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**RE: NIRAB Advice to Regulators on Phase B of AMR RD&D programme**

Dear Greg,

I write in response to your request for advice from the Nuclear Innovation and Research Advisory Board (NIRAB) on the technical engagements that the Regulators will have with the vendors engaged in the Advance Modular Reactor Research, Design and Demonstration Phase B programme (AMR RD&D). This letter serves as an update to the advice that the Board has previously provided regarding Phase A of the programme in July 2022, whilst recognising that a further Phase C is likely to be initiated in the near future.

We note that as regulators you are constrained by resource and anticipate having a limited number of engagements with the vendors. We also recognise the scope and purpose of the Phase B programme, in that the RD&D identified should be of value to the further advancement of AMR technology in the UK, and should be considered “no-regret” from a funding perspective. Lastly all RD&D undertaken should help facilitate deployment of AMR technology to meet the government’s 2050’s delivery timescale. Hence, the Board has given your request for support careful thought and offers high level advice in this letter which I hope that you will find useful.

In NIRAB’s view, the discussion with the vendors should focus on those regulatory aspects that are novel for Advanced Reactors and different to current generating systems. Within the context of the pressing dual challenges of energy security, and net zero by 2050, in NIRAB’s view important areas for RD&D consideration include:

- 1) Fuel:** Recognising that many of the AMRs are designed to operate using fuels that are not commercially available in industrial quantities in the UK, we believe it is vital for vendors to understand the fuel qualification process and the verification and validation of their chosen fuel route, including opportunity to address regulatory guidance for the associated supply chain. In addition, the vendors will need to have a comprehensive understanding of any safety claims associated with the fuel, its anticipated performance, how it behaves post irradiation, in accident situations, and finally disposal arrangements. Furthermore, we believe the AMR R&DD projects will need to have independently made the case for the integrity of their fuel of choice as well as graphite, and not rely solely upon the US AGR programme. Consideration of models available to the Designer and independent models for the Regulator may be useful given the length of time to develop and qualify such codes.



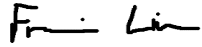
- 2) **Core, moderator and cooling circuits;** AMRs may utilise new coolants and/or moderators. In-core inspection and associated instrumentation used to monitor their performance must be considered. This is particularly relevant given there may be through-life refurbishment of the core. Understanding the process for inspection, replacement/ replenishment during routine maintenance, particularly the use of robotic technology during the necessary periods of outage, will be important. Additionally, the behaviour of He (and molten salt if appropriate) in a hot coolant environment is required as this is a key differentiation from existing reactors. The potential generation of graphite dust (which will have some crossover with the UK's Magnox and AGR fleets) should be understood by vendors to substantiate their understanding of the key reactor components.
- 3) **New/different safety systems:** Addressing the maturity of passive safety claims, autonomous operations and novel instrument control systems early on is important for substantiating new safety claims. We are mindful that a First-of-a-Kind/ Demonstrator reactor may require more safety systems to mitigate limited evidence of reliability and will likely also need more monitoring systems than the subsequent fleet. Discussion on how this could be progressed may be helpful.
- 4) **Accident tolerance:** Determining the operational and accident performance of the reactor (and fuel) in the context of a very different use case to historic reactors in accident conditions will be needed to underpin emergency planning and risk management processes. We believe that vendors will need to be able to model and prove appropriate code validation, (including nuclear and conventional thermal hydraulics to do this).
- 5) **Whole lifecycle substantiation (fuel enrichment, production, reactor operation, waste management):** Understanding the whole lifecycle for an advanced reactor system will require many considerations. At present we feel there should be particular focus on the substantiation of materials at high temperatures for long periods of time, and on the operating lifecycle/ maintenance schedule/ core replenishment from a safety-case perspective. Consideration of fuel disposability cases will be made in GDA or equivalent under Nuclear Site Licencing and Permitting. Plant that uses single cycle graphite reflectors may imply a change in waste disposal strategy for the UK and there are other waste management and decommissioning challenges which the vendors will need to address including on-site waste storage, transport and waste form behaviour.
- 6) **Integration of end-use:** Addressing features and hazards connected to the ambition for AMRs to target harder-to-decarbonise industries through output heat and/or hydrogen as well as electricity is required. We would suggest that the Design Briefing & Licensing Readiness Review occurs across the Plant, including a realistic definition of how a use case technology would be integrated with the reactor outputs, and how any hazards it would present will be addressed, with the onus on the vendor to show how the design is substantiated.

NIRAB is mindful of the need for vendors to reach a point of equivalence with GDA Step 2 entry by the end of Phase B. An assessment of organisational capabilities as well as skills development strategies is important for becoming both a Requesting Party and Responsible Designer. We note it is likely there will be re-use of submissions from other countries in the AMR RD&D/GDA process and that vendors will need to explore harmonisation between design assessment processes and streamline assessments. NIRAB will continue to follow



the progress of the AMR RD&D Phase B programme and would welcome an update on the regulatory aspects from our observers as appropriate.

Kind regards,



Professor Francis Livens (Chair, Nuclear Innovation & Research Advisory Board)

