NRC / BWROG Meeting

BWR LOCA Long Term Cooling Fuel Effects to Debris Blockages

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Agenda

- Review of Previous Presentation (~10 min)
  - Limiting LOCA Scenario Selection
  - Limiting Bundle Blockage Case
- TRACG LOCA Simulation Results (~ 25 min)
  - Sensitivity of PCT to Blockage Scenarios
  - Reference Limiting Case for Long Term Cooling
- Maximum Blockage Criteria (~ 10 min)
  - Lower Tie Plate Grid
  - Spacers and Upper Tie Plate Grid
- Boundary Conditions for Fuel Testing (~ 10 min)
  - Bottom Reflood
  - Natural Circulation
  - Bypass Region Refill
  - Top Channel Downflow

Review of Previous Presentation

TRACG LOCA Simulation Results

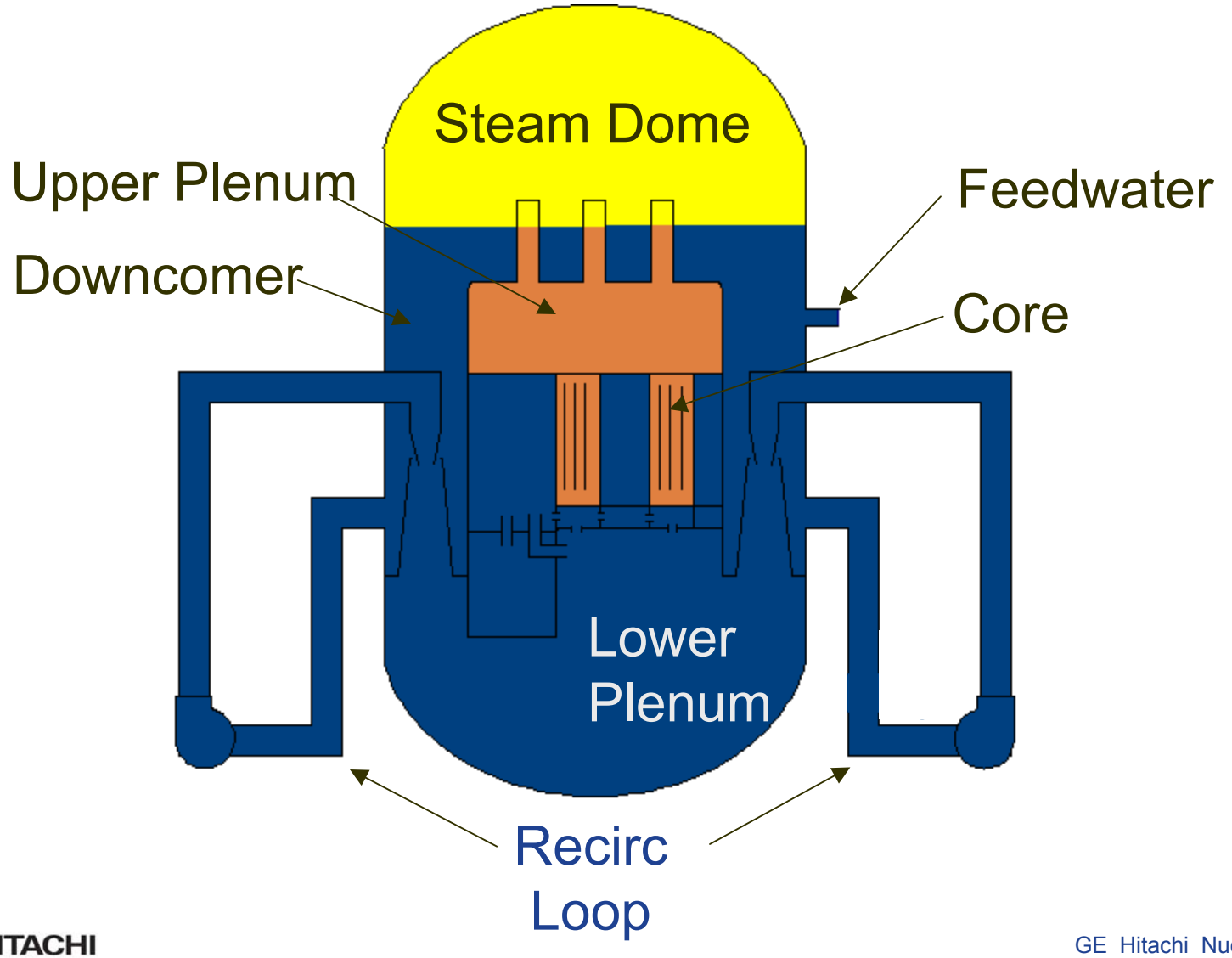
Maximum Blockage Criteria

Boundary Conditions for Fuel Testing

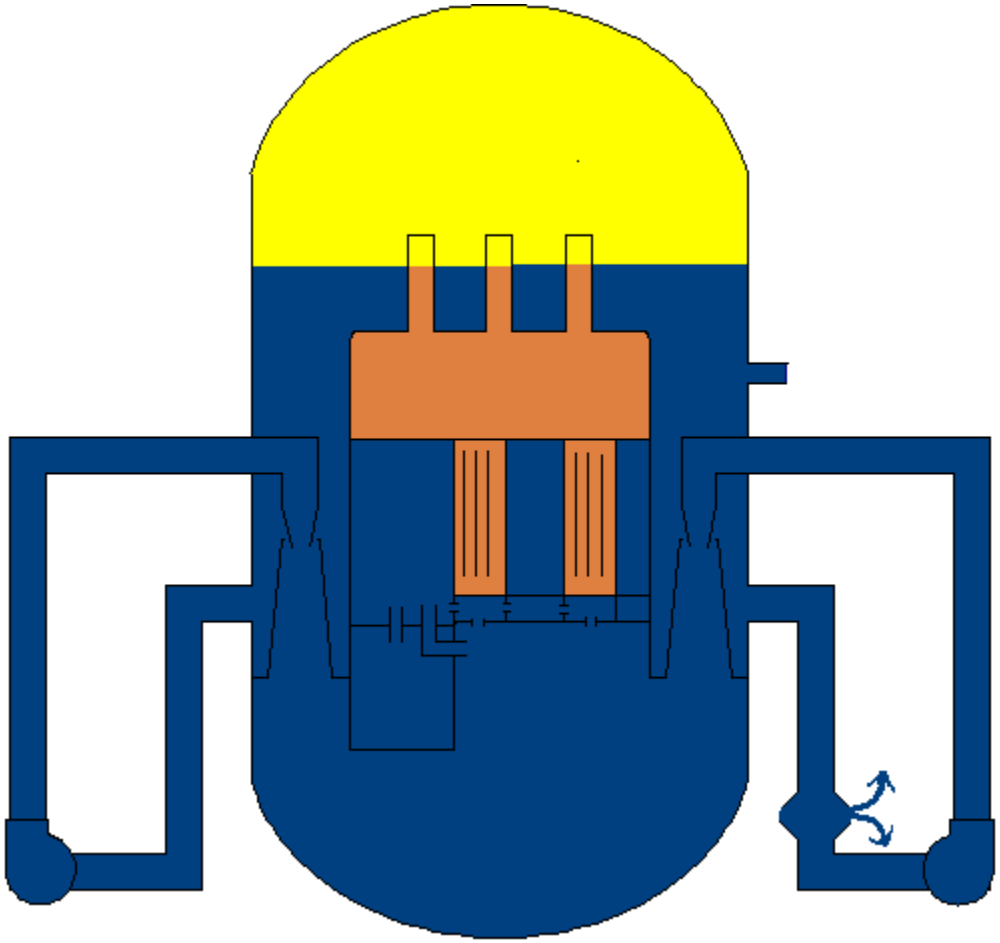
Review of Previous Presentation

- Limiting LOCA Scenario Selection
  - –Largest Pipe Break
  - –Early Uncovery and Late Recovery
- Debris Flow Paths
  - –Level and Bypass Refill, Secondary Effects
  - –Inlet Natural Circulation, Short Term
  - –Outlet Downflow, Long Term
- Limiting Bundle Blockage Case
  - –Full Blockage at Inlet
  - –Partial Blockage at Exit

