NUCLEAR INNOVATION AND RESEARCH ADVISORY BOARD

NIRAB III
Summary Report

2021 / 2024

As NIRAB III's term comes to an end I am delighted to share with you a summary of the important work which we have delivered over the last three years.

NIRAB III has addressed a number of important strategic national initiatives and programmes and has provided advice and guidance on several Government consultations. The majority of our work has been focused on addressing the question posed to us by DESNZ:

"What RD&I is required to deliver a High Temperature Gas Reactor demonstrator by the early 2030s?"

This question has been examined through three lenses: what the reactor will be used for (its use case), the reactor technology itself and the delivery arrangements.

The detailed report and technical appendices were published in October of this year. We have been delighted to be involved in a number of dissemination activities where we have shared this work with many different audiences, including most recently with the Minister for Energy Security and Net Zero, Lord Hunt.

Professor Francis Livens
Chair of the Nuclear Innovation and Research Advisory Board (NIRAB)

A short summary of this work is provided herein

NIRAB III has also overseen the fourth iteration of the Civil Nuclear Landscape review. Despite the challenges realised by the sector post-COVID, our review of the civil nuclear landscape shows several positives. Government has increased nuclear R&D spending which has enabled the overall capacity of the sector to grow. Significant support to the National Nuclear User Facility has enabled many researchers to undertake world-class research in support of the nuclear sector. Our review also revealed the highest number of people employed in, or working on, or supporting R&D programmes since the 1990s.

I am especially grateful to all members of NIRAB for the hard work and unwavering support that they have shown to our activities over the past three years. As unpaid volunteers they have dedicated many hours of time and effort to our work. I would also like to extend my thanks to the Nuclear Innovation Research Office (NIRO) - we have worked together to ensure that we have a positive impact on the civil nuclear R&D sector, and I wish NIRO continued success.

Contents

PUBLICATION: December 2024
NIRAB-3-313

Glossary

AMR	Advanced Modular Reactors
ANT	Advanced Nuclear Technologies (UK term for SMRs and AMRs)
BEIS	Department of Business, Energy and Industrial Strategy
CPF	Coated Particle Fuel
DCO	Development Consent Order
DESNZ	Department for Energy Security and Net Zero
EA	Environment Agency
FOAK	First Of A Kind
GBN	Great British Nuclear
GDA	Generic Design Assessment
GIF	Generation IV International Forum
HALEU	High Assay Low Enriched Uranium
HMG	Her/His Majesty's Government
HoC	House of Commons
HoL	House of Lords
HTGR	High Temperature Gas-cooled Reactors
JET	Joint European Torus
NAMRC	Nuclear Advanced Manufacturing Research Centre
NIRAB	Nuclear Innovation and Research Advisory Board
NIRO	Nuclear Innovation and Research Office
NIP	Nuclear Innovation Programme
ONR	Office for Nuclear Regulation
RAG	Red-Amber-Green
R&D	Research and Development
RD&D	Research, Development and Demonstration
RD&I	Research, Development and Innovation
T&CP	Town and Country Planning
SMR	Small Modular Reactor

Executive Summary

The third iteration of the Nuclear Innovation and Research Advisory Board (NIRAB) was convened in autumn 2021 comprising of experts from industry, academia, and independent consultants with diverse backgrounds.

The Board has the remit to work in partnership with the Nuclear Innovation and Research Office (NIRO) to advise Ministers, Government Departments and Agencies on issues related to nuclear research and innovation.

NIRAB does not have responsibility for managing or delivering R&D programmes or for directing or managing R&D budgets.

Details of NIRAB's terms of reference and all of NIRAB's outputs can be found at

www.nirab.org.uk.

NIRAB III was tasked by DESNZ to answer the following question:

"What RD&I is needed to deliver a High Temperature Gas Cooled Reactor (HTGR) by the early 2030's?"

NIRAB examined this question through three lenses.

"Who would be the end user of the outputs from a HTGR?"

"What research is needed from a technology perspective?"

"What innovation is needed to support the delivery of a HTGR?"

