

Title: “Expectations vs engineering readiness for the implementation of AI for the Design and operation of Advanced Nuclear Reactors in the next 20 years.”

Type of event: Online Workshop

Date: September 8 and 9, 13.00h – 17.00h

Organized by: CENWS064 – Phase 4 and the Joint Research Centre of the European Commission.

Context: There are expectations that AI, and Machine Learning in particular, will support design and deployment of Advanced Modular Reactors (AMRs). AI/ML has entered as a tool for accelerated and more cost-effective methods for material/component qualification, in-service inspection and component life assessments. In the last decade there has been tremendous development which has raised the expectations for using AI/ML. The question is to what extent can we expect ML to be integrated in engineering methods and if there is regulatory acceptance for advanced nuclear reactors and what is actually being implemented. To this end we would like to organize an informal online Workshop to broaden the discussion.

Objective: The key objective of this Workshop is to explore expectations vs engineering readiness for the implementation of AI/ML for the design and operation of advanced reactors. The key time-dependent degradation mechanisms are: creep, fatigue, irradiation and corrosion. These are all long-term degradations, and data are limited (even non-existent for novel materials and advanced manufacturing) so extrapolation is the key challenge. Moreover, it is necessary that designers, material experts and AI experts are involved and can work as one. Fundamental questions that require a shared language include:

1. Conceptual approach how could ML and qualification interact?– both directions.
2. The environmental challenges high-temperature, loads, coolant and irradiation and their couplings;
3. Extrapolation to long-term operational conditions (the core ML problem)
4. Where does ML helps – and where is it risky;
5. Readiness across 0-20 years;
6. Collaboration bottleneck designers – materials – AI as one team.

Specific questions that could be addressed by expert panelists:

1. For component life prediction for safety critical components, is the right target a *better predictive model*, or a *better-quantified uncertainty* around a physics model we already trust?
2. What is the minimum a regulator would need to accept an ML-informed allowable — and is anyone close?
3. Where should the next decade's scarce test budget go: generating data for ML, or generating data to *validate* ML's extrapolations? (They're not the same.)
4. Which degradation mode should be the pathfinder case, and why?

The Workshop consists of invited expert presentations and expert panel discussions. The audience will have the opportunity to interact with presenters and panelists through the chat function. A pre-registration is required to attend this event. In case of a large number of participants the number of participants may be limited.

Organizing Committee:

- **Technical:** Karl-Fredrik Nilsson, JRC/AM&C&S AB, Celine Cabet, CEA; Cécile Petesch, CEA/AFCEN; Nawal Prinja, CORDEL
- **Organizational:** Aralda Torres Serano (JRC), Alice Seibert (JRC), Bianca Hirte (JRC)

For additional information, please contact: JRC-G4-WORKSHOPS-AND-EVENTS@ec.europa.eu

Tentative Agenda

Below is a tentative agenda. We may accommodate some additional presentations (to be confirmed).

Day 1: September 8, 13h -17h CET

Technical presentations (30 minutes including questions)

- Introductory presentation K-F Nilsson, JRC/AMR C&S AB, Sweden
- Material qualification: Physics informed ML for creep fatigue & irradiation life assessment under RCC MRx: lessons from ITER to AMRs, M Ortiz de Zuiniga, F4E, Spain
- Extrapolating creep properties including uncertainty analysis with a combination of physics-based models and ML, Marc Messner ANL, USA
- Overview of the DIAMOND platform focusing specifically on the AI tools, F. Willaime, CEA, France
- "Smart Engineering: AI for the Next Generation Nuclear Reactors", Nawal Prinja, Cordel, UK
- Additional presentation (TBC)
- Panel Discussion

Day 2: September 9, 13h -17h CET

- New activities aligned with that database generation from pdf reports, high throughput corrosion tests in molten salts, development of ML interatomic potentials... C. Degranges, CEA, France (TBC)
- Accelerated irradiation and corrosion materials testing and qualification: high-throughput experiments and ML workflows to support alloy design for advanced reactors, A. Couet, U. of Wisconsin, USA
- AI for Nuclear Power Plant Inservice Inspections, R. Jacob, PNNL, USA
- Regulatory grade data & model governance: making AI/ML evidence usable for AMR qualification and life assessment, M. Ortiz de Zuiniga, F4E, Spain (topic to be confirmed)
- Additional presentation, (TBC)
- Additional presentation (TBC)

- Panel Discussion
- Concluding Remarks

The proceedings including Abstracts, if available the presentations, and the conclusions will be prepared after the meeting and published as an official JRC report.