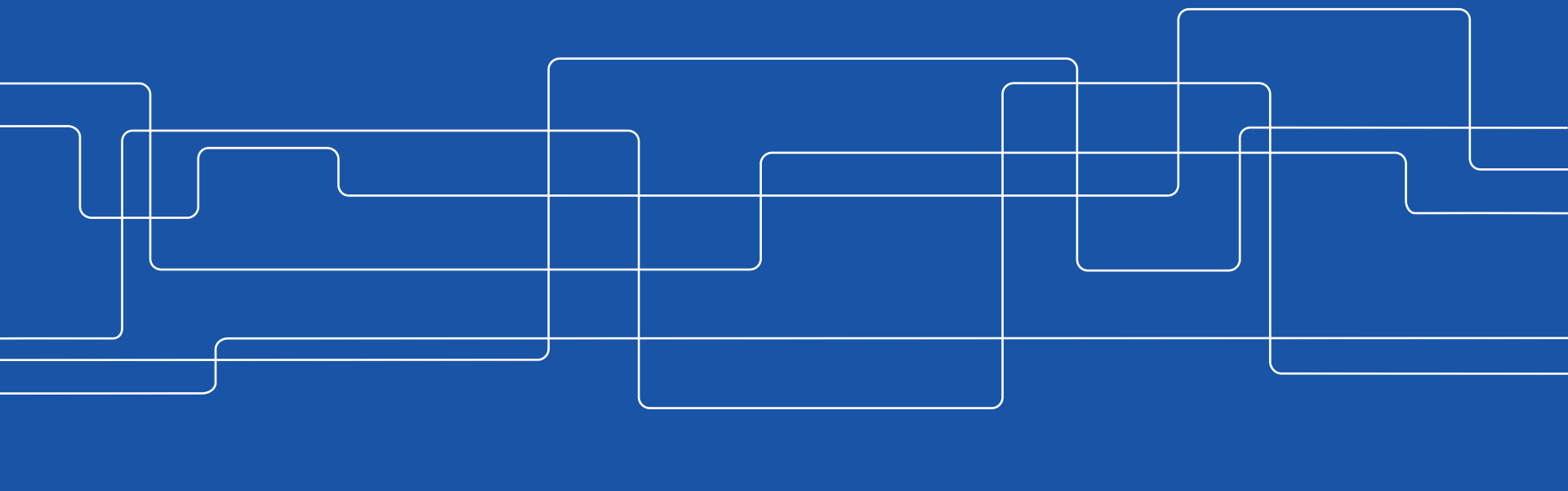
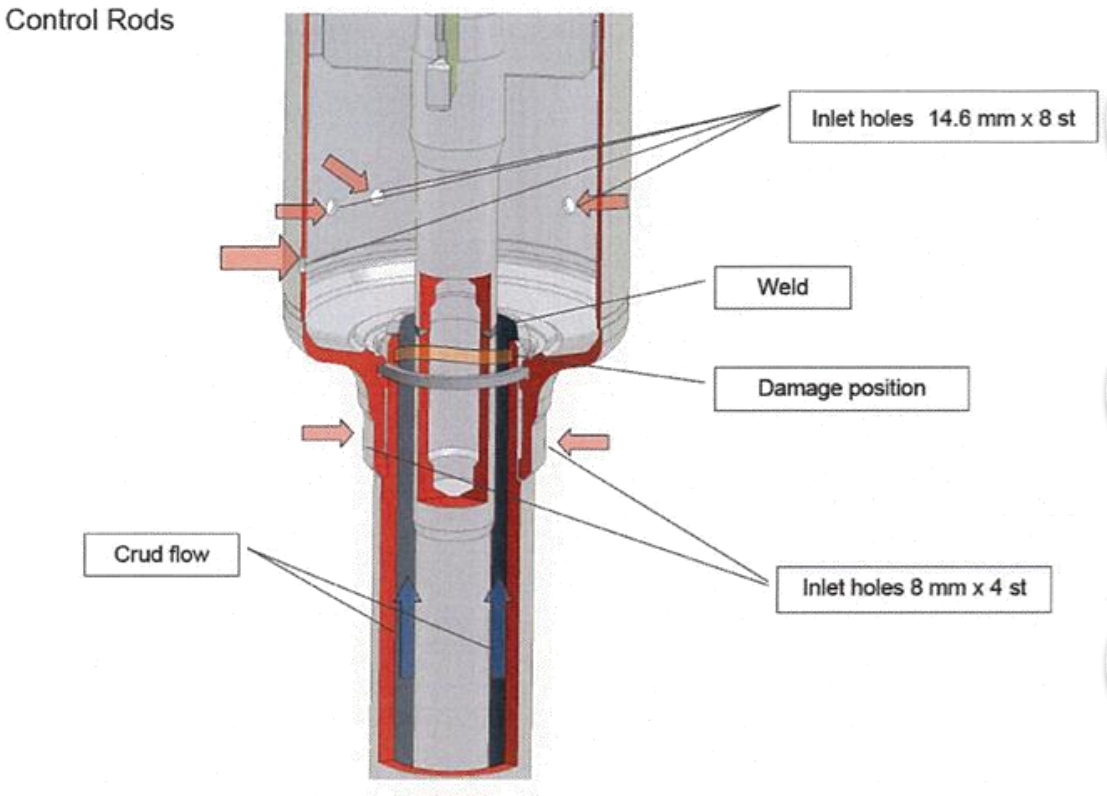
# Oskarshamn-3 & Forsmark-3 CR-Issue

