NUCLEAR RESEARCH INSTITUTE

Supporting New Builds with Cutting-Edge Core Design and Safety Analysis Methods

21.10.2026

Dr. Adam Kecek



UJV Group
PEOPLE | INNOVATION | TECHNOLOGY

CEZ GROUP

UJV Group, a member of CEZ GROUP

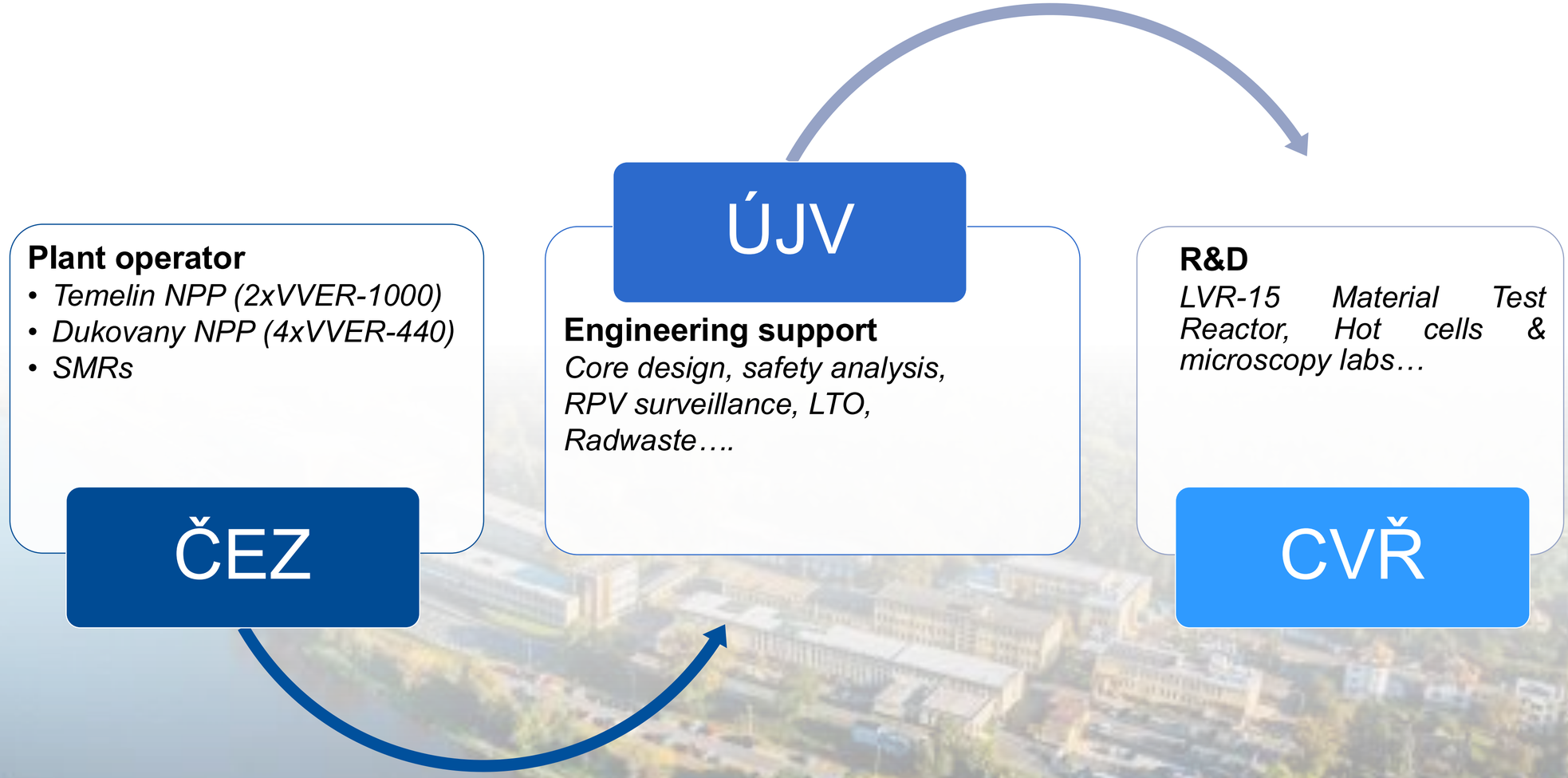
NUCLEAR RESEARCH INSTITUTE

CONTENT

- UJV‘s position and mission
- Support to new builds
- Highlights and synergy in experimental and analytical area
- Summary

UJV Proprietary Information - Unauthorized Distribution Prohibited

UJV‘S POSITION AND MISSION



UJV Proprietary Information - Unauthorized Distribution Prohibited

UJV‘S POSITION AND MISSION

Mission:

- To be the leading Czech expert provider of:
  - Core design, nuclear fuel cycle optimization and nuclear fuel performance assessment
  - Deterministic and probabilistic safety assessment of nuclear installations
  - Design and safety assessment of the Gen IV Nuclear Reactors

Background

- Application of cutting-edge computer codes and state of the art methodologies
- Active participation in the top-level international expert bodies (IAEA, OECD NEA, EPRI…)
- International and national experimental programs providing state-of-the art data
- Project experience (power uprates, implementation of new fuel etc.)

