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**Accelerating deployment of artificial intelligence in nuclear installations,
focusing on use of AI to analyse, interpret and categorise data**

ONR Innovation (contact: [REDACTED])

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1. What are the aims of your project?

Context

The Office for Nuclear Regulation (ONR) and the Environment Agency (EA) recognise that artificial intelligence (AI) could be used in nuclear installations to:

- Support the UK government's growth agenda on nuclear, including its net zero ambitions, by delivering faster and more predictable regulatory outcomes;
- Accelerate hazard and risk reduction for legacy facilities through innovative approaches; and
- Provide benefit from a nuclear safety, security, conventional health and safety, and environmental perspective.

As nuclear regulators, ONR and EA are conscious of their role in enabling implementation of innovative approaches, including AI. The regulators are working together to realise this potential, by increasing their understanding of the technologies and how they could support regulatory activities.

Examples of completed and ongoing ONR and EA collaborations include:

- Regulatory sandbox pilot on AI in nuclear¹;
- Targeted research on regulating AI and machine learning (ML) in the nuclear industry (phase 1 completed²; phase 2 in progress);
- Collaboration with other UK regulators to reduce risk of regulatory fragmentation and share best practices (through involvement in the UK Health and Safety Regulators' Network's (UKHSRN) subcommittee on AI and innovation, as well as the UK National Committee on Robotics and Autonomous Systems (RAS));
- International engagement with peer regulators to align expectations and prevent unnecessary duplication (e.g., ONR and EA's work with US NRC and CNSC³, and ONR chairing International Atomic Energy Agency TECDOC on the safety and security implications of AI in nuclear); and
- Exploring other opportunities (e.g., ONR and EA are members of the Nuclear Energy Agency's RegLabs management board, supporting three international regulatory

¹ Regulators' Pioneer Fund (Department for Science, Innovation and Technology): Pilot of a regulatory sandbox on artificial intelligence in the nuclear sector [Outcomes of nuclear AI regulatory sandbox pilot published | Office for Nuclear Regulation](#)

² Adelard, 2021. The Impact of AI/ML on Nuclear Regulation [onr-rrr-121_redacted-1.pdf](#)

³ [New paper shares international principles for regulating AI in the nuclear sector | Office for Nuclear Regulation](#)

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sandboxes on the use of AI in nuclear; ONR is also a member of the steering committee for the IAEA ISOP⁴).

Whilst there is consensus both nationally and internationally on the potential of AI in nuclear, currently there are only limited examples of deployment in active applications on nuclear installations, particularly using AI to support safety-related functions.

Aim

The purpose of this proposal is twofold:

1. To accelerate the safe and secure deployment of AI in nuclear installations, through engagement between nuclear regulators, licensees and AI experts on examples of high-impact applications to support the UK Government's nuclear industry ambitions; and
2. To support a responsible and gradual shift of focus from applications with low autonomy and safety significance (star in Figure 1) to beneficial applications of higher autonomy and safety / environment significance of failure (shaded area on centre-left of Figure 1).

