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Electric Vehicle Batteries as Components of a Post Nuclear
Detonation Radiological Environment (EVNUDET)

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Abstract

EVNUDET focused on assessing radiological consequences of neutron activation in modern EV batteries and surrounding materials following a nuclear detonation. The study integrated Geant4 neutron-transport simulations, analytical activation calculations, and targeted irradiation experiments to validate models and quantify activation products, dose rates, and environmental impacts. Simulations assumed a thermal neutron fluence of 10^{12} n/cm². Activation is highly chemistry-dependent: NMC-811 and NCA chemistries produce substantial short-lived gamma-emitting isotopes, notably ⁵⁶Mn and ⁶⁴Cu, while long-lived isotopes such as ⁶⁰Co and ⁵⁹Fe occur at much lower activities. LFP batteries, lacking cobalt and nickel, generate minimal gamma activation but form ³²P, a strong beta emitter and the most significant long-term nuclide for this chemistry. Total induced activity in NMC/NCA packs reaches $\sim 10^9$ – 10^{10} Bq, whereas LFP packs are one to two orders of magnitude lower. Dose rates near activated packs are transient and localized: NMC/NCA surfaces may exhibit tens of mSv/h immediately post-exposure, while LFP remains far lower; at one meter, even high-cobalt chemistries typically fall below a few mSv/h. Activation of sodium-bearing soils and pavement dominates the radiation field in post-detonation environments. EV batteries can create localized short-lived gamma radiation fields, increasing exposure near the vehicle, but their overall contribution is minor compared to widespread activation of urban materials. Importantly, outside the vehicle, batteries do not present persistent radiological hazards.

Key words

Neutron activation, nuclear detonation, electric vehicle battery, dose rates