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INL

Modeling EBR-II Loss of Flow and Loss of Heat Sink without SCRAM using RELAP5-3D

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Outline

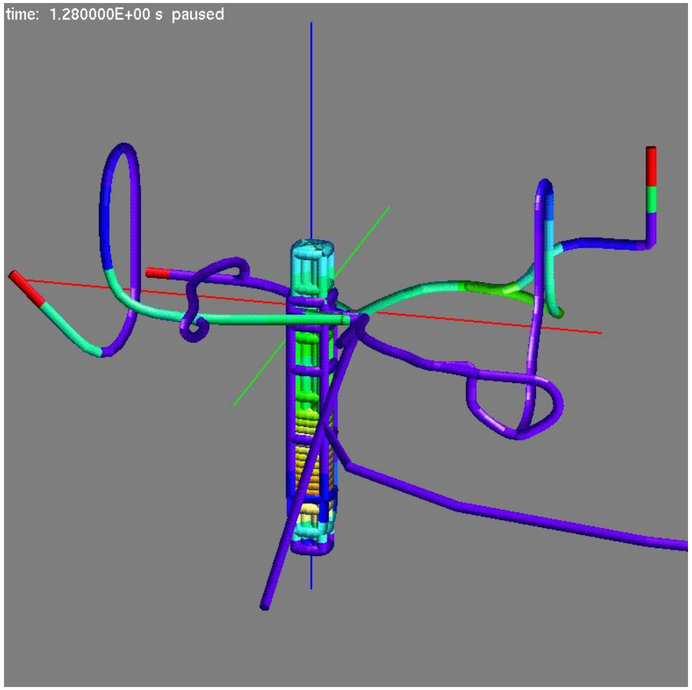
- Objective
- Description of RELAP5-3D
- Description of EBR-II
- Description of XX09 Measurement Subassembly
- Test Conditions
- RELAP5-3D Results
- Conclusions

Objective

- **The purpose of this study was to help validate the ability of RELAP5-3D