Analysis of Proliferation Resistance of Small Modular Reactors (SMR) for the Expansion of Civilian Nuclear Power Systems

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Abstract

Nuclear energy has the potential benefit to make an important contribution for mitigating greenhouse gas (GHG) emissions that cause climate change. Expanding nuclear energy capacity worldwide based on large centralized facilities poses many challenges and risks due to the large capital costs, important safety issues, obstructive public attitude, and persistent concerns about proliferation-that is, the intentional misuse of nuclear technology and material. SMRs, defined as units with a production capacity of less than 300 MWe, may represent a viable alternative to large reactors designs. Among many benefits, SMRs could allow for more proliferation resistant designs, manufacturing arrangements, and nuclear fuel-cycle practices at widespread deployment. In addition, some SMR designs may give rise to less public obstruction from the viewpoint of safety. A principal SMR advantage includes its installation in smaller grids typical of electrical power systems in developing countries. It is observed that there is limited work evaluating the proliferation resistance of SMRs, and existing proliferation assessment methods for large nuclear reactors designs are not well appropriate for these novel arrangements. The objective of this study is to conduct a proliferation resistance evaluation for future nuclear energy deployment driven by SMRs. We develop the scenarios to investigate relevant technical and institutional features that are postulated to enhance the proliferation resistance of SMRs. Different aspects of SMR designs such as: core-life, refueling, burnup, enrichment, fissile material inventory, excess reactivity, fuel element size, breeders etc. are discussed in the context of proliferation concerns.

Key words: Nuclear energy, SMR, designs, proliferation, resistance, core-life