National Quantum Computing Centre

Action Plan

Responsible and Ethical Quantum Computing at the NQCC

Introduction

At the National Quantum Computing Centre (NQCC), we work to harness the potential of quantum computing to solve some of the most complex and challenging problems facing society.

We recognise that alongside this work, we must also support its responsible and ethical use and development. To this end, we developed the Quantum STATES principles – the NQCC's commitment to responsible and ethical quantum computing (REQC).

This Action Plan sets out how we plan to put these principles into practice across NQCC activities, over the next five years.

Dr Natasha Oughton
Quantum Computing Policy and Ethics Lead, NQCC
Principle Author

"We are approaching a critical point in the deployment roadmap for quantum computing as the technology scales and organisations pivot from research activities to operational readiness. It is timely to consider the wider impact of quantum computing on society. I welcome this REQC Action Plan as we look forward over the next five years and the thought-leadership and convening power the NQCC can bring to bear as we support industry adoption of the extraordinary potential promised by quantum computing technologies."

Dr Michael Cuthbert Director, NQCC

"This Action Plan brings together two major strands of work led by the NQCC: first, the development of key principles for responsible and ethical quantum computing as they relate to our mission; and second, the creation of a plan to put those principles into practice. Realising and embedding these principles can only be achieved through collective action. This is why engaging a broad range of stakeholders – including teams across the NQCC – has been central to this process. By publishing our Action Plan now, we are setting out a framework for the years ahead. It will serve as a guide for us, and for others across the ecosystem, as we continue to advance the development and adoption of quantum computing."

Dr Simon Plant Deputy Director of Innovation, NQCC

The NQCC's Quantum STATES principles

S	**Societally beneficial**	Develop quantum computing capabilities for the **benefit of society**, taking a pro-active and responsible approach.
T	**Trusted**	Be a **trusted voice**, sharing our knowledge with the quantum computing community and wider society.
A	**Accountable**	Recognise our responsibility to the wider community, and **hold ourselves accountable** for our actions throughout our activities.
T	**Transparent and explainable**	Provide **transparency and explainability** in the quantum computing systems we develop, procure, and use, and in our decision-making.
E	**Equitable, fair and inclusive**	Embed **fairness and inclusivity** into our activities, working to build a diverse community in which quantum computing benefits are **equitability** distributed.
S	**Safe, reliable and secure**	Build and test for **safety, reliability, and security**.

NQCC's approach to REQC

Our work on REQC spans three pillars

1 **Research-led thought leadership**
Advancing collective understanding of REQC by undertaking and disseminating research on REQC, leveraging technical expertise to contribute to thought leadership as a trusted authority.

2 **Enabling the ecosystem**
Building REQC capabilities across the quantum computing ecosystem by championing and enabling awareness of and engagement with REQC, supporting organisations in understanding key considerations and best practices.

3 **REQC at the NQCC**
Embedding and operationalising REQC throughout NQCC's activities, building on the Quantum STATES principles to support responsible processes and decision-making.

Development approach

The Action Plan was developed by: undertaking a literature review; surveying actions to support responsible innovation by other institutions; and broad stakeholder consultation both within and external to the NQCC.

Also carefully considered was UKRI's approach to responsible innovation, including the AREA framework[1], and the British Standard Institution's (BSI) responsible innovation standard, PAS 440[2], as well as NPSA guidance on Trusted Research[3] and Secure Innovation[4], along with UKRI guidance on Trusted Research and Innovation.

Internal engagement was done through an extended process, consisting of two phases of workshop with each NQCC team, across our Innovation, Research, Programme Delivery and Operations directorates. The first phase of workshops aimed to achieve collective understanding of and commitment to the principles. The second round of workshops focused on the operationalisation of REQC and how best the STATES principles could be put into practice in the context of each team's work. By identifying common themes, responsibilities and actions, the output from these workshops has been built upon to inform our REQC Action Plan.