to accurately model a liquid sodium cooled fast reactor. Ultimately, the goal is to model this type of reactor for the Global Nuclear Energy Partnership (GNEP) initiative.**

RELAP5-3D

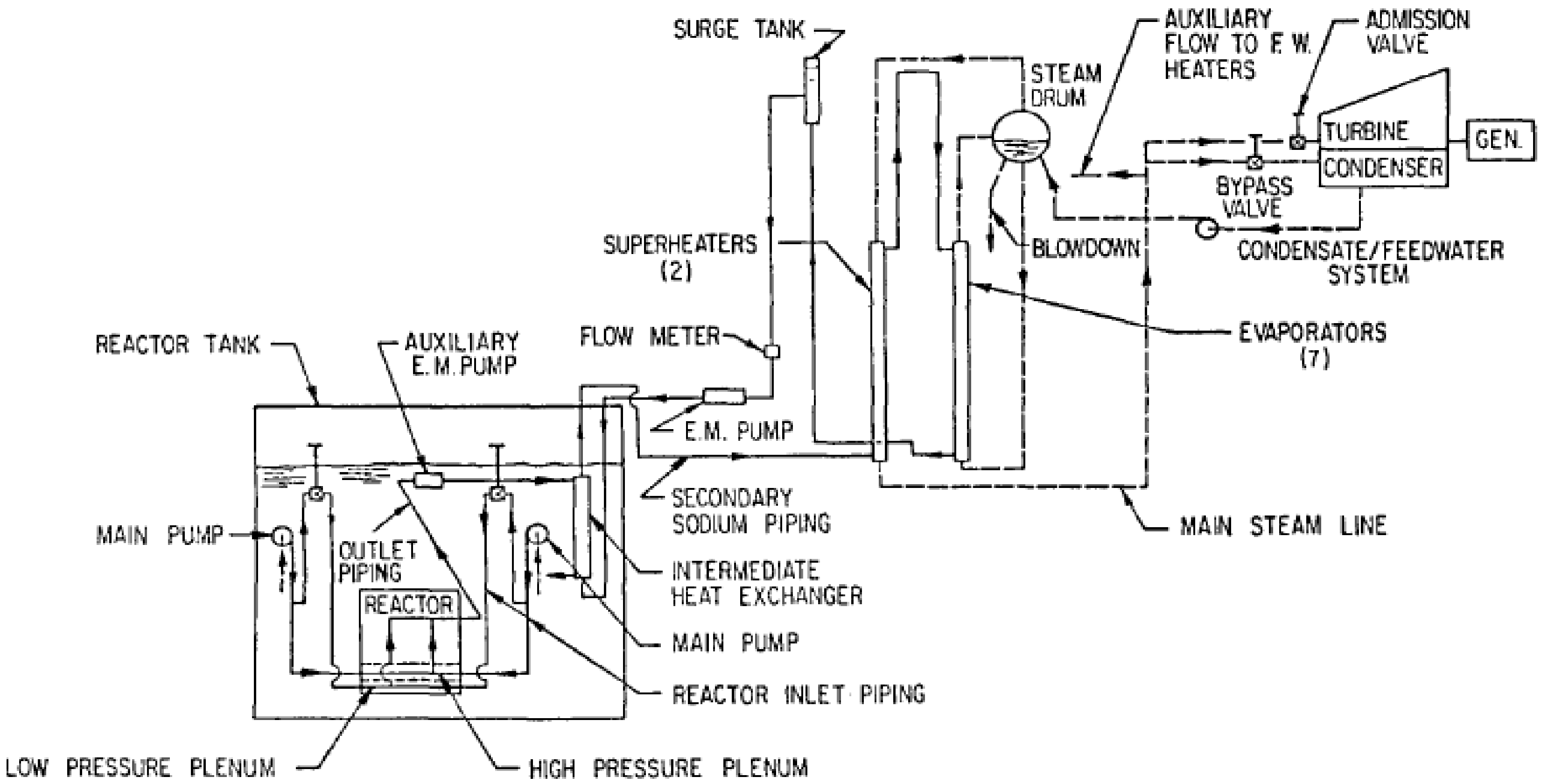
- **RELAP5-3D is a computer code used to model thermal-hydraulic systems**
- **Provides an analysis tool to help understand system responses and to verify design safety**
- **Applicable to a wide range of systems for simulation of transients and accidents**



