Sensitivity of Ambient Dose Equivalent to the Concentration of Cobalt Impurity Present in Stainless Steel

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Abstract

Stainless steels contain nickel in large amounts (~ 8 %) to improve its corrosion and heat resistance. Traces of cobalt are present in nickel, which are hard to separate because of its chemical similarity. Therefore, cobalt content in steel is restricted to a maximum of 2 parts per mille for applications in nuclear industry, as natural cobalt (composed of 100% Co-59) transmutes into highly radioactive Co-60 by absorbing a thermal neutron. Co-60 has a rather long half-life of 5.3 years decaying to stable Ni-60 by emitting 2 gammas of 1.17 MeV and 1.33 MeV during the process. These hard gammas will be mostly responsible for the dose rates seen in the next few tens of years. Therefore, it is important to consider the activation of cobalt in steel and estimate the dose contributed by it. Monte Carlo simulations are performed where stainless steel samples with different cobalt concentrations are irradiated with thermal and epithermal neutrons. The ambient dose equivalent, H*(10) from irradiated samples is found to be linearly proportional to the concentration of cobalt. This paper explains the motivation, the procedure, and the detailed results of the simulations.