**Regulating criticality safety in the UK: experience from Office for Nuclear Regulation cross‑sites inspection series**

|  |
| --- |
| Regulating criticality safety in the UK: experience from Office for Nuclear Regulation cross-sites inspection series |
| Eoin Flannery, Clive Ingram, Adam NicholsConference paper presented at the 12th International Conference on Nuclear Criticality Safety (ICNC 2023), 1–6 October 2023 in Sendai, Japan |
|  |

Contents

[Abstract 4](#_Toc152060823)

[Keywords 4](#_Toc152060824)

[Introduction 5](#_Toc152060825)

[Method 5](#_Toc152060826)

[Results 8](#_Toc152060827)

[Conclusions 9](#_Toc152060828)

[Acknowledgments 9](#_Toc152060829)

[References 10](#_Toc152060830)

# Abstract

The Office for Nuclear Regulation (ONR), the nuclear regulator for the United Kingdom (UK), has over a two-year period completed a cross-site series of criticality-themed inspections to assess how licensees on nuclear licensed sites are managing criticality safety. Inspections were carried out at a range of sites chosen to represent a broad cross-section of the nuclear industry and the wide spectrum of associated criticality hazards.

The inspection series had three main aims:

* To identify any deficiencies in the licensees’ management of criticality safety (and/or any regulatory non-compliances) and to work with licensees to ensure prompt and sustained rectification of these deficiencies;
* To identify areas of good practice adopted by individual licensees and to share these more widely across UK nuclear industry; and
* To influence improvements across the various sites sampled and to further develop ONR’s guidance for inspectors.

Each inspection was conducted against key regulatory requirements of ONR’s Licence Conditions, with some site specific variations, to achieve consistency of approach and to ensure a representative picture was obtained of each licensee’s management of criticality safety. In addition, each inspection was conducted against a standard question set drawn from ONR’s inspection guidance.

The inspections were conducted by plant walk-downs, sampling of key licensee documentation and meetings with relevant licensee personnel (for example operators, criticality safety professionals and managers). This paper will describe the conduct of the criticality-themed inspection series and discuss the key findings.

# Keywords

Criticality safety, inspection, regulation, relevant good practice

# Introduction

ONR carried out a series of criticality safety interventions over a two-year period beginning in 2021, across a representative sample of licensees. This inspection series followed on from similar inspections carried out approximately ten years earlier. Due to the changing nature of the UK nuclear industry (for example, changes in operations as sites transition from operating to decommissioning activities, a decreasing work force) and the reduction in expert criticality safety resource, it was considered an appropriate time to carry out repeat inspections in order to benchmark current practices and standards.

The inspection series had three key aims:

* To identify any deficiencies in the licensees’ management of criticality safety (and/or any regulatory non-compliances) and to work with licensees to ensure prompt and sustained rectification of these deficiencies;
* To identify areas of good practice adopted by individual licensees and to share these more widely across UK nuclear industry; and
* To influence improvements across the various sites sampled and to further develop ONR’s guidance for inspectors.

In addition to the above aims, the inspections presented a valuable opportunity to expose lesser experienced ONR inspectors within the criticality safety specialism to on-site inspections in order to develop their regulatory skill set.

It was also recognised that the inspections had the potential to identify important cross-industry themes. ONR could therefore use its regulatory influence to drive national improvements of criticality safety management in the UK.

# Method

As most of the UK nuclear licensed sites hold and operate with fissile material, a sample of sites were chosen to represent the broad cross-section of the nuclear industry and the wide spectrum of associated criticality hazards. The selection was based upon a number of factors including whether ONR had carried out any inspections relating to criticality safety on the site recently, whether there had been recent incidents reported on site relating to criticality safety, whether operations on the site were soon to undergo significant change (for example, defueling), or whether there had been significant changes to criticality safety resource on site. A number of nuclear licensed sites that hold fissile material (for example, the Sellafield waste and reprocessing site in the north of England and the Atomic Weapons Establishment in the south east) were not included in the sample, as ONR already liaises frequently with the criticality safety experts on these higher hazard sites so inclusion in the inspection series was not considered proportionate.