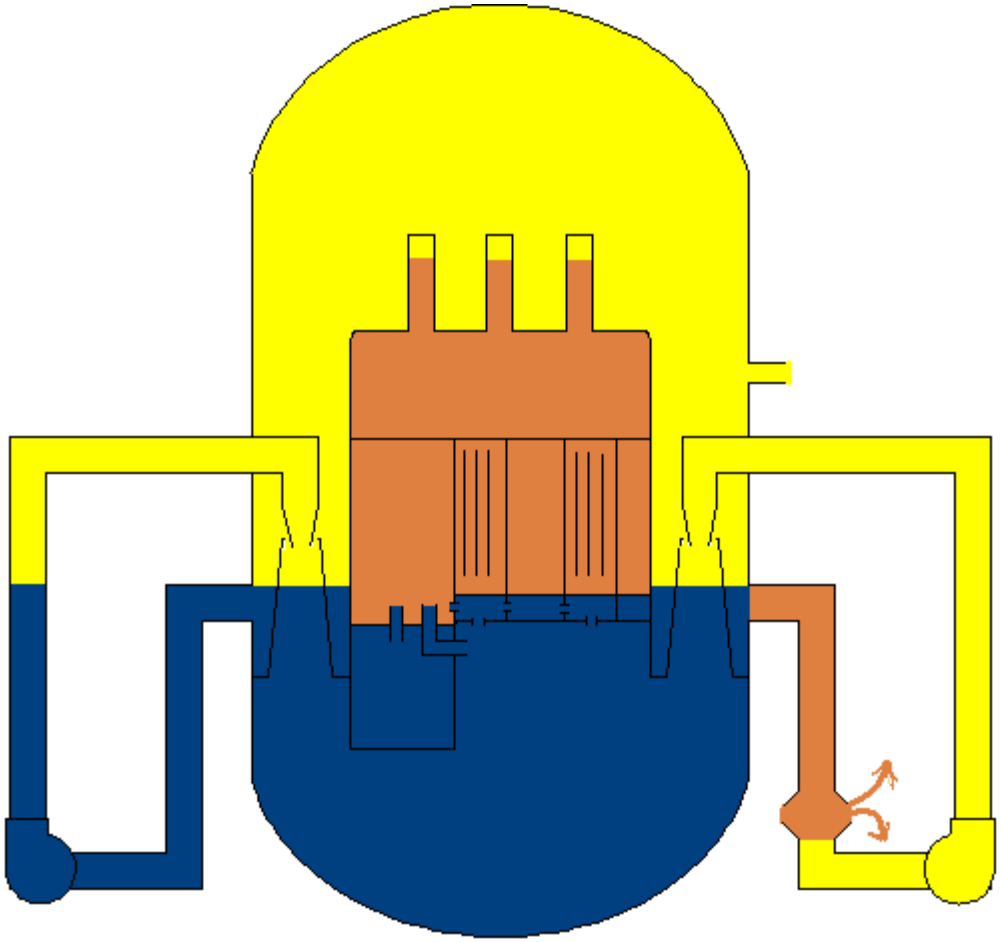
Typical BWR Normal Operation



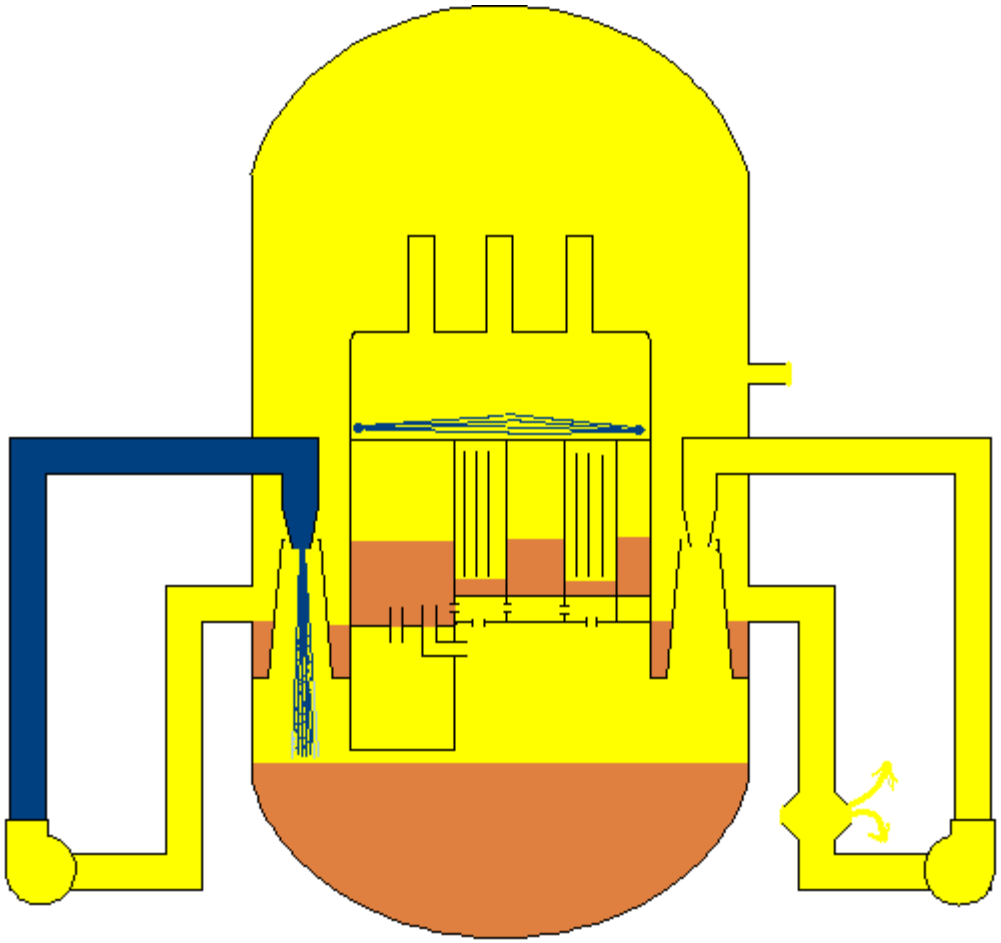
