



Contribution ID: 178

Type: **Wedge Participant**

International Safeguards for Microreactors: Opportunities and Challenges for the International Atomic Energy Agency

The last 15 years have witnessed increased investment in small-modular reactors (SMRs) as a cost-effective, flexible, and potentially safer alternative to large-scale nuclear generation. Part of this trend has been renewed interest in a sub-category of ultra-small SMRs known as microreactors, which produce no more than 10 MWe. Many microreactor designs embrace novel features or operation concepts, including rapid deployment, easy transportation of main components or an entire unit, unattended operation, minimal onsite fuel storage, or factory construction and refueling. These reactors may be particularly useful for remote operating locations, low-capacity electric grids, or when reactor transportability is required.

Since these features would mark a considerable departure from current nuclear power plant (NPP) design and operations, it is important to evaluate how microreactors may affect the International Atomic Energy Agency (IAEA) safeguards system. This paper reviews current and historical microreactor concepts from the open literature and then performs a deep-dive safeguardability assessment of the 4 MWe U-Battery high-temperature gas reactor design. It examines how low nuclear material quantities, long refueling intervals, and sealed storage locations typical of microreactors may affect inspections, while evaluating how Safeguards-By-Design might help to address potential IAEA needs.

Beyond these technical questions of safeguards implementation, microreactors may also affect safeguards at broader systemic and policy levels. For example, a widespread deployment of microreactors could require substantially greater safeguards resources than a similar generating capacity concentrated at large NPPs. Traditional IAEA practices for design information reporting and verification might not apply well to mobile, factory-fabricated reactors. And simplified reactor designs—fabricated, delivered, and possibly owned and operated by a foreign supplier state—may lower the barriers-of-entry to nuclear power development. This could compress the development milestone process for nuclear newcomers or lead to novel regulatory concepts. This paper examines how the Agency might address each of challenges through existing authorities and implementation of new technical or policy approaches.

Which "Key Question" does your Abstract address?

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Topics

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Session Classification: [NEW] The Safeguards Challenges of New and Advanced Reactors

Track Classification: Preparing for safeguards new facilities, processes and campaigns (NEW)