Sean Roshan



# BACKGROUND

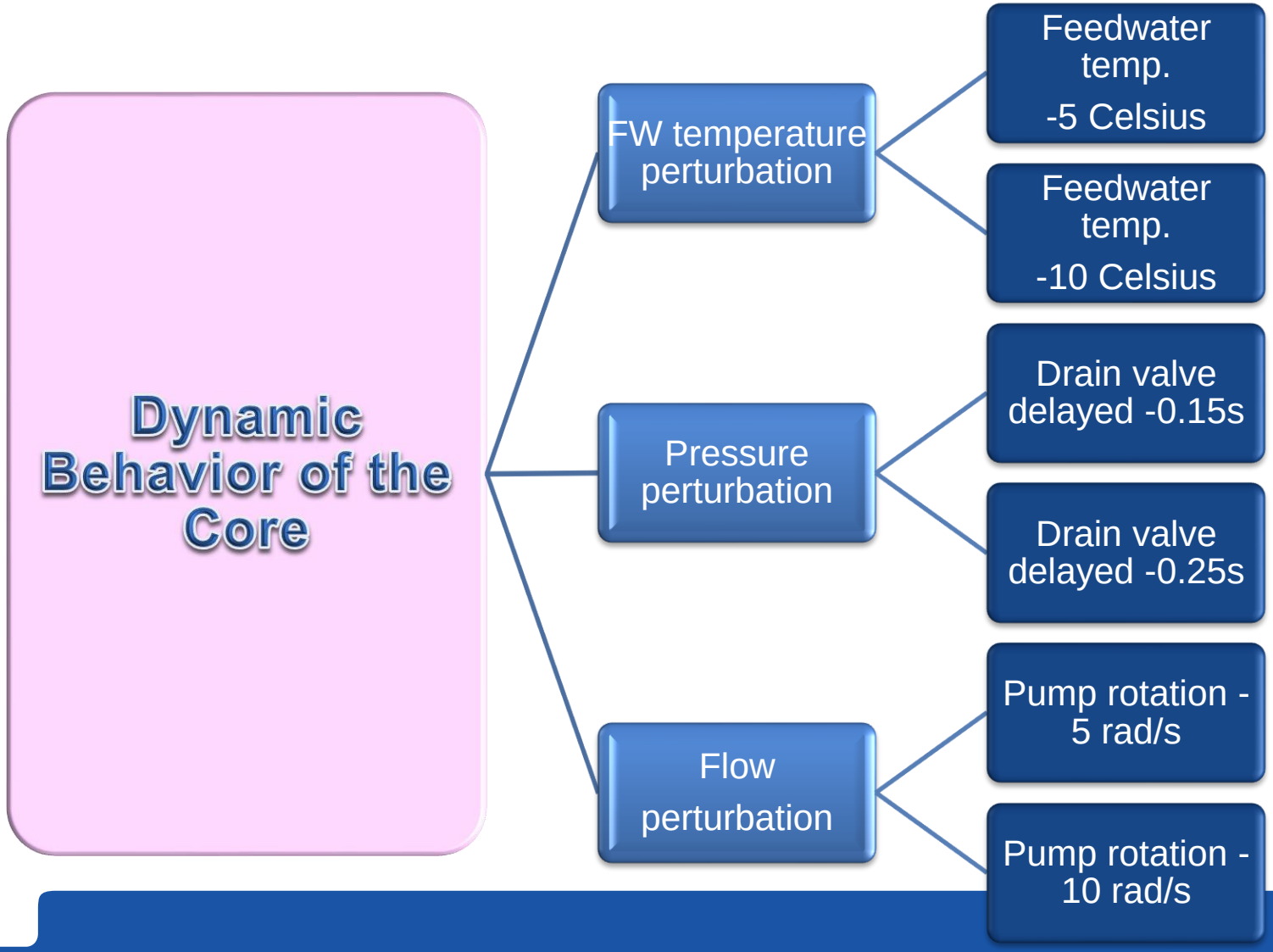



1. Operate the reactor at 129% power with CR 86%
2. Adopt the core-loading to the new Power & CR pattern
3. License the reactor for new conditions

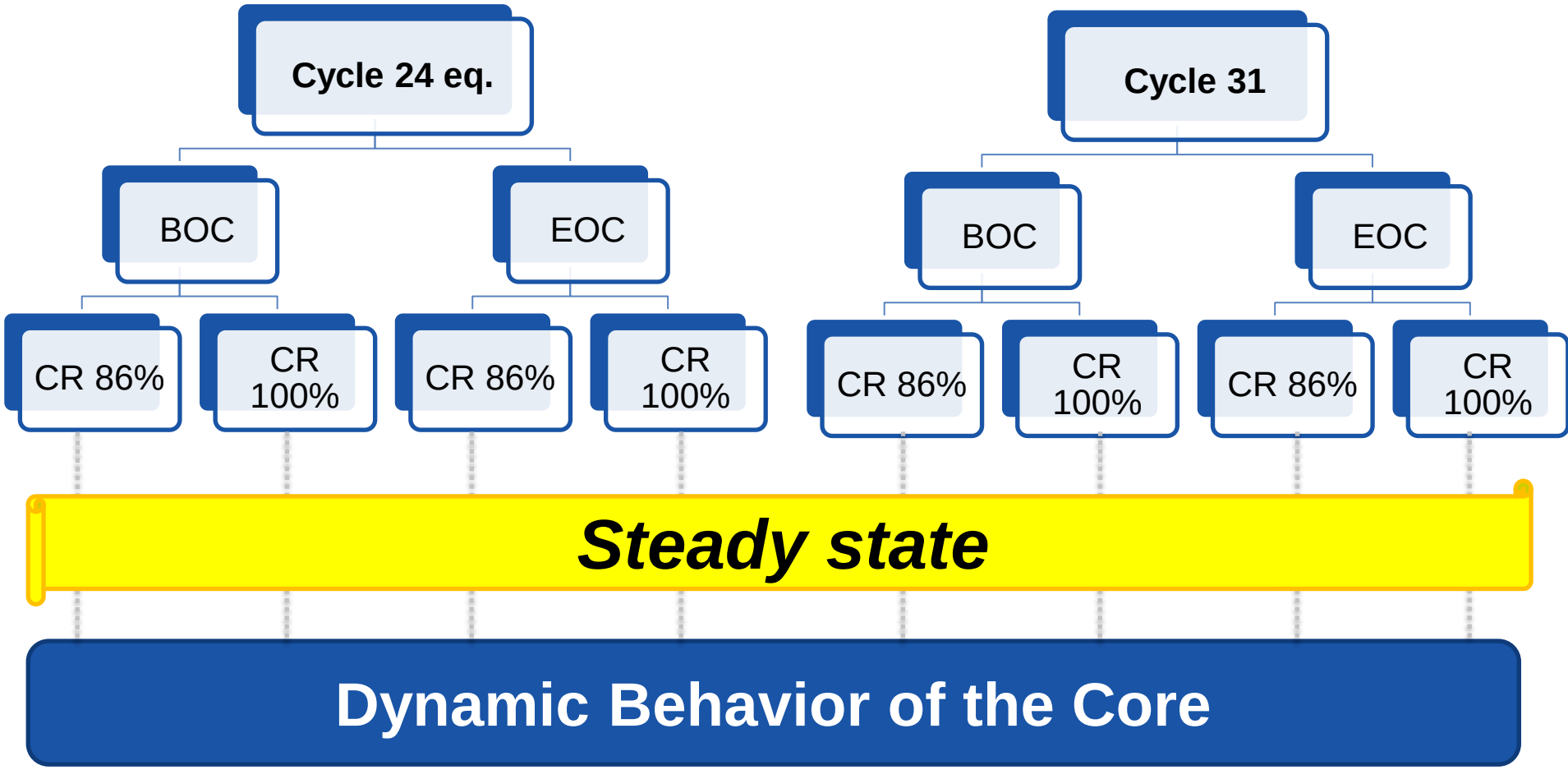
# Compare effect of 14% CR insertion on following parameters

- Power level — NOT DONE
- Void coefficient — DONE
- Peaking factors
- (~1.6 radial/2.5 volume) — DONE
- Axial power shape — DONE
- Core pressure drop — DONE
- Dynamics of the core
  - Temperature perturbation — DONE
  - Pressure perturbation — DONE
  - Flow perturbation — DONE
- Partial scram effect — NOT DONE

