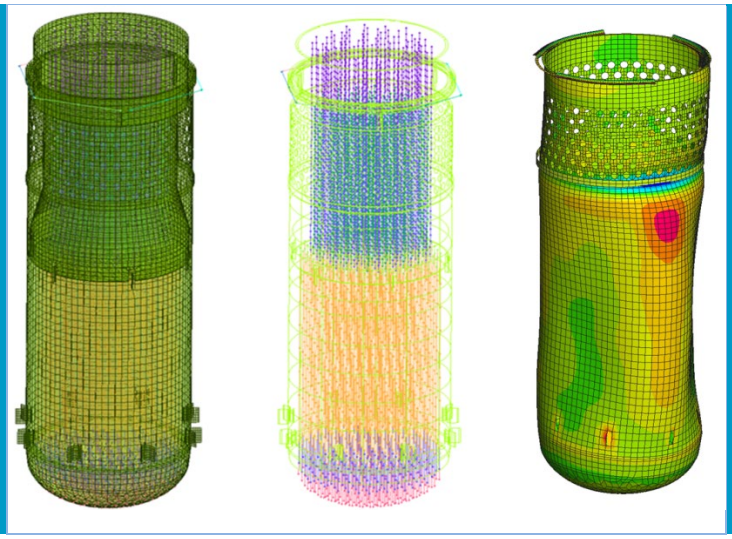
NUCLEAR RESEARCH INSTITUTE

Structural and Lifetime Assessment Department
Integrity and Technical Engineering Division



REACTOR PRESSURE VESSEL INTERNALS EVALUATION

FE model of internals for seismic and dynamic calculations in the domain

Value for customers

- Demonstration of reactor pressure vessel (RPV) internals integrity during original design lifetime and long term operation (LTO)

Application

- RPV internals of newbuild nuclear power plants (NPPs)
- RPV internals of operating NPPs during original design lifetime and for LTO justification

What we offer

- Ensuring of long-term lifetime of RPV internals
- Evaluation of RPV internals is a multidisciplinary process – cooperation among thermal-hydraulic experts, diagnostic experts and experts in structural and fracture mechanics analyses, including knowledge of material properties and their change due to irradiation
- Main degradation mechanisms (thermal fatigue, vibrations and wear) as well as the specific ones (radiation ageing, radiation swelling, radiation creep, IASCC) are taken into account
- The evaluation is based on calculation of thermal, strain, and stress fields at different operational stationary or transient regimes, as well as at accident regimes.

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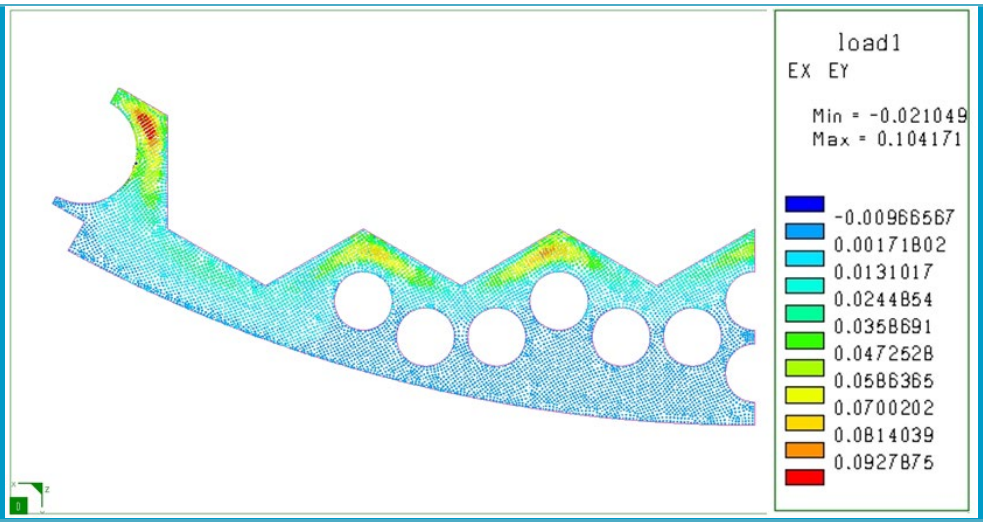
- Experience with using FE codes for thermal and strength calculations (FE codes SYSTUS, MSC.MARC and ABAQUS are available)
- Evaluation of static strength and fatigue lifetime (including environment effect)
- Evaluation of internals resistance against ductile/brittle fracture, changes in mechanical properties due to radiation are considered
- Prediction of change of shape (change of geometrical dimensions) due to radiation swelling and radiation creep. In determination of thermal fields, heat generation due to gamma radiation is considered. In determination of stress fields, change in mechanical properties due to radiation is considered.
- Evaluation of RPV internals resistance against vibrations, and prediction of wear. The evaluation is performed based on dynamic response of the internals which is determined based on evaluation of signals obtained from diagnostic systems and using numerical simulation with help of tuned dynamic model of reactor.
- Computational evaluation of seismic resistance and determination of seismic margins. The evaluation is performed in frequency domain using response spectra, as well as in time domain using artificial accelerograms.
- Dynamic evaluations of the water hammer at design accidents

Our references

- Evaluation of fatigue lifetime of reactor internals of Dukovany NPP (2006-2007)
- Determination of dynamic response of internals to operational excitations for Dukovany and Temelin NPPs (1999 and 2008)
- Evaluation of condition and operational time extension for South-Ukrainian NPP unit 1 (2008-2011)
- Evaluation of condition and operational time extension for Rivne NPP unit 3 (2011-2018)
- Evaluation of condition and operational time extension for Khmelnytskyi NPP unit 1 (2017-2019)
- Participation in development of methodology for evaluation of internals for VVER type reactors; Appendix C in „VERLIFE" normative document
- Comprehensive service P3 – Evaluation of lifetime of RPV and its internals for Dukovany and Temelin NPPs (2011 - today)



Distribution of cumulative swelling and creep deformation in the core shroud horizontal cross-section for 60 years of operation of a VVER-1000 reactor