Dose and Risk Assessment of Argonaut Reactor Severe Accident

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Keywords: *Accidental release, atmospheric dispersion, Argonaut reactor*

In the early days of nuclear energy in Brazil, a reactor named Argonaut, designed at Argonne National Laboratory, reached criticality at the Institute of Nuclear Engineering (IEN). Even though, the risk premium paid to IEN workers has been recently disputed by the National Office of Account Control. Thus, the aim of this study is to assess the radiological impact and potential risk from Argonaut reactor accidental releases. The damage caused by failure of a handling crane dropping concrete shielding covers (each weighing 2.5 tons) on the core would lead to breaking of the aluminum coating and the nuclear fuel plates with their release to the reactor hall. This paper evaluates the short-term effective dose rates by inhalation and plume immersion for workers and members of the public, which would be induced by inventory partial release to the atmosphere [1]. The effective dose is the primary quantity of radiation protection, which characterizes the exposure of an individual to both internal and external radiation sources in an independent manner from the individual's body related parameters (sex, age, physiology, etc.). The basic parameters of biokinetic models describing the fate of inhaled and ingested radionuclides to reference individuals, are used in the calculation of dose coefficients for the reference worker and members of the public [2]. The average effective doses and uncertainties for the 2-h period at several receptor distances for the Exclusion Area Boundaries (EAB) and Low Population Zone (LPZ), which are expressed in logarithmic scale for $mSv \cdot h^{-1}$ or $\mu Sv \cdot h^{-1}$, are shown in Figs. 1a and 1b. The radiological impact to workers becomes clear in this chart, which shows the incurred effective dose during the facility evacuation time (Figure 1a). These figures were 23 to 42, 14 to 25, and 8 to 15 mSv for workers located at 50, 75, and 100 m, respectively, considering class D and class E. These distances comprise all the buildings occupied by the workforce. The outer boundary at IEN's fence received 3 to 6 mSv at 150 m. The overall uncertainties remain at one order of magnitude, mostly associated with the deviations of releasing rates of radioisotopes and includes the range of dispersion factors for the stability classes.

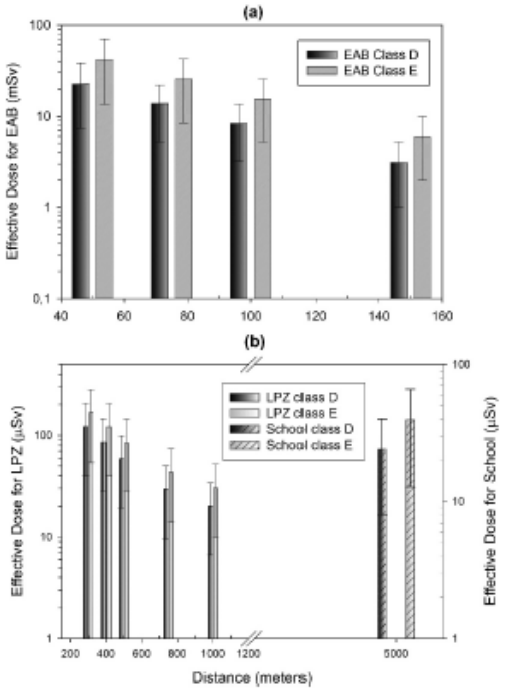

Figure 1. The effective dose and uncertainties to (a) EABs; (b) LPZ and 5-year dose at school.

The maximum dose from the Argonaut accident to the LPZ, was 0.28 mSv and the average dose was 31 μSv to individuals living outside the campus to a distance of 5 km (Figure 1b). This average corresponds to approximately the same dose of a 10-h airplane flight, half a chest X-ray dose or 330 times less than a CT scan. The conclusion is that potential risk remains above 1/10 of the limit of annual dose for workers while it stays below the transient levels for members of the public in unrestricted areas.

References

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