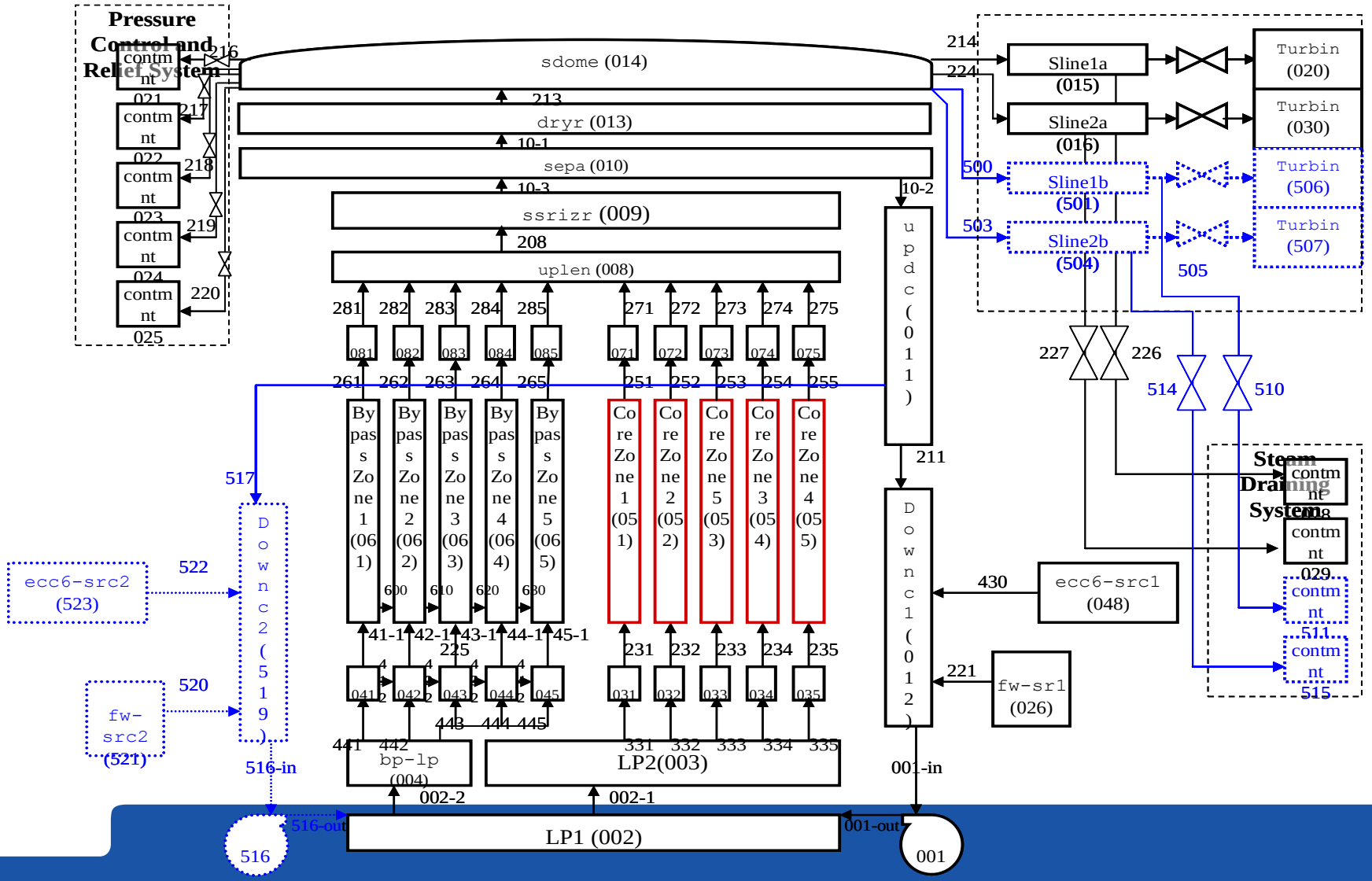
# Test Matrix


Dynamic Behavior of the Core
FW temperature perturbation
Feedwater temp. -5 Celsius
Feedwater temp. -10 Celsius
Pressure perturbation
Drain valve delayed -0.15s
Drain valve delayed -0.25s
Flow perturbation
Pump rotation -5 rad/s
Pump rotation -10 rad/s

# Test Matrix


Cycle 24 eq.
BOC
EOC
CR 86%
CR 100%
CR 86%
CR 100%
Cycle 31
BOC
EOC
CR 86%
CR 100%
CR 86%
CR 100%
Steady state
Dynamic Behavior of the Core

