

Reactor Pressure Vessel Fluence Validation

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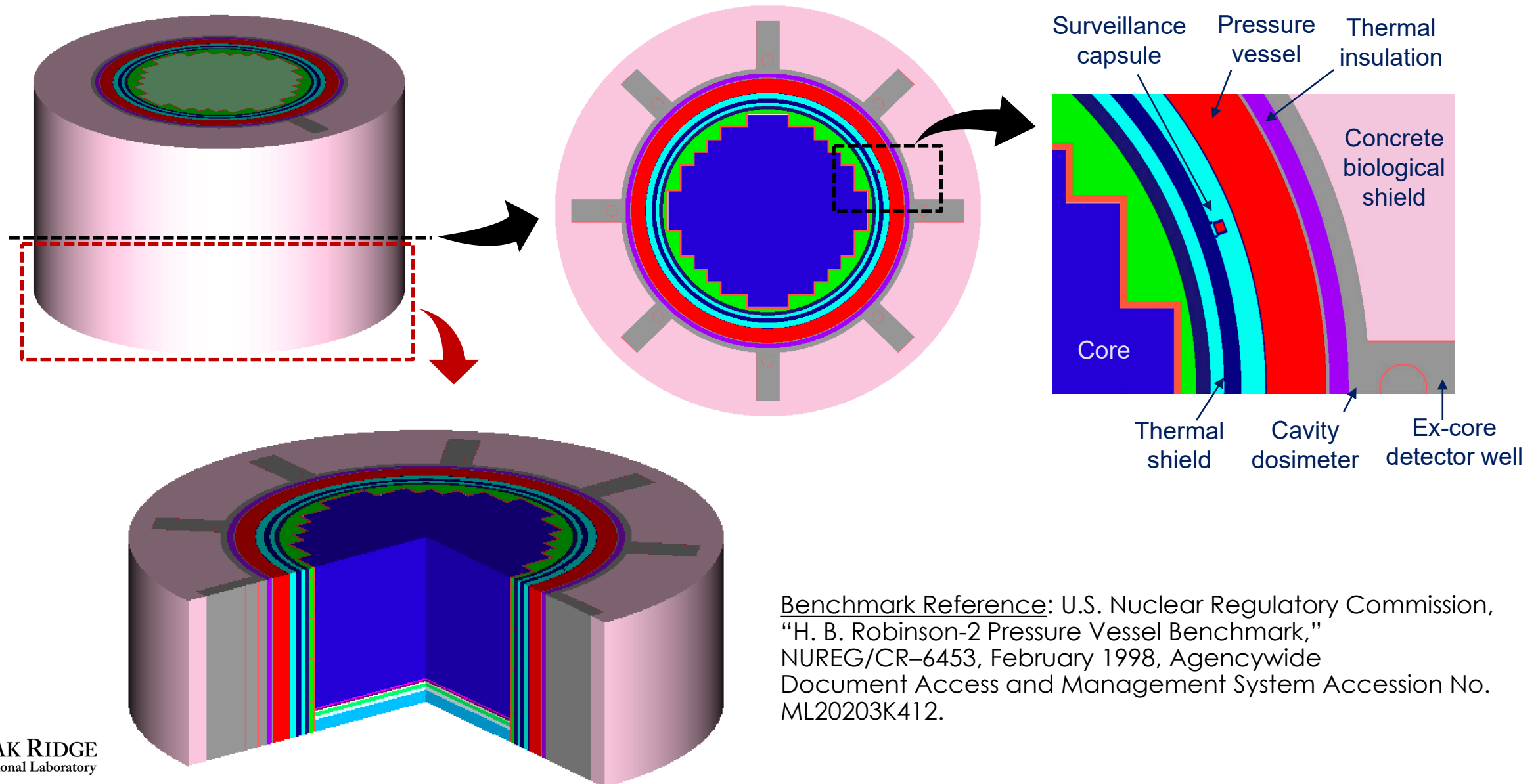
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Oak Ridge National Laboratory

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H. B. Robinson Unit 2 Cycle 9 Pressure Vessel Benchmark



Benchmark Reference: U.S. Nuclear Regulatory Commission, "H. B. Robinson-2 Pressure Vessel Benchmark," NUREG/CR-6453, February 1998, Agencywide Document Access and Management System Accession No. ML20203K412.