BWR LOCA Event – Initial Pipe Rupture



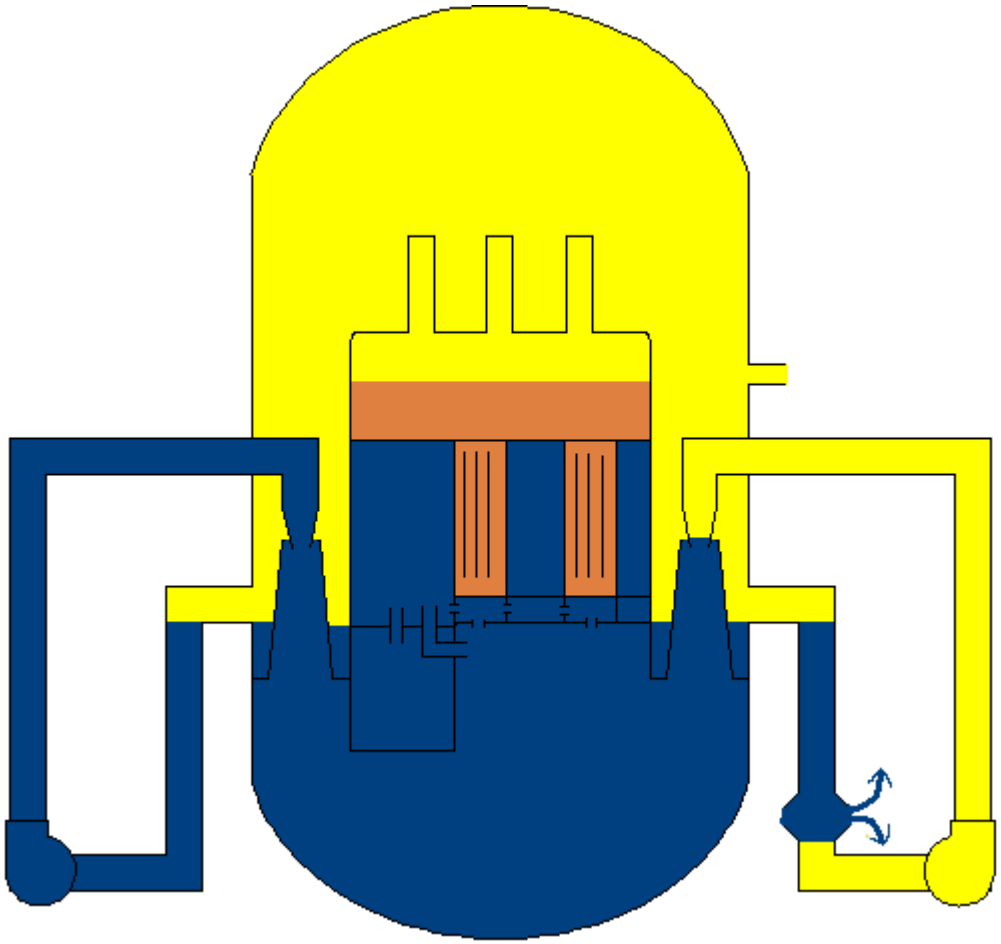
BWR LOCA Event – Prior to ECCS Injection