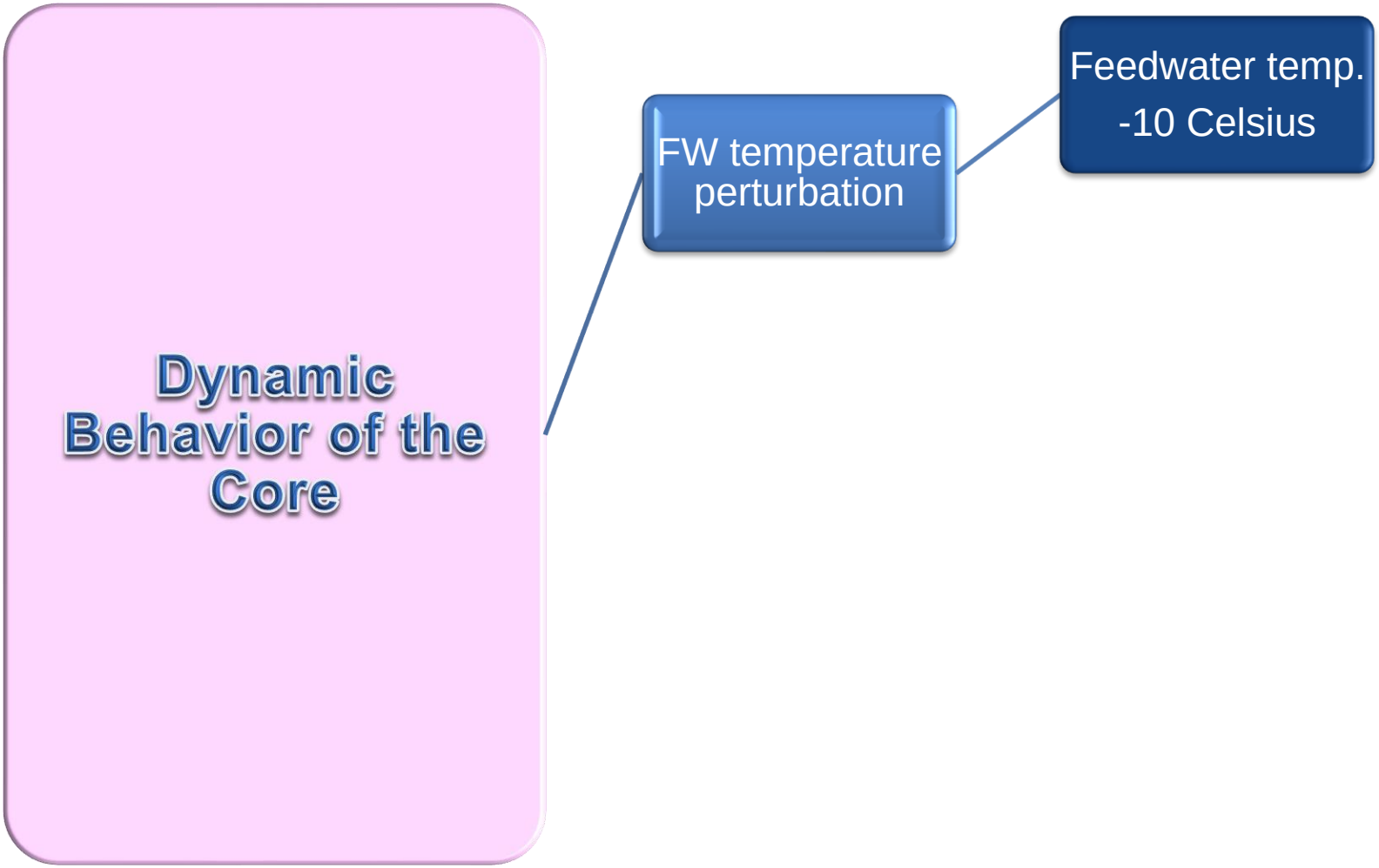
# RELAP5 Nodalization



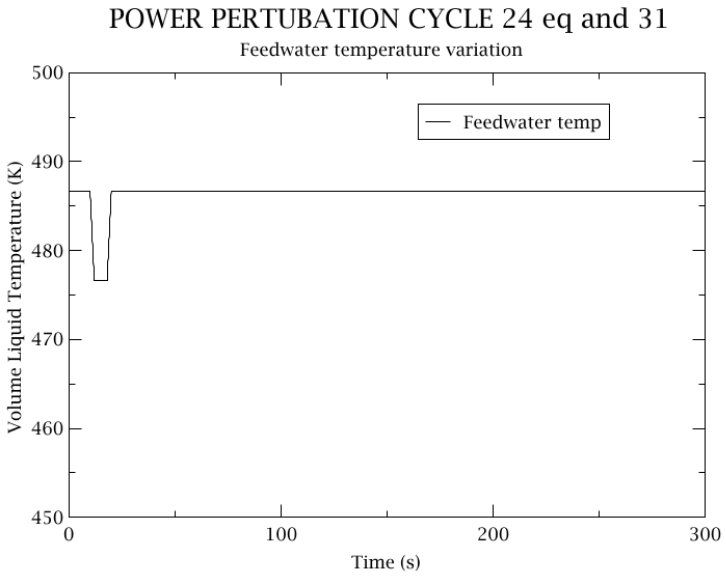
# Steady state results

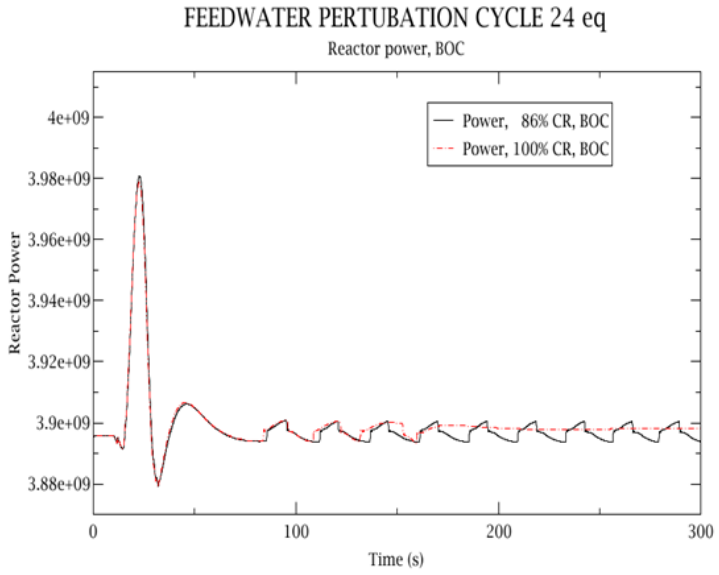
| Value | O-3 fuel cycle **24** | | | | O-3 fuel cycle **31** | | | |
|---|---|---|---|---|---|---|---|---|
| | BOC | | EOC | | BOC | | EOC | |
| | CR withdrawal **100 %** | CR withdrawal **86 %** | CR withdrawal **100 %** | CR withdrawal **86 %** | CR withdrawal **100 %** | CR withdrawal **86 %** | CR withdrawal **100 %** | CR withdrawal **86 %** |
| TPC (1/MWt) | -9.9 | -9.53 | -9.3 | -9.03 | -9.93 | -10.2 | -9.53 | -13.5 |
| Core void (%) | 0.454 | 0.418 | 0.409 | 0.377 | 0.488 | 0.435 | 0.567 | 0.500 |
| Total flow (kg/s) | 12186. | 12250. | 14468. | 14524. | 12130. | 12246. | 14067. | 14268. |
| Volumetric Peak. Fact. | 2.73 | 2.98 | 2.58 | 2.78 | 3.71 | 3.40 | 5.57 | 4.41 |
| Pressure (MPa) | 7.019 | 7.024 | 7.019 | 7.019 | 7.024 | 7.024 | 7.019 | 7.018 |
| Vessel $\Delta P$ (MPa) | 0.231 | 0.229 | 0.275 | 0.272 | 0.233 | 0.229 | 0.292 | 0.283 |

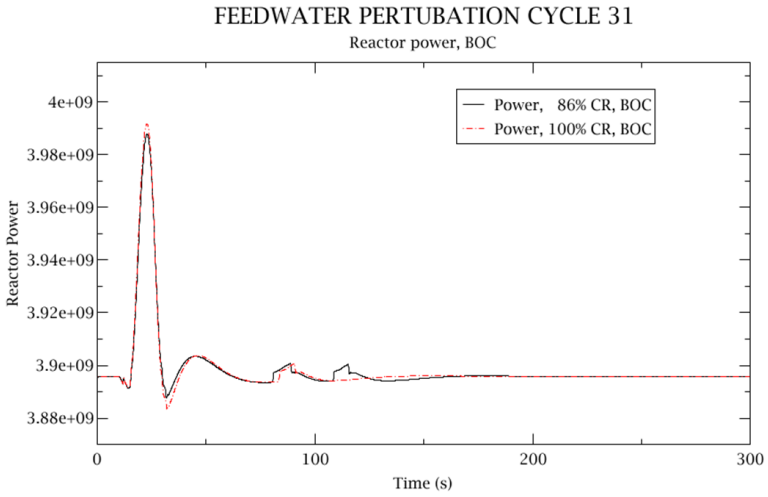
# Case 1: FW Temperature Pertubation

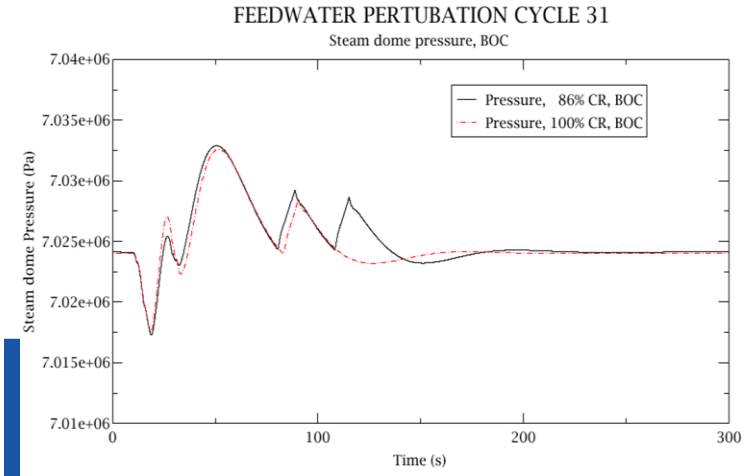


# FW TEMP. PERTUBATION
# Feedwater temp. reduction with 10°C



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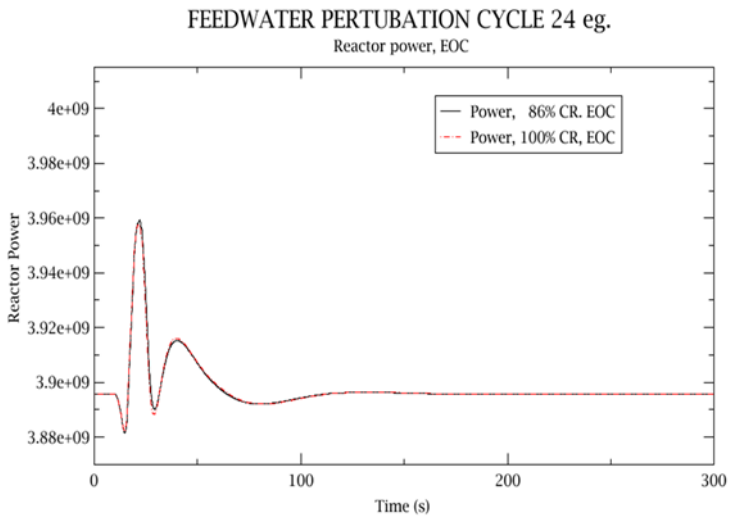