Benchmark Modeling Specifications

- Geometrical dimensions, number of fuel assemblies, fuel assembly type, number of fuel pins per assembly
- Region materials / material compositions /material volume fractions
- Core-average water and downcomer temperatures; water densities in different regions
- Boron concentration in coolant
- Reactor coolant system pressure
- Core thermal power
- Core power distributions: cycle-average assembly relative powers, cycle-average assembly-wise axial relative power distributions, cycle-average assembly relative pin powers

SCALE Radiation Transport / Shielding Calculation Sequences

- MAVRIC (Monaco with Automated Variance Reduction using Importance Calculations)
 - Performs serial computing (single processor)
- MAVRIC-Shift: Shift Monte Carlo transport solver with automated various reduction using importance calculations
 - Performs parallel computing, which means faster simulation times compared to MAVRIC
 - Available in SCALE 6.3.0 production release

MAVRIC-Shift Does Not Support All Input Cards Supported by MAVRIC

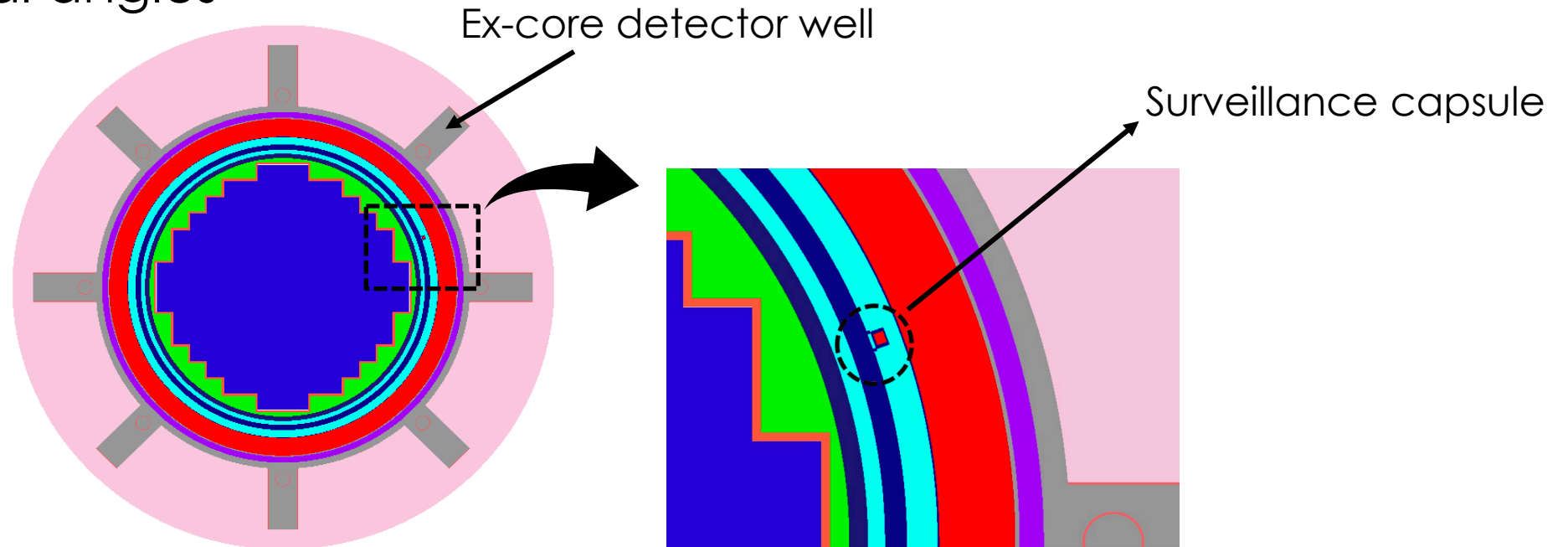
- Several input cards are not supported by MAVRIC-Shift, for example:
 - makeChart: produces a *.chart file for a response to be plotted
 - make3dmap: makes a *.3dmap file showing the grid geometry
 - allowShortImpMap: allows importance maps that do not cover the entire problem, giving particles outside the importance map zero importance
 - subCells: division of cells into subcells in converting user-entered source distribution to a mesh-based source
 - zDistributionID in sources block: points to a z/axial distribution in the definitions block

Tips in Modeling

- Material compositions: SCALE accepts only one temperature to be assigned to a mixture. If the mixture is a homogenized region of multiple materials, each of those materials must have the same temperature.
 - Recommendation: a sensitivity study assigning different temperatures to a region
 - Example: a homogenized core region consisting of fuel, clad, moderator, etc.

