Advanced Nuclear Skills Innovation Campus

GAMECHANGERS
DELIVERING NUCLEAR INNOVATION

Department for Business, Energy & Industrial Strategy

Challenge: Irradiation of Material Specimens in Advanced Nuclear Reactors

Delivered by

FIS 360
INNOVATION | TECHNOLOGY | BUSINESS

NATIONAL NUCLEAR LABORATORY

Summary

The design and development of advanced nuclear reactors offers a unique opportunity to develop technologies that can harness some of the energy produced to be used for irradiation of material specimens, without affecting primary reactor operations for power generation. This may include, but is not limited to, targets and specimens for irradiation research, medical isotope production, materials development, and materials processing and recycling.

On behalf of the Department for Business, Energy and Industrial Strategy (BEIS) and the National Nuclear Laboratory (NNL), Game Changers are inviting proposals for innovative technologies that will enable the controlled irradiation of material specimens in nuclear reactors which are being simultaneously used for power generation. Solutions should take into consideration safe and secure integration into a range of advanced nuclear reactor designs, with regard for factors such as: how to introduce material into the reactor, control irradiation, remove material and extract samples. Subsequent sample preparation for transportation should be assumed to be undertaken in facilities located at or close to the reactor within appropriate timeframes.

These secondary target irradiation activities must not affect long-term continuous reactor operation.

Background

This call is part of a short pilot of the Advanced Nuclear Skills and Innovation Campus (ANSIC), delivered by NNL on behalf of BEIS, as part of the UK Government's commitment to the continued development of advanced nuclear technology to help the UK reach net zero emissions by 2050.

The pilot campus programme, with a physical base near Preston on the Springfields nuclear licensed site, will serve as a research and innovation hub. ANSIC aims to support industry and academia to work on projects designed to help accelerate the deployment of advanced nuclear technology.

The pilot programme will help to build an informed, reliable evidence base to:

- establish future demand and scope for future initiatives
- identify opportunities for industry collaboration and the practical challenges of delivering campus activities on a nuclear licensed site

The UK Government has committed to significant investment in the development of Small Modular Reactors (SMRs) and Advanced Modular Reactors (AMRs) as part of the transition to a low carbon economy. In July 2021, the Government also announced plans to explore the potential of High Temperature Gas Reactors (HTGRs) to enable an AMR demonstration by the early 2030s, to support net zero by 2050. As part of the delivery of the pilot phase of ANSIC, a series of challenge-led calls offers applicants the opportunity to receive a feasibility funding grant of up to £25k to develop ideas or technologies applicable to any potential advanced nuclear technologies.