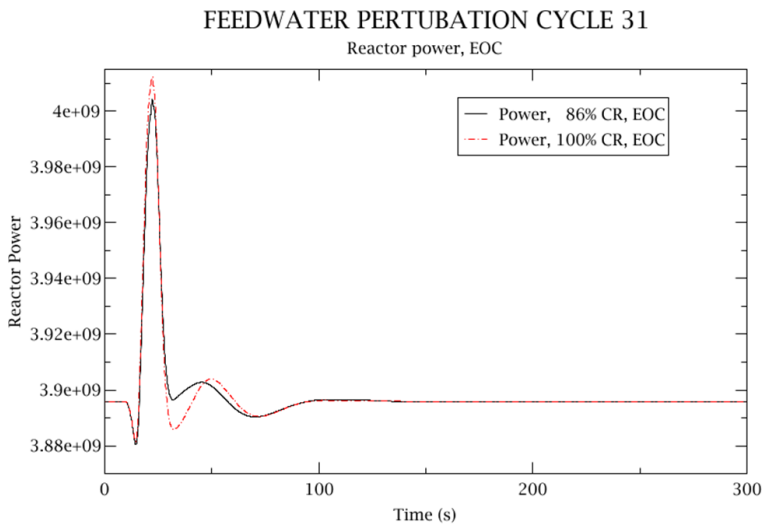


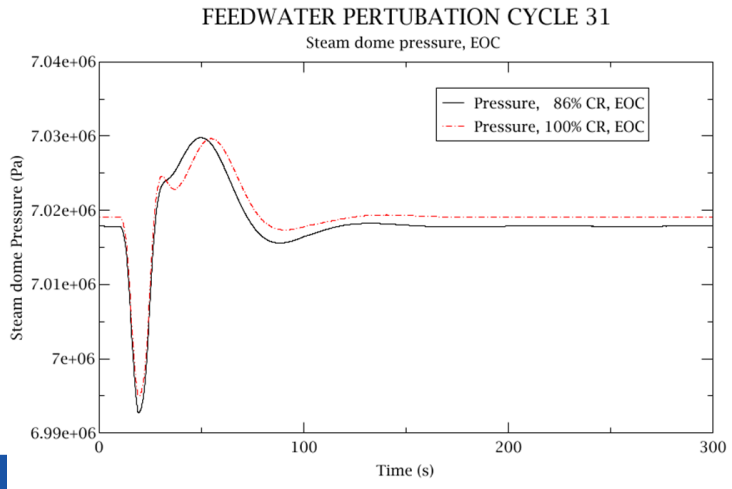


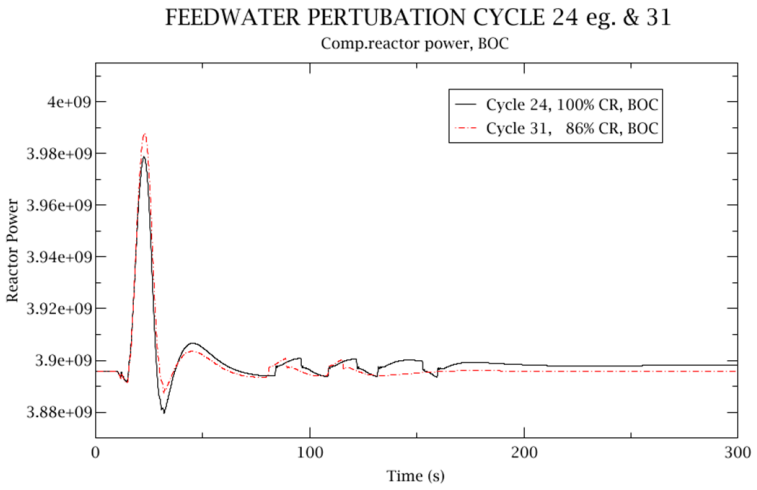

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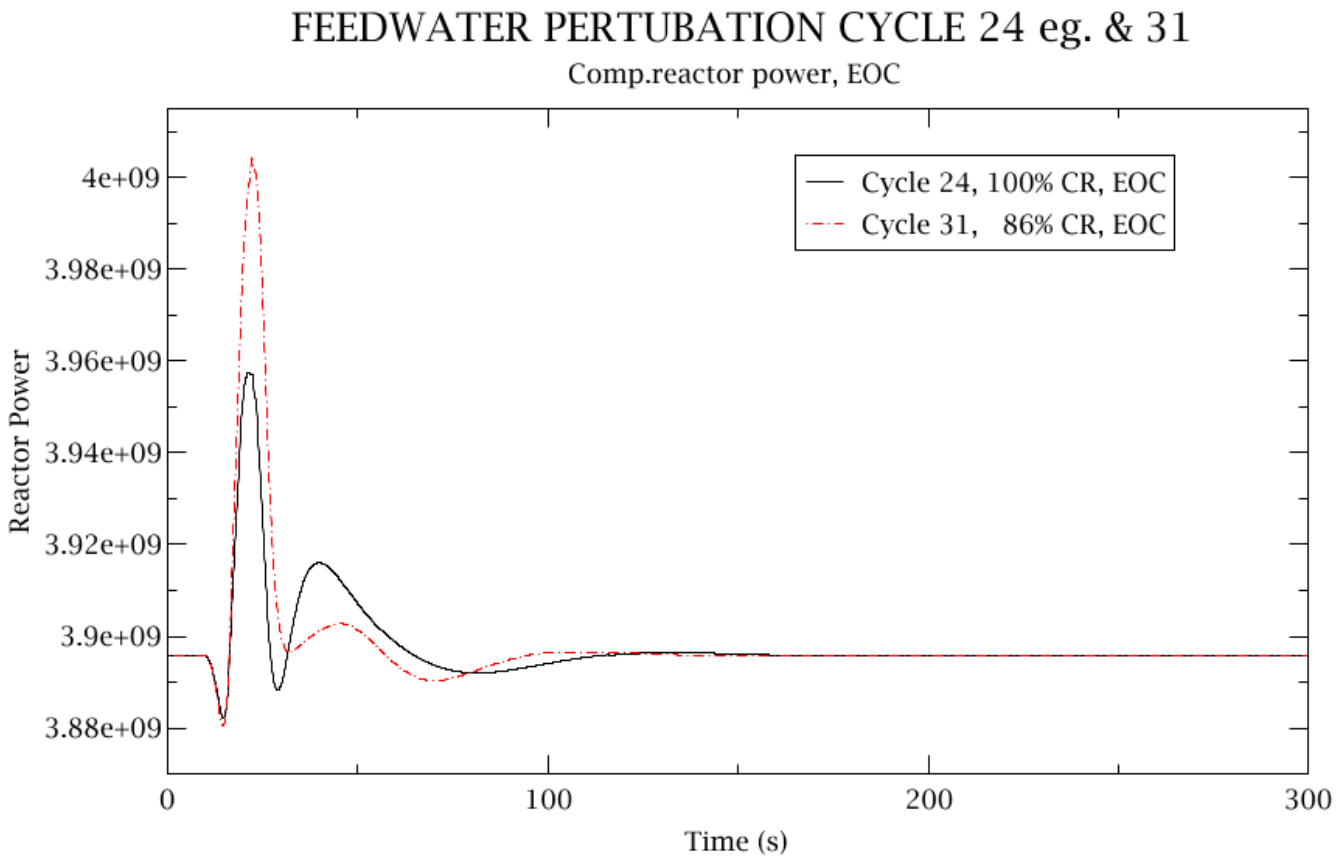
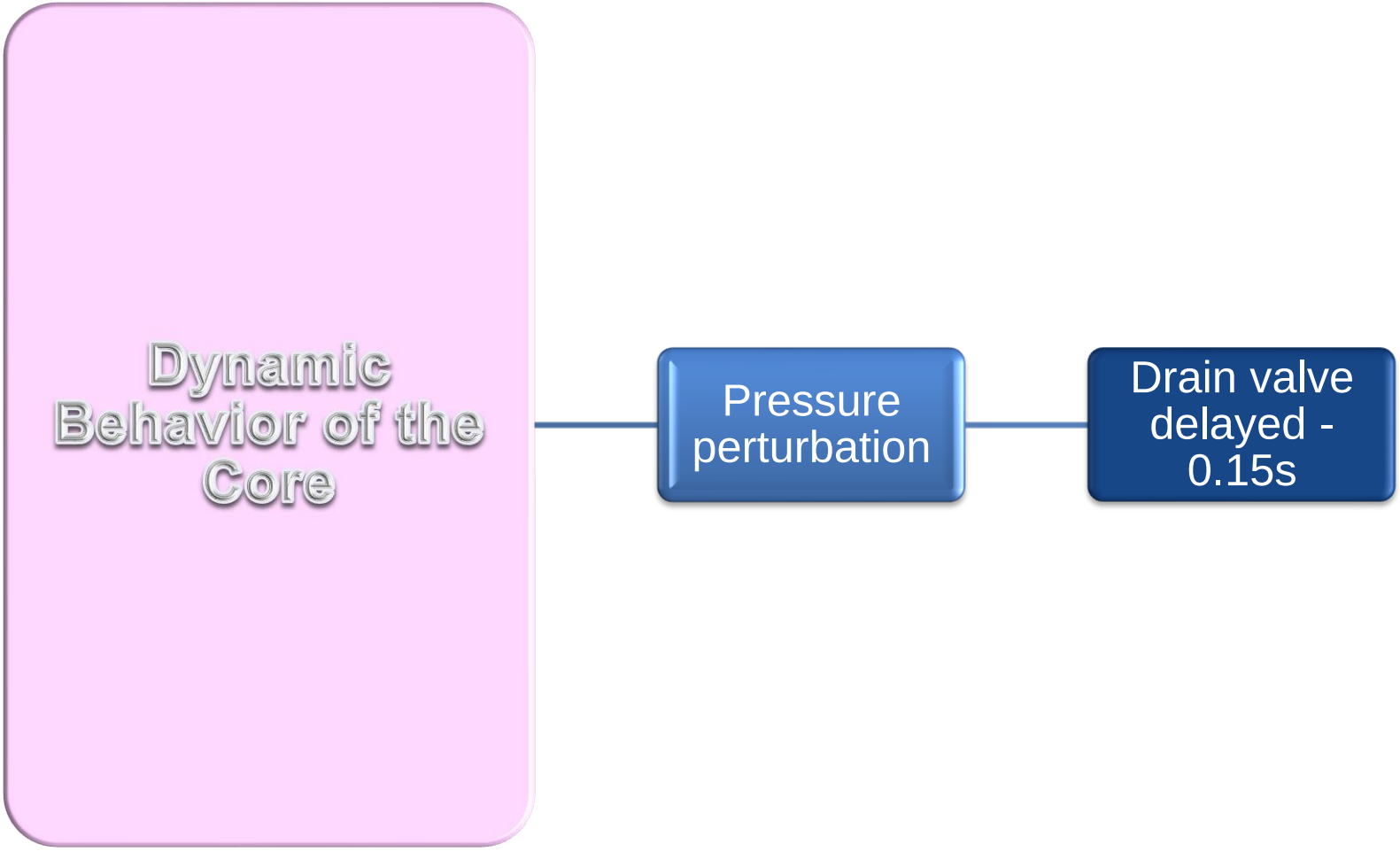
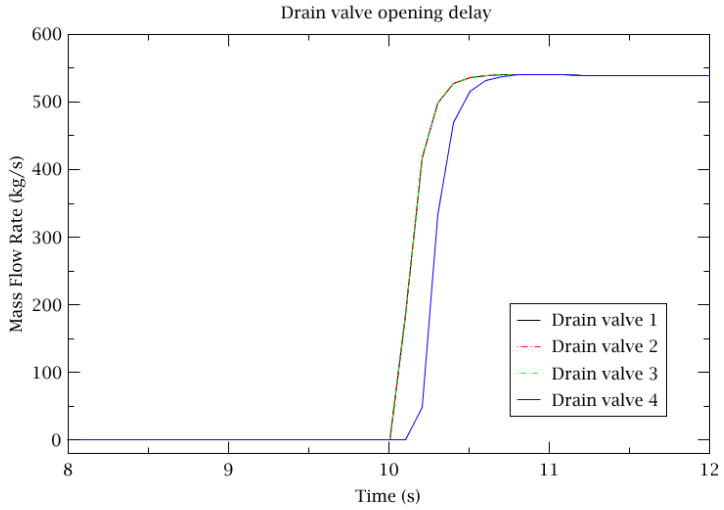