The six sites selected (and their respective licensee company) were:

* Dounreay (Dounreay Site Restoration Ltd, now Magnox Ltd);
* Capenhurst (URENCO UK Ltd);
* Springfields (Springfields Fuels Ltd);
* Raynesway (Rolls-Royce Submarine Ltd);
* Hunterston B (EDF Energy Nuclear Generation Ltd); and
* Hartlepool (EDF Energy Nuclear Generation Ltd).

These sites cover a number of activities in the fuel cycle process including enrichment, fuel production, manufacture, power generation and decommissioning. The geographical locations of the sites are shown in Figure 1.



**Figure 1.** Map of nuclear sites inspected.

The inspections were typically carried out by two inspectors, one experienced and one less experienced, who would lead on a subsequent inspection. A number of inspections also included an ONR Nuclear Graduate or ONR Degree Apprentice to provide them with valuable inspection experience. All inspections were supported by the ONR Nominated Site Inspector for that site.

The inspections were conducted against the ONR Technical Inspection Guide (TIG) (ref. [1]). This TIG provides guidance to inspectors to judge whether a licensee’s arrangements to protect workers and the public from an accidental criticality event are adequate. The TIG is supported by tables of questions that include the latest learning and good practices in criticality safety (including a number of national and international sources (refs. [2]–[7]). These questions have been reviewed in detail by ONR and the wider UK criticality safety community (by way of the UK Working Party on Criticality (WPC)) and formed the basis for the question set sent to the licensees before the inspections.

ONR inspections of nuclear licensed sites are undertaken against Licence Conditions (LC) (ref. [8]) attached to the nuclear site licence. To meet the aims of the inspection series and cover an adequate range of areas on the sites, inspection against the following LCs were agreed by the ONR criticality safety inspectors:

* LC8 – Warning notices;
* LC10 – Training;
* LC12 – Duly authorised and other suitably qualified and experienced persons;
* LC23 – Operating rules;
* LC24 – Operating instructions; and
* LC28 – Examination, inspection, maintenance and testing (EIMT).

The question set sent to the licensees focused on these LCs. The objective was to determine whether the criticality safety controls identified within the plant safety case had been adequately implemented on plant (LC8, LC23, LC24), the engineered safety measures relevant to criticality safety had undergone adequate EIMT (LC28), and whether personnel who could affect criticality safety on plant had been adequately trained (LC10, LC12). This objective was achieved by reviewing the criticality safety case before the inspection, by discussion with the relevant licensee personnel and by a site visit.

At the end of each inspection, ONR inspectors provided feedback on the findings to the licensee’s management team on-site along with an overall inspection rating. Once all inspections in the series had taken place, a summary report was written covering the key findings and suggested recommendations; these are to be communicated to the UK criticality safety community via the UK WPC.

# Results

The key finding of the inspection series, based on the evidence sampled, was that licensees are appropriately managing criticality safety and no significant matters of legal non-compliance were identified.

Areas of good practice identified included:

* On-site limits and conditions relevant to criticality safety control had clear links to the safety case where they were derived. Inspectors found them to be clear such that operators (who were questioned during inspection) could readily demonstrate understanding and compliance with them. On some limits and conditions displayed on plant, useful visual images were included to aid compliance;
* Some licensees had a site-wide electronic database of all limits and conditions displayed on plant, recording details such as location, current issue number and expiry date;
* On a number of plants, the notices detailing limits and conditions were kept within locked glass-fronted cabinets, helping to maintain their good condition;
* Criticality safety training to personnel was found to be comprehensive, with tiered levels tailored for different roles (for example, awareness training for plant operators and managers as well as in-depth training for criticality specialists). Training could consist of a mix of classroom and on-site elements;
* Training for criticality safety specialists was found in most cases to be benchmarked against competencies developed by the UK WPC;
* Key calculations were cross-checked by licensees using a different independent calculational code (for example MONK vs MCNP);
* There was evidence of partnering with universities to undertake criticality projects and develop criticality safety training courses;
* Licensees showed innovative approaches to validation of safety measures (for example, use of sacrificial strips of PVC to allow destructive testing for neutron poisons); and
* Use of a limited number of detachable trolley handles and limiting the number of trolleys that can be used to move fissile material at any one time.

