Karlsruhe Institute of Technology

Institute for Neutron Physics
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Peach Bottom Unit-2 ASTEC V2.2.0.1 Model and Stationary Plant Results

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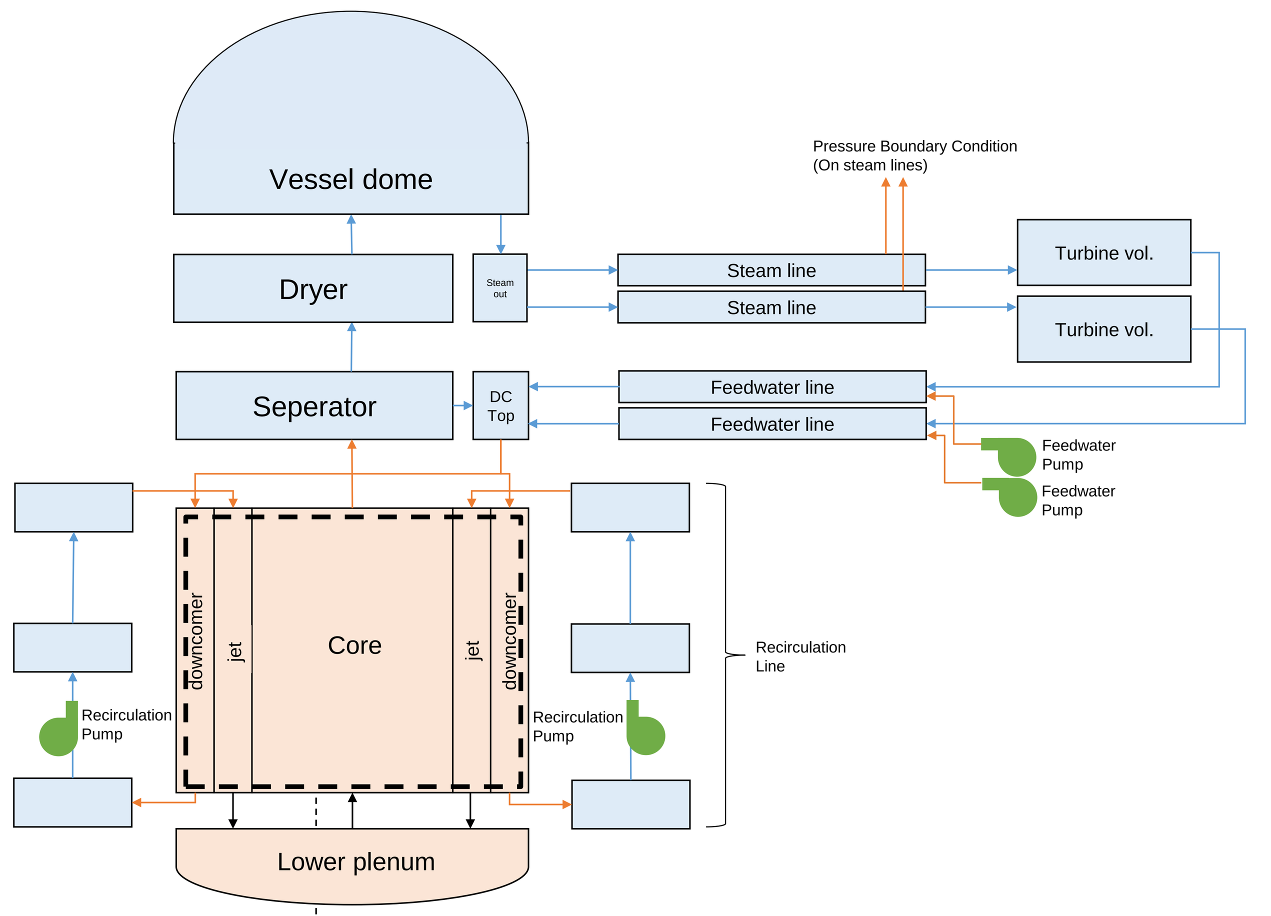
Motivation

- The severe accidents at Fukushima Daichii emphasized the importance of the SAMGs and preventive actions based on the severe accident tools prediction capabilities of the accident progression.
- In order to further extend the modeling capabilities of the European reference Accident Source Term Evaluation Code (ASTEC)[1] to simulate severe accident scenarios in BWR type reactors, a KIT/IRSN collaboration was established.

