ENCLOSURE 2

MFN 09-501

NRC/BWROG Meeting Presentation
"BWR LOCA Long Term Cooling Fuel Effects to Debris Blockages"
July 23, 2009

Non-Proprietary Information

IMPORTANT NOTICE

Enclosure 2 is a non-proprietary version of the Presentation from Enclosure 1, which has the proprietary information removed. Portions that have been removed are indicated by open and closed double brackets as shown here [[ ]].

NRC / BWROG Meeting

BWR LOCA Long Term Cooling Fuel Effects to Debris Blockages

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July 23, 2009

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Agenda

- Overview of LOCA Scenario (~ 10 min)
  - Emphasis on flow patterns after low pressure ECCS injection
- TRACG LOCA Simulation Results (~ 20 min)
  - Simulation Model Description
  - Limiting Case and Non-limiting Sensitivity Results
- Basis for Application to all BWR/2-6 Plants (~ 10 min)
- Method for Establishing Thermal Hydraulic Boundary Conditions for Fuel Testing (~ 5 min)
  - Bottom Reflood
  - Natural Circulation
  - Bypass Region Refill
  - Top Channel Downflow
- Method of Validation for Other Fuel Characteristics (~ 5 min)

Overview of LOCA Scenario

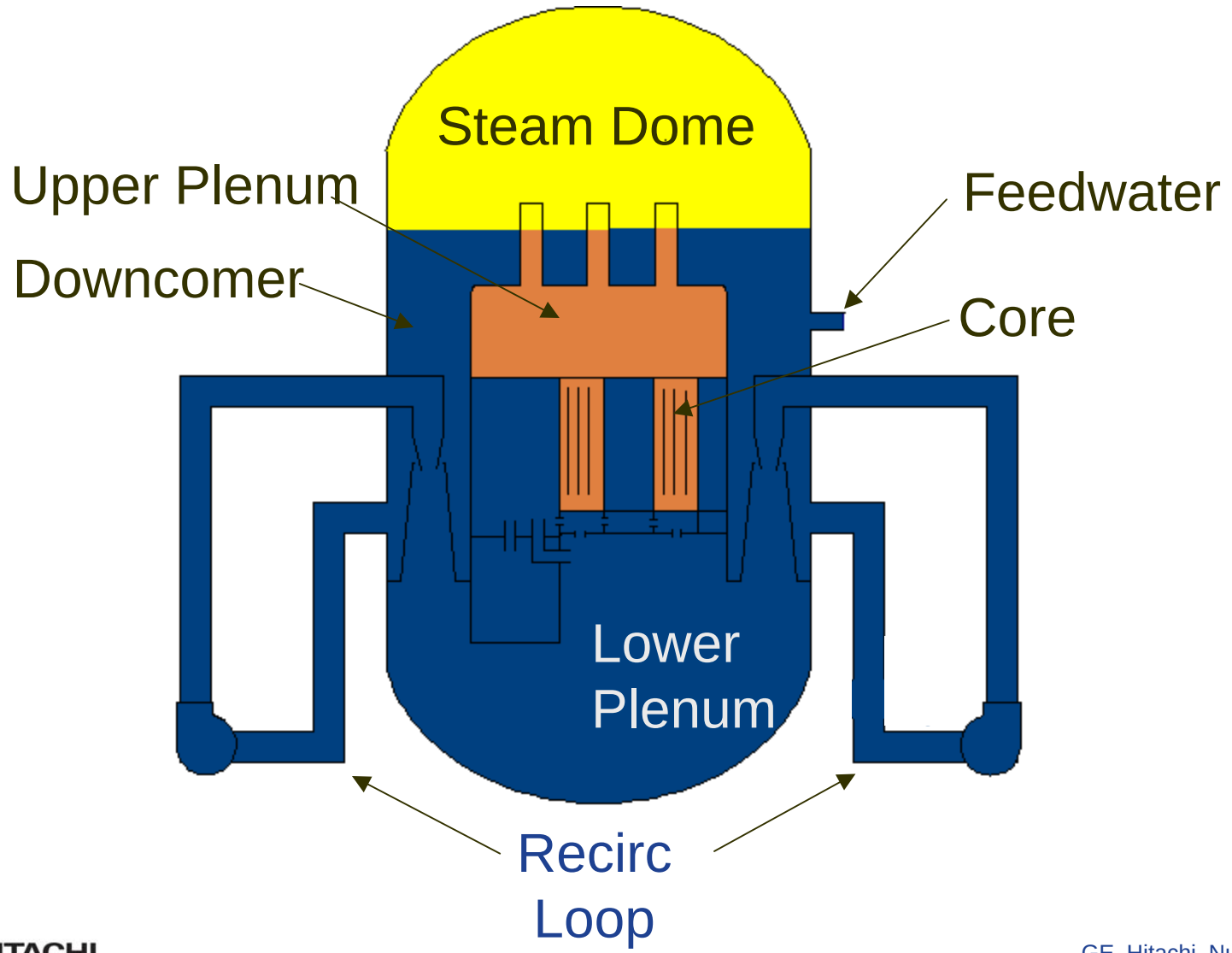
TRACG LOCA Simulation Results

Basis for Application to all BWR/2-6 Plants

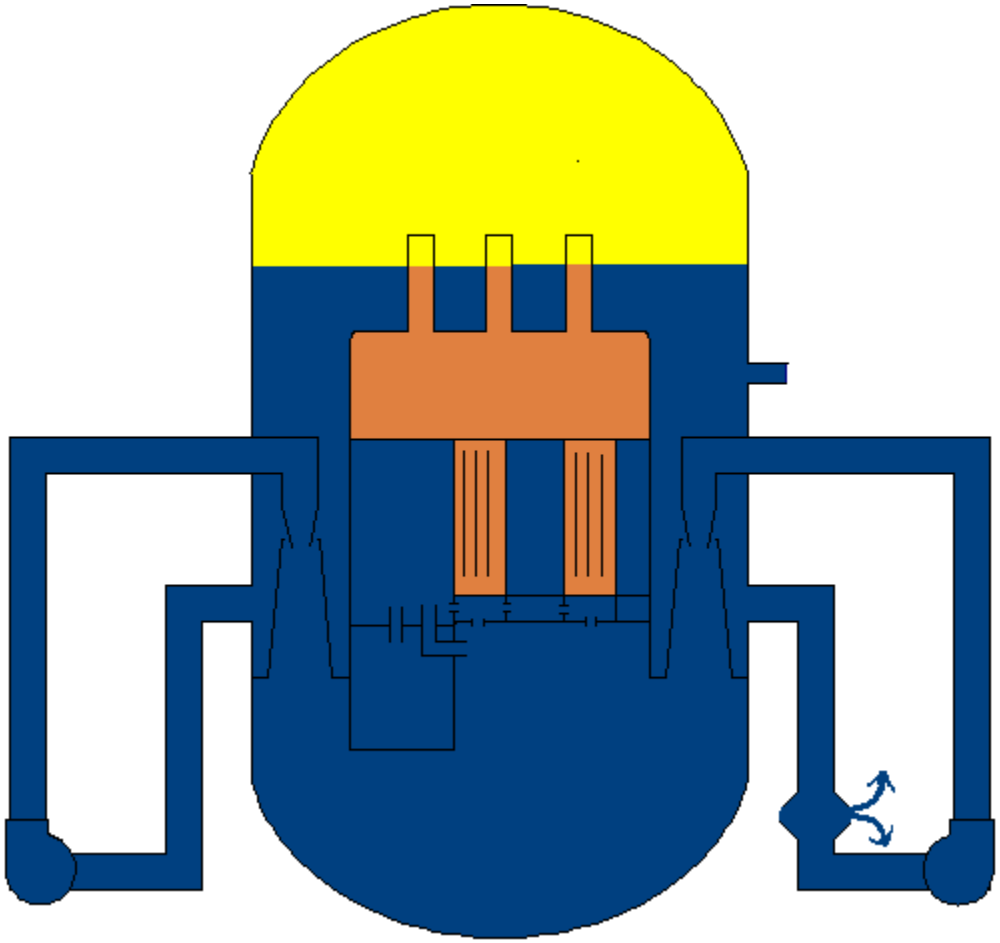
Method for Establishing Thermal Hydraulic Boundary Conditions for Fuel Testing