UJV Proprietary Information - Unauthorized Distribution Prohibited

UJV SUPPORT TO NEWBUILDS

Expert support

- Providing services throughout the project, from early phases including the tendering activities up to the newbuild commissioning and operation
- Alignment of the Design and Safety Case with the Czech legislation, EU and International guidelines and recommendations

Design evaluation

- Supporting the owner to review and assess the design and documentation provided by vendor

Independent safety assessment

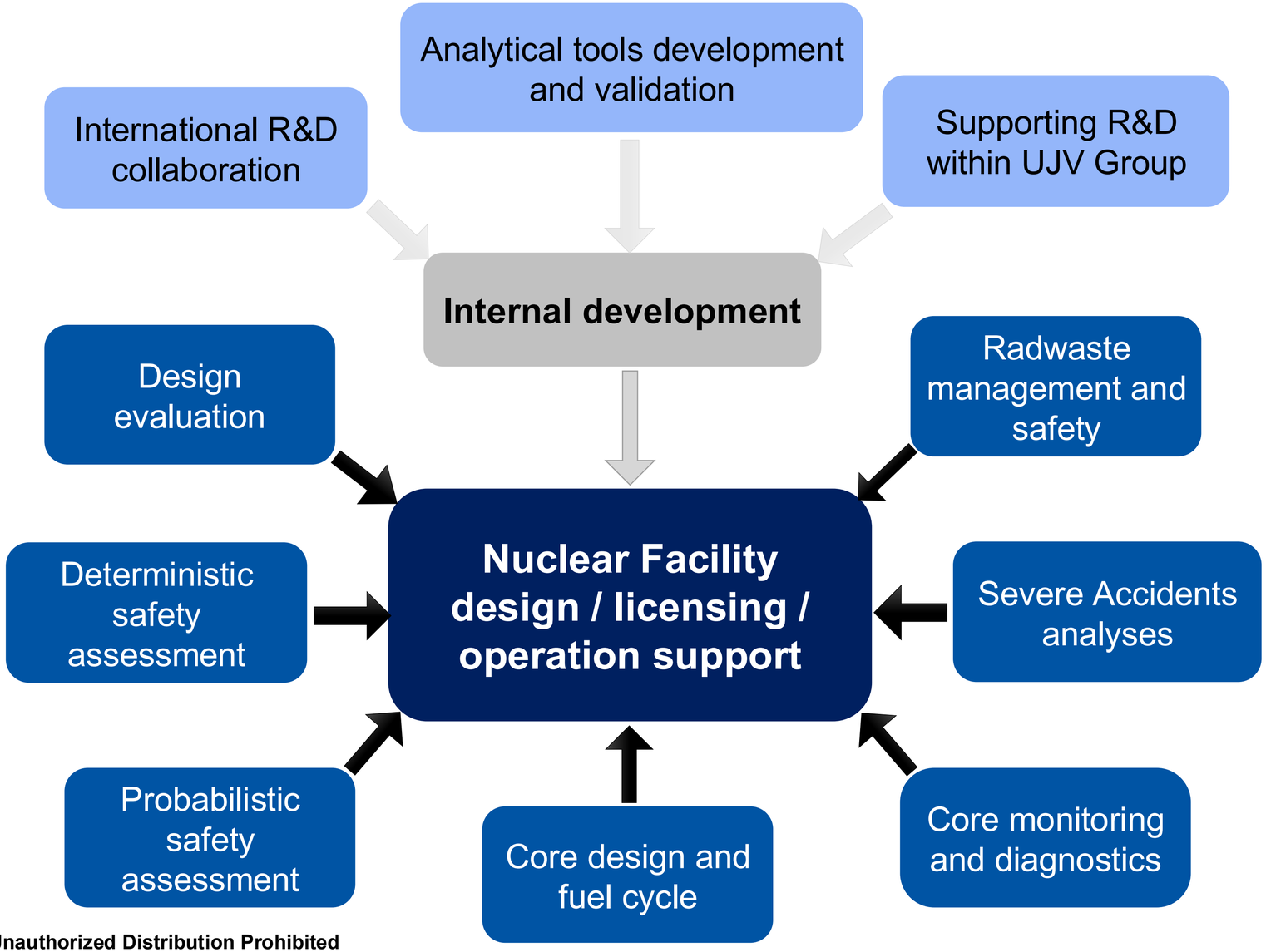
- Development of independent models, methodologies and analyses to support the licensing of the newbuild.
  - Including core design, deterministic and probabilistic safety assessment

