Consistent Code Qualification Process and Application to WWER-1000 NPP

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Calculation analysis by application of the system codes are performed to evaluate the NPP or the facility behavior during a postulated transient or to evaluate the code capability. The calculation analysis constitutes a process that involves the code itself, the data of the reference plant, the data about the transient, the nodalization, and the user. All these elements affect one each other and affect the results. A major issue in the use of mathematical model is constituted by the model capability to reproduce the plant or facility behavior under steady state and transient conditions. These aspects constitute two main checks that must be satisfied during the qualification process. The first of them is related to the realization of a schematization of the reference plant; the second one is related to the capability to reproduce the transient behavior.

The aim of this paper is to describe the UMAE (Uncertainty Method based on Accuracy Extrapolation) methodology developed at University of Pisa for qualifying a nodalization and analysing the calculated results and to perform the uncertainty evaluation of the system code by the CIAU code (Code with the capability of Internal Assessment of Uncertainty).

The activity consists with the re-analysis of the Experiment BL-44 (SBLOCA) performed in the LOBI facility and the analysis of a Kv-scaling calculation of the WWER-1000 NPP nodalization taking as reference the test BL-44. Relap5/Mod3.3 has been used as thermal-hydraulic system code and the standard procedure adopted at University of Pisa has been applied to show the capability of the code to predict the significant aspects of the transient and to obtain a "qualified nodalization" of the WWER-1000 through a systematic qualitative and quantitative accuracy evaluation. The qualitative accuracy evaluation is based on the selection of Relevant Thermal-hydraulic Aspects (RTAs) and is a prerequisite to the application of the Fast Fourier Transform Based Method (FFTBM) which quantifies the error in code predictions related to the measured experimental signals. A reference test scenario (SBLOCA) is then performed with the qualified WWER-1000 NPP nodalization and the CIAU code is applied for the uncertainty evaluation of the calculated results.

Keywords: Nodalization qualification, Uncertainty, Best-Estimate, UMAE, CIAU