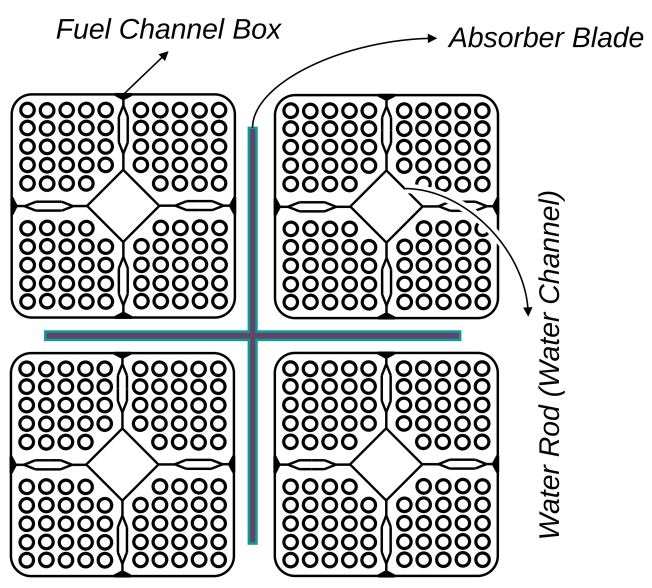
ASTEC Model of a generic Peach Bottom Unit-2 NPP

- The latest release of the ASTEC code (V2.2.0.1) employed.
- Peach Bottom Unit-2 type-1 initial fuels selected for core loading.
- Sub-channel structure BOX4SIDE (BWR-specific) placed to model the fuel channel boxes.

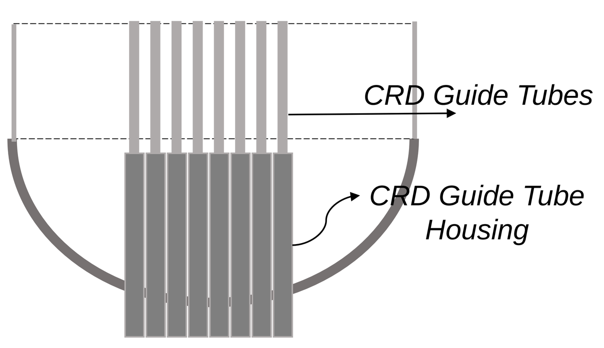


Peach Bottom Unit-2 ASTEC Model Water Cycle (ICARE+CESAR Domain)

Current Capabilities of ASTEC V2.2.0.1 related with BWR specific structures



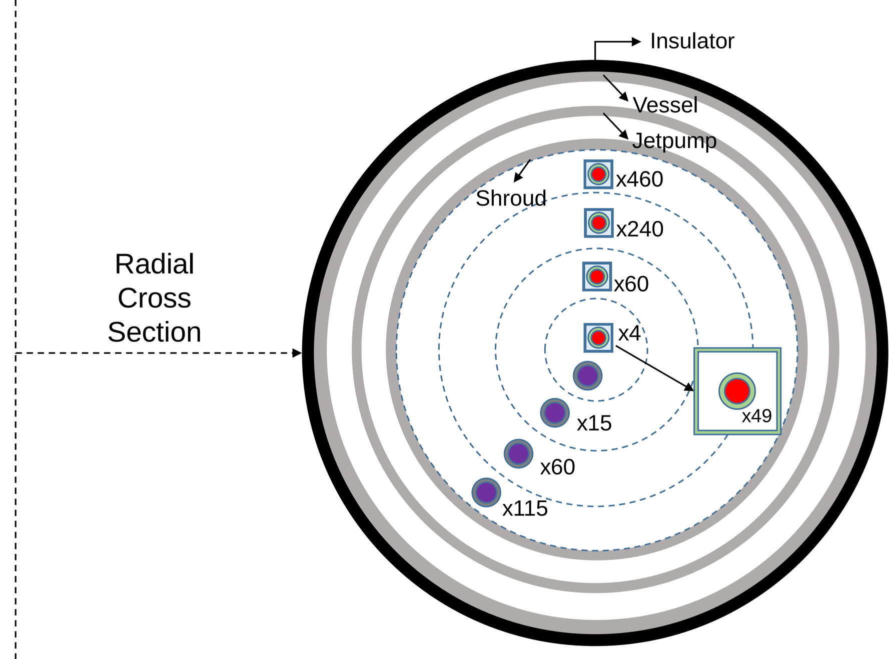
Example of BWR type fuel: SVEA-96 Optima-2