Licensing

- Development of licensing documentation to fulfill the legislative requirements
  - Relevant chapters of PSAR (Preliminary safety assessment report), SAR (Safety assessment report)

UJV Proprietary Information - Unauthorized Distribution Prohibited

HIGHLIGHTS - SYNERGY

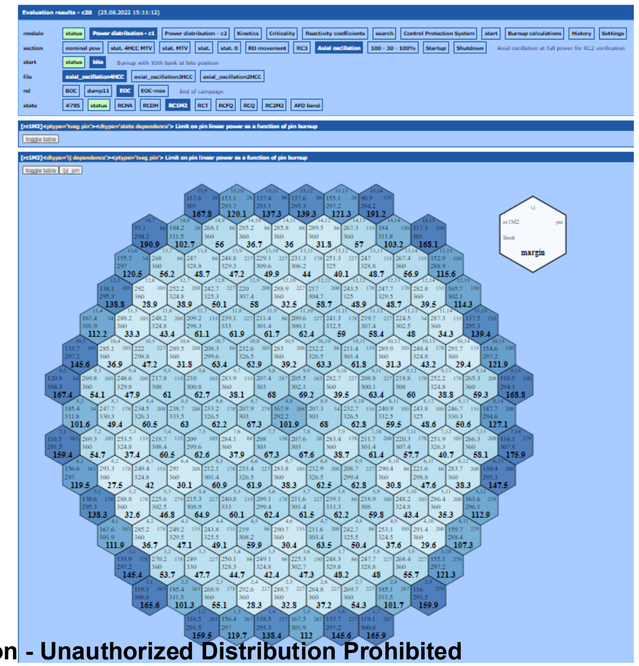


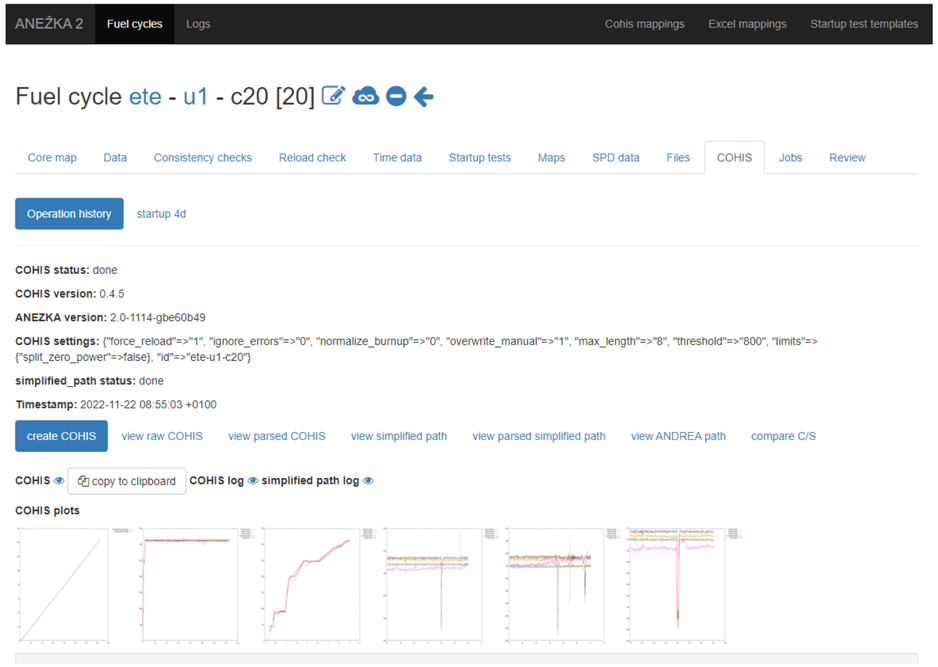
UJV Proprietary Information - Unauthorized Distribution Prohibited

HIGHLIGHTS - CORE DESIGN

In-house suite core design

- In-house suite core design software suite (ANDREA, CYCLEKIT, LPOPT…)
- High-fidelity 3D modelling capabilites (SERPENT, MCNP)
- Fast, customizable and automated work environments
- Automated Verification and Validation (plant data, benchmarks, code to code - ANDĚLA)
- Subchannel DNBR analysis and/or Fuel Performance analyses coupling (VIPRE, TRANSURANUS)





