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Licensing Challenges for Risk-Informed Small Modular Reactor Designs in European Deterministic Regulatory Frameworks

Small Modular Reactors (SMRs) represent a promising advancement in nuclear technology, offering enhanced safety features, scalability, and flexibility compared to traditional large-scale reactors. The use of passive safety features combined with the lower source term make an SMR inherently safer than a large Nuclear Power Plant (NPP) and opens the possibility for optimization of the design through a graded approach. Explicit guidance for the grading down of SMR related requirements and recommendations is lacking. Certain SMR-designs have used a risk-informed approach to achieve an overall optimization of safety measures, supporting the effective and balanced implementation of the defence in depth concept. However, their deployment faces significant licensing challenges in countries with deterministic regulatory frameworks, which prioritize prescriptive safety standards over risk-informed approaches. This paper explores the complex interplay between risk-informed design methodologies and deterministic regulatory requirements in the licensing process for SMRs. It examines the tension between the desire for innovation and the regulatory imperative for rigorous safety assurance, highlighting a balanced approach that integrates risk assessment principles into existing regulatory frameworks. Through a comparative analysis, this paper identifies key barriers and licensing challenges associated with risk-informed SMR designs within deterministic regulatory environments. Additionally, it underscores the importance of stakeholder engagement, regulatory harmonization, and knowledge sharing to foster a conducive regulatory environment that promotes the safe and efficient deployment of SMRs while ensuring regulatory compliance.

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