Method of Validation for Other Fuel Characteristics

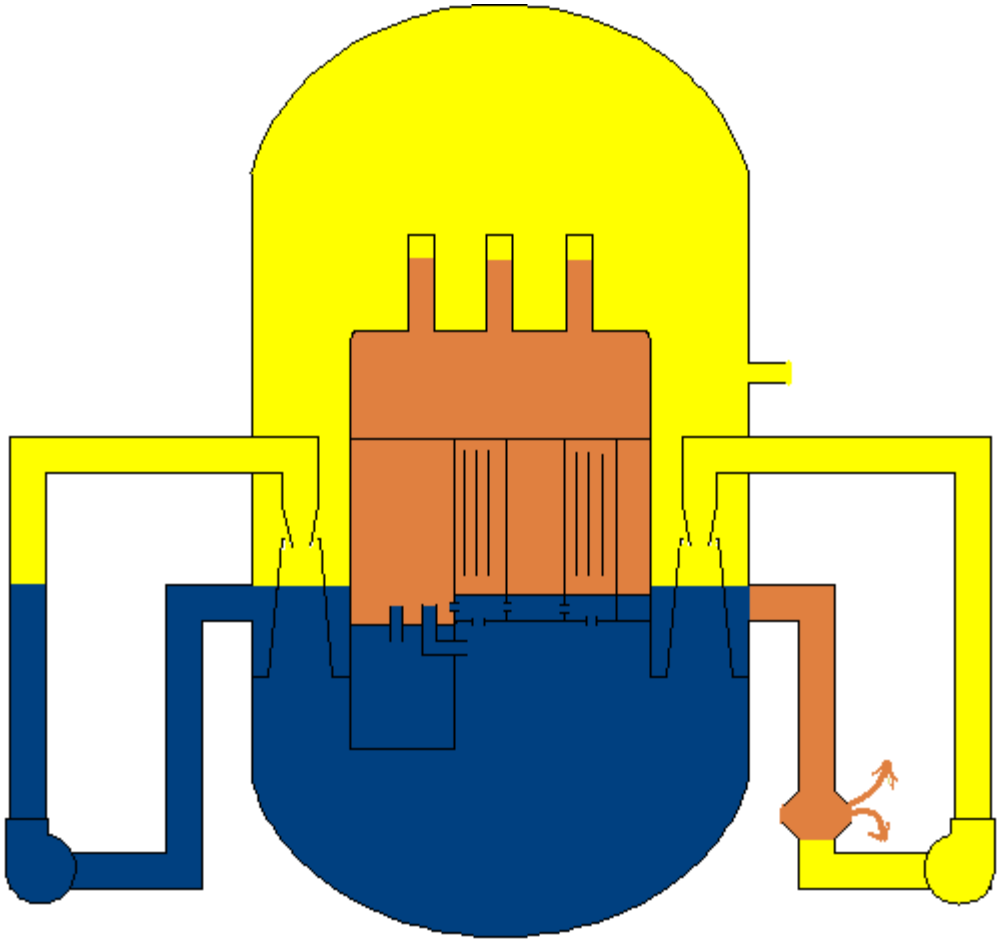
Typical BWR Normal Operation