UJV Proprietary Information - Unauthorized Distribution Prohibited

HIGHLIGHTS - CORE DESIGN EXPERIMENTAL SUPPORT

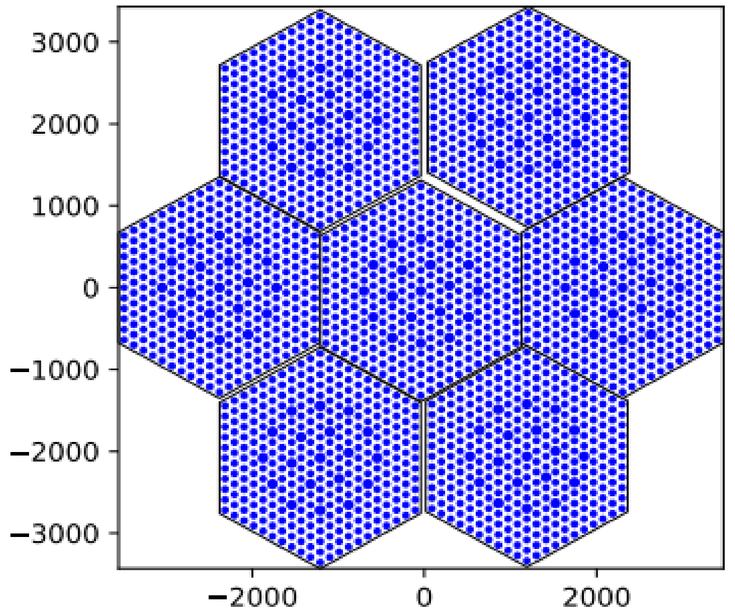
Experimental support at LR-0 reactor

- Various geometries and configurations
- Measurement of specific neutronic data

Reduction of uncertainties

- Utilization of experimental data to improve the precisions in core design and safety evaluation
- Common project with FRAMATOME





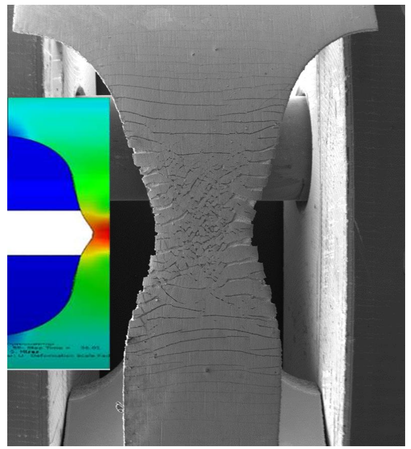
"TQ16000076 - Experimental Simulation of Void Effects and Extended Water Gap Phenomena in VVER-1000 Reactors for the Validation of Computational Codes"
"This project is co-funded by the Technology Agency of the Czech Republic (TA CR) under the SIGMA Programme for the Support of Applied Research and Innovation."