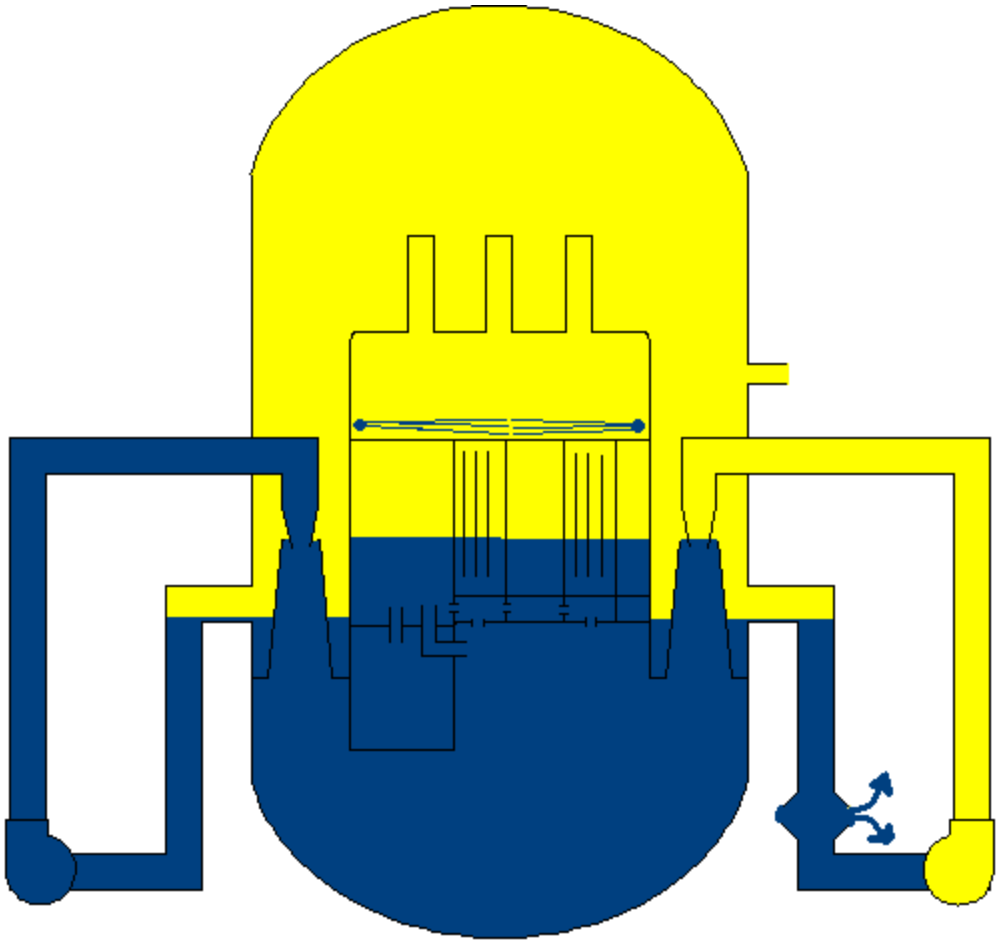
BWR LOCA Event – Initial ECCS Injection



BWR LOCA Event – Core Reflood



BWR LOCA Event – Long Term Cooling



Review of Previous Presentation

TRACG LOCA Simulation Results

Maximum Blockage Criteria

Boundary Conditions for Fuel Testing

TRACG LOCA Simulation Results

- Sensitivity of PCT to Blockage Scenarios
  - Plant Types and Break Size
  - Blockage Magnitude and Time
- Reference Limiting Case for Long Term Cooling
  - Full Inlet Blockage
  - Partial Outlet Blockage
  - Coolant Flow Magnitude