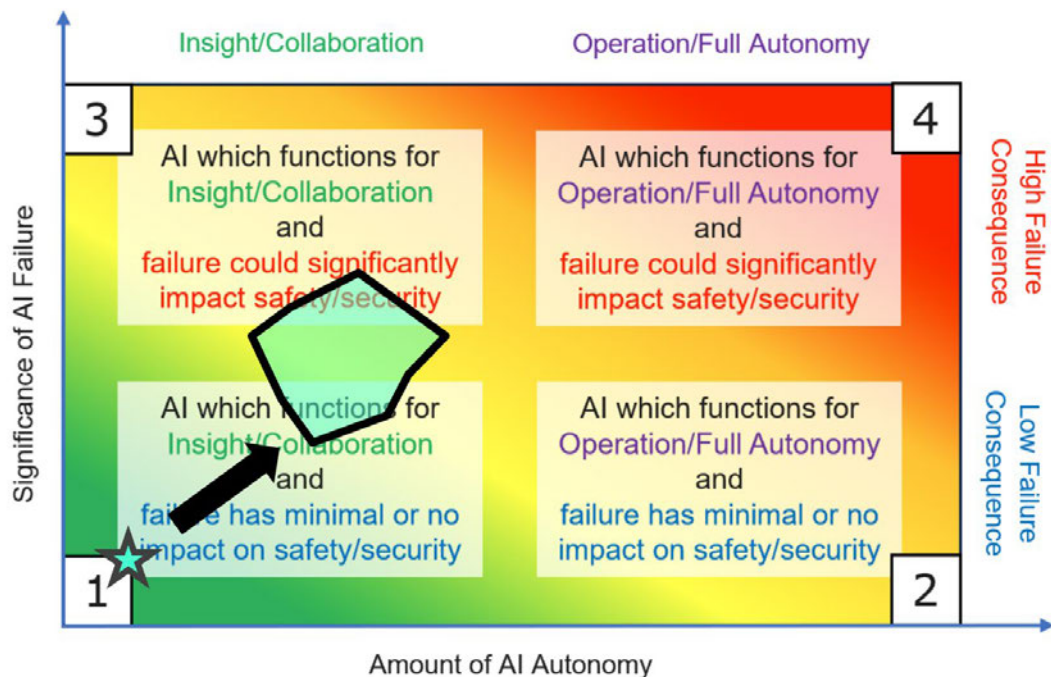


Figure 1. Four box model illustrating the purpose of this proposal (from ONR/US NRC/CNSC trilateral⁵ paper).

This work will build on ONR and EA's previous work in AI regulatory sandboxing⁶, taking into account its learnings and key recommendations. It will target AI applications related to data and image analysis and classification, considering their technological readiness for deployment and

⁴ The International Network on Innovation to Support Operating Nuclear Power Plants [Home](#)

⁵ [New paper shares international principles for regulating AI in the nuclear sector | Office for Nuclear Regulation](#)

⁶ Regulators' Pioneer Fund (Department for Science, Innovation and Technology): Pilot of a regulatory sandbox on artificial intelligence in the nuclear sector [Outcomes of nuclear AI regulatory sandbox pilot published | Office for Nuclear Regulation](#)

the specific strengths of AI in pattern recognition and categorisation. As part of this, two test cases of interest to the UK nuclear industry will be considered in a nuclear regulatory sandboxing environment:

1. Use of AI in non-destructive testing (NDT), e.g., interpretation of weld radiographs; this is of interest to new build and operating facilities, including defence; and
2. Use of AI for nuclear waste characterisation, including sorting and segregation of intermediate-level waste (ILW) items from low-level waste (LLW) items, as well as determining waste properties, e.g., sludge rheology and radiological property; this will support optimised waste management and is of interest to the nuclear decommissioning and waste management industries.

Both applications could provide significant benefits in terms of new build acceleration (considering the amount of welding necessary as part of the construction of new reactors) as well as efficiency in waste management (with an estimate of several hundreds of millions of pounds in savings from more efficient characterisation of waste alone⁷). They also offer safety and environmental benefits, e.g., opportunities for improved radioactive waste management and reduced dose exposure of operators.

Programme outline

A high-level outline of the work programme is presented in Figure 2, which summarises the sequencing of the activities to support the preparation of the project summary report by the end of March 2026 (based on the assumption that formal approval of funding is granted by Regulatory Innovation Office (RIO) by end of July 2025). This project will be delivered through collaborative regulatory and industry sandboxing focusing on the two test cases, with different challenges in terms of the AI/human interface (e.g., independent check of the AI sentencing by an operator) and safety significance (failure mode and consequences of AI).

The value added by this work is the development of a proportionate approach to the gradation of different AI applications. An initial workshop with experts in the field will provide a baseline for the technical discussions on assurance of AI between different stakeholders. Ahead of the sandbox deep dives for each test case, ONR and EA will work with relevant external stakeholders to develop outlines of mock safety cases, with a focus on claims and arguments about a specific application, to support discussions of concrete examples relevant to the nuclear industry.