Experimental Breeder Reactor-II

- Experimental Breeder Reactor II (EBR-II) was a sodium cooled fast breeder reactor operated by ANL
- Performed experiments to verify the safety of a liquid metal reactor
- Maximum reactor power of 60 MWt
- Primary and secondary loops contained liquid sodium which powered a tertiary steam cycle loop to produce 20 MWe

Experimental Breeder Reactor-II



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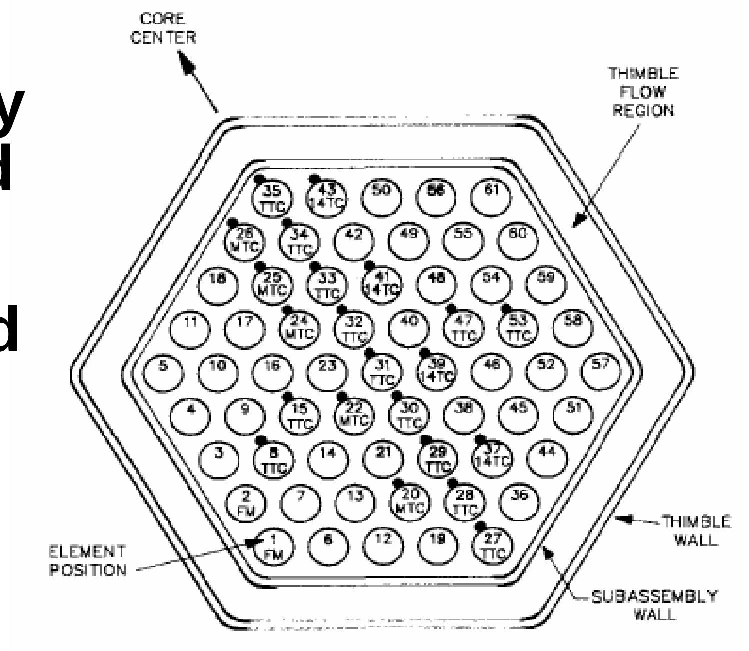
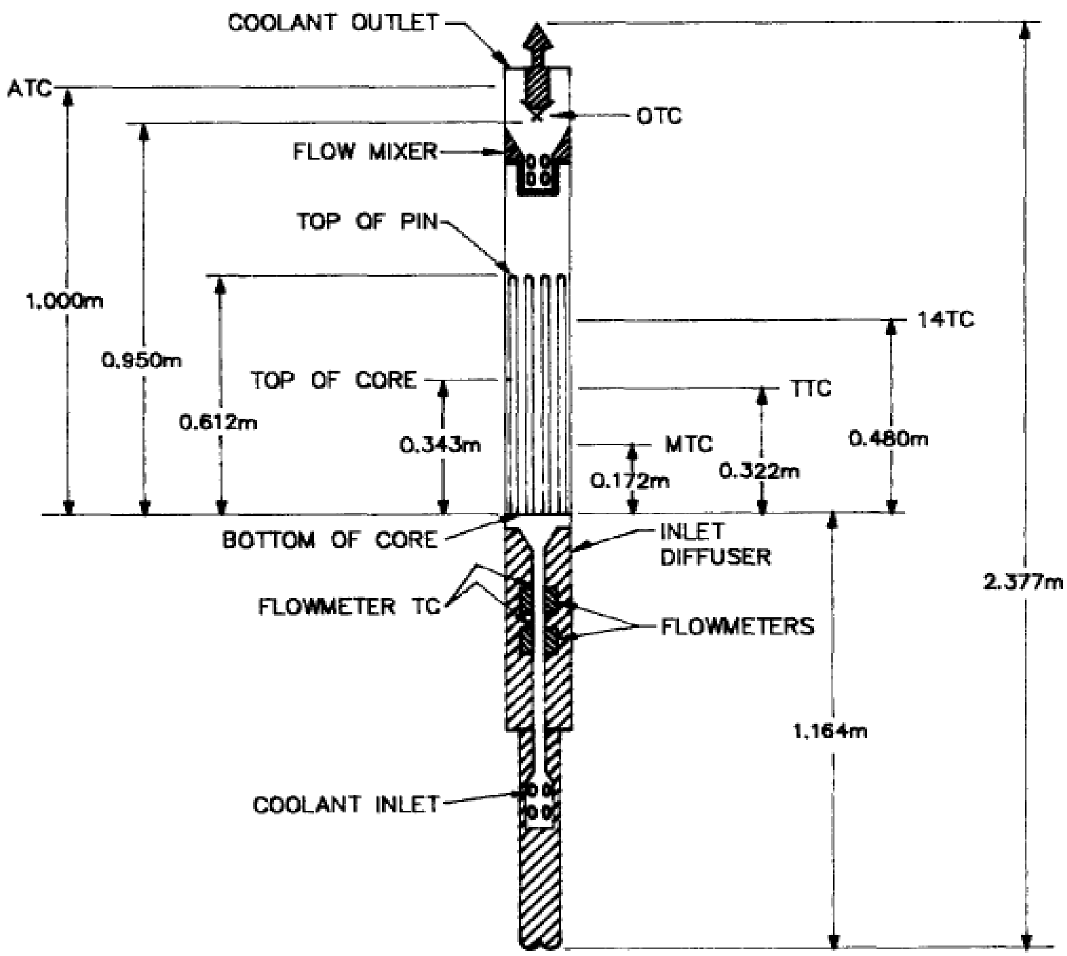
XX09 Subassembly

- **Measurement subassembly equipped with two flowmeters and 28 thermocouples to measure in core values**
- **Contained hexagonal array of 59 fuel rods surrounded by a hexagonal annulus**
- **The two remaining fuel rod positions were used for instrumentation leads**