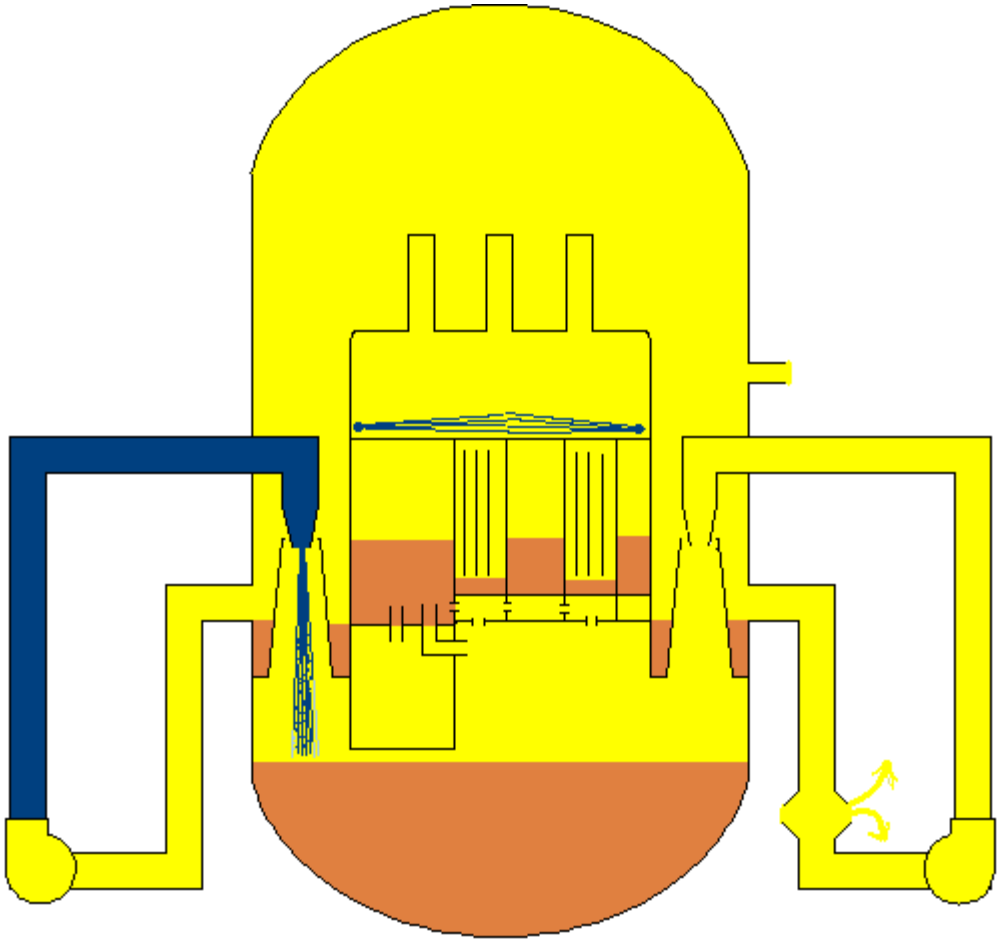
BWR LOCA Event – Initial Pipe Rupture



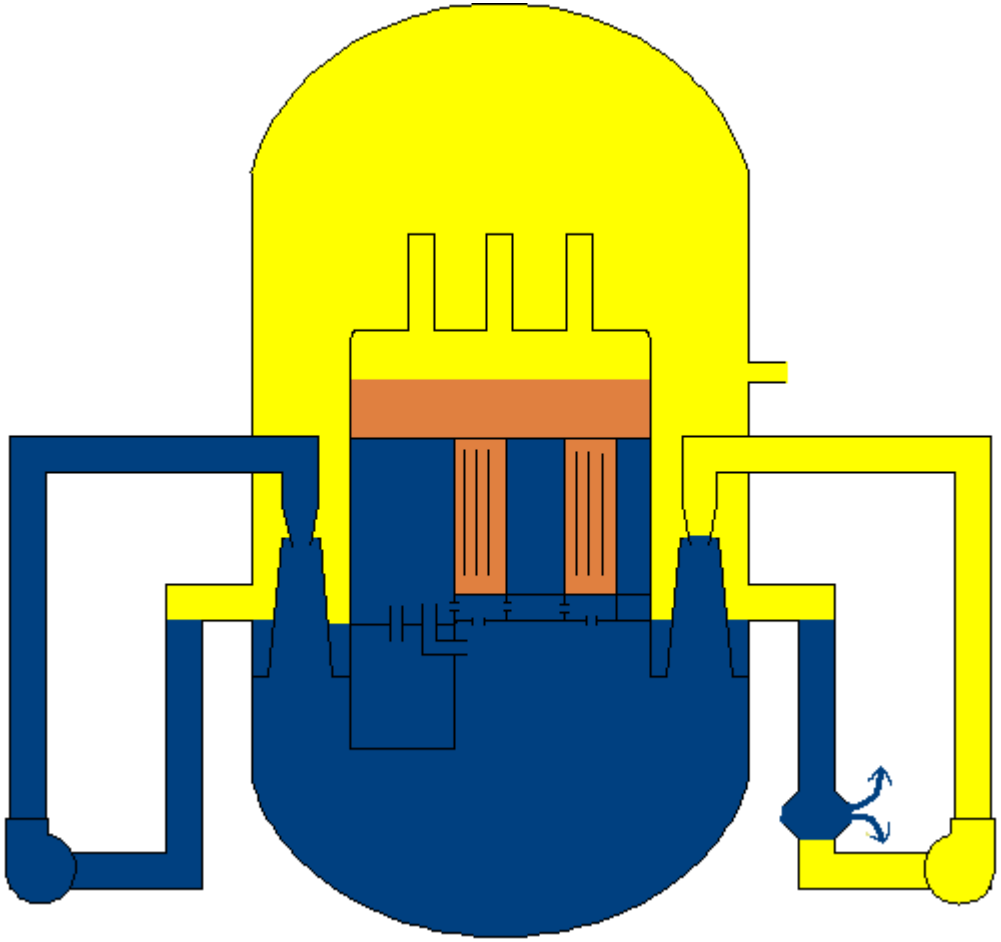
BWR LOCA Event – Prior to ECCS Injection



