



UJV activity in the field of fuel cycle support

R. Vočka, F. Havlůj

CORTEX workshop, February 20, 2019, ÚJV Řež



- 1 Core physics calculations
- 2 Core reload safety assessment and optimization
- 3 Other activities



Core physics software ANDREA development (1/3)



- ANDREA: nodal core physics code with pin-power reconstruction
- developed in UJV since 2005



Core physics software ANDREA development (2/3)

- very flexible and easy to use
- supports hex and square geometries
- using HELIOS for XS library generation
- XS libraries from SERPENT in development
- dynamic feedback capability in development



Core physics software ANDREA development (3/3)

- standardized by the Czech regulatory body SUJB
- used for Reloading safety assesment at Temelin NPP, as independent evaluation system at Slovak regulatory body UJD, as research and education tool at Czech technical university (CVUT)
- coming with a rich framework for tools, including advanced visualization tool VIZAR
- supports both VVER-440 and VVER-1000 reactors
- models for TVSA-T, VVANTAGE-6, TVS-2M fuels; framework QUADRIGA for lattice code model management



Reactor records databases ANEZKA and ANDELA

- relevant data from reactor records (in terms of neutron-physical characteristics) are processed and stored in a database application ANEZKA
- time-dependent data are stored as well as reactor startup tests
- ANDELA is a prediction fidelity evaluation and visualization tool which recalculates all cycles and startup tests using ANDREA code (both standard and development versions)
- both apps have web interface and a HTTP API for programmatic access



ANEZKA: core loading

ANEZKA 2 Fuel cycles Logs

Core mappings

Excel mappings

Startup test templates

Fuel cycle **ete - u1 - c13**

Core map + data

Time data

Startup tests

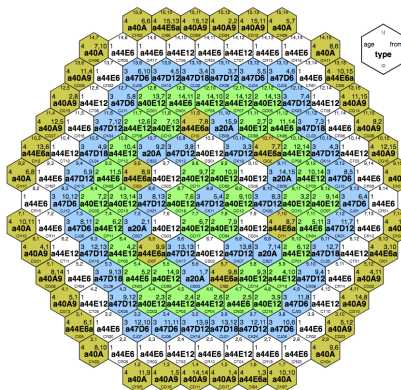
Maps

SPC data

Files

CRHS

Review





ANEZKA: COHIS (condensed history)





Core monitoring system SCORPIO-VVER

- developed with SKODA JS (CZ), Chemcomex (CZ), IFE HRP Halden (NO), VUJE (SK)
- used at Dukovany NPP (CZ) and Jaslovske Bohunice NPP (SK)
- we provide support and maintenance for NPPs



Reloading pattern optimization software LP-OPT

- for VVER reactors there is significant need for optimization (no equilibrium LP, constant fuel type evolution, power uprating)
- advanced reloading pattern optimizer – fast convergence, very good results, fully parallel with perfect scaling
- using ANDREA as a neutronic solver over a TCP/IP interface with adaptive load balancing
- being routinely used for Temelin NPP LP design
- new version LP-OPT 2 based on pareto algorithms in development and testing



Automated framework CycleKit for reloading SA

- reloading safety assessment is very complex for VVER-1000 reactors and follows a large set of rules
- cannot be automated in a straightforward way
- we have developed a complex framework CycleKit
- after intricate setup it provides a 'push-button' approach from loading pattern to a full PDF report



Reloading SA and LP optimization as a service

- we offer RSA and LPO both as providing the software or as a service
- current practice for NPP Temelin is that the assessment is done in parallel by us and at the powerplant
- loading pattern design is done as a service only due to high computational cost



Criticality safety assessment

- criticality safety evaluation, mainly for spent fuel storage pools
- using MCNP, SERPENT or KENO
- Partial boron credit implementations
- Burnup credit (BUC) research and development



More fuel cycle support activities

This was just our department, but there are many more activities going on in our division, including:

- fuel performance analyses
- thermohydraulic calculations
- safety analyses
- accident analyses



Research and development activities

- SFULLCORE – automated framework for full-core reference calculations using SERPENT
- AMALKA – framework for full-cycle coupled HELIOS-ANDREA calculations
- sensitivity calculations (TSUNAMI, Total Monte Carlo) and bayesian inference methodologies