Office for Nuclear Regulation

Regulatory decision making on Nuclear Systems containing artificial intelligence January 2023

Dr Andrew White
Superintending Inspector, Nuclear safety
Professional Lead for the Electrical, Control and Instrumentation (E,C&I) Specialism

Office for Nuclear Regulation, UK

This presentation

The objective of this presentation is to:

- Explore why regulators should encourage the use of AI for nuclear safety applications.
- Describe how ONR regulates conventional computer systems.
- Identify the differences between AI systems and conventional computer systems.
- Consider how regulatory approaches may vary according to the different applications of AI systems.
- Explore a range of different regulatory options to licence AI.
- Outline ONR's approach to learning to regulate AI.

Why should regulators encourage the use of AI for nuclear safety applications?

- AI has the potential to give operators insights that are currently not visible using existing approaches to improve safety. For example deeper insights into maintenance data and the causes of failures. This has the potential to improve safety by, for example, avoiding intrusive maintenance and to save money by improving targeting.

- AI has the potential to reduce doses to operators, for example by the automated surveying of contaminated areas, and performing activities that require operators to work closely with radioactive materials, e.g. gloveboxes.

…but there is a clear need for strong and effective regulation.

How does the ONR regulate conventional computer-based safety systems?

ONR regulates conventional computer-based safety systems using a two legged approach that is goal setting and primarily deterministic, based on risk.

- Production Excellence – The operator is expected to show that the design processes used are suitable for the system classification and have been carried out competently. Suitable processes are described in International Standards such as IEC 60880 and IEC 62138, etc.

- Independent Confidence Building Measures – The operator is expected to be able to show that the PE measures have been effective in generating a system that fulfils the design criteria.

What are the differences between AI and conventional computer-based safety systems?

- Conventional computer system designs are based on requirements to generate complex functionality.
- There is a focus on avoiding complexity in conventional safety systems as this aids design, avoids inadvertent introduction of design errors, and improves the ability to analyse the system.
- AI is ‘designed’ using training data to ‘shape’ the system outputs to achieve the desired behaviour. This is inherently complex and difficult to analyse. Some AI systems continuously learn, so behaviour changes over time.

Both system types can fail suddenly due to a fault, but it may be difficult to identify when an AI system has failed.

How might different applications of AI affect regulatory outcomes?

If a safety function can be adequately performed using a conventional system, and the AI provides marginal benefits, then should the operator be using AI?

If a hazard may take some time to cause damage or loss, could AI provide additional benefits over a conventional system?

Are there radiological consequences for which it would not be justifiable to use AI, e.g. criticality, off-site release?

Could AI achieve better, more benign plant designs?

Could AI improve analytical techniques?

What potential approaches could be taken to regulating AI?

- Regulate against the requirements of standards, but which standards?
- Regulate testing as a means of demonstrating correct behaviour, and iteration to correct faults, but how much testing is enough?
- Insisting that AI systems are built so that they can be verified and validated. Possible for AI?
- Ensuring that AI failure cannot lead to a hazardous event. Possible for all applications?
- …

Considering the benefits, how can ONR be an enabling regulator for AI systems?

We took a multi-pronged approach incorporating :

- Licensee engagement, e.g. development of an approach for using AI, support with producing an AI strategy.
- Engagement with other UK regulators, e.g. industrial, maritime, aviation, automotive, health care, defence, etc. – what are they doing and what problems do they face?
- Engagement with government, Innovate UK, Office for AI, etc.
- Academia, support for research, e.g. Robots and Artificial intelligence in nuclear, Manchester University safety case development, etc.

Considering the benefits, how can ONR be an enabling regulator for AI systems?

Continued:

- Engagement with Institutions, IET, Nuclear Institute
- Commissioned research into ONR regulatory readiness - ONR-RRR-121 at: https://www.onr.org.uk/research/
- Contributed to IAEA guidance initiatives
- Developing regulatory principles with other international regulators, e.g. USNRC, CNSC

An example route map to regulating AI

- Develop a way by which we can engage early with operators and provide advice – Establishing an Innovation Cell, and sandboxing potential applications in a safe environment. This gives us an opportunity to learn.
- Start with AI applications that will have no direct impact on safety but will be beneficial.
- Progress to applications where the benefits of AI can be achieved, whilst using conventional approaches to achieve safety.
- Progress to applications where the benefits clearly outweigh the disbenefits, and where the nuclear consequences are acceptable.
- When ready, progress to applications with more significant consequences.
- When ready, progress to applications where continuous learning is necessary and beneficial.

Thank you for listening.

Questions?