⁷ Lockwood (Sellafield Limited) *et al*, A Study on the Application of Artificial Intelligence/Machine Learning to Determine Sludge Consistency and Rheological Properties through Computer Vision, WM2025 Conference, March 9 – 13, 2025, Phoenix, Arizona, USA.

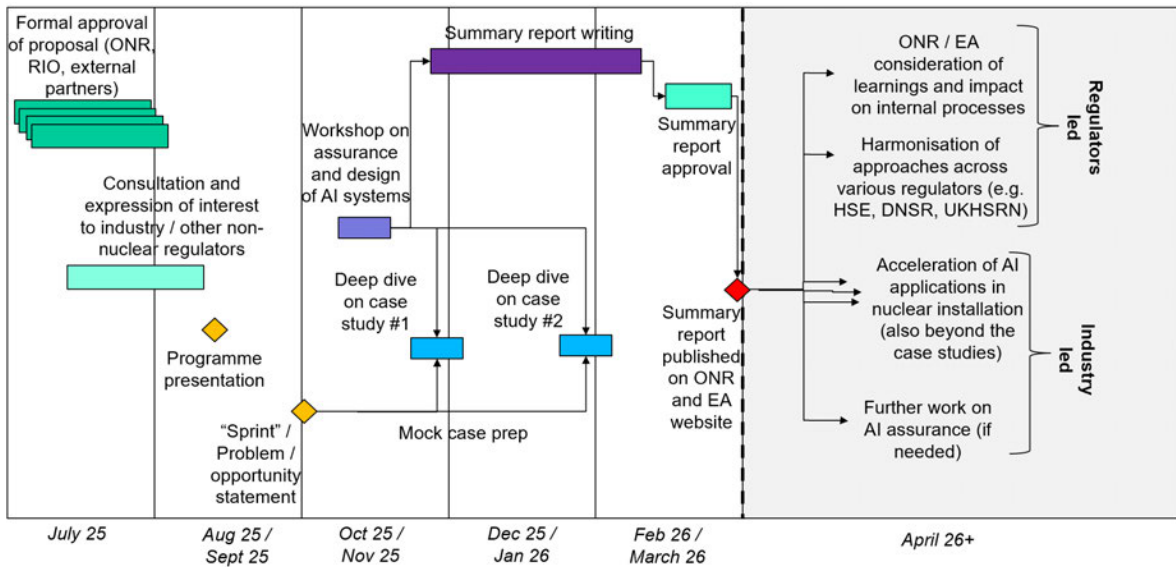


Figure 2. Outline of the project plan.

Considering the compressed timescale of this funding opportunity, project risks and mitigations are presented in Annex 2 of this proposal.

Benefits

The benefits of this project are:

- Acceleration of AI deployment to support applications with high cost or schedule benefits to the nuclear industry, by proactive engagement of the nuclear regulators with the industry and key stakeholders on concrete test cases in a regulatory sandbox. The scope of benefits will include operating facilities, new build and decommissioning, and fuel waste management;
- Acceleration of other AI applications in nuclear (beyond test cases), by facilitating changes in mindset on innovation, particularly risk aversion, e.g., by discussing real and perceived regulatory barriers and identifying enablers to support AI deployment (see Figure 1);
- Increased technical understanding of AI assurance practices, through ONR and EA engaging with contractors with cutting edge AI expertise;
- Strengthening cooperation between UK nuclear regulators and other relevant regulators, reducing the risk of regulatory fragmentation and facilitating learning across sectors; and
- Strengthening cooperation between UK nuclear regulators and innovators, through direct engagement and collaboration across the sandbox deep dives and broader consultation.

