HTTF RELAP5-3D
Applications and Assessment

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Overview

• High Temperature Test Facility (HTTF) description
• Recent RELAP5-3D analyses
• Future plans
High Temperature Test Facility highlights

- Integral experiment being built at Oregon State University
- 2.2 MW electrically-heated, scaled model of a high temperature gas reactor
  - Reference is the Modular High-Temperature Gas-cooled Reactor (MHTGR) (prismatic blocks)
  - Large ceramic block representing core and reflectors
  - ¼ length scale
  - Prototypic coolant inlet (259°C) and outlet (687°C) temperatures
  - Less than scaled power
  - Maximum pressure of ~700 kPa
- Primary focus is on depressurized conduction cooldown transient
HTTF RELAP5-3D Input Model Description

• Four systems
  – Primary coolant
  – Secondary coolant
  – Reactor cavity
  – Reactor cavity cooling system (RCCS)
• Central and side reflector regions divided into regions with or without coolant holes
• 2-D (radial/axial) conduction in all vertical heat structures
• Heater block unit cell centered on the coolant channel
• Radial conduction and radiation inside core barrel
• Radiation from core barrel to vessel to RCCS
**Reactor Vessel Nodalization**

- Multiple flow paths through core
  - Three heated channels
  - Central reflector
  - Side reflector
- Gaps on either side of permanent side reflector not flow-through
- Riser annulus between core barrel and pressure vessel
- No coolant between upper plenum shield and upper head
HTTF RELAP5-3D Core Region Radial Nodalization

- Reactor vessel
- Core barrel
- Permanent reflector
- Side reflector
- Coolant
- Core region
- Central reflector
- Coolant gaps
- Heater rod
- Coolant hole
HTTF Ex-vessel Nodalization
Steady state scoping calculations

- Effect of reduced power
- Effect of reduced pressure
- Maintain nominal coolant inlet and outlet temperatures
- Can a representative core temperature distribution be maintained?
- Can operational costs be reduced?
Effect of primary coolant system pressure

700 kW

2200 kW
Effect of power on axial average temperatures
Effect of power on core block 2 temperatures
Effect of power on core block 6 temperatures
Effect of power on core block 10 temperatures
Depressurized conduction cooldown transient

- 5-s forced flow coastdown
- System depressurization valve opened at 3 s
- At 20 s
  - System depressurization valve closed
  - Hot and cold duct break valves opened
  - Loop isolation valve closed
- Scram assumed at transient initiation (0 s)
Core ceramic temperature response

![Diagram showing temperature response over time for different rings and power levels.](image_url)
Central reflector temperature response
Side reflector temperature response
Outer structure temperature response

![Graph showing temperature response](image-url)
How low can the power go?
**Summary of results**

- System pressure had little effect on core temperature distribution
- In general, decreasing power at steady state
  - Increased the central reflector temperatures
  - Reduced the core temperatures
  - Reduced the side reflector temperatures
- Lower power resulted in lower temperatures during the depressurized conduction cooldown transient
  - Effect not as large as in initial temperature difference
  - Decay power is the same in all cases
- Reduced power operation may be viable for many cases
  - Lower electricity cost
  - Less water usage
- Model must still be benchmarked!
Future plans

- Update model when final drawings and component information is available
- Benchmark model using system characterization test data
- Perform assessment calculations using transient test data
- Provide operational support analyses as needed