Tips in Modeling 2/5

- UNITs and HOLES: HOLE is used to position a UNIT within a surrounding UNIT relative to the origin of the surrounding UNIT
 - Recommendation: modeling components located in different azimuthal angles as a separate unit and inserting it into the global unit as hole(s) provides ease in modeling
 - Examples: surveillance capsule, ex-core detector wells at multiple azimuthal angles

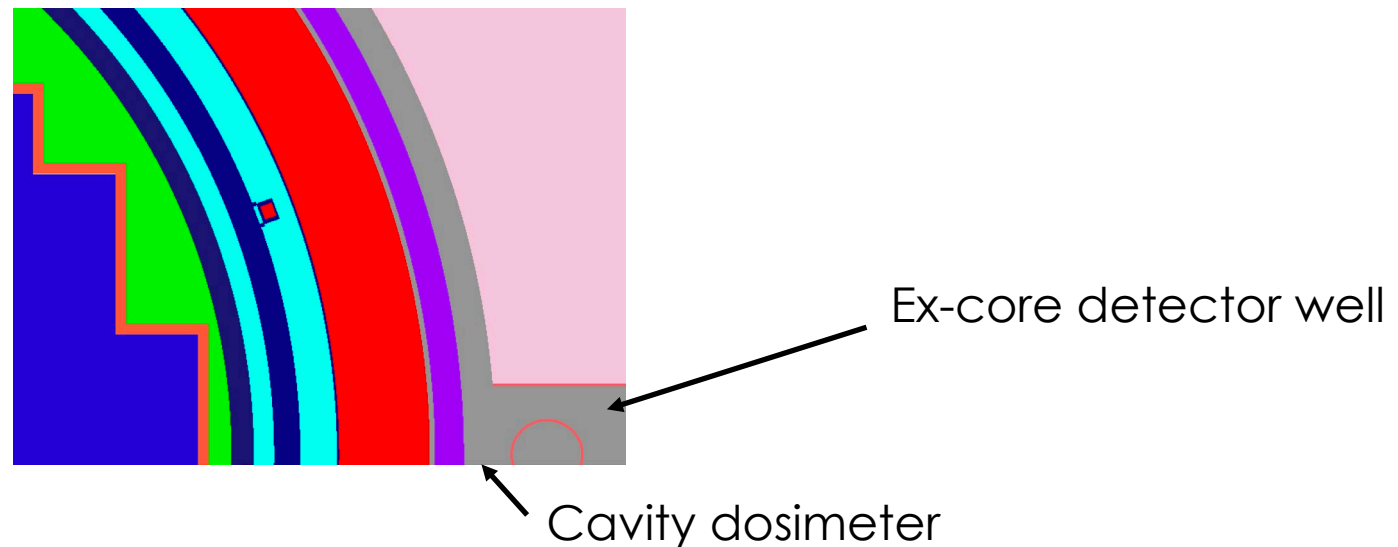


Tips in Modeling 3/5

- Response functions for detectors: Cross sections from the transport cross-section library can be used to define response functions but using data from a reactor dosimetry file would be desirable
 - Recommendation: response functions can be entered by a binned histogram function or value/function pairs
 - Example: data from International Reactor Dosimetry and Fusion File, IRDFF-II can be entered in the input

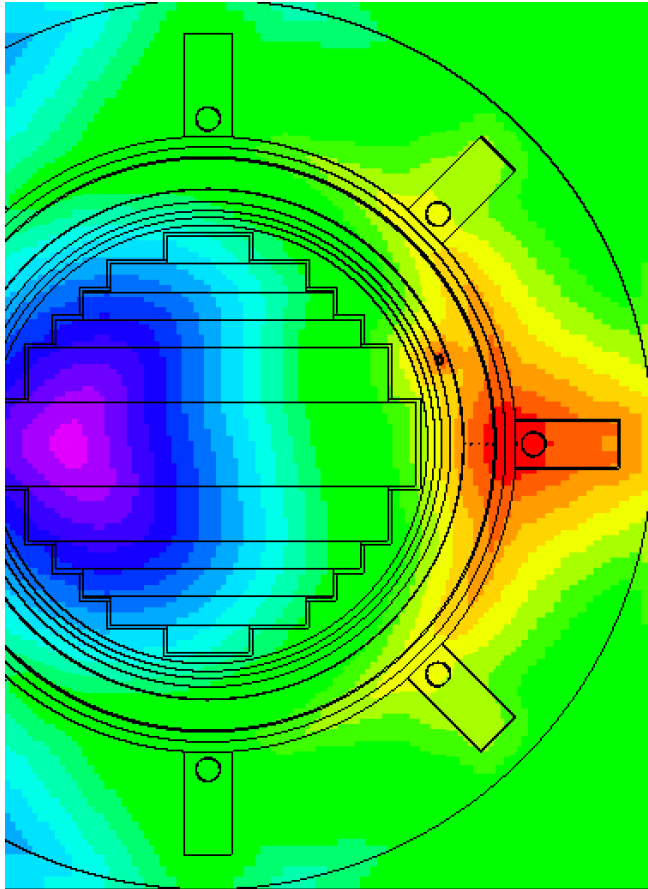
Tips in Modeling 4/5

- Caution in defining tally regions near HOLES: Tallies might be located very close to HOLE boundaries
 - Recommendation: Make sure that tally volumes are not defined to be in multiple units
 - Example: Tally volume representing a cavity dosimeter in front of an ex-core detector well that is inserted as a HOLE

