Kozloduy NPP Unit 6 Natural Circulation standard problem analysis

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Independent analysis of the Natural Circulation standard problem has been done by the National Taras Shevchenko University of Kyiv, Ukraine.

The definition of a RELAP5 validation benchmark problem based on operational data from Kozloduy NPP was performed by the INRNE, Bulgaria, in the frame of Joint project ”Kozloduy Nuclear Plant Safety Analysis Capability – Transient Analysis Code Assessment for VVER Reactors”, as an integrated part of US DOE International Nuclear Safety Program. All necessary data to modelling and analyze the transient with RELAP5/MOD3.2 code was provided.

The VVER-1000 RELAP5/MOD3.2 model has been developed by the Kyiv National University for Kozloduy NPP Unit 6. The model was developed based on Zaporizhzhya NPP Unit 5 VVER 1000/320 RELAP5 model. Zaporizhzhya NPP Unit 5 is similar to Kozloduy Unit 6 with respect to general design, set of main operation equipment as well as safety and control systems. The model being disposed was tested taking into account actual Kozloduy Unit 6 Data.

The VVER-1000 RELAP5 model was used for the analysis of the natural circulation transient with RELAP5/MOD3.2 code.

All available plant data on Natural circulation test results were used for analysis. The data (reactor unit parameters versus time) taken from the plant test plots, which have been used as basis for the analysis, are as follows:

- Primary Side Pressure;
- Cold Leg Temperature;
- Hot Leg Temperature;
- Pressurizer Water Level;
- SG No.1 Water Level;
- SG No.3 Water Level;
- MCP No.4 Pump Head;
- SG Primary Side Pressure Drop.

The calculation was performed during the 10 min (600 sec) transient time period. Before running the investigated transient the RELAP5 model was run with the real plant equilibrium conditions at 5% power. All main parameters of model have been stabilized very close to the test data at the beginning of transient.

The comparison of the natural circulation test data versus transient calculated data demonstrates a reasonable agreement between the RELAP5 calculation results and the Plant test data for all parameters analyzed.

All characteristics of measured parameter variation (increase/decrease time history, maximum/minimum location) are presented with calculated curves. The deviations of measured and calculated results are within design tolerances.

The results of comparative analysis are an important part of the validation of the RELAP5/MOD3.2 code.

The comparison demonstrates that RELAP5 predicts the test results with acceptable accuracy, i.e. within design tolerances.

The overall conclusion is that RELAP5/MOD3.2 is adequate to simulate the transient phenomena occurring in a VVER-1000 under Natural Circulation conditions.