UJV Proprietary Information - Unauthorized Distribution Prohibited

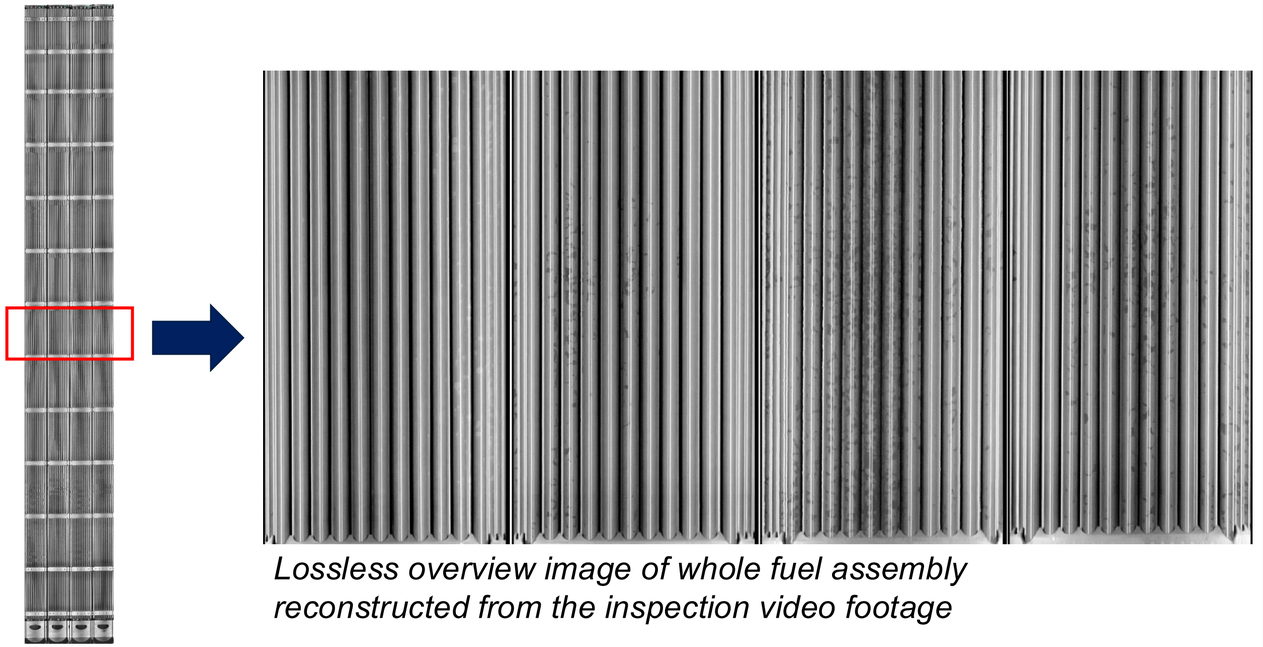
HIGHLIGHTS - FUEL PERFORMANCE

Analytical modelling of fuel

- Traditional fuel performance codes (TRANSURANUS) and detailed 2D/3D FEM models (ABAQUS)
- Analytical modelling of fuel behavior from in-core performance to dry storage conditions supported by experimental programs in Research Centre Řež (CVR) including Accident Tolerant / Advanced Technology fuel R&D
- Expert support to plant operators including poolside fuel inspections



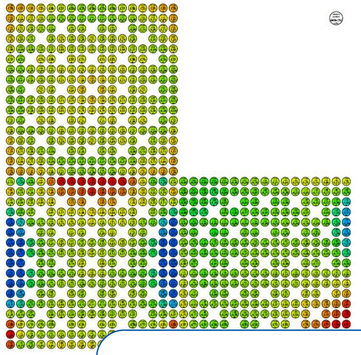
FEM simulation of tensile test of ATF cladding ring tensile specimen test performed at CVR



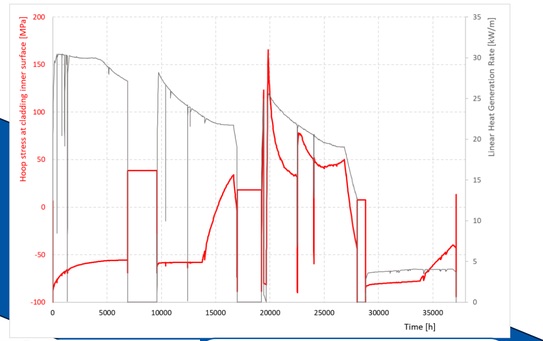
Lossless overview image of whole fuel assembly reconstructed from the inspection video footage

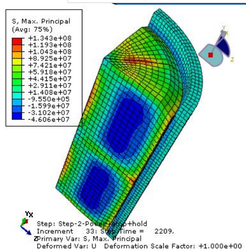
UJV Proprietary Information - Unauthorized Distribution Prohibited

HIGHLIGHTS - PCI RISK MITIGATION EXPERIMENTS AND MODELLING



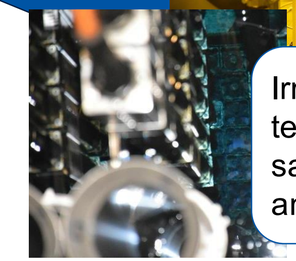
Power distribution calculations



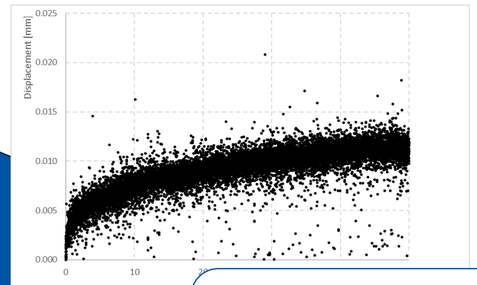


Fuel performance modelling





Irradiation and mechanical testing of fuel cladding samples at selected loads and temperatures



Key properties of irradiated cladding

PCI-risk

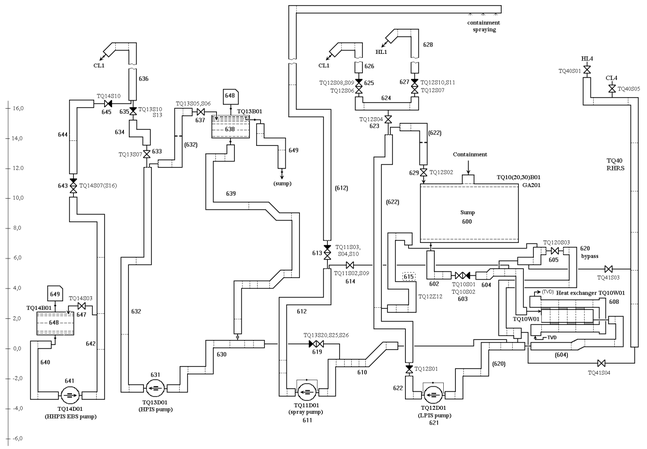
- PCI-risk management guidelines and tools for core design
- PCI-risk monitoring and prediction module in Core Monitoring System