2. How do your project aims align to our policy rationale, particularly the focus on AI?

The aims of this project align with the objectives of RIO funding as follows:

RIO funding objective	Project aim
“Support or explore initiatives to develop the regulation of Artificial Intelligence in the UK.”	To develop, inform and enable nuclear regulators’ capability to regulate AI applications proportionately and effectively, by working with recognised experts in the sectors and other regulators on practical test cases in a safe environment (regulatory sandboxing).
“Support or explore novel approaches to regulation through using Artificial Intelligence to improve outcomes i.e. for public safety, for economic growth.”	Through the test cases, to explore opportunities for nuclear regulators to reduce project risk in determining the regulatory readiness of new AI solutions in specific applications. This will encourage wider adoption of AI within the sector, which can help to improve regulatory services and compliance for the nuclear industry.
“Support the initiatives set out in the AI Opportunities Action Plan.”	To support a number of actions from the above action plan, including action 25 (“regulators to scale up their AI capabilities”), action 27 (“regulators to accelerate AI in priority sectors and implement pro-innovation initiatives like regulatory sandboxes”), 29 (“AI assurance ecosystem to increase trust and adoption by: Investing significantly in the development of new assurance tools”) and 30 (collaborative work with the Alan Turing institute, or an organisation with equivalent expertise).

The nature of the proposal falls under the definitions outlined in the OECD’s Frascati Manual⁸ for identifying research and development:

- Novel in that it involves an emergent approach to cooperative work (sandbox) between various stakeholders (nuclear and non-nuclear regulators, industry and experts) with a clear focus on the acceleration of innovative AI applications;
- Creative in that it aims to generate an innovation-enabling framework (regulatory readiness levels or equivalent – see e.g., Annex 3) that is new to this industry, which can help provide confidence during the development of applications beyond the specific test cases considered in this project;
- Uncertain in that ONR and EA are open minded about the results of the project, and do not have any preconceptions about its outcome; the project will be informed by discussions with stakeholders and learnings from other regulators in non-nuclear sectors;
- Systematic in that the project has a well-defined structure to deliver the expected outcomes (see Figure 2) and the learning will be captured in final report, to be published on the ONR and EA websites for the wider benefit of the UK nuclear industry as well as the broader regulatory ecosystem; and
- Transferable in that the benefits of the proposal will extend beyond the duration of the project itself, as the approach is meant to be reproducible for future applications in the

⁸ [Frascati Manual 2015 | OECD](#)

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nuclear industry (sponsored by the industry). Considering the applications considered (e.g., NDT), the findings will benefit to sectors and their regulators beyond the nuclear industry.

3. What funding does your project need and how long would the project need to run?

Annex 1 of this proposal presents the cost breakdown of the project, including assumptions. The total funding proposed is [REDACTED], and will be used as follows:

ONR

- Project resources: project lead and support (meeting, logistics, drawing conclusions, progress report, final report coordination, knowledge management)
- Technical resources: technical specialist (2 or 3 technical disciplines depending on the test cases)
- Admin support: project management and finance, and other support including communications, administration and policy
- Logistics of the deep dive meetings (x2) plus assurance workshop
- Travel and subsistence (T&S) for ONR staff not based in Redgrave Court / Bootle

Contract with AI expertise (specification in Annex 4)

- Workshop on AI assurance and design (organisation, delivery, support material)
- Technical support to deep dive workshops
- Technical support to report writing
- Technical in-depth knowledge to facilitate identification of enablers
- T&S for attendance of key workshops

EA and other non-nuclear regulators (e.g., the Health and Safety Executive (HSE) and Defence Nuclear Safety Regulator (DNSR))

- Technical resources to support key meetings
- T&S for attendance of key workshops

Other partners from the UK nuclear industry will fund their own expenses to support this work (incl. related T&S). The funding for non-nuclear regulators could be optional, although it would be an enabler to ensure their attendance. The estimate for the contractor with AI expertise is realistic but conservative (there could be opportunities for some cost savings options to be discussed as part of the tendering process).

4. How will the outcomes of the project lead to delivering sustainable benefits to your sector/stakeholders?

The benefits of the project extend beyond the acceleration of the specific use of AI for interpretation and categorisation of data as considered in the test cases.

