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Environmental and Safety Studies for Advanced Fuel Cycle Fusion Energy Systems: The ESSENTIAL Approach

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Abstract : In the US, the SPARC-ARC projects of compact tokamaks are being developed: both are aimed at the technological demonstration of fusion power reactors with cutting-edge technology but following different design approaches. However, they show more similarities than differences in the fuel cycle, safety, radiation protection, environmental, waste and decommissioning aspects: all reactors, either experimental or demonstration ones, have to fulfill certain "essential" requirements to pass from virtual to real machines, to be built in the real world. The paper will discuss these "essential" requirements. Some of the relevant activities in these fields, carried out by our research group (ESSENTIAL group), will be briefly reported, with the aim of showing some methodology aspects that have been developed and might be of wider interest. Also, a non-competitive comparison between our results for different projects will be included when useful. The question of advanced D-He3 fuel cycles to be used for those machines will be addressed briefly. In the past, the IGNITOR project of a compact high-magnetic field D-T ignition experiment was found to be able to sustain limited D-He3 plasmas, while the Candor project was a more decisive step toward D-He3 fusion reactors. The following topics will be treated: Waste management and radioactive safety studies for advanced fusion power plants; development of compact high-field advanced fusion reactors; behavior of nuclear materials under irradiation: neutron-induced radioactivity due to side DT reactions, radiation damage; accident analysis; reactor siting.

Keywords : advanced fuel fusion reactors, deuterium-helium3, high-field tokamaks, fusion safety
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