# Case 2: Pressure Perturbation

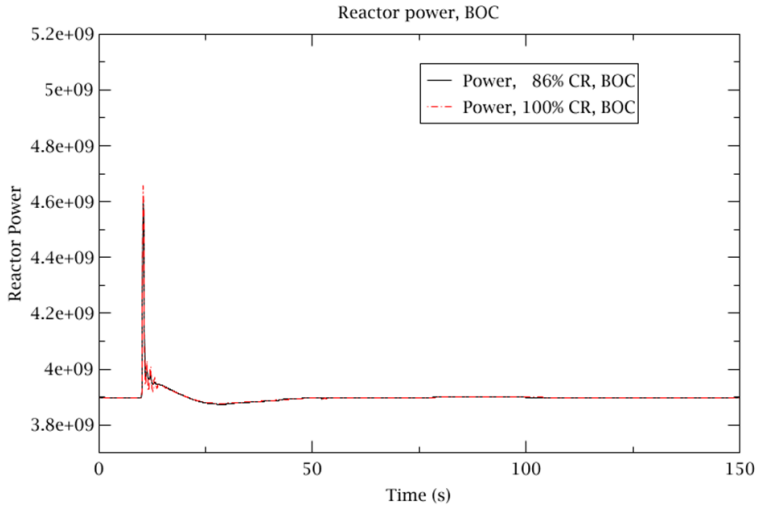


# PRESSURE PERTUBATION
## Drain valve opening delay at TT with 0.15s

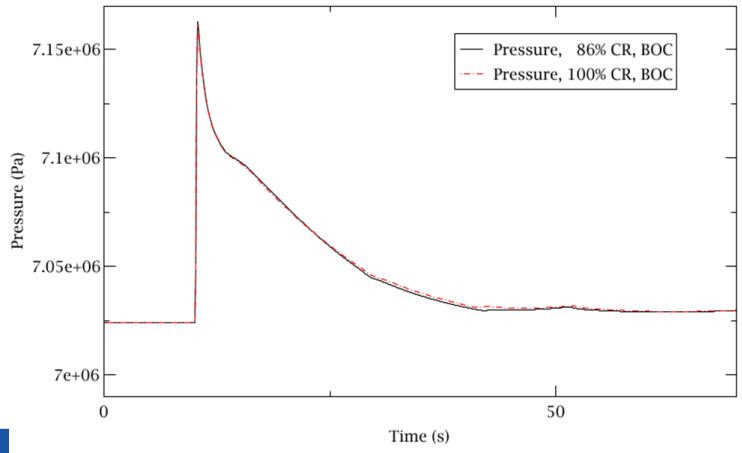
DRAIN VALVE DELAY PERTUBATION CYCLE 24 eq. & 31



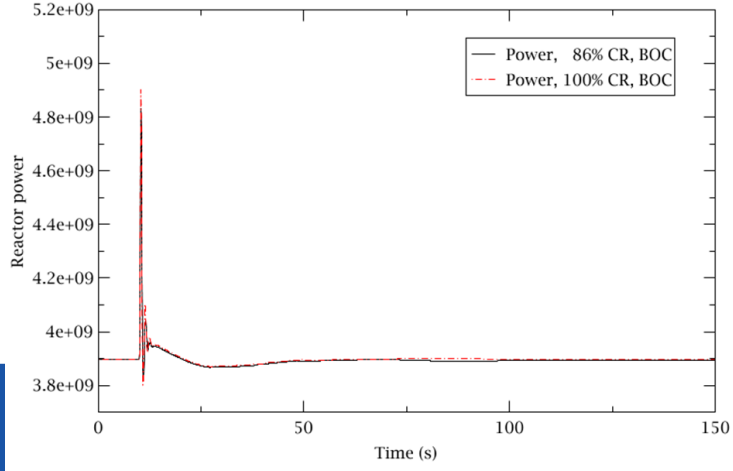

DRAIN VALVE DELAY PERTUBATION CYCLE 24 eq.




DRAIN VALVE DELAY PERTUBATION CYCLE 24 eq.