XX09 Subassembly

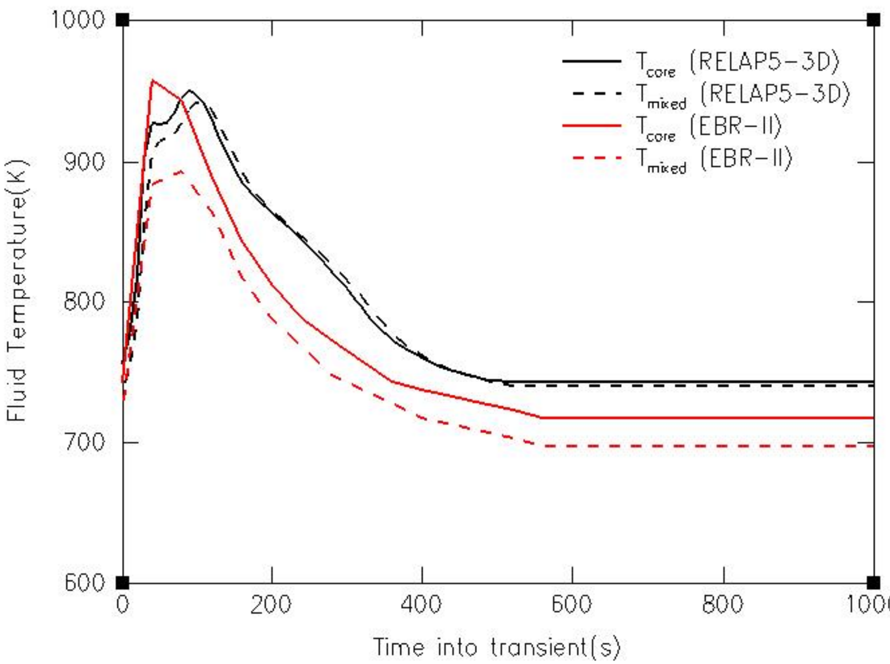


Loss of Flow without SCRAM

- The LOFWS test was initiated from full reactor power and flow by a trip of the primary pump
- As the primary pump coasts down the heat removed from the core decreases, which in turns causes a negative reactivity feedback in the core and begins to limit the fission process
- This experiment was performed to verify predictions that showed the reactor would shut itself down before reaching critical temperatures in the cladding and fuel

Loss of Flow without SCRAM

- Prediction made by RELAP5-3D is in generally good agreement with the experimental data
- Results show that the fluid temperature in the core does not reach dangerous levels
- Actual XX09 undergoes constant cooling from thimble
- Maximum Temperature:
  - Fluid~950 K
  - Cladding~952 K
  - Fuel~963 K

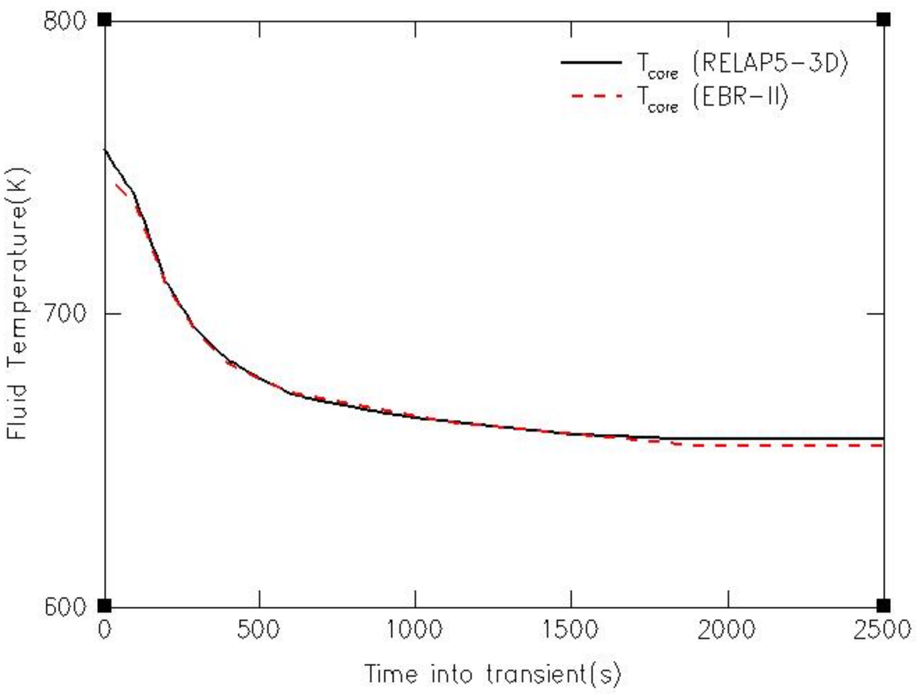


Loss of Heat Sink without SCRAM

- The LOHSWS test was initiated from full reactor power and flow by a trip of the secondary pump
- As the secondary pump coasts down the heat removed from the core decreases, which in turns causes a negative reactivity feedback in the core and begins to limit the fission process
- This experiment was performed to verify predictions that showed the reactor would shut itself down before reaching critical temperatures in the cladding and fuel

Loss of Heat Sink without SCRAM

- **Prediction made by RELAP5-3D is in excellent agreement with the experimental data**
- **Results show that the fluid temperature in the core does not reach dangerous levels**
- **Maximum Temperature:**
  - **Fluid~755 K**
  - **Cladding~765 K**
  - **Fuel~830 K**



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Conclusions

- The XX09 measurement assembly from the EBR-II was modeled using RELAP5-3D
- Two different experiments, the LOFWS and the LOHSWS, were performed using the model
- Good agreement was found between the RELAP5-3D predictions and the experimental data
- Discrepancies in the predicted and experimental values can be attributed to the accuracy with which the data was presented as well as a lack of information about the XX09 surroundings and thimble temperature