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Policy paper

Compliance with the Convention on Nuclear Safety Obligations: 9th National Report

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Contents

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Contributors to the United Kingdom's National Report

The Office for Nuclear Regulation (https://www.onr.org.uk/) prepared this report on behalf of the Department for Business, Energy & Industrial Strategy (BEIS) (https://www.gov.uk/government/organisations/department-for-business-energy-and-industrial-strategy) and in consultation with, and incorporating contributions, from:

- UK Government (BEIS (https://www.gov.uk/government/organisations/department-for-business-energy-and-industrial-strategy))
- Environment Agency (https://www.gov.uk/government/organisations/environment-agency)
- Scottish Environment Protection Agency (https://www.sepa.org.uk/)
- Natural Resources Wales (https://naturalresources.wales/?lang=en)
- EDF Energy Nuclear Generation Limited (https://www.edfenergy.com/energy)
- NNB Generation Company (HPC) Limited (https://www.edfenergy.com/energy)

Foreword

The United Kingdom (UK) remains firmly committed to meeting its obligations under the Convention on Nuclear Safety and we welcome this peer review of our activities.

This, our ninth National Report, provides a comprehensive update on how the UK has maintained a high level of safety through the establishment and application of fundamental safety principles to safely manage our land-based civil nuclear power plants.

The UK has 11 reactors generating within the UK, consisting of twin advanced gas-cooled reactors at 5 sites, and a separate single pressurised water reactor. One of the sites with twin advanced gas-cooled reactors is due to cease generation in readiness for defuelling in the summer 2022. A further 2 advanced gas-cooled reactor sites have already ceased generation. All 15 reactors fall under the scope of the Convention as those reactors that have ceased generation remain fuelled, continuing to meet the Convention's definition of a Nuclear Installation under INFCIRC/449 Article 2. A further twin pressurised water reactor site which is currently under construction, is also reported upon, as it falls under the UK's jurisdiction.

There are 2 companies that hold nuclear site licences for the Nuclear Installations in the UK, which are granted by the Office for Nuclear

Regulation, as well as permits and authorisations issued by the relevant environmental agency. These licensees have primary responsibility for safety and environmental protection under UK law and they must demonstrate that they are meeting relevant good practice to minimise risks to people and the environment.

The principal statutory regulators for the purposes of the Convention are the Office for Nuclear Regulation (covering the whole UK), the Environment Agency in England and the Scottish Environment Protection Agency. There are no nuclear facilities in Northern Ireland and none that are applicable under the Convention located in Wales.

The UK Government's British Energy Security Strategy sets out its long-term ambition to increase plans for the deployment of nuclear power by up to 24 gigawatts by 2050. The strategy also announced plans to establish Great British Nuclear, a government development vehicle looking to unlock barriers in the UK nuclear market to enable new nuclear projects to be brought forward and delivered, contributing to a resilient British energy system.

The UK has also enacted the Nuclear Energy (Financing) Act 2022. This will establish the tried and tested Regulated Asset Base (RAB) funding model for new nuclear, providing developers with greater options for project financing and unlocking private investment. Using RAB could also reduce the cost of financing new projects compared to the Contracts for Difference model, resulting in savings for consumers.

The UK completed its most recent Generic Design Assessment (GDA) in February 2022, issuing both a Design Acceptance Certificate and a Statement of Design Acceptability for the UK HPR1000 design; it has received an application for a GDA from Rolls-Royce UK SMR Limited, and has been preparing for additional submissions from a range of other potential vendors. Further, the UK continues to make progress towards bringing the UK's first new nuclear power plant in more than 30 years into operation at Hinkley Point C and is due to make a decision this year on a licence application for Sizewell C.

Throughout this reporting period the UK has continued to comply with the requirements of the Convention. The UK addressed the issues identified in response to the National Reports submitted for the seventh and eighth Review Meetings, such as proposals for Suggestions and Challenges raised during the seventh Review Meeting, and those identified in the draft Country Review Report for the eighth Review Meeting. The UK Report continues to provide responses to the Major Common Issues, the Vienna Declaration on Nuclear Safety and, in addition, reports upon the topic of the UK's response to the COVID-19 pandemic.

On 31 January 2020, the UK formally left the European Union and Euratom having entered a transition period that ended on 31 December 2020.

Measures were already in place to enable the UK's nuclear industry to continue to operate to high safety and environmental protection standards, and to comply with nuclear material accountancy safeguarding requirements. Specific aspects directly relevant to the Convention have been mentioned in this report.