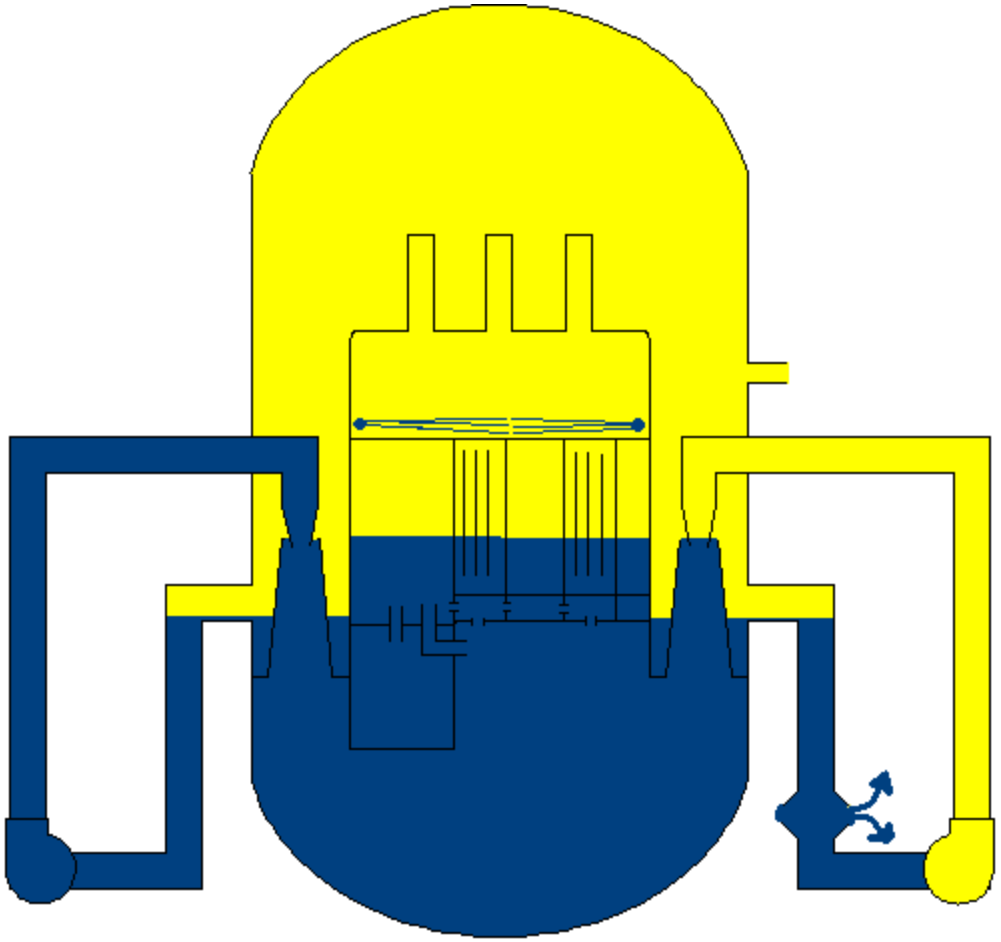
BWR LOCA Event – Initial ECCS Injection



BWR LOCA Event – Core Reflood



BWR LOCA Event – Long Term Cooling



BWR LOCA Long Term Cooling Phenomena

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Overview of LOCA Scenario

TRACG LOCA Simulation Results

Basis for Application to all BWR/2-6 Plants

Method for Establishing Thermal Hydraulic Boundary Conditions for Fuel Testing

Method of Validation for Other Fuel Characteristics

Simulation Model Description

- Objective - Demonstrate the effect that blockage has on long term fuel cooling.
  - Full inlet blockage
  - Blockage at Spacer #1 and Upper Tie Plate
- Method - GEH TRACG model
  - Parametric Study Approach
  - Variation in Blockage Degree and Timing