NIRAB concluded that the six main areas of RD&I which require intervention are:

1. Connecting the HTGR to a use-case application.
2. Developing leading UK technology, embedding advanced manufacturing techniques and construction methods in advanced reactor designs.
3. Supply of fuel and core materials which are not commercially available in industrial quantities in the UK or internationally but will be key to independence in nuclear power.
4. Reliably harnessing the necessary fluids[1], and assessing performance of key systems and structures, components and materials in a hot fluid environment.
5. Designing and through-life substantiation of a safe and highly thermally efficient system achieving high integrity and reliability.
6. Enabling delivery by clarifying roles and responsibilities and ensuring appropriate siting and regulatory arrangements are in place.

A summary report and detailed technical appendices provide a long list of all the RD&I considerations which NIRAB identified and includes details of how these were classified into essential, highly valuable and valuable activities. Both documents can be found on the NIRAB website. A series of engagement activities was undertaken in the latter part of NIRAB's term to disseminate the findings of the work and to support engagement activities with reactor vendors, regulators and the Department.

[1] The term "fluids" refers to liquid and gasses used as coolants and heat exchange media.

In addition to answering the substantial question on HTGR's, NIRAB III also commissioned and oversaw a detailed assessment of the Civil Nuclear Landscape where it found that:

Nuclear R&D funding in the UK for 2022/2023 was around **£570m**

5400 Full-time employees in nuclear R&D

Over **50 international facilities** supported UK nuclear R&D

Whilst respondents welcomed this increased level of funding, they are very concerned that the UK may be entering a period of increased fiscal discipline and political uncertainty which has historically led to reduced and short-term R&D budgets. Should this happen now, at a time where momentum is needed most, the ability to achieve any net zero decarbonisation targets will be compromised.

The respondents to this survey believe that the UK has world leading nuclear R&D expertise and facilities that provide a solid foundation on which to build and advance the civil nuclear sector's capacity. Further funding in specific areas of research, coupled with development and access to wide reaching research facilities will reduce the risk of future nuclear programmes not delivering on time whilst re-establishing the UK's reputation as a world-class nuclear R&D nation.

NIRAB III has also reviewed the impact of the Nuclear Innovation Programme (2016-2022). NIRAB found this project to be particularly successful in developing key areas of nuclear technology identified as gaps in the UK's overall programme, developing the supply chain in these areas and the breadth of expertise required for the UK to remain an intelligent customer, thereby remaining an independent nuclear nation. NIRAB advises that a follow-on research programme be commissioned as soon as possible covering the same or similar programme areas. Such a programme should be designed, as far as possible, to minimise any stop-start approach to funding and to provide the certainty and continuity of research that will maximise benefit.

The programme should have dual objectives. The first is to develop engineered solutions towards licensable HTGR technology and associated infrastructure, opening the potential to deliver an HTGR fleet. The second is to maintain and extend broad strategic knowledge and technical capability to underpin future energy policy and support the future UK nuclear industry (fission and fusion), without prematurely foreclosing options.

In addition to the three substantial reviews described above, NIRAB III has also provided several written outputs including:

- Early Advice to support the Advanced Modular Reactor Research, Development and Demonstration Programme (AMR RD&D), March 2022
- Advice to Regulators on the scope of AMR RD&D Phase A programme, July 2022
- Response to House of Lords Inquiry on People and Skills, September 2022
- Response to House of Commons Science and Technology Committee Inquiry on Nuclear Power, September 2022
- Response to the Future Systems Operator (FSO) consultation on Strategy and Policy Statement for Energy Policy in Great Britain, July 2023
- Advice to Regulators on engagement with AMR RD&D vendors, Jan 2024

Throughout its term NIRAB III has engaged with senior officials in DESNZ on its advice, including with the DESNZ Chief Scientific Advisor and the Ministers for Energy and Net Zero (formerly Business, Energy and Industrial Strategy- BEIS).

1. Introduction

The Nuclear Innovation and Research Advisory Board (NIRAB) is a group of independent experts who work in partnership with the Nuclear Innovation and Research Office (NIRO) to advise ministers, government departments and agencies on issues related to nuclear research, development and innovation in the UK.

NIRAB also invites observers from the Office for Nuclear Regulation (ONR), Environment Agency (EA) and The Engineering and Physical Sciences Research Council (EPSRC) as well as DESNZ Chief Scientific Adviser to attend plenary meetings.

Details of NIRAB membership can be found in Appendix 1, and Terms of Reference and all of NIRAB's publications can be found at:

www.nirab.org.uk.

The third iteration of NIRAB was convened in autumn 2021 with experts from industry, academia, and independent consultants with a broad range of expertise. Since 2021 NIRAB III has worked on a variety of tasks and has provided input to a range of activities.

This report provides an overview of the work of NIRAB III over its tenure.

Figure 1. NIRAB Stakeholders

2. Work undertaken by NIRAB III

The main focus of NIRAB III has been High-Temperature Gas Reactors (HTGR), but it has also been involved in a number of consultations and has provided a variety of outputs which are summarised below.

Further details of all of NIRAB's outputs can be found on the NIRAB website or by email request to info@niro.org.uk.

2.1 RD&I required for a HTGR demonstrator

In 2021 Government proposed to have an operational High Temperature Gas Reactor (HTGR) demonstrator by the early 2030's. Government asked NIRAB III to consider what RD&I is required to deliver a HTGR within this timescale. The specific reactor design, size, use-case, the developer, licensee, operator, siting, cost and precise schedule have not yet been determined; so NIRAB looked to answer this question through a technology agnostic lens, without access to design details, level of maturity or details of RD&I programmes required by specific advanced reactor designs.

NIRAB interpreted the question as meaning the demonstrator should ideally couple energy utilisation, possibly including electricity productionand other energy utilisation with high temperature heat output, suitable for use in industrial applications and it must be able to operate under conditions representative of a full-scale reactor for substantial periods of time. Whether the electricity is output to the national grid or by private connection has not been considered.

NIRAB has also interpreted "the early 2030s" to mean between 2030-2034 and therefore deprioritised some aspects of RD&I which would take longer to resolve. NIRAB advised that the demonstrator should ideally be as close as possible to a First of a Kind (FOAK) or prototype to de-risk and support timely roll-out of a fleet (provided the demonstrator meets programme objectives and a business case can be made for fleet build), to enable HTGRs to make a significant contribution to net zero by 2050. These deployment timescales are extremely challenging and require innovative but pragmatic solutions and high levels of 'ambition', underpinned by RD&I, if they are to be achieved.

There is also likely to be some prioritisation and sequencing required in the RD&I activities, running some in parallel and identifying those which are more complex and will require longer to solve. The demonstrator will also need to have some attributes of an experimental, research and training reactor to support this aim, and it will also need to deliver significant improvements in HTGR reliability and operability compared to historical plants.

To some extent, the basic science and engineering behind HTGR technology is mature, but a licensable, commercially viable plant of any size has yet to be developed anywhere in the world outside of China.

Experience of connecting a civilian nuclear reactor to a non-electricity use case is particularly limited, although Calder Hall was used to provide process steam to the Sellafield site and other countries such as Canada, Russia etc. have local district heating networks connected to their nuclear power stations.

NIRAB therefore undertook a thorough review of all RD&I requirements across the HTGR lifecycle to understand the possible uses of the reactor's outputs and their requirements for high temperature heat (greater than 500°c). Secondly, we looked at the technological challenges associated with the HTGR reactor, highlighting areas that will need specific research, development or innovation. Lastly, we looked at what is needed to deliver a HTGR demonstrator.

A list of RD&I requirements has been produced and is provided as an addendum to the HTGR RD&I report. This list has been categorised, with NIRAB identifying 'Essential' RD&I (without which there cannot be a working demonstrator), '***Highly Valuable***' RD&I (activities which are needed to realise the full benefits of the HTGR demonstrator) and '***Valuable***' RD&I (activities which will generate useful data to benefit the use case, improve efficiency or apply learning to increase the likelihood of a favourable investment decision for fleet deployment).

From a use-case perspective, there are several industrial sectors in the UK which could be assisted in decarbonisation by the heat outputs from a HTGR. Synthetic Aviation Fuel production is a particular example that NIRAB used since it provides a good illustration of the challenges and opportunities. Production of Synthetic Aviation Fuel is currently limited by the need for hard-to-acquire biological feedstock but could be improved through use of hydrogen and captured carbon using a Reverse Water Gas Shift (RWGS) reaction at circa 800˚C combined with the Fischer-Tropsch process. A HTGR could provide the necessary heat and power for both hydrogen production and direct air capture (DAC) of carbon. NIRAB therefore undertook a deep dive into the Synthetic Aviation Fuel production process to understand what RD&I may be needed to effectively couple HTGR outputs to this use-case.

Interfacing HTGRs with end users such as Synthetic Aviation Fuel producers will require smart reactor manifold designs to manage reactor heat outputs at different temperature ranges required for different steps in the process. Further RD&I is therefore needed on heat exchanger and heat exchange media modelling which may be required over some distance to off-takers, looking at, for example, gas-gas or gas-to-molten salt heat exchange, as well as innovation in design and manufacturing for all components attached to the reactor. Research on and down-selection of both heat storage technologies to allow steady state HTGR operation and the associated heat network transmission media is needed to realise the benefits of HTGR heat output. This RD&I will also have benefit to other sectors that are considering molten salt or similar high temperature energy storage and transmission.

From a technology perspective, NIRAB recommends that RD&I is centred on three themes of;

1. Fuel and core materials
2. Materials and methods for manufacture (including graphite)
3. Modelling, simulation and design

To enable delivery, NIRAB believes that RD&I related to planning, siting and regulation, especially the interaction with associated industrial plants, is needed. It would be highly valuable to develop an integrated regulatory approach covering nuclear and non-nuclear regulatory regimes if co-location is to be adopted.

Additionally, NIRAB has identified a number of areas where decisions on who is responsible and accountable for leading specific aspects of the HTGR through the design and delivery process need attention and/ or clarification.

In summary:

NIRAB believes the following high-level RD&I themes warrant further investment:

- Connecting the HTGR to use-case applications
- Developing leading UK technology, embedding advanced manufacturing techniques and construction methods in advanced reactor designs
- Supply of fuel and core materials which are not commercially available in industrial quantities in the UK or internationally but will be key to independence in nuclear power
- Reliably harnessing the necessary advanced fluids, and assessing performance of key systems and structures, components and materials in a hot fluid environment
- Designing and through-life substantiation of a safe and highly thermally efficient system achieving high integrity

Additionally, NIRAB believes engagement with end user industries and collaboration across sectors needs to ramp up significantly to realise the full benefits of HTGRs, starting with Government funding of strategic RD&I activities and coordination of related projects. Such collaboration between the nuclear sector and other beneficial industries will require significant effort and must be carefully facilitated to achieve the highly ambitious timescales associated with the net zero targets.

nirab NUCLEAR INNOVATION AND RESEARCH ADVISORY BOARD

2.2 Civil Nuclear R&D Landscape Review

NIRAB III has also overseen the fourth review of the civil nuclear R&D landscape across the snap-shot year of 2022/23.

Organisations, institutions, companies or bodies involved in nuclear R&D were invited to submit a response. A total of 48 respondents provided some level of input. This was slightly fewer than previous reviews, a result of changes to various companies' structures, the amalgamation of some organisations and the streamlining of R&D by others, as well as an absence of submissions from a small number of nuclear organisations that had previously provided input. These changes in the organisational landscape, and the fact some organisations provided only partial data sets, made it hard to make direct comparisons to previous reviews. Qualitative interviews were also undertaken for the first time in this edition by an independent research organisation to provide a deeper dive into some of the responses provided by organisations that are significant contributors to nuclear R&D.

The key findings from this landscape review are as follows:

Total R&D funding has increased (with the majority of funding being provided by Government)
Our key finding from this landscape review is that there has been a significant rise in total funding for nuclear R&D in the financial year 2022/2023 since the previous landscape study in 2018/2019. Funding has risen by 52% (after inflation) and stands at £570m (0.03% of UK GDP).

Approximately £77m is for nuclear fusion activities (up from £54m in 2018/19) and £500m for nuclear fission (up from £140m in 2018/19). Over 1/5 of this annual spend is on Waste Management and Decommissioning activities associated with the NDA estate (£114m). Annual spend is in-line with other economies with significant nuclear programmes, but from a very low UK baseline of R&D spend in recent decades and against the backdrop of a significant need to scale up R&D capacity to support new nuclear ambitions. 7% of total R&D funding is leveraged from a combination of private sector and international sources, the remaining balance originates from Government sources.

Significant R&D resourcing and staffing challenges in support of scaling-up wider sector capacity
This landscape analysis indicates that the sector has increased its R&D activity significantly over the last ten years. There are currently approximately 5400 full time equivalent (FTE) persons working on nuclear R&D in the UK.

Work undertaken by the Nuclear Skills Strategy Group (NSSG) in 2022 to understand labour market requirements identified a significant challenge in resourcing new nuclear programmes whilst continuing to deliver existing programmes. In the context of a 24GWe target, the total nuclear sector (civil and defence) is projected to need an increase of between 80% and 120% in labour capacity on top of replacing workers that retire. The R&D skills growth rate in 2022/23 does not meet the projected needs of an expanding nuclear sector.

UK researchers access a diverse array of facilities to conduct their research
This landscape review revealed that during 2022/23 nuclear research was undertaken at over 50 international facilities and there was a heavy reliance on UK facilities accessed under the National Nuclear User Facility (NNUF) scheme. As a result of the ambiguity in future financing of the NNUF facilities and the reliance on access arrangements to international facilities, a case is beginning to form for new UK research provisions and more certainty on UK access/long-term funding arrangements to existing facilities.

Responders also provided suggestions as to facilities and equipment which they feel the UK needs to undertake research and development activities. These included access to neutrons, a test/ zero-power reactor etc.

Nuclear R&D activities require a coordinated and clear strategy to meet net zero targets
Given the Government's ambitions for net zero and for 24GWe of electricity supply (plus additional heat) to be provided by nuclear by 2050, the sector would welcome greater clarity and coordination of the R&D activities needed to achieve this increase of nuclear contribution to the energy mix. Whilst the UK currently remains open to all types of nuclear reactors to fill this energy capacity gap, respondents report that this means the sector is pointed in many directions at once, making strategic decisions on what R&D needs to be undertaken and by when very challenging.

Additionally, many responders report that the history of nuclear funding is characterised by periods of 'boom and bust'. Whilst respondents welcomed current levels of funding, they are concerned that the UK may be entering a period of increased fiscal discipline and political uncertainty which has historically led to reduced and short-term R&D budgets. Should this happen now, at a time where momentum is needed most, the ability to achieve any net zero decarbonisation targets will not be successful within the timescales proposed.

In summary:

The respondents to this survey believe that the UK has world-leading nuclear R&D expertise and facilities that provide a solid foundation on which to build and advance the civil nuclear sector's capacity.

Further funding in specific areas of research, coupled with development and access to wide-reaching research facilities will enable this.

This will reduce the risk of future nuclear programmes not delivering on time whilst re-establishing the UK's reputation as a world-class nuclear R&D nation.

3. Summary of other NIRAB III advice

Over the past three years NIRAB has developed and provided several other written outputs, which can all be found on the NIRAB website (www.nirab.org.uk) and are summarised below:

NIRAB overview of Impact of Nuclear Innovation Programme (NIP) (2016-2022)

NIRAB has assessed the impact of the Nuclear Innovation Programme (NIP) funded by BEIS (now DESNZ) between 2016 and 2022. The assessment considered whether the NIP has changed the research landscape and the extent to which it has achieved the programme's high-level objectives. Our conclusion was that the programme has undoubtedly had a significant positive impact. The sustained loss of critical, at-risk skills has been interrupted by the multi-pronged approach of the NIP and has enabled the UK to re-engage with international research bodies, restoring the status of the reputation of the UK as a valuable research partner.

Some level of ongoing research and innovation funding will be required if the benefits to date are to be sustained, and a more ambitious programme for acceleration will be required to build on progress further. For example, advanced fuel cycle skills are no longer at immediate risk, but some level of work will be required to prevent the recurrence of that risk in the future.

The programme has supported research relevant to High Temperature Gas Reactors (HTGR), which was (in 2022) identified by BEIS (DESNZ) the preferred Advanced Modular Reactor (AMR) concept. NIRAB advises that a follow-on research programme be commissioned as soon as possible covering the same or similar programme areas. Such a programme should be designed, as far as possible, to minimise any stop-start approach to funding and to provide the certainty and continuity of research that will maximise benefit. The programme should have dual objectives.

The first is to develop engineered solutions towards licensable HTGR technology and associated infrastructure, opening the potential to deliver a HTGR fleet.

The second is to maintain and extend broad strategic knowledge and technical capability to underpin future energy policy and support the future UK nuclear industry (fission and fusion), without prematurely foreclosing options.

NIRAB response to House of Lords Inquiry on People and Skills (September 2022)

While this parliamentary inquiry on 'People and Skills in UK Science, Technology, Engineering and Mathematics' was not necessarily focused on nuclear energy, NIRAB provided a view on the nuclear skills landscape and made suggestions for initiatives to support the development of nuclear skills, some applicable to other sectors.

NIRAB response to House of Commons Inquiry on Nuclear Power (September 2022)

The House of Commons Science and Technology Committee launched an inquiry into the Government's approach to developing new nuclear power. NIRAB's response focused on technical challenges for AMRs and delivery challenges for new nuclear across the piece.

NIRAB Advice to Regulators on Phase A of the AMR RD&D programme (July 2022)

In July 2022 the nuclear regulators (Office for Nuclear Regulation (ONR) and Environment Agency (EA)) asked NIRAB to provide advice on the proposed scope of Phase A of the Advance Modular Reactor Research, Development and Demonstration (AMR RD&D) programme, specifically with regard to regulatory considerations. NIRAB responded via a joint letter to the regulators in which it advised that the regulatory guidance should focus on aspects of the programme that are novel for high temperature gas reactors (HTGRs) and different to current generating systems. NIRAB provided a list of considerations for the regulators to consider further and also advised on engaging with regulators from other countries who are also considering or have experience of regulating a HTGR.

Future Systems Operator (FSO) Consultation on Strategy and Policy Statement for Energy Policy in Great Britain (July 2023)

NIRAB reviewed the Future Systems Operator (FSO) consultation and provided the following high-level points:

- Further clarity is needed on the technologies which will be contributing to achieving net zero aims
- There is current ambiguity with regards to the regulation of research and development projects such as nuclear demonstrator reactors, which may generate electricity, heat and hydrogen
- Clarifying roles for oversight of projects for delivery of funding via Regulated Asset Base (RAB) is needed
- Broadening the RAB model contract form to apply to heat generation technologies is required
- More clarity is needed to explain how FSO expands to cover electricity, heat and/or hydrogen, including use of related networks. Clarity is needed on the use of heat and heat distribution versus burning hydrogen or using electricity to provide heat locally, as this could provide better direction for those considering building advanced nuclear technologies and linking them to hydrogen production for example
- The need to build up capability to take a systemic view of network planning, design and markets across electricity, natural gas, heat and hydrogen, and the role of nuclear which also considers the system impacts of other emerging and innovative technologies such as Carbon Capture, Utilisation & Storage (CCUS), Direct Air Capture (DAC), synthetic fuel manufacture etc. is needed

NIRAB Advice to Regulators on Phase B of AMR RD&D programme (January 2024)

Further to initial advice provided in July 2022, in December 2023, the nuclear regulators jointly requested specific advice from NIRAB on the technical engagements that the Regulators will have with the vendors engaged in the AMR RD&D Phase B programme. NIRAB reinforced its stance that discussion with the vendors should focus on those regulatory aspects that are novel for Advanced Reactors and unique to each vendor's reactor design. This included having specific discussion on fuel, core, moderator and cooling circuits, new/different safety systems, accident tolerance, whole lifecycle substantiation (fuel enrichment, production, reactor operation, waste management) and integration of end-use.

4. Conclusions

NIRAB III has undertaken a significant programme of work over its tenure. This has all been undertaken on a voluntary basis. Feedback from stakeholders has been positive.

As the term of this NIRAB draws to a close, we wish to thank all members who have given their time and effort in attending meetings and producing the outputs, which have been summarised here.

An extended thanks also goes to the NIRO team who have provided unwavering support over the past three years.

5. Appendix 1: NIRAB Membership

Further details on each NIRAB member can be found on the NIRAB website.

Professor Francis Livens
Director of the Dalton Nuclear Institute

John Stairmand
Technical Director Amentum

Alyson Armett
Strategy and Planning Director Sellafield Ltd

Maggie Brown
Supplier Relationship Management, EDF Energy

Gordon Bryan
Independent Expert

Professor Gregg Butler
Head of Strategic Assessment, Dalton Nuclear Institute

Alun Ellis
Independent Expert

Kirsty Gogan
Managing Partner, LucidCatalyst and co-founder of TerraPraxis

Kirsty Armer
Director of Westinghouse Government Services UK

Professor Malcolm Joyce
Nuclear Engineering and Associate Dean for Research, Lancaster University

Mike Lewis
Director of Lewis Risk Consulting Limited

Professor Edoardo Patelli
Professor in Risk and Uncertainty, University of Strathclyde

Fiona Rayment
Special Advisor National Nuclear Laboratory

Former NIRAB members:

Amanda Quadling
Director of Materials UKAEA

Martin Goodfellow
Technical & Assurance Director, Nuvia UK

nirab

NUCLEAR INNOVATION AND RESEARCH ADVISORY BOARD