Areas for improvement included:

* Succession planning for criticality personnel – many inspections found that the criticality resource available to the licensee was decreasing. Reasons for this included personnel retiring or moving outside the criticality safety discipline, and a scarcity of new personnel applying to fill the criticality safety roles;
* There was a reliance on contractors to provide criticality safety expertise, in some instances from a single contracting company and a corresponding potential lack in in-house criticality expertise to manage these contracts/ contractors; and
* There is an opportunity for the UK criticality safety community to review and enhance the criticality competency guidance published (ref. [9]) by UK WPC, to take account of recent developments and industry operating experience (for example, in new plant based roles).

# Conclusions

With respect to the first of the three aims identified for the inspection series, no significant regulatory non‑compliances were found in any licensees’ management arrangements for criticality safety. Sufficient standards were found to be implemented across all licensees inspected. With regard to the second aim, areas of good practice have been identified and these will be shared across the wider nuclear industry via the UK WPC. In meeting the third aim, the inspection provided a valuable trial of the updated TIG (ref. [1]) (plus supporting tables) and highlighted two areas where ONR can influence improvement:

* Continued engagement with the UK WPC to support the development of a strengthened criticality competency guidance; and
* Continued engagement with the UK WPC (and its parent body – the Safety Directors Forum) to understand the extent of the resource issue and to raise awareness across the industry of the current shortage of criticality specialists. The development of an industry-wide initiative to increase the number of criticality safety personnel within the UK would be beneficial.

These actions will be managed via the ONR Criticality and Shielding Sub-Group with progress reported to ONR senior management.

# Acknowledgments

ONR acknowledges the licensees’ participation in these inspections.

# References

[1] ONR Nuclear Safety Technical Inspection Guide – Criticality Safety, NS-INSP-GD-053, Revision 6, February 2020. https://www.onr.org.uk/operational/tech\_insp\_guides/ns-insp-gd-053.pdf.

[2] IAEA, Criticality Safety in the Handling of Fissile Material, SSG-27, Revision 1, 2022.

[3] British Standard Institute (BSI) International Standard Organisation (ISO), Fissile Materials - Principles of criticality safety in storing, handling and processing, BS ISO 1709:2018, Third edition, 28 February 2018.

[4] R. Haley et al, Criticality Detection at UK Nuclear Licensed Sites, WPC/P289, Issue 1, December 2017.

[5] E. Cracknell et al, Minimum Subcritical Margins, WPC/P288, Issue 1, June 2020.

[6] Amec Foster Wheeler, Use of Burn-Up Credit in the Assessment of Criticality Risk, ONR‑RRR‑026, Issue 1, August 2017. https://www.onr.org.uk/documents/2017/onr-rrr-026.pdf

[7] Wood, Research into the Effect of Temperature on the Criticality Safety of Fissile Systems, ONR‑RRR-077, Issue 2, February 2019. https://www.onr.org.uk/documents/2019/onr-rrr-077.pdf.

[8] ONR Licence Condition Handbook, February 2017. https://www.onr.org.uk/documents/licence-condition-handbook.pdf.

[9] Derek Putley (WPC Chair), The WPC Criticality Competence Framework, WPC/P243, Issue 2, 24 May 2017.

© Office for Nuclear Regulation, 2023

Any enquiries related to this document should be sent to contact@onr.gov.uk