UJV Proprietary Information - Unauthorized Distribution Prohibited

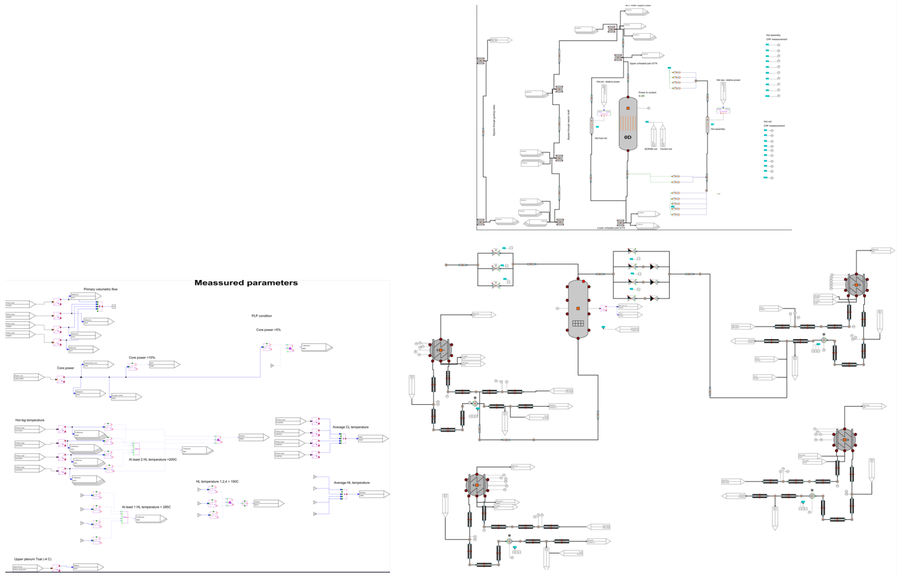
HIGHLIGHTS - SYSTEM ANALYSIS

System analysis

- Steady-state and transient sytem analysis (APROS®, RELAP5-mod3)
- Extensive verification and validation – OECD NEA projects and benchmarks
- Safety assessment methodologies following SUJB, IAEA, WENRA and US NRC guidelines (inc. DEC-A, ATWS, shutdown states…)
- Advanced analytical methods and models (fully coupled coupled system 3D core models / CFD, BEPU methods….)
- Follow-up containment thermal-hydraulics, FP transport and radiological consequences



RELAP 5 model of VVER-1000 ECCS



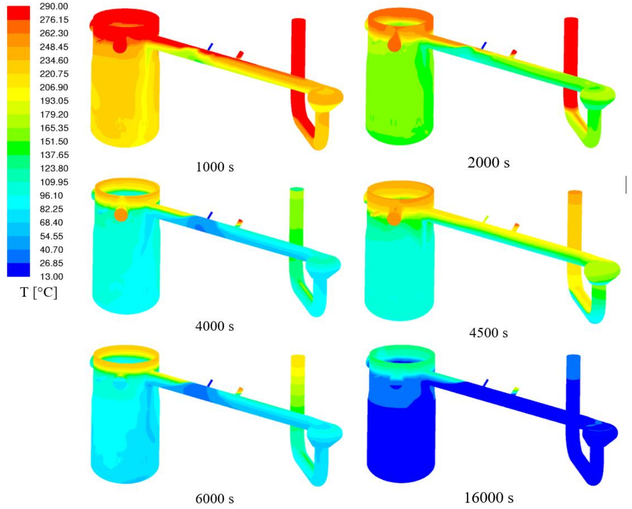
APROS® VVER-1000 primary circuit model

UJV Proprietary Information - Unauthorized Distribution Prohibited

HIGHLIGHTS - CFD AND SUBCHANNEL ANALYSIS

CFD (ANSYS FLUENT)

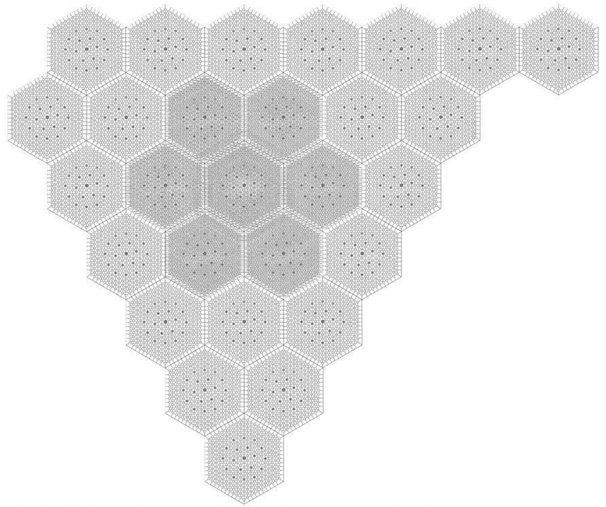
- **Detailed analysis of complex TH phenomena**:
  - Pressurized Thermal Shocks / Thermal Shocks
  - Hot leg mixing
  - Mixed core effects and fuel assembly / fuel rod bowing
  - Spent Fuel Pool Liner local hot – spots
  - In and ex -vessel corium behaviour



