# Probabilistic approach to estimates of radioiodine release at Fukushima accidents

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## Abstract

Radioiodine behavior and long-term releases at Fukushima severe accident scenarios are assessed using probabilistic framework. First, the prominent phenomena and processes are identified which might dictate the iodine behavior at an accident. Then the dedicated, small Accident Progression Event Tree (APET) is built which describes the iodine release from fuel, its transport in the containment, original iodine speciation, and radiochemical interactions responsible for the formation of the volatile iodine compounds from the non-volatile forms. The specifics of the Fukushima accidents and their progression with respect to the iodine behavior are taken into account in the APET, including possible boron influence on the chemistry of cesium and iodine.

The analyses of the iodine behavior and transport are performed using the EVNTRE code, written for general purposes of the APET evaluations in the frame of the NUREG-1150 project. The radiochemical interactions of iodine in the containment, or in the reactor buildings of the Fukushima reactors, which produce volatile iodine species are calculated by the specialized containment iodine code IODE, modified version of the old standalone French code. IODE is called automatically by EVNTRE whenever in the tree the question occurs about the iodine speciation, that is, about the speciation driven by kinetic considerations and not just by equilibria.

The sets of input values to the IODE runs are selected automatically based on the path through the tree which precedes the question node from which the IODE is called. To divide the long accident progression of the Fukushima scenarios into distinct phases for iodine calculations, both the starting point and the end point of the iodine speciation evaluations can be also supplied this way for the repeated runs of the IODE code, with possibly different boundary conditions in each of the runs. The older integral calculations help to define the boundary conditions and the amounts of various radionuclides in the containment volumes/reactor buildings.

Preliminary results of the APET evaluations show that the formation of the volatile iodine compounds is responsible for a notable fraction of the total iodine releases to the environment at Fukushima accidents, with the key phenomena behind the volatile iodine formation identified by the EVNTRE runs. A simple uncertainty analysis with selected parameters related to the key phenomena and processes determining the iodine behavior was also performed within the EVNTRE calculations.

**Keywords:** radioiodine source term, APET probabilistic methods, EVNTRE, Fukushima accidents, IODE