NE 620/860 - Applied Reactor Physics - Lab 3

References

- Lectures 7, 8, 9
- CASMO-4 Manual
- EPRI document

Software/Hardware

- Access to *eigendoit.ksu.mne.edu* via an MNE or your machine for using NJOY using SSH **or** an installation of NJOY on your machine (Linux or maybe OS X)

Tasks

Understanding PWR Lattice Design Features

Westinghouse has two basic designs for fuel, STD and OFA, and we want to compare the performance of each design for a 4.25% enriched assembly:

- STD is CASE 3 described in EPRI Appendix B
- OFA is CASE 4 described in EPRI Appendix B

At hot conditions, and as functions of burnup (up to 80 MWd/kg), produce plots of - k-infinity - moderator temperature coefficient in pcm/K - fuel temperature coefficient in pcm/K - boron coefficient in pcm/ppm vs. burnup - Hot zero power (HZP, at T = 560 K) to hot full power (HFP at 900 K) reactivity defect - Xe-135 worth in pcm vs. burnup (read the manual on CNU card) - Sm-149 worth in pcm vs. burnup (read the manual on CNU card) - Plot the moderator temperature history in pcm/K vs. burnup - Plot the fuel temperature history in pcm/K vs. burnup - Plot the boron history in pcm/ppm vs. burnup - If core inlet coolant is at 560 K and core exit is 600K, plot the difference in Pu-239 concentration for fuel depleted at inlet and exit coolant conditions vs. burnup

BWR Lattice Design Optimization

For this task, we want to optimize a typical BWR bundle for a 24-month cycle (typical for BWRs). Specifically, the task is to seek an optimal enrichment/Gd design to maximize fuel burnup (EOL defined as the burnup at which where $k_{\infty} < 0.95$ with a minimum reactivity swing and a minimum linear heat generation rate (LHGR).

Designs are subject to the following, absolute **constraints**: - $k_{\inf} > 1.00$ at zero burnup (for equilibrium Xe) - $k_{\inf} < 1.13$ at all burnups (for equilibrium Xe) - $\text{max pppf} < 1.35$ at all burnups (for equilibrium Xe) - ${}^{235}U enrichment intervals of 0.1% from 2.0 to 4.90% - Gd enrichment intervals of 1.0% from 2.0 to 10.0%

Simplifications: - Bundle geometry is fixed as given in bwr_bundle.inp - Density of non-gad fuels are

10.5 g/cc - Density of all Gd fuels are 10.2 g/cc - Void=40%, TFU=900K, TMO=560K, 54 kW/L

Designs will be assessed by using the following objective function:

$$ f(\text{EOL Burnup}) = 8(\text{EOL burnup} - 46.5) + 4(1.30 - \text{max pppf) + 2 (1.11 - \text{max } k_{\infty}) \, . $$