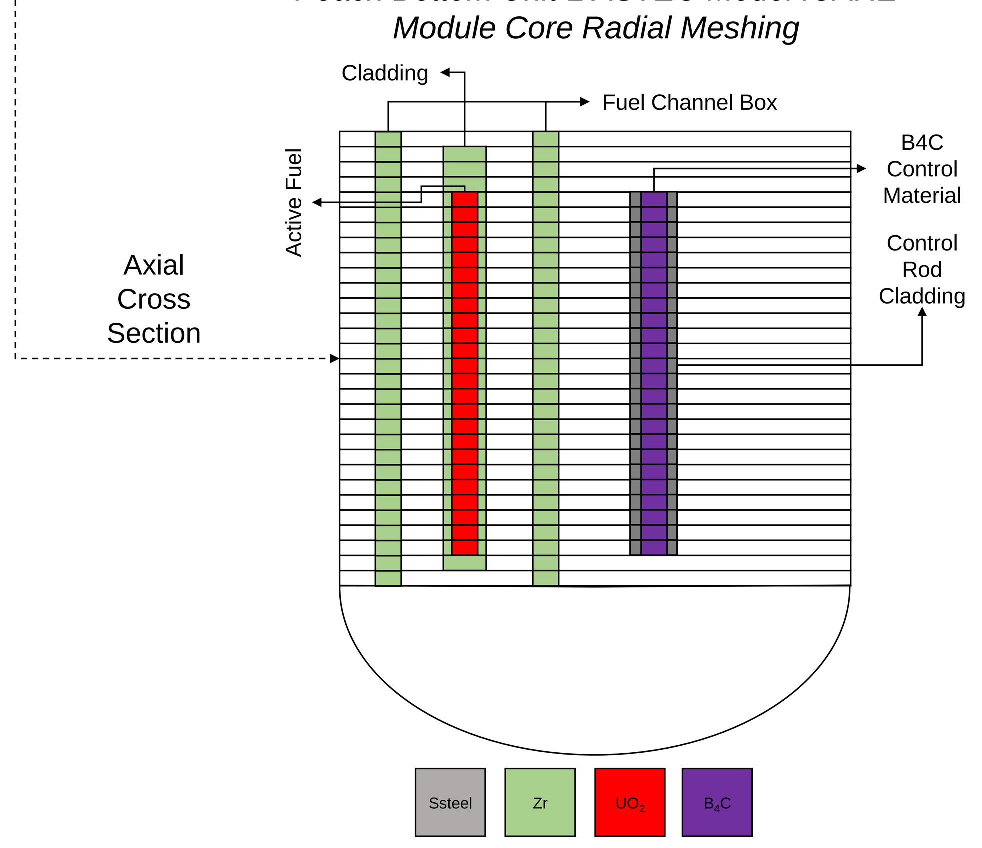
BWR Lower plenum with inner structures representation

	Geometry	Chemical Interaction	Mechanical Integrity	Molten Material Movement
Fuel Channel Box	BOX4SIDE rectangular structure is available	Oxidation, Eutectic Interactions	Loss of integrity available	Mass transfer to MAGMA and corium movement
Absorber Blade*	Only cylindrical definition is available	Oxidation, Eutectic Interactions	Loss of integrity available	Mass transfer to MAGMA and corium movement
Water Rods	Water rods can be defined inside BOX4SIDE (1 Structure allowed)	Oxidation, Eutectic Interactions	Loss of integrity available	Mass transfer to MAGMA and corium movement
Guide tubes (Lower plenum structures)	Cylindrical and Plate type structures	N/A	Only melting of the structure is available	N/A

**Absorber Blade chemical interactions, mechanical integrities and material movement definitions valid for cylindrical definition.*