DRAIN VALVE DELAY PERTUBATION CYCLE 31



# PRESSURE PERTUBATION
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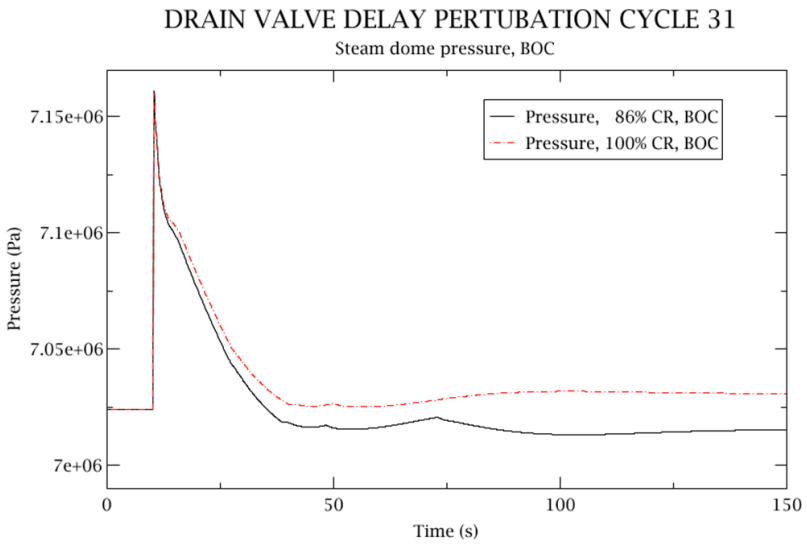


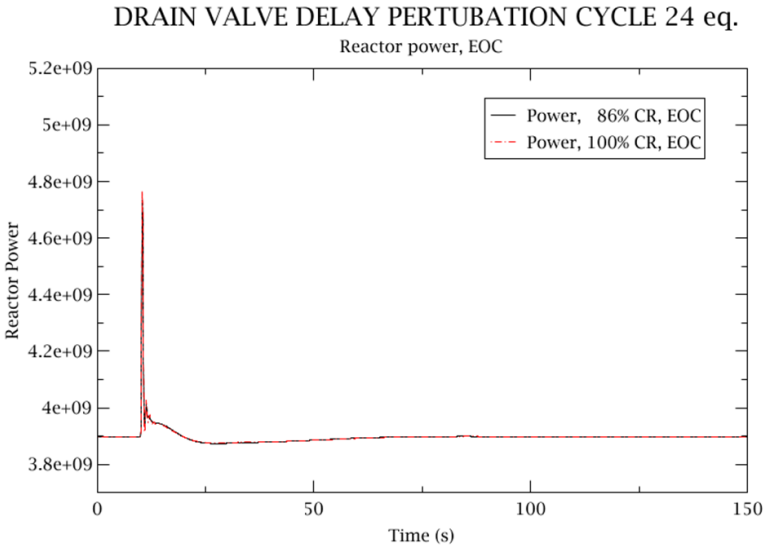


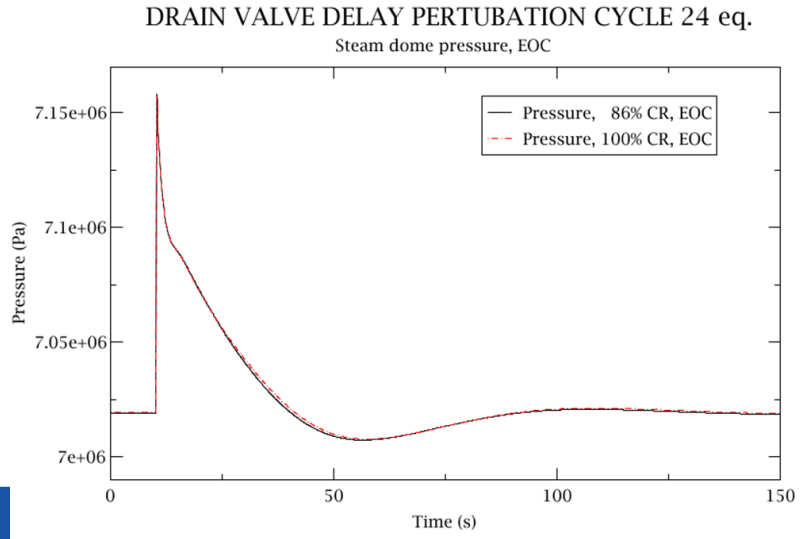


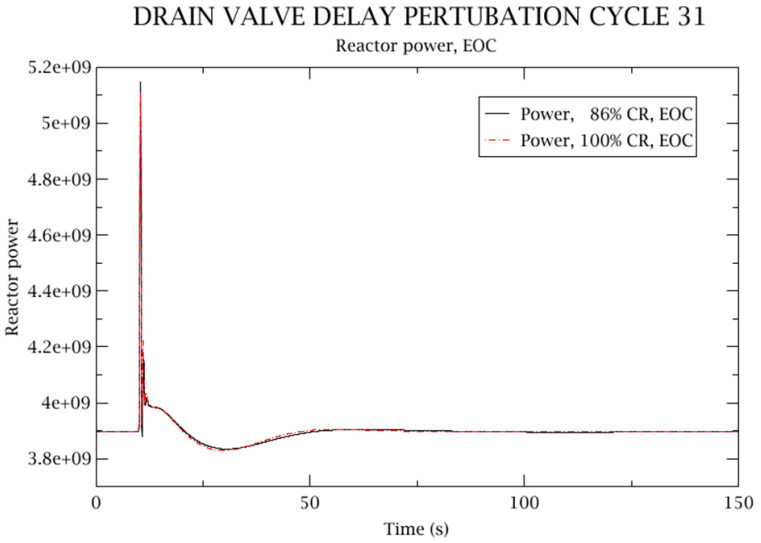

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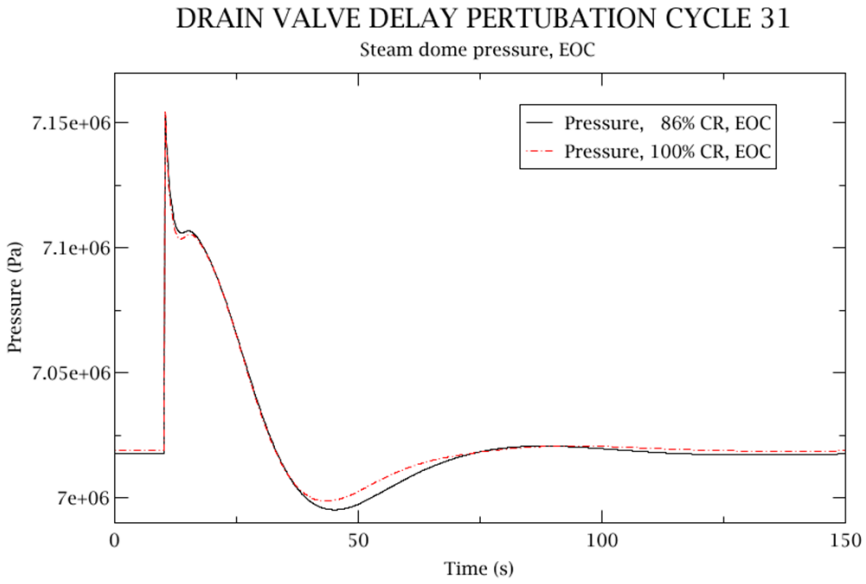
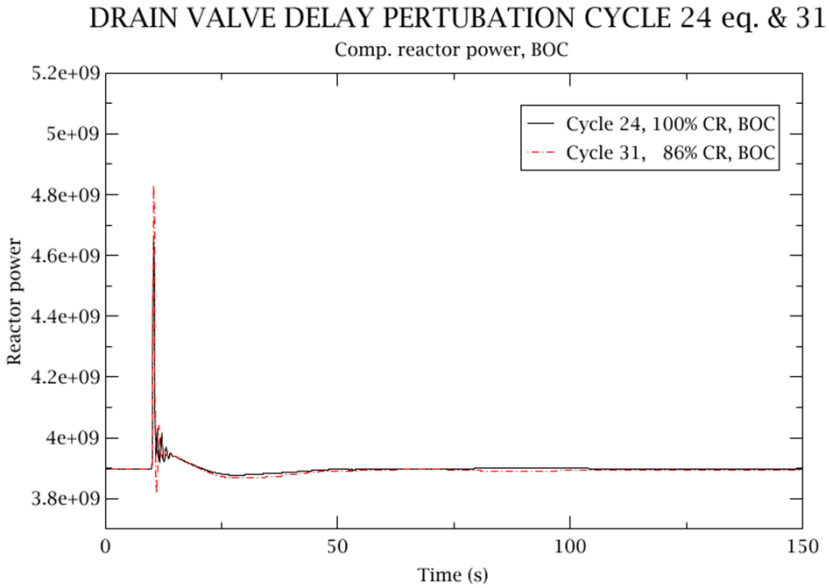
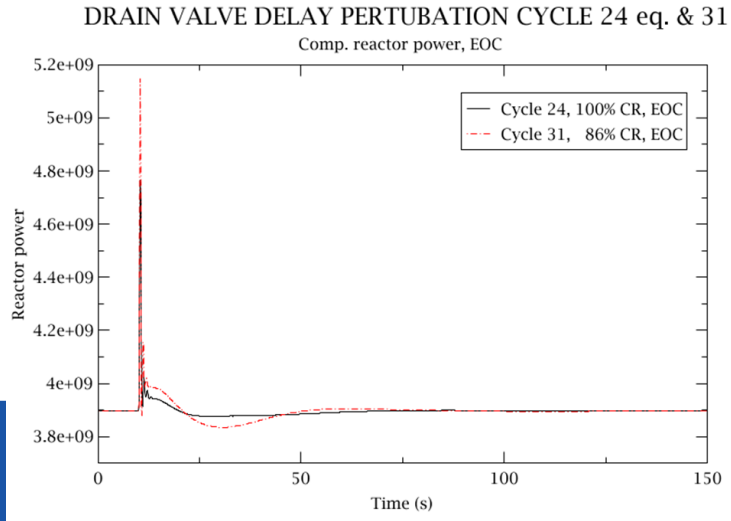