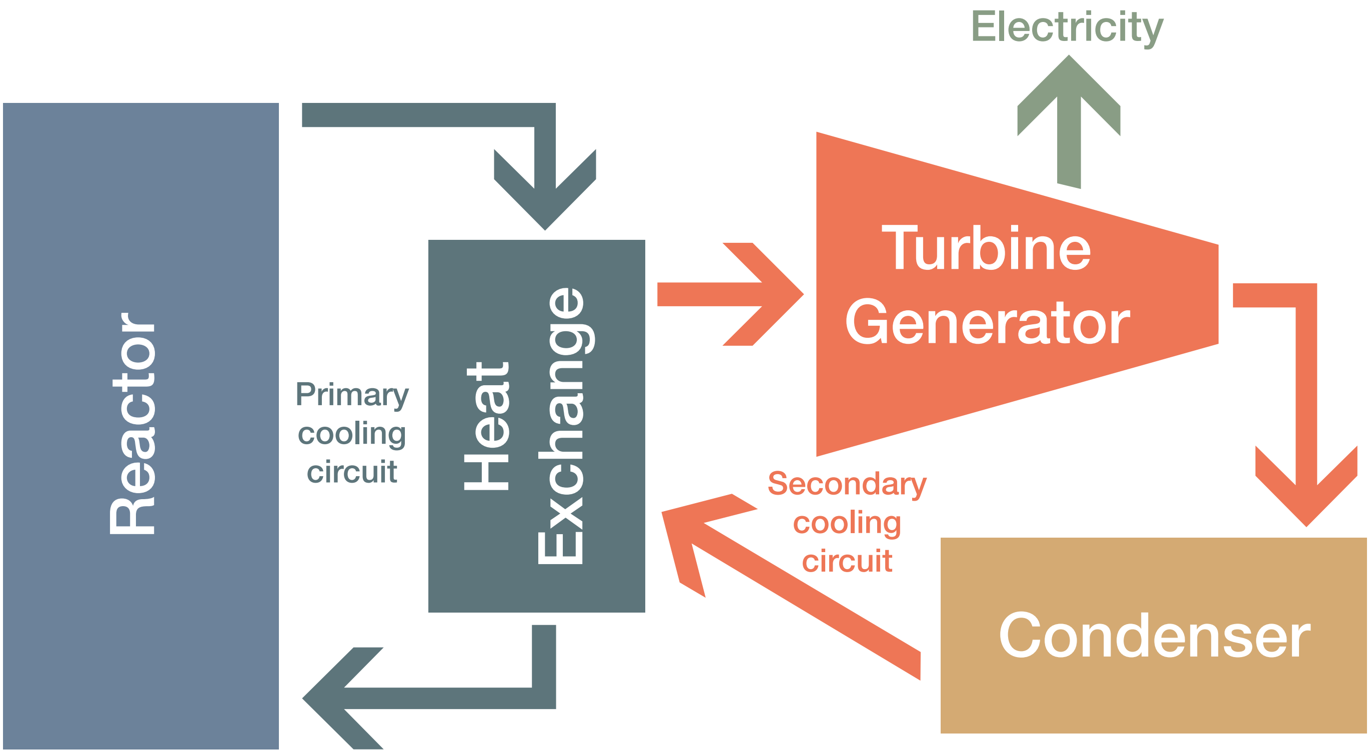
Feasibility funding is aimed at supporting the exploration and development of novel ideas and concepts. Typical activities within a feasibility project can include desk-based studies, development and production of small prototypes, and demonstrations.

Funded feasibility projects should be carried out at the applicant's own premises, and these calls do not include access to the ANSIC campus. **All agreed project tasks and final reports must be completed by 25th March 2022.**

Introduction

The development of SMRs and AMRs provides an opportunity to consider the potential of nuclear reactors to irradiate material specimens without reactor downtime. This is very difficult in currently active nuclear reactors for power generation due to conflicting operational requirements. For example, production of radioisotopes for medical applications requires short, controlled exposure to radiation (e.g. a number of hours to a couple of days), whereas commercial reactor operation for energy generation requires long periods of operation without shutdown (e.g. up to 18 months).

While SMR and AMR reactor designs may vary, the basic key components of the system remain unchanged, and are illustrated in Figure 1.



In addition to technologies enabling the irradiation of medical specimens in advanced nuclear reactors, there is significant interest in proposed solutions that could be used or adapted for other specimen types, extending the value of the technology integration with SMRs or AMRs. Examples of other applications may include use of the technology to enable radiation from the reactor to be used for irradiating materials testing specimens and target fuel samples, and for chemical and materials processing, for example to break down and recycle oils or plastics into other useable materials.

Current Practice

Nuclear irradiation activities for research, specimen testing, and other applications such as medical isotope production, are currently carried out in specialist research reactors. These reactors are located outside the UK, with a dedicated workforce and associated high costs of operation and transport of specimens. Many of these specialist reactors were built in the 1950s and 1960s and are reaching the end of their lifespans, requiring more frequent interventions for maintenance and repairs, with associated reactor shutdowns affecting availability[1].

Radioisotopes are essential tools in medicine, used for diagnostic and therapeutic applications. Due to their short half-lives, they cannot be stored for extended periods or stockpiled, and therefore a secure and stable supply chain is essential.