PCT & RPV Level Response - No Blockage

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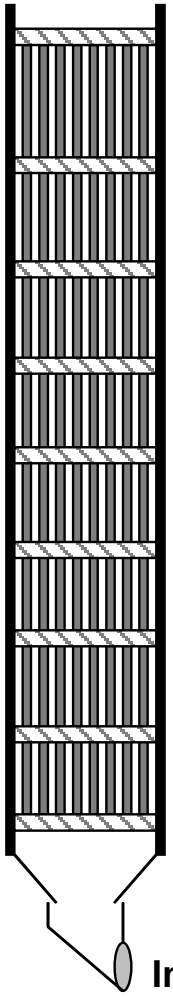
Case Matrix



Percentage Blocked	Delay after ECCS Injection
25%	5 sec
50%	30 sec
75%	60 sec
100%	120 sec
	180 sec

Plant Type & Break Size PCT Sensitivity

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Plant Type & Break Size PCT Sensitivity

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Plant Type & Break Size PCT Sensitivity

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Plant Type & Break Size PCT Sensitivity

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PCT Sensitivity to Blockage at LTP

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PCT Sensitivity to 50% Blockage at UTP with 100% Blockage at LTP

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PCT Sensitivity to 50% Blockage at UTP with 100% Blockage at LTP

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High Power Bundle Flow after ECCS Injection – No Blockage

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High Power Bundle Flow after ECCS Injection – No Blockage

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High Power Bundle Flow after ECCS Injection – 50% UTP 100% LTP Blockage

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High Power Bundle Flow after ECCS Injection – 50% UTP 100% LTP Blockage

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High Power Bundle Flow after ECCS Injection – 50% UTP 100% LTP Blockage

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High Power Bundle Flow after ECCS Injection – 50% UTP 100% LTP Blockage

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Conclusions

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Review of Previous Presentation

TRACG LOCA Simulation Results

Maximum Blockage Criteria

Boundary Conditions for Fuel Testing

Maximum Blockage Criteria

- Lower Tie Plate Grid
  - Full Blockage applied after short term PCT
  - Allows early cooling from downflow, same as long term cooling and non-jet pump plant
- Upper Tie Plate Grid
  - Limited Blockage applied after flow reversal
  - Flow exceeds cooling requirements after quenching

Review of Previous Presentation

TRACG LOCA Simulation Results

Maximum Blockage criteria

Boundary Conditions for Fuel Testing

Boundary Conditions for Fuel Testing

- Bottom Reflood
  - Initial Two Phase Level Recovery: Delay
- Natural Circulation
  - Natural Circulation Flow: Inlet Blockage
- Bypass Region Refill
  - Lower Plenum Refill: Bypass Flow Holes Blockage
- Top Channel Downflow
  - Core Spray Cooling: Outlet Blockage

Boundary Conditions for Fuel Testing

Flow Path	Criteria	Hydraulic Parameters
1 – Fuel Inlet Grid	Less than 95% free area blockage in three minutes of injection with debris	Maximum driving head of 7 psid
2 – Fuel Outlet Grid	Less than 50% free area blockage over long term injection wit debris	Flow rate from 1 to 12 gpm
3 – Level Recovery	Insignificant delay in level recovery over 10 feet during initial two minutes of injection with debris	Level Rise rate corresponding to fastest in BWR
4 – Bypass Flow Refill	Insignificant flow reduction over initial 3 minutes of injection with debris	Maximum driving head of 7 psid

THANK YOU !

Supporting Slides:

Cross section area for inlet filter, spacers and outlet grid

LTP UTP and Spacers

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