# CONCLUSION

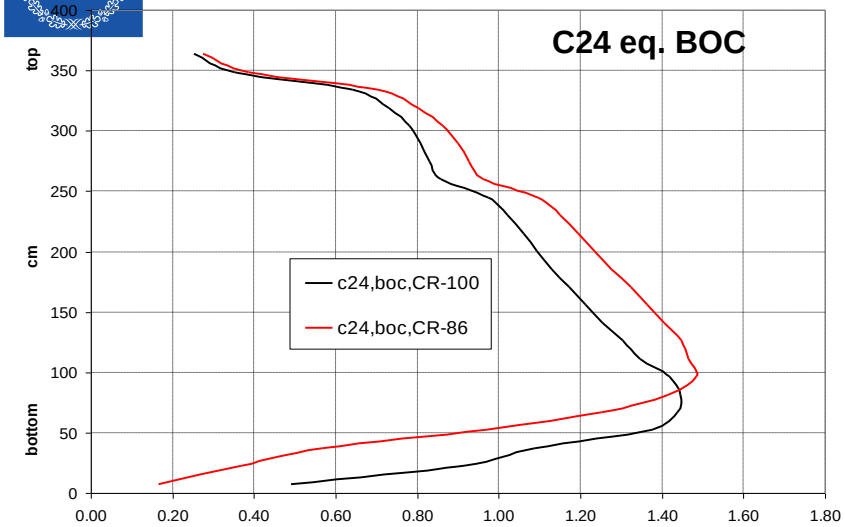
•TPC was c ted more negative tha fore, possibly due to very kewed axial power

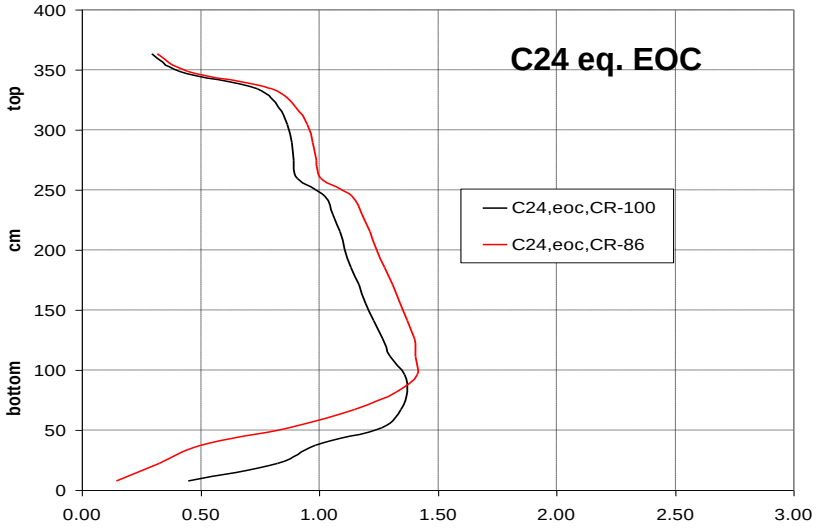
•Core pressure eases effect on the core stability shoul in

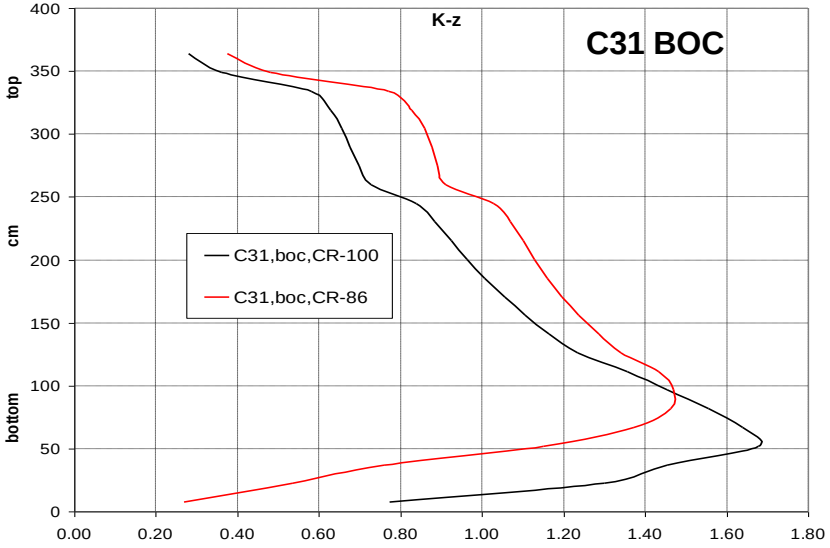
•Dynamic of the core w or cycle effect (c24 vs. c31), CR position eff 86%) and burnup effect (BOC vs. EOC). was found between the c24 core wi ou c31 with 86% CR out. The diff clearly du ent TPC.

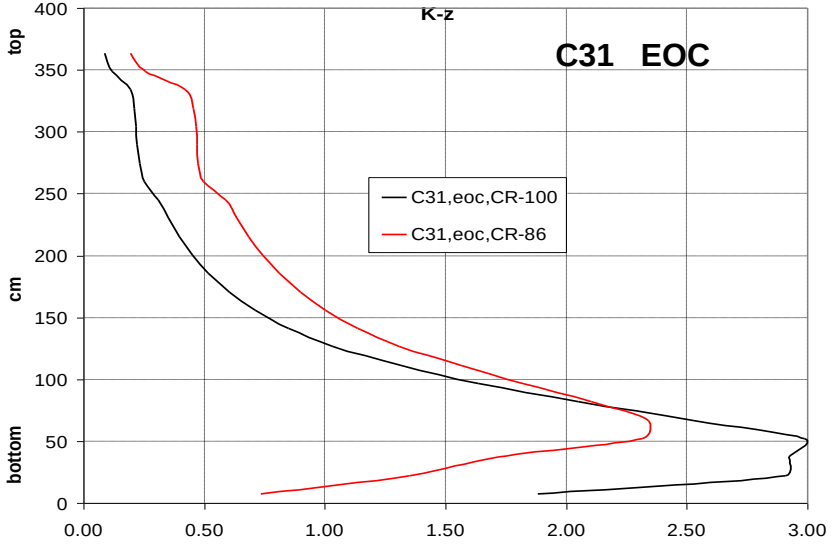
•THE OPE AT THE NEW CO DING AND CONTROL R D PATERN DOES NOT GNIFICANTLY EFFET THE REACTOR DYNAMIC BEHAVIOR

# Steady state results




Axial Power profile is too bottom-skewed, causing large Peaking Factors