VVER-1000 SB LOCA ECCS actuation

Subchannel analysis (VIPRE)

- Main tool for DNBR analysis
- Transient Analysis
- Core Thermal Limits



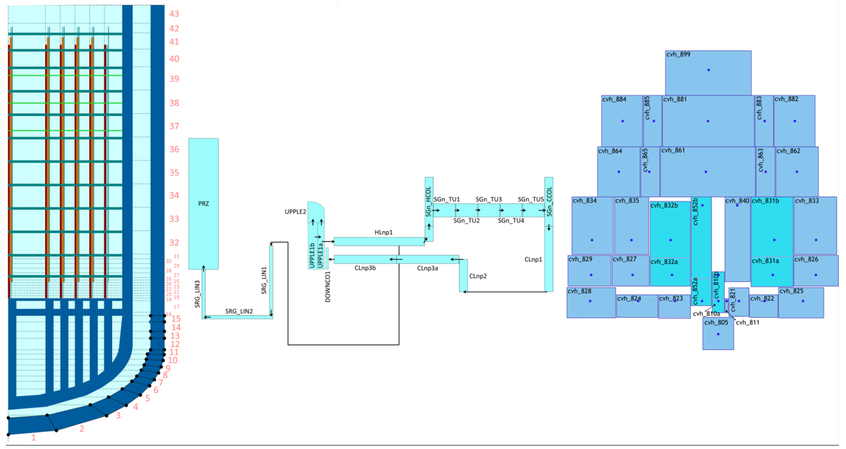
VVER-1000 „Full Core“ subchannel model

UJV Proprietary Information - Unauthorized Distribution Prohibited

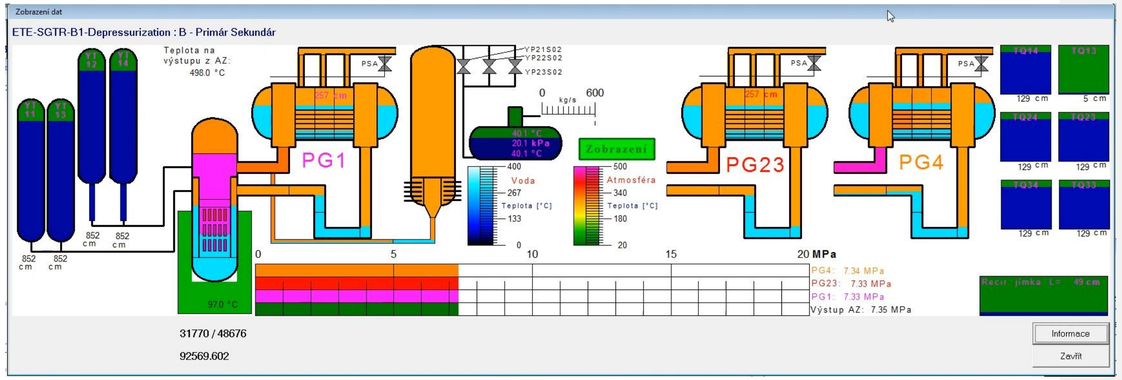
HIGHLIGHTS - SEVERE ACCIDENT MANAGEMENT

Accident management

- Assessment of scenarios involving core degradation (MELCOR, ASTEC and MAAP codes)
- In-house modular visualization and operator training software (VINSAP)
- Design and assessment of measures and strategies enhancing plant (hydrogen, containment venting, corium coolability)
- Development of severe accident management guidelines