Summary of Conclusions

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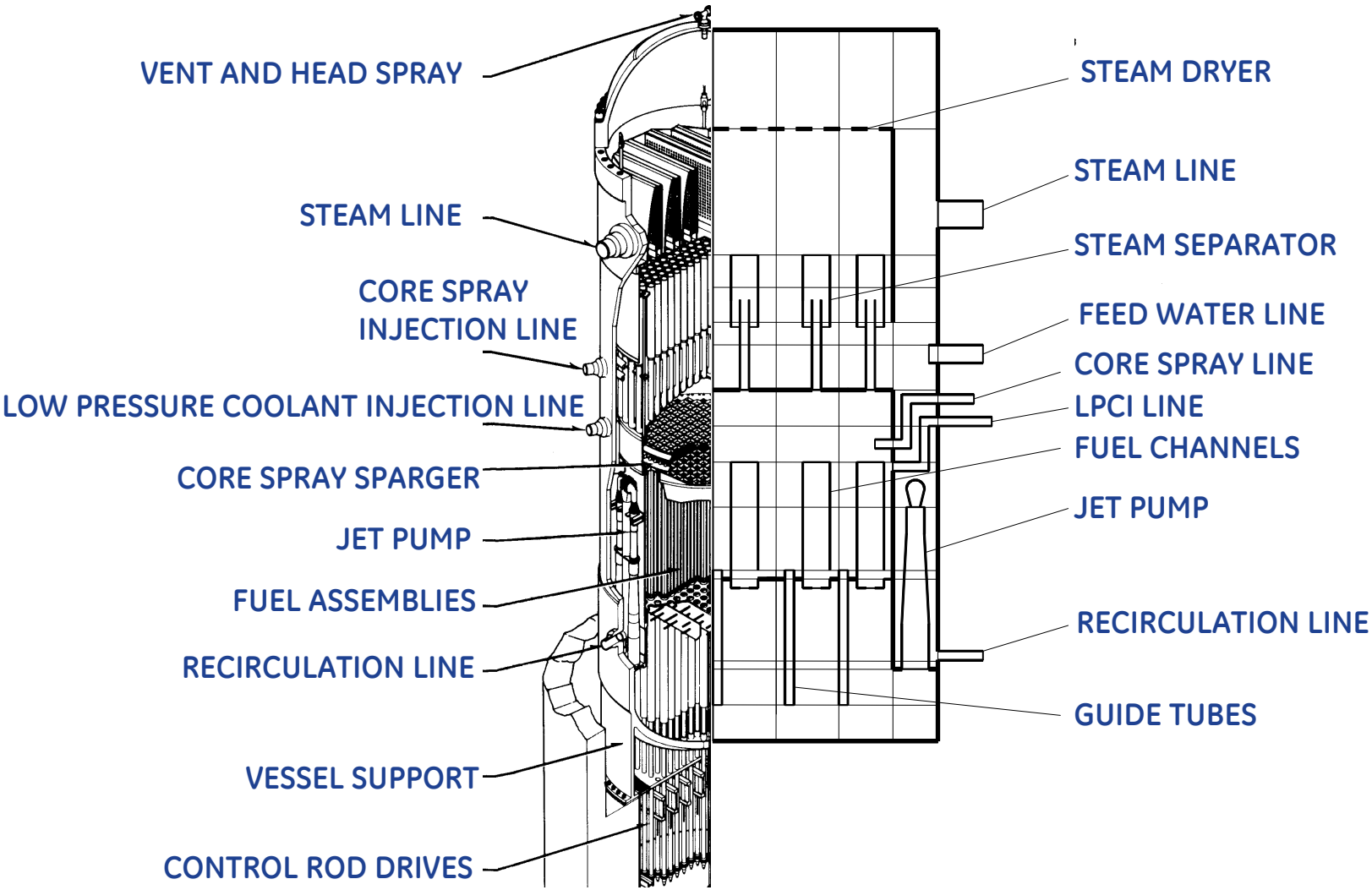
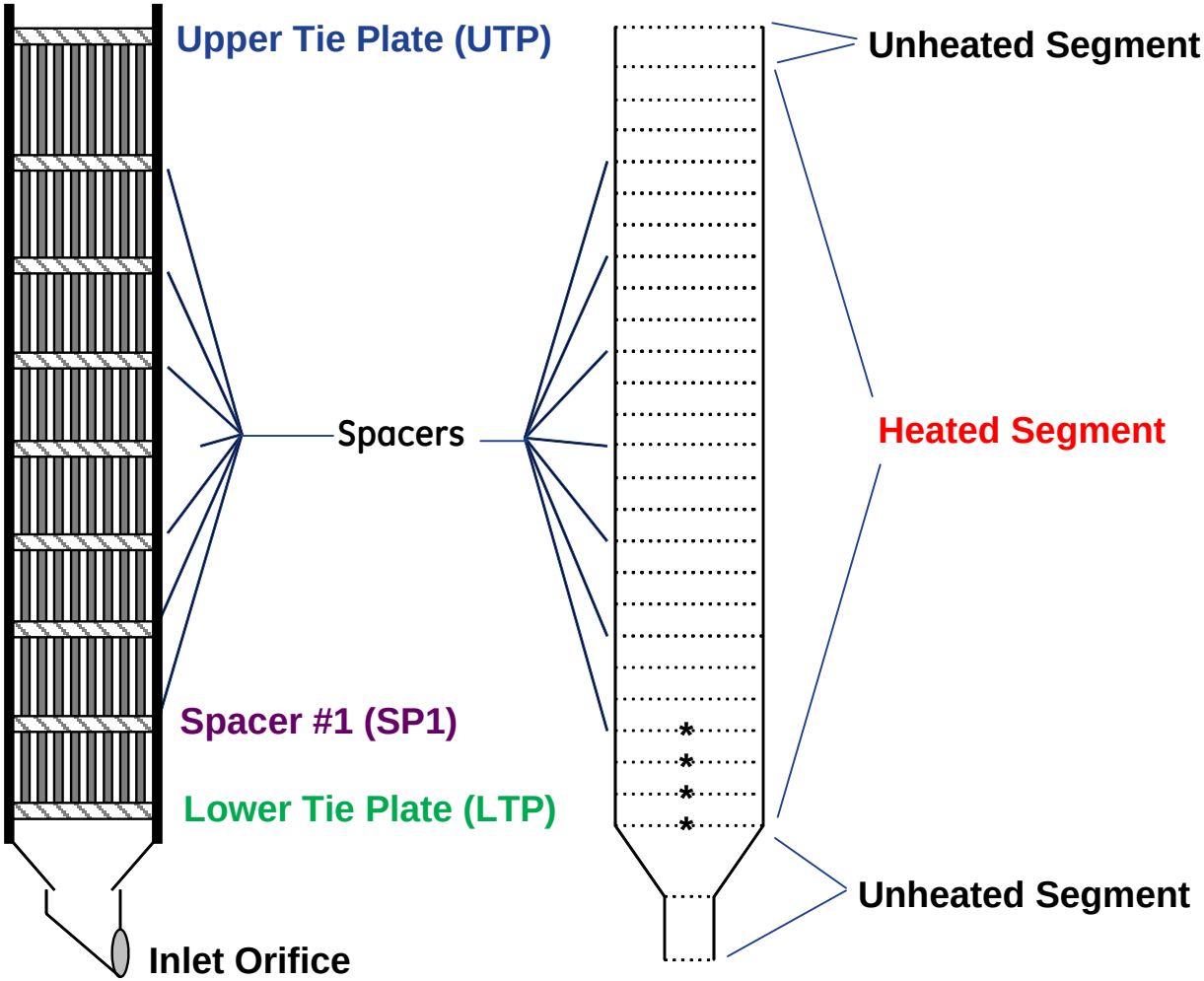
TRACG Vessel Nodalization