This report demonstrates that the UK's approach to safety and environmental protection relevant to the management of civil land-based nuclear power plants is well-established, effective, and drives sustained improvements, thereby meeting the requirements of the Convention on Nuclear Safety.

The UK works closely with its counterparts in other countries to ensure its approaches reflect international good practice and captures relevant lessons learnt from experience elsewhere. The UK seeks, continually, to benchmark its arrangements against others, and since the UK's eighth National Report has hosted a full scope Integrated Regulatory Review Service mission.

The UK remains keen to share its experience with other Contracting Parties.

Section A – Introduction

Introductory remarks

A1. This, the United Kingdom's (UK) ninth National Report (NR), is aimed at demonstrating the UK's compliance with its obligations under the Articles of the Convention on Nuclear Safety (Ref. A.1) – hereinafter referred to as "the Convention".

A2. This report provides a comprehensive update of progress since the UK's eighth NR, published in August 2019 (Ref. A.2) and now covers the period 01 June 2019 to 31 May 2022. Significant developments after this date will be included in the UK presentation to the joint eighth and ninth Review Meeting (RM) scheduled for March 2023 and recorded as appropriate within the UK's tenth NR in 2025.

A3. This NR presents the application of modern safety standards and processes to the land-based civil nuclear power plants (NPP) reportable under the Convention and against the UK's new build projects.

A4. The UK nuclear industry continues to evolve, with a mixture of operational NPPs and end-of-generation (EoG) NPPs just entering defuelling in preparation for decommissioning. The UK also has plans to develop a new generation of NPPs in England and Wales as part of the government’s energy policy (Ref. A.3) and British energy security strategy (Ref. A.4) and has on-going construction activities.

A5. The UK maintains high standards of operational nuclear and radiological safety and environmental protection within a robust regulatory framework. The UK’s approach reflects its strong safety culture characterised by learning and continuous improvement.

A6. Facilities used for defence purposes are excluded from this NR, as are the facilities and activities reportable under the Joint Convention on the Safety of Spent Fuel and on the Safety of Radioactive Waste Management (Ref. A.5) – hereinafter referred to as “the Joint Convention”.

A7. The Office for Nuclear Regulation (ONR) is the UK’s national statutory regulator for nuclear safety, nuclear site conventional health and safety, civil nuclear security, nuclear safeguards, and the transport of civil nuclear and radioactive materials. ONR is the author of this report on behalf of the UK Government (Department for Business, Energy & Industrial Strategy (BEIS)). Aspects of environmental protection and radioactive waste management covered by the articles of the Convention are also regulated by the relevant environmental regulator in England, Wales, and Scotland.

A8. Since the Convention came into force in 1996, the UK has participated in all reporting cycles, meeting its obligations under the Convention. This, the UK’s ninth NR, continues to demonstrate full compliance with the obligations of the Convention.

Overview of the UK’s nuclear programme

A9. The UK civil nuclear industry consists of a diverse range of nuclear facilities, which includes reactors under construction, operational and decommissioning NPPs; research facilities; fuel manufacturing; spent fuel storage and reprocessing; and radioactive waste processing, and storage and disposal facilities. They are geographically spread across England, Scotland, and Wales, collectively known as Great Britain (GB). There are no nuclear facilities in Northern Ireland, and none that are applicable under the Convention located in Wales.

A10. This report uses the term UK, rather than GB, as it is the UK that is the Contracting Party, apart from to indicate when some laws have been passed by the UK Parliament that apply to GB only, or specifically to England, Scotland, and/or Wales. An overview of all the UK’s nuclear facilities is provided in the ONR Guide to Nuclear Regulation (Ref. A.6).

A11. The NPPs reportable under the Convention are operated in the UK by 2 licensees. The operational NPPs for which Électricité de France Energy Nuclear Generation Ltd (EDF Energy NGL) is the licensee, and the reactors under construction licensed by Nuclear New Build Generation Company (Hinkley Point C) Ltd (NNB GenCo (HPC)). In all, the NPPs being reported upon consist of:

- Ten generating Advanced Gas-cooled Reactors (AGR) spread across 5 sites (Hinkley Point B, Heysham 1, Hartlepool, Heysham 2 and Torness), each with twin reactors;
- Four AGRs across 2 sites (Hunterston B and Dungeness B) each with twin reactors that have ceased