulk Coolant Margin	149°C	148°C	148°C
Cladding Margin	102°C	94°C	58°C

- Primary heat transport system:
  - Able to transition quickly & effectively to natural circulation
- Reactor Protection System:
  - Dominates transient behaviors and inherent feedbacks
- RVACS:
  - Provides sufficient heat rejection capability
- Large margins for all criteria predicted for all analyzed transients
- VTR being designed with a high level of safety

Thank you for your attention

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