TRACG Fuel Bundle Nodalization



Scenario

- Double Ended Guillotine Recirculation Suction Line Break (BWR 3/4)
- Battery Failure - HPCI, two LPCI, and one LPCS are disabled
  - One LPCI and LPCS available for makeup
  - Other LPCI injects into the broken loop
- Feedwater system and pump trip at time = 0
- Scram signal generated based on DW Pressure Signal
- Blockage incorporated via area reduction for the hot fuel bundles at discrete times after Low Pressure ECCS Injection

PCT & RPV Level Response - No Blockage

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PCT & RPV Level Response – 75% Blockage at LTP

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Hot Rod Clad Temperature Profile – No Blockage

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Hot Rod Clad Temperature Profile – 75% Blockage at LTP

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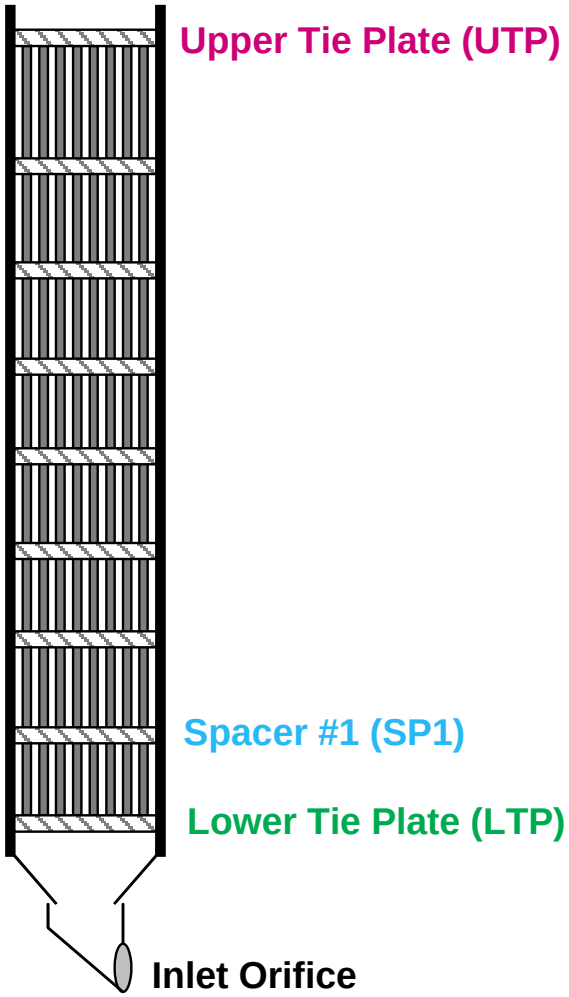
Case Matrix



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

PCT Sensitivity to Blockage at LTP

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PCT Sensitivity to Blockage at UTP

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Conclusions

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Overview of LOCA Scenario

TRACG LOCA Simulation Results

Basis for Application to all BWR/2-6 Plants

Method for Establishing Thermal Hydraulic Boundary Conditions for Fuel Testing

Method of Validation for Other Fuel Characteristics

LOCA Long Term Cooling Conditions Similar for BWR/2-6

- Low vessel pressure with ECCS injection from suppression pool
- Fuel submerged by a two-phase mixture and cooled by natural circulation
- Fuel uncovered and cooled by core spray

BLOCKAGE ANALYSIS RESULTS DIRECTLY APPLIED

Overview of LOCA Scenario

TRACG LOCA Simulation Results

Basis for Application to all BWR/2-6 Plants

Method for Establishing Thermal Hydraulic Boundary Conditions for Fuel Testing

Method of Validation for Other Fuel Characteristics

Thermal Hydraulic Boundary Conditions

- Heatup Phase
  - Initial Two Phase Level Recovery – Inlet Blockage
  - Lower Plenum Refill – Bypass Flow Holes Blockage
- Quench Phase
  - Natural Circulation Flow – Inlet Blockage
  - Core Spray Cooling – Spacer and Channel Top Blockage

BLOCKAGE ANALYSIS PROVIDES BOUNDARY AND CRITERIA FOR TEST

Overview of LOCA Scenario

TRACG LOCA Simulation Results

Basis for Application to all BWR/2-6 Plants

Method for Establishing Thermal Hydraulic Boundary Conditions for Fuel Testing

Method of Validation for Other Fuel Characteristics

Method of Validation for Other Fuel Characteristics

- Blockage Test Basis and Results
  - LOCA Analysis Parameters, Fuel Temperature and Inlet Flow History
  - Various Paths Minimum Area Clearing
  - Scale Test Results, Debris Type and Blockage History

OTHER FUEL DESIGNS VALIDATED BASED ON LOCA PERFORMANCE AND BLOCKAGE CHARACTERISTICS

THANK YOU !

PCT Sensitivity to Blockage at LTP

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PCT Sensitivity to Blockage at LTP

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PCT Sensitivity to Blockage at LTP

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