5-1 For Risk-Informed Safety Management in Nuclear Power Plants

－Development of the Procedure for Uncertainty Analysis of Source Terms－

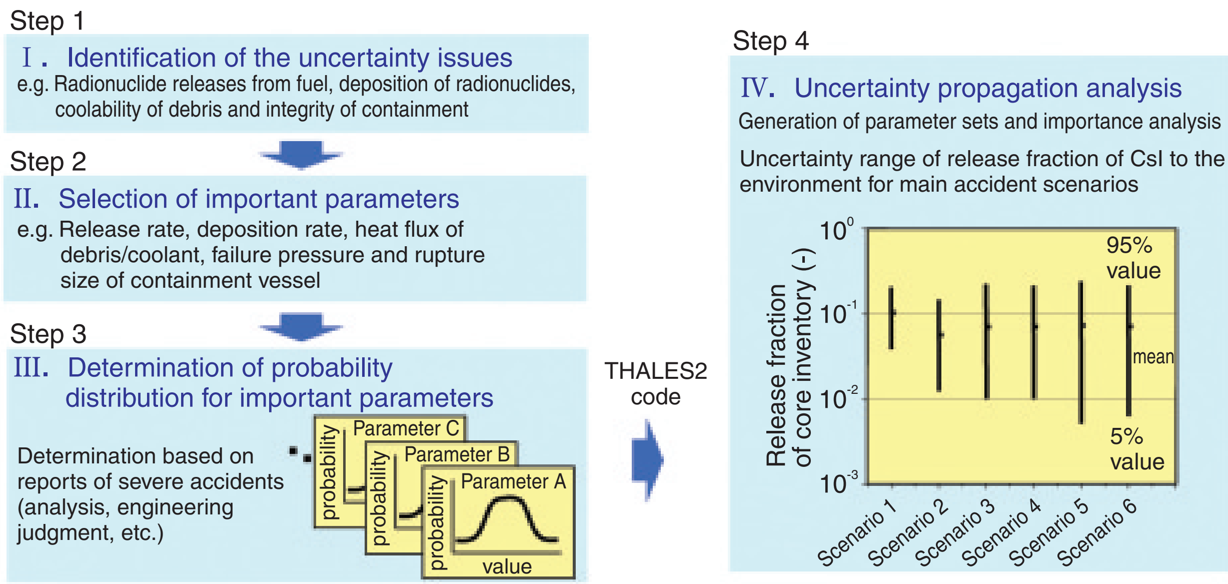

Fig.5-3 Procedure of the uncertainty analysis of source terms and an example of results
This procedure consists of four steps: "Identification of the uncertainty issues", "Selection of important parameters", "Determination of probability distribution for important parameters" and "Uncertainty propagation analysis". The result is obtained in the form of the cumulative probability distribution. The final result is represented by 5% , 95% and mean values.

Recently, the use of probabilistic safety assessment (PSA) methods is making rapid progress in the safety regulation and risk management of nuclear power plants in Japan. For the sake of maintaining the quality of PSA results, the Standards Committee of the Atomic Energy Societies of Japan (AESJ) is developing the standards for PSA procedures. Uncertainties should be considered in applications of PSA results such as the comparison of risk with safety goals.

In a PSA, source terms, defined as the timing and the characteristics of radionuclide release into the environment, are evaluated by using severe accident analysis codes which simulate thermal hydraulic and radionuclide behavior in the plant. Because of the complexity of severe accident phenomena and the computer resources thus needed, development of an efficient procedure of uncertainty analysis was needed. Therefore, we proposed a procedure for uncertainty analysis of source terms using the severe accident analysis code THALES2, and applied this procedure to the source term analysis of a BWR-5/Mark-II plant. This procedure consists of four steps. First, we identified uncertainty issues that might have strong influence on source terms. We divided the progress of a severe accident into four stages, and selected important factors in each stage systematically. Next, we selected important parameters that can contribute to the uncertainty of each uncertainty issue. Then, the probability distributions of these important parameters were determined by surveying existing experimental and analytical studies. Finally, the uncertainties of these parameters were used to make estimates by the Monte Carlo method.

The uncertainty analysis was performed for six containment vessel overpressure-caused failure scenarios. Fig.5-3 shows the calculated release fractions of Cesium Iodide (CsI) to the environment. From these analyses, it was found that the release fractions of CsI to the environment (mean value) for all six scenarios are about 10% of the initial core inventory and the uncertainty ranges from one to two orders of magnitudes. This application confirmed the usefulness of this procedure. This procedure was reflected in the above-mentioned AESJ operations standards for level 2 PSA.

Reference
Ishikawa, J. et. al., Uncertainty Evaluation of Source Terms under Severe Accident Conditions at LWRs, Nippon Genshiryoku Gakkai Wabun Ronbunshi, vol.5, no.4, 2006, p.305-315 (in Japanese).