Peach Bottom Unit-2 ASTEC Model ICARE Module Core Radial Meshing

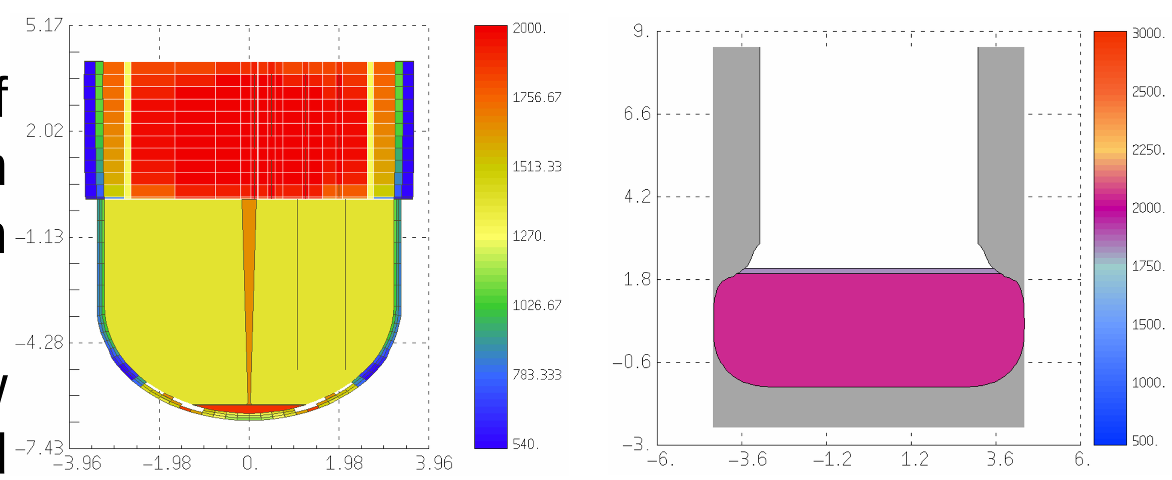


Peach Bottom Unit-2 ASTEC Model ICARE Module Core Axial Meshing

Reference Design Parameters[2]		ASTEC
Core Power (MW)	3293	**3293**
Feedwater mass flow rate (kg/s)	1679.68	**1691.03**
Total mass flow rate (kg/s)	12914.78	**12903.35**
Core mass flow rate (kg/s)	11336.75	**11285.27**
Bypass mass flow rate (kg/s)	1578.03	**1618.08**
Steam mass flow rate (kg/s)	1685.98	**1691.03**
Steam temperature at dome (K)	559.29	**559.28**
Core outlet temperature (K)	560.48	**559.48**
Core inlet temperature (K)	548.53	**547.96**
Feedwater temperature (K)	464.32	**464.32**
Dom pressure (MPa)	7.033	**7.033**
Pressure drop over sep. and dryer (MPa)	0.103	**0.0156**
Core outlet pressure (MPa)	7.1564	**7.051**
Bundle pressure drop (MPa)	0.081	**0.084**
Core inlet pressure (MPa)	7.3084	**7.135**
Core exit void fraction	0.65	**0.679**
Core avg. void fraction	0.304	**0.472**
RPV water level (m)	14.326	**14.9**

Outlook

- Simulation of a ST-SBO accident scenario including in-vessel and ex-vessel progression (Early figures presented on the right side).
- Source term evaluation and analysis of the fission product transport through vessel and containment domain including enviromental release.
- Analysis of the performance of the new BWR-specific ASTEC capabilities and related model implementation.



Peach Bottom Unit-2 ASTEC Model Core Degradation up to Vessel Failure and Cavity Ablation Figures resulted by SBO scenario

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[1] Chatelard, P., Belon, S., Bosland, L., Carenini, L., Coindreau, O., Cousin, F., Marchetto, C., Nowack, H., Piar, L., Chailan, L., 2016. Main modelling features of the ASTEC V2.1 major version. Ann. Nucl. Energy 93, 83-93. https://doi.org/10.1016/janucene.2015.12.026.
[2] Larsen, N., 1978. Core Design and Operating Data for Cycles 1 and 2 of Peach Bottom 2, NP-563, California: General Electric Company.