MASLWR Overview and RELAP5 Simulation

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Outline

- Purpose of Research
- MASLWR Overview
- Test Data Overview
- RELAP5 Simulation
- Results
Purpose of Research

• Overall
  ◦ SMR Development
  ◦ NuScale Design Application

• RELAP-5 Simulation
  ◦ Establish Steady State Simulation
  ◦ Simulate Test Facility Operations
  ◦ Predict Behavior of Test Facility
Outline

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MASLWR Facility Configuration

- Reactor Pressure Vessel
- Automatic Depressurization System
- High Pressure Containment
- Heat Plate
- Cooling Pool
Primary Circuit Overview

- Core Heater Rods
- Hot Leg
- Pressurizer
- Heat Removal
- Cold Leg
- Lower Plenum
- Core Inlet
Secondary Circuit Overview

- Feed Water Pump
  - Variable Speed Centrifugal pump
- 3 Sections of SG Tubes
- Steam Drum
- Exhaust to atmosphere
Containment Overview

- HPC and Cooling Pool
  - Heat Transfer Plate
- Model Heat Transfer
- HPC Connected to RPV via ADS lines
  - Blowdown
  - Sump Return
Outline

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Test Overview

- Steady State at Multiple Power levels
  - Secondary system operating to remove net primary core power minus ambient losses

- Secondary Loop

- Primary Loop

- Steady State Instruments
  - TF-106
  - TF-131
  - FDP-131
## Test Matrix

<table>
<thead>
<tr>
<th>Steady State Test Matrix</th>
<th>Core Exit T(K)</th>
<th>Cold Leg T(K)</th>
<th>Mass Flow Rate (kg/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>40 kW</td>
<td>535.8</td>
<td>523.0</td>
<td>0.45</td>
</tr>
<tr>
<td>80 kW</td>
<td>541.3</td>
<td>525.2</td>
<td>0.90</td>
</tr>
<tr>
<td>120 kW</td>
<td>539.7</td>
<td>518.6</td>
<td>1.22</td>
</tr>
<tr>
<td>160 kW</td>
<td>541.9</td>
<td>517.4</td>
<td>1.39</td>
</tr>
<tr>
<td>200 kW</td>
<td>543.0</td>
<td>514.8</td>
<td>1.52</td>
</tr>
<tr>
<td>240 kW</td>
<td>517.4</td>
<td>484.1</td>
<td>1.64</td>
</tr>
<tr>
<td>280 kW</td>
<td>523.0</td>
<td>486.3</td>
<td>1.74</td>
</tr>
<tr>
<td>320 kW</td>
<td>525.2</td>
<td>487.4</td>
<td>1.84</td>
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</tbody>
</table>
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RELAP5-Developing the Model

- Started with a model built in 2008 by Dr. Brian Woods
- Modified components
- Defined Test conditions
- Achieved Steady State
- This process was repeated for 30%, 40% and 50% power
Outline

- Purpose of Research
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- Test Data Overview
- RELAP5 Simulation
- Result Comparison
## Results

### Temperature

<table>
<thead>
<tr>
<th>Power</th>
<th>Test</th>
<th>Relap</th>
<th>Difference</th>
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<tbody>
<tr>
<td>30%</td>
<td>540.37</td>
<td>541.56</td>
<td>1.19</td>
</tr>
<tr>
<td>40%</td>
<td>542.7</td>
<td>543.31</td>
<td>0.61</td>
</tr>
<tr>
<td>50%</td>
<td>543.15</td>
<td>543.96</td>
<td>0.81</td>
</tr>
</tbody>
</table>

### Lower Hot Leg (Fahrenheit)

<table>
<thead>
<tr>
<th>Power</th>
<th>Test</th>
<th>Relap</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>30%</td>
<td>520.2</td>
<td>519.12</td>
<td>1.08</td>
</tr>
<tr>
<td>40%</td>
<td>517.87</td>
<td>516.75</td>
<td>1.12</td>
</tr>
<tr>
<td>50%</td>
<td>514.82</td>
<td>513.28</td>
<td>1.54</td>
</tr>
</tbody>
</table>

### Mid Cold Leg (Fahrenheit)

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Mass Flow Rates vs % Core Power

- Test Data
- RELAP Simulation
Possible Error

- Instrument Tolerance
- Flow Loss Calculations
- Geometry of Model
Conclusion

- Temperature Distribution
- Flow Rates Underpredicted
- Achieved Steady-State Baseline
Future Adjustments to the Model

- New Flow Loss Calculations
  - New Test Data

- Secondary Side

- Containment Model

- Simulate MASLWR Test Facility Behavior
Acknowledgements

- Dr. Qiao Wu
- Dr. Brian Woods
- Dr. Wade Marcum
- Jordan Bowser
- John Mclerran

References

- NUREG/CR-5535/RevP3
- OSU-MASWLR-07001: Test Facility Description Report
Discussion