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More specifically, the right panel in Figure 2 provides an indication of the longer-term opportunities, including:

- Internal consideration in ONR and EA of the project learnings and opportunities to sustain safe and secure development of wider AI applications within the nuclear industry;
- Enhanced collaboration to share project learnings between different UK regulators to upskill the broader ecosystem and avoid fragmentation within and across sectors;
- Acceleration of other AI applications in nuclear installation (e.g., leveraging on the enablers identified as part of the regulatory sandbox or wider framework – see considerations in Annex 3); and
- Consideration of further industry-led work on assurance of AI for nuclear applications.

The final report, to be published on the ONR and EA websites, will contain the results of the deep dive and key learnings, which will provide benefit for the wider industry and regulators, and sustain a change in mindset for other AI applications in the nuclear industry. On completion of the project, the learnings from this activity will be shared internally with the wider inspector community and with senior management as appropriate, also considering any implications for ONR internal processes and best practices. After closure, opportunities to present the learnings at future events will be considered to sustain a change in the mindset on innovation in nuclear.

5. Will your project require other stakeholders (public bodies or private businesses)? If so, who?

Besides ONR, the contractor (see technical specification in Annex 4) and EA, the key participants expected to be involved are:

- UK licensees and dutyholders (expression of interest to be sent out after agreement of funding – prior interest from the Nuclear Decommissioning Authority, Sellafield Limited and Rolls-Royce); and
- Other regulators and regulatory networks (ONR and EA are already in contact with DNSR, HSE and UKHSRN).

Involving key stakeholders from the nuclear industry will ensure the project is informed by their knowledge and expertise. This will enable regulatory work to be targeted at the areas adding the most value to the industry (related project risks due to short timescales of this project and relevant mitigations in Annex 2).

Engaging with other regulators will facilitate learning from the experiences and expertise in other sectors. This will help avoid regulatory fragmentation, ensure consistent and enabling approaches across regulatory bodies, and support the overall growth ambition of the UK government across various industries.

Annex 1: Breakdown of the funding

Note: The figures below represent a conservative estimate of the effort (efficiencies will be explored as part of the delivery of the project). If the overall proposal is of general interest to RIO and the Department for Science, Innovation and Technology (DSIT), further adjustments of the figures below could be discussed depending on the budget available.

Organisation	Description	Effort	Assumptions
ONR	Project and technical resources (including general technical project management and planning, coordination and interface of external input, support to mock case prep, attendance to the assurance workshop, technical input to sprint and deep dives, report writing, support for approval, identification of next steps) Overhead (incl. admin, finance, comms, PMO, e.g. invoicing, periodic reporting to RIO/DSIT, contract management, support to review of summary report) Logistics (1 x assurance workshop, 2 x deep dive workshops) T&S for non-Bootle based ONR staff		- Each deep dive will consist of a one-day hybrid meeting plus a virtual pre-meeting - A maximum of 15 in-person participants will attend each deep dive, plus virtual participants - A maximum of 20 in-person participants will attend the one-day assurance workshop, plus virtual participants - All other meetings will take place online - Logistics for in-person meetings to include room bookings in Bootle, plus lunch and refreshments
Contractor (tech spec Annex 4)	Project and technical resources (contribution to introductory and sprint meetings, prep and delivery of the assurance workshop, input to mock case prep, technical input to deep dive workshops, drafting summary for each deep-dive workshop, input to the summary report, general support incl. in-depth technical knowledge) T&S for 1 x assurance workshop and 2 x deep dive		- In-person meetings to be held in Redgrave Court/Bootle - Meeting to be scheduled to allow for travelling in the day (e.g., starting at 10 am and finishing at 4 pm) - Lunch and refreshments provided for the in-person meetings <i>Note: The estimate for the contractor with AI expertise is realistic but conservative (there could be opportunities for some cost savings options to be discussed as part of the tendering process).</i>
EA	Technical resources T&S		See assumptions above
Other regulators	Technical resources T&S		See assumptions above <i>Note: this could be optional (although it would be an enabler to ensure attendance of key non-nuclear regulators)</i>
Total			<i>Note: conservative estimate to be confirmed during tendering</i>

