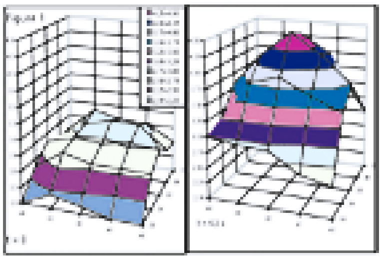
METHODOLOGY AND ANALYSIS OF REACTIVITY INITIATED ACCIDENTS

(I. Stenbock, M. Rozhdestvensky, V. Panin, V. Davidov, P. Kuznetcov, T. Saharova, Yu. Alimov)

> Analysis Goal

The report provides description of methodology and results of calculations of RIA analysis within "In-depth Safety Assessment of Kursk NPP, Unit 1". The following design-basis accidents are considered: **erroneous refueling; full withdrawal of a single CPS rods and rod banks at nominal and startup power levels; ejection from the core of fully inserted shortened bottom-entry rod at nominal power; falling of a fully withdrawn scram rod into the core at nominal power; CPS CC voiding or gas ingress to the circuit at nominal power.**

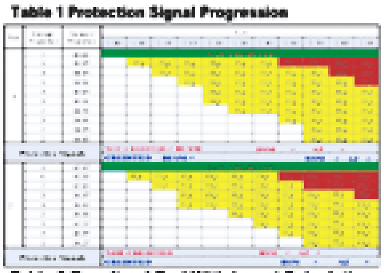
For each emergency situation considered a methodology of analysis is provided and detailed description of the initial states is given. For each of the reactor initial steady-state conditions full-scale 3-D neutronic an thermal hydraulic calculations were made using the verified and validated SADCO software complex (Figure 1), developed for RBMK studies and licensed by RF GAN.



> Integrated Monitoring, Control and Protection System

IMCPS implemented now in the RBMK NPPs (the first system is under operation at Kursk-1) is different from control and protection systems of other power units with RBMK reactors. The main advantages are as follows: **two independent and diverse shutdown systems; two independent and diverse instrumentation sets of monitoring, control and protection, including process instrumentation; physical separation and functional isolation of monitoring, control and protection elements; higher redundancy.**

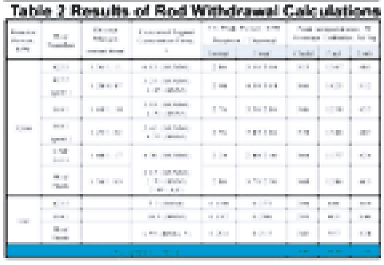
Table 1 Protection Signal Progression



> Rod Withdrawal Analysis

Calculational investigations show that maximum rise of power in FA near the rod withdrawn is observed during withdrawal of a central rod in perturbed state at nominal power, it is equal to ~ 50% (Figure 1). System of in-core power monitoring provides for timely generation of a great number of signals on excess of set points by sensors in both sets, which initiate CPS protective actions even in case of failure of two sensors, by one in each set (Table 1). In all the situations considered the safety parameters regulated by acceptance criteria remain considerably lower than the limiting values (Table 2).

Table 2 Results of Rod Withdrawal Calculations



> CPS Circulation Circuit Voiding Accident

CPS CC voiding leads to insertion of the most positive reactivity (~1.9$). So, in order to demonstrate effectiveness of both shutdown systems in accordance with items 2.3.1.4, 2.3.1.5, 2.3.2.1 and 2.3.2.2 of PBYa RU AS-89 the analysis is carried out for two modes of IMCPS operation: operation of BSM system; operation of AZ (scram) system only, without one the most effective rod (Figure 3).

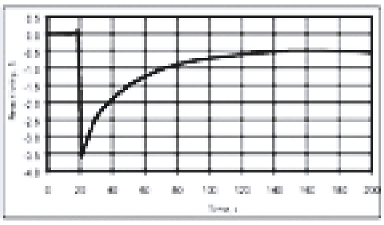


Figure 3 Reactivity during CPS CC Voiding

> Conclusion

Calculational analysis of reactivity design-basis accidents for RBMK NPP under conditions of its equipping with the Integrated Monitoring, Control and Protection System demonstrates that all emergency processes considered occur without violation of acceptance criteria, i.e. nuclear and engineering safety is assured. Two independent and diverse shutdown systems and instrumentation sets ensure timely generation of protection signals, reactor shutdown and maintaining it in subcritical state for all DBAs.

Research and Development Institute of Power Engineering - I.A.Stenbock
P. O. Box 788, 101000, Moscow , Russia/ sten@nikiet.ru