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### ► **To cite this version:**

Anne Saturnin, François Sudreau, Christine Chabert-Koralewski, Virginie Wasselin, Robert Mandoki. SMR/AMR waste assessment: an analysis methodology proposal. GLOBAL 2024 - International Conference on Nuclear Fuel Cycle, Oct 2024, Tokyo, Japan. cea-04711363

**HAL Id: cea-04711363**

**<https://cea.hal.science/cea-04711363v1>**

Submitted on 26 Sep 2024

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# SMR/AMR waste assessment: an analysis methodology proposal

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The paper focuses on type of waste produced by power reactors and SMR/AMR (Small Modular Reactor, Advanced Modular Reactor). An assessment methodology is proposed to analyse and compare advantages and disadvantages of the different SMR/AMR concepts (PWR, SFR, HTGR and MSR) in terms of radioactive waste management. This approach focuses on the entire lifespan of reactors and on fuel management, based on the experience acquired in French waste assessment studies for high-power reactors and associated nuclear fuel cycles.

Keywords: SMR, AMR, radioactive waste management

## Introduction

Nowadays, different companies develop many SMR/AMR concepts (Small Modular Reactors/Advanced Modular Reactors). Their use can be electricity, but also heat, hydrogen... production or even cogeneration. They concern concepts with various maturity levels like pressurized or boiling water reactors, fast neutron reactors (with sodium or lead coolant) or high temperature reactor (with gas coolant) and molten salt reactor. Each of these concepts has its own specificities that might lead to specific waste production during operation or decommissioning phases. Comparison criteria between these concepts can be multiple like their future use, their safety conditions, their economic competitiveness but also their spent fuel management and radioactive waste production during operation and decommissioning steps.

## Context/Assumptions

The various SMR/AMR concepts are analyzed here from the point of view of radioactive waste management. The management of waste from PWR-like reactors, with the largest feedback in the world, can vary according to the spent fuel strategy considered (reprocessing and recovery of reusable materials such as uranium and plutonium or direct disposal of spent fuel). The example of waste generated by SFRs using oxide fuels is also discussed [1].

More innovative concepts are also described in terms of waste, such as high temperature gas reactors (coated fuel particles (e.g. TRISO) dispersed in graphite matrix, helium coolant, graphite moderators with limited experience feedback), lead fast reactors (lead coolant) and molten salt reactors (liquid fueled system, various design concepts, highly corrosive reactor environment with no industrial scale experience) [2, 3].

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## Results and Discussion

We propose a few principles in order to develop comparable waste assessments between reactor concepts and sizes. Many assumptions must be made and clearly explained in order to get answers to the following questions on waste management.

In order to facilitate comparison, the first question will concern the choice of metrics for the quantification of waste production and their expression in normalized units related to the provided service.

Another question is related to the location for taking into account the national regulations for the cycle, the decommissioning, the waste strategy. The envisaged fuel cycles or plant lifetime might also be important to define boundaries between operation and decommissioning.

To be complete, this approach must be associated to the impact study on the entire fuel cycle to identify front and back-end waste and specific issues expressed in terms of material, quantity, nature, operation and long term safety aspects.

The compatibility of waste form(s) to be produced with disposal solution(s) (with/without treatment) must also be considered: does the demonstration for compatibility needs to develop a R&D program? Is there a need to extend existing disposal capacity and/or to develop new capacity?

## Conclusion

The proposed approach can be described as an integrated Waste Management approach by design in order to obtain an overall vision of the impact of the SMR/AMR concepts on the entire fuel cycle (front and back-end; transportation). To avoid creating a new burden for the next generations, the focus should be set on the anticipation of waste assessment: we proposed here a consistent methodology for SMR/AMR waste and disposability assessment in the concerned country based on different questions (how many; where; when and what are the specific issues related to disposal concepts?).

## References

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