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A Study on the Evaluation of the Radioactive Source Term for Korean Next Generation Reactor

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Abstract

The amount of radioactive materials released from nuclear power plant must be evaluated before construction stage for the shielding design and radioactive systems. Since 1984, any new methodologies for source term evaluation are not provided. At present, a few codes such as PWR-GALE used for evaluation of source term have some limitations for application to the next generation plants of Korea. The purpose of this study is to provide the method and evaluation tool for radionuclide concentrations at reactor primary coolant systems and radioactive material released from NPP, and to compare the results with those of the well-known and recognized tools. The evaluation method for radionuclide concentrations at RCS is suggested and a corresponding code for source term evaluation is developed. The code named as Visual GALE is able to predict the radionuclide concentration of fission product at primary with various reactor design parameters based on the simple calculations. Also, Visual GALE is able to calculate the radioactive materials released from nuclear power plant with various waste treatments components. Visual GALE uses the simplified equation with the assumption of steady state condition for the fission product concentrations at RCS. At fuel pellet region, ORIGEN 2 code was used for the activity of fission product. For reflection of radwaste system of next generation reactor, waste treatment system is divided as waste input, radionuclide removal process and discharge rate. The reference system is pressurized water reactor with U-tube steam generator and the formal radwaste treatment system. By applying Visual-GALE code to YGN unit 3, 4, the results are compared with the actual data measured from the reference plants and calculation results of PWR-GALE and FSAR of YGN 3, 4. In this study, specifically, the expected fuel defect rate and the concentration distribution of the fission product was focussed for the analysis in detail. The comparison has shown that the well-known and recognized tools relatively overestimate radionuclide concentrations at the reactor coolant systems. Also, the resultant concentration distribution of the fission product from Visual-GALE is similar to the that of actual data measured from the reference plants and calculation results of PWR-GALE and FSAR (Final Safety Analysis Report) of YGN 3, 4. In conclusion, Visual-GALE can be used to evaluate the radioactive source term due to change of fuel inventory. Despite of the simple method, Visual-GALE showed reasonably good results as compared to the well-known and recognized tools such as PWR-GALE. For evaluation of the source term with various fuel defect rate, the Visual-GALE is turned out to be useful and applicable, for next generation reactor, to evaluate the radioactive source term.