Challenge Aims

The desirable outcomes of this challenge include the advancement of novel technologies that have the potential to enable controlled irradiation of test specimens and/or the production of medical isotopes. The aim would be to enable activities typically carried out in research reactors to be conducted within nuclear reactors without affecting primary reactor operations for power generation.

Solutions should take into consideration safe and secure integration into a range of advanced nuclear reactor designs, with regard for factors such as how to introduce material into the reactor, control irradiation, remove material, extract desired end products, and prepare specimens for transportation at or close to the reactor.

Whole system solutions are not required. Individual technologies that address specific factors within the process of irradiating specimens in advanced nuclear reactors are welcomed.

[1].POSTNOTE Number 558 July 2017 Supply of Medical Radioisotopes available on https://post.parliament.uk/research-briefings/post-pn-0558/

In the wider advanced nuclear reactor and technologies markets, there are a number of ongoing reactor design and development programmes which range greatly in timescale. Whilst there is no defined timescale for the proposals received in response to this challenge to achieve its aims, proposals should make reference to any reactor or demonstrator development programmes they align with, and at what stage in their lifecycle. Proposed solutions should also indicate the potential quantities of material that could be irradiated.

Benefits

Incorporating additional specimen irradiation processes within advanced nuclear reactor design could bring further advantages in overall reduction of energy use, and a reduction in transport costs and environmental impact in comparison to building further dedicated research reactors.

There is a significant opportunity to develop advanced nuclear reactor technology to incorporate localized, secure and stable production of medical isotopes

Exploiting the radiation energy within a reactor system to provide additional benefit has the potential to open up new opportunities for using this resource.

Constraints

Constraints include:

Safety – Additional irradiation activities must not impact on the safe and continuous operation of the reactor for its primary purpose (power generation).

Scalability – Proposed solutions should be scalable to different reactor designs.

Security – Proposed ideas and technologies should not increase nuclear security risks.

Functional Requirements

As there is currently a wide range of advanced nuclear reactor designs under development, proposed solutions should consider ease of implementation across a range of advanced nuclear reactor designs.

Solutions should include technologies that would enable a process for specimen irradiation that is repeatable, predictable, controllable, and able to be switched on or off to meet demand.

Solutions related to medical isotope production should take into account the need to prepare specimens for transport at or close to the reactor within timescales appropriate to their half-lives.

Consideration should be made of the overall footprint of equipment external to the reactor, such that it can readily be incorporated into overall power plant design.

What Next?

Game Changers are hosting an online briefing webinar for this challenge. Details of the webinar will be available on the Game Changers website www.gamechangers.technology. If you have new ideas or innovations which can be applied to address this challenge we invite you to join us.

Please visit our FAQs for ANSIC on the website for answers to some commonly asked questions, or contact us on apply@gamechangers.technology if you have further queries about this call.

Applications must be submitted using the Game Changers online application portal. This includes a short application form and a requirement for a poster outlining the proposed solution.

The deadline for applications for this challenge is **12 noon on Friday 12th November 2021.**

Assessment of applications

Submissions will be assessed by a panel and written feedback will be provided by Game Changers for all applications, whether or not successful. The panel will comprise members of the ANSIC Steering Group, which includes representatives from NNL, BEIS and the Nuclear Innovation and Research Office (NIRO).

Application forms and posters will be assessed consistently and transparently using the following criteria:

1. Clarity of project objectives and alignment to the challenge aims
2. The level of technical innovation involved in the proposed work
3. The skills, capability and capacity of the applicant team to deliver the proposed project
4. Value for money
5. Identification of risks and mitigating actions

Key dates

Date	Activity
30th September 2021	**Call Opens.**
22nd October 2021 (TBC)	**Briefing Webinar. Registration via Eventbrite.**
12th November 2021	**Call Closes at 12 noon.**
W/C 22nd November 2021	**Panel Review of Proposals.**
W/C 29th November 2021	**Notification of Panel Decisions and Feedback.**
W/C 6th December 2021	**Project Kick-off Meetings.**
December 2021 – March 2022	**Project Work in Progress.**
25th March 2022	**All Project Work and Final Reporting Completed.**

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