1 Owen, R., Stilgoe, J., Macnaghten, P., Gorman, M., Fisher, E., & Guston, D. (2013). A framework for responsible innovation. *Responsible innovation: managing the responsible emergence of science and innovation in society*, 27-50.

2 BSI PAS Responsible Innovation Guide - PAS 440 :2020, https://www.bsigroup.com/en-GB/insights-and-media/insights/brochures/pas-440-responsible-innovation-guide/

3 NPSA Specialised Guidance – Trusted Research, https://www.npsa.gov.uk/specialised-guidance/trusted-research

4 NPSA Specialised Guidance – Secure Innovation, https://www.npsa.gov.uk/specialised-guidance/secure-innovation

Goal **1**

To embed REQC into NQCC activities through incorporation into high-level processes

Through embedding responsible innovation and ethical considerations into existing processes that provide accountability and governance at the NQCC, we aim to enable integration at multiple levels and across a range of the NQCC's activities. In doing so, this goal aligns with our **Accountability** principle by providing mechanisms to ensure the responsible development and use of quantum computing throughout our activities, along with reporting on our efforts to key stakeholders.

It also enables alignment with all of the STATES principles: through upskilling colleagues on REQC, and by prompting consideration of the principles in processes such as the project management process, and in personal objectives.

Actions

- **Incorporate REQC into the NQCC's Project Management process**
- **Drive personal accountability through staff training and adoption of personal objectives advancing REQC**
- **Report on REQC regularly through existing governance structures**

Goal **2**

To enable the understanding of how quantum computing might impact society, seeking to minimise harms and maximise positive societal impact

A critical component of responsible and ethical quantum computing is pro-actively seeking to understand the impact of its use on society, and responding accordingly to minimise harms and risks, and maximise positive societal impact. For our use case development activities at the NQCC, a key priority is developing tools and processes to consider the impact of the quantum computing use cases we develop and support. This will then inform the implementation of appropriate guardrails where needed, in line with our **Safe, reliable and secure** principle.

The NQCC also recognises that a wide range of use cases will be critical to the technology's development, from more fundamental through to highly applied, sector-specific use cases. We are committed to promoting and supporting use cases for societal benefit as part of our wider use case portfolio, enabling our **Societally beneficial** principle.

Actions

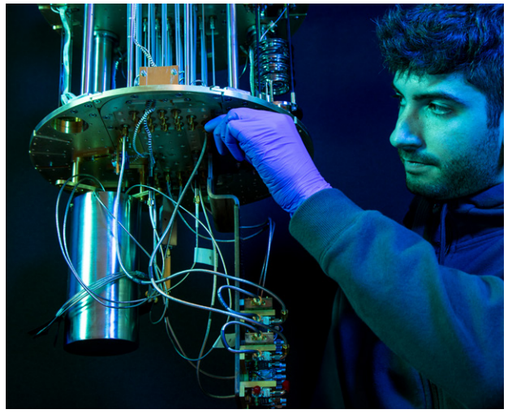
- **Develop and use impact assessments to understand use case implications**
- **Enable responsible use case development, identifying interventions to minimise harm and maximise positive societal impact**
- **Promote and support use cases for societal benefit, in line with the UK Government's National Quantum Strategy, such as those aligned with the UN's Sustainable Development Goals**

Goal **3**

To promote and enable environmental sustainability in research and innovation

The future environmental implications of the development and use of quantum computing remains a critical and open research question. We aim to enable environmental sustainability in research and innovation through taking appropriate measures within our own work, as well as carrying out research on sustainability and sharing our findings with the wider quantum computing community.

Through seeking to understand the environmental impact and putting in measures to mitigate harms to the environment, this aligns with both the **Societally beneficial** and **Safe, reliable and secure** principles.