Annex 2: Project risks & mitigation

No.	Key Risk	Owner/role	Mitigation	Residual risk post mitigation (H/M/L)
1	Inability to deliver the benefits outlined in the proposal due to the short timeframe, leading to reputational risk	ONR/Project Lead	Ambitious but realistic programme of work to suit the short timescales (max two test cases) ONR's focus to lead on a single funding proposal, with targeted support to the other EA-led project	L
2	Administrative challenges in securing contractor	ONR/Project Lead	Preliminary work with ONR finance to understand various options for assignment of contract Initial consideration of contractors who can support this activity and definition of a technical specification Programme of work allowing initial activities to be started without the contractor being in place	L
3	Insufficient technical resources to support the discussions	ONR/Project Lead	Upfront work with heads of profession to identify availability and target effort	L
4	Insufficient support from the industry to develop the mock safety cases	External partners	Preliminary engagement of ONR with two stakeholders If risk materialises, opportunity for ONR to internally support part of the development of the mock safety case outlines	L
5	Not fully realising the potential of cooperation with other regulators	ONR/Project Lead	Preliminary discussions of ONR with key partners (HSE and DNSR) Preliminary contact with UKHSRN (further discussions in parallel to formal approval)	L
6	Additional time required for approval of the final report	ONR/Project Lead	In case of delays due to approval process in other organisations, opportunity to publish a follow up report (after issuing the summary report by March 2026) in areas where further consolidation is required to gain consensus	L



Annex 3: Example of an enabling framework to support AI applications in nuclear

Based on recent discussions with the UK nuclear industry (e.g., workshops on robotics and autonomous systems in 2021 and 2024), one of the barriers identified by licensees and dutyholders in adopting innovation (including AI) relates to regulatory uncertainty from a project management perspective of an innovative solution, compared to more traditional solutions. This has the effect of stifling innovation on the ground of project risks, as opposed to safety and security considerations.

The regulatory sandboxing project will also explore opportunities to develop a qualitative framework that can indicate the regulatory readiness of a proposed AI solution for a specific application (see some initial considerations in Annex 3). This would allow dutyholders to adopt these solutions with far greater certainty. As part of this, the project will explore whether project uncertainty can be reduced without undermining the independent assessment of the safety case for permissioning the activity. Examples of criteria for assessing readiness of a specific AI application include:

- Understanding its failure modes and consequences;
- Defence in depth using alternative independent safety guards;
- Availability of operational experience from other industries or from demonstrators / inactive mock within the nuclear industry; and
- Clarity in the interface between AI and humans and their respective roles and responsibilities.

Alternative means to manage regulatory uncertainty from a project perspective will also be developed and tested, in conjunction with industry, as part of the sandboxing process.





Annex 4: Technical specification for contractor to support the proposal

Subject-matter knowledge and skills

- Recognised cutting-edge technical knowledge on artificial intelligence and data science;
- In-depth understanding of design and validation of AI-based systems, to support their assurance for safety critical applications; and
- Multidisciplinary expertise, including technical, governance, safety, societal and ethical, as required to understand the sociotechnical implications of AI systems deployed in industry settings.

Delivery experience and activities

- Leading role and track record of supporting AI-based work with regulators, and building regulatory capacity and capability for AI;
- Strong exposure in working with DSIT on AI, supporting the pro-innovation growth agenda of the UK government;
- Experience in developing AI policy and governance frameworks to support the pro-innovation agenda across the UK industry;
- Strong focus in driving change in mindset on innovation and AI, by driving the public conversation and leading engagement with key stakeholders in the public, industry, regulators and government; and
- Expertise in delivering training workshops to support upskilling of regulators and industry on AI.

Relationships and convening power:

- Recognition of AI authority at government and national level;
 - Commercial neutrality as a convenor;
 - Strong network of connections on AI with academia, regulators and industry; and
 - Strong track record of convening government and regulators around AI technical and governance topics.
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