ASTEC VVER-1000 model



VINSAP visualisation / training SW overview screen

UJV Proprietary Information - Unauthorized Distribution Prohibited

HIGHLIGHTS – PROBABILISTIC SAFETY ASSESSMENT, RISK AND RELIABILITY

NUCLEAR RESEARCH INSTITUTE

Development and maintenance of full scope Living PSA

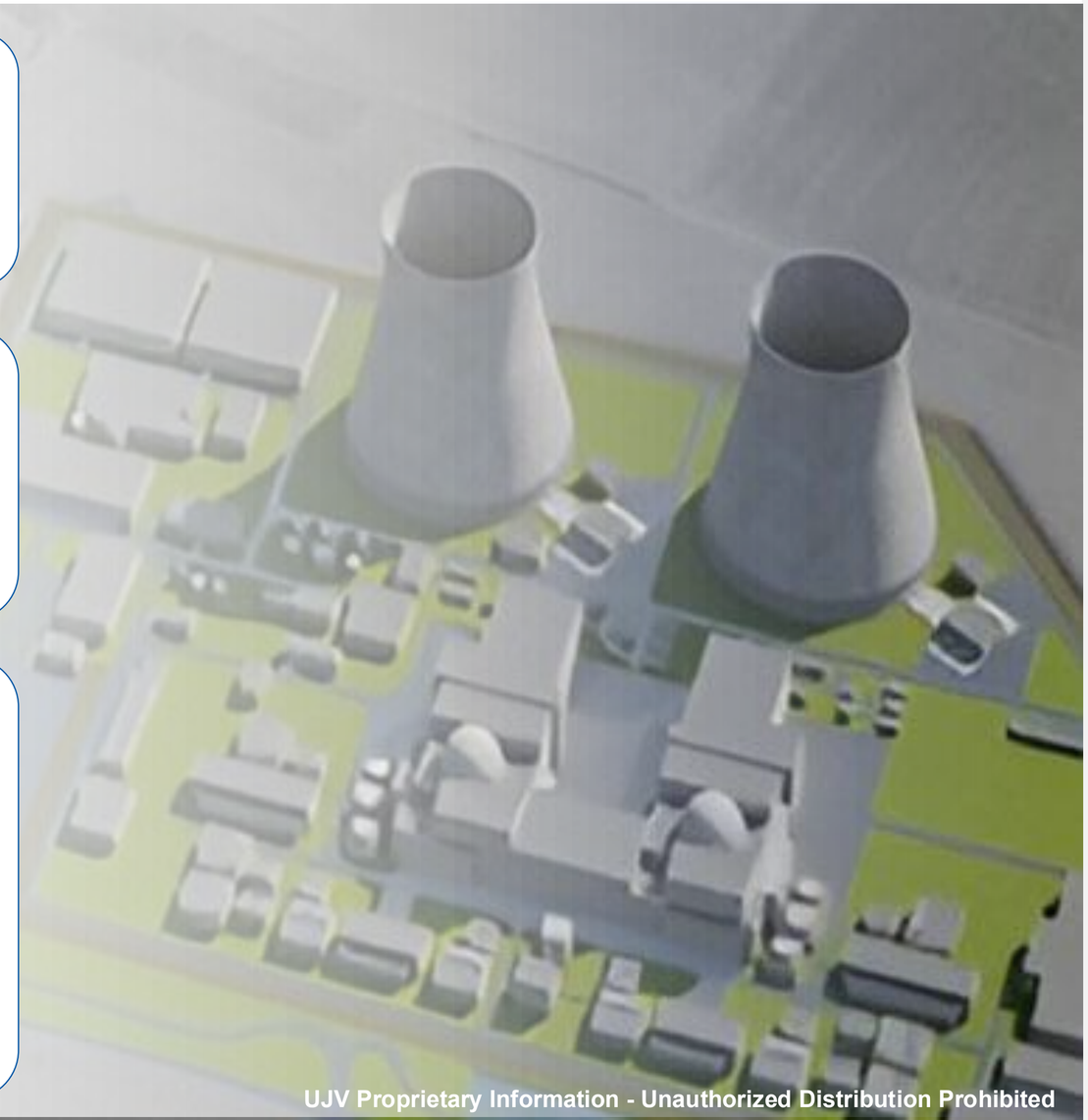
- Level 1 & Level 2 (reactor core & spent fuel pool) power operation & shutdown
- Internal & external hazards

PSA applications

- Monitoring of instantaneous risk
- Evaluation and prioritization of safety measures
- Maintenance support, etc.

Reliability

- Regular Plant Specific Component Data collection and analyses
  - System analyses
  - NPP Modernization, LTO
- Simulator data collection
  - HRA, Procedures ergonomics, Training…



UJV Proprietary Information - Unauthorized Distribution Prohibited

SUMMARY

UJV‘s position and mission

- The leading Czech expert provider in safety assessment thanks to cutting edge tools and methodologies supported by experimental programmes
- Synergy of application and development of cutting-edge codes and methodologies, experimental activities and experience from international programmes

Support to newbuilds

- Providing expertise in all stages of the project

Key areas of synergy in supporting the newbuilds

- Core design
- Fuel performance
- System analysis
- Probabilistic assessment, risk and reliability

UJV Proprietary Information - Unauthorized Distribution Prohibited

Thank you for your attention.

adam.kecek@ujv.cz
+420 606 614 244

UJV Group
PEOPLE I INNOVATION I TECHNOLOGY

CEZ GROUP

UJV Group, a member of CEZ GROUP