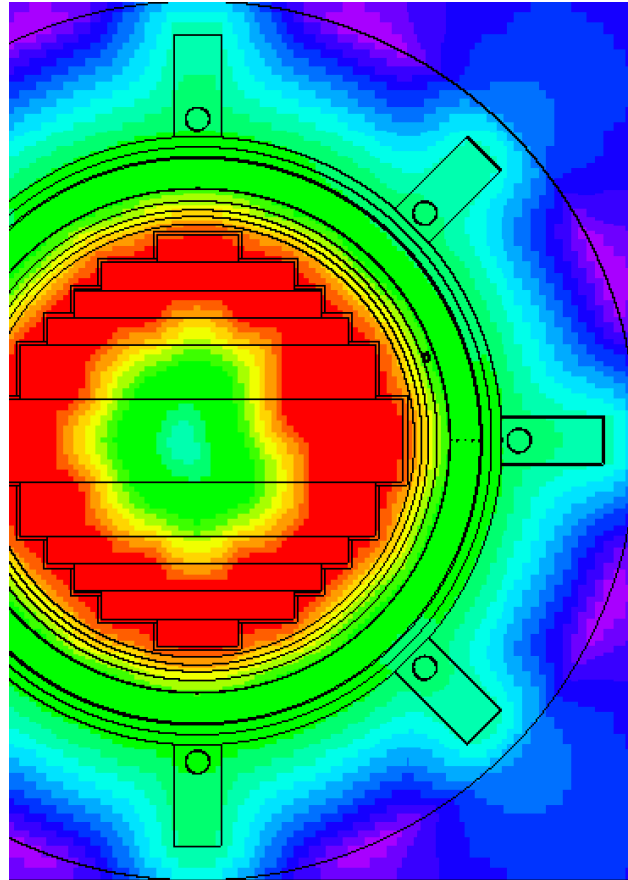


Tips in Modeling 5/5

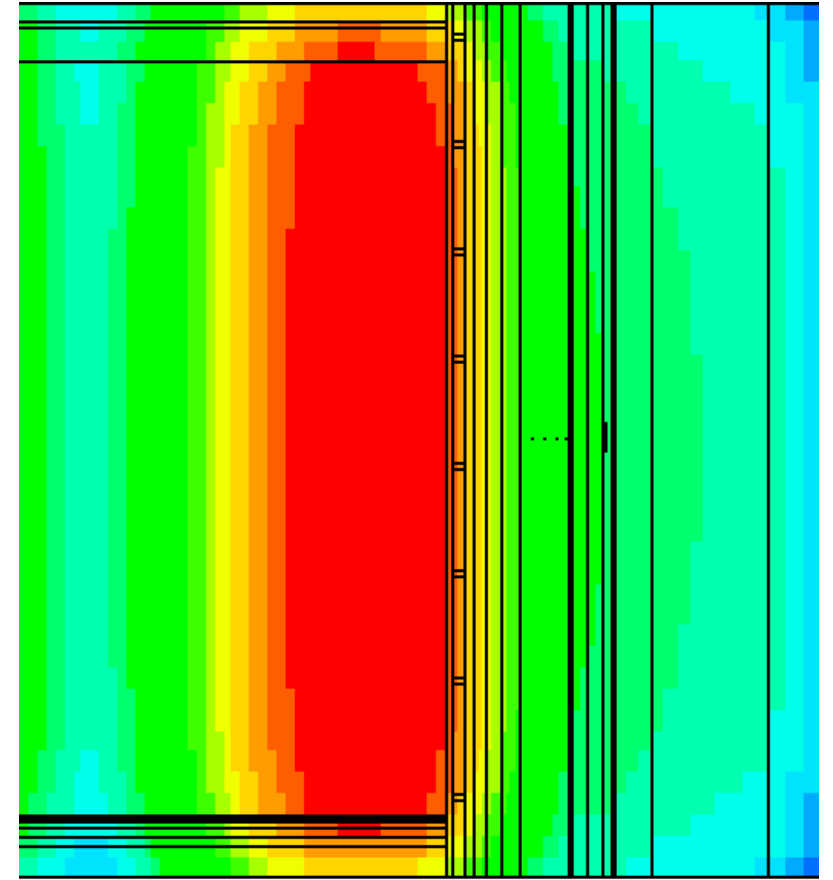
- Fulcrum is a very useful Graphical User Interface to check the accuracy of your model



Neutron adjoint function -
core midplane, plan view



Neutron flux -
core midplane, plan view



Neutron flux -
section view

Acknowledgement

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