Actions

- **Promote environmental sustainability in internal development by ensuring efficient use of resources through monitoring and responding to environmental metrics**
- **Carry out research into energy and resource usage of quantum computing to inform future research**
- **Promote environmental sustainability in collaboration and procurement activities in line with UKRI policy**

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Goal **4**

To champion and uphold REQC when engaging with the wider community, ensuring NQCC resources are used and distributed in alignment with our Quantum STATES principles

As a national lab with collaborators from industry, academia and government, we have a key role to play in championing, upholding and enabling adoption of REQC throughout our engagement with external organisations.

This aligns with our **Accountability** principle, enabling us to demonstrate our commitment to REQC. It also aligns with our **Equitable, fair and inclusive** principle, ensuring that our resources are distributed equitably. Finally, it enables alignment with the STATES principles throughout our broader ecosystem activities.

Actions

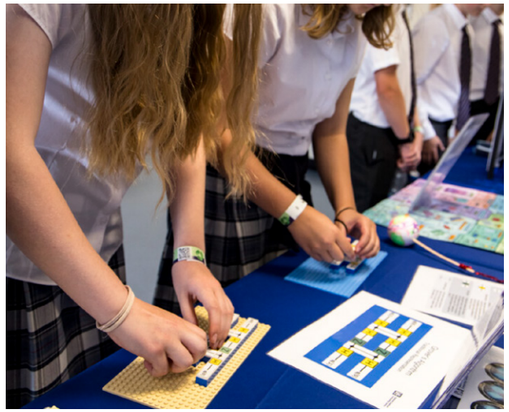
- **Support organisations we work with in operationalising REQC by enabling understanding of implications and sharing best practices for REQC**
- **Incorporate REQC questions into application processes for requesting access to NQCC resources and establishing collaborative R&D activities**
- **Incorporate REQC considerations in procurement requirements where appropriate**

Goal **5**

To share knowledge in an accessible and inclusive way, acting as a trusted authority

As a trusted authority, we are committed to sharing knowledge in ways that are accessible and inclusive, for a range of audiences, whilst respecting commercial confidences and intellectual property rights. We recognise the importance of doing so to build trust, further progress, and widen opportunities.

This aligns with our **Trusted** principle, offering unbiased and trustworthy assurance on quantum computing capabilities, as well as our **Transparent and explainable** principle. It also aligns with our **Equitable, fair and inclusive** principle, providing inclusive opportunities to learn and benefit from quantum computing.



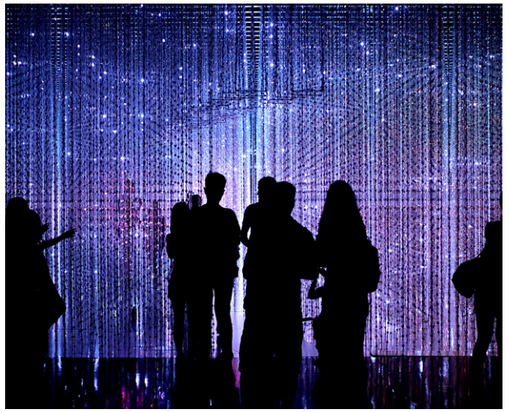
Actions

- **Publish findings and research output**
- **Undertake public engagement activities for a range of audiences, including underserved populations**
- **Undertake policy engagement to inform on technology progress and horizon scanning**
- **Follow Equality, Diversity and Inclusion (ED&I) best practices in our events and activities**

Goal **6**

To enable REQC through research and supporting and championing its adoption

In addition to embedding REQC into our work across the NQCC, we also work directly to enable REQC, offering research-informed thought leadership, and convening and upskilling the ecosystem. This supports and aligns with all of the STATES principles, and informs their development and adoption.



Actions

- **Undertake research and enable technical aspects of REQC**
- **Enable a responsible quantum industry through the Responsible Quantum Industry Forum (RQIF)**
- **Upskill the ecosystem on REQC**

Acknowledgements

This Action Plan draws on inputs from colleagues across the NQCC, gathered through team workshops and focussed discussions with key stakeholders. The author is grateful for guidance provided by Dr Abby Casey, Dr Simon Plant, and Dr Michael Cuthbert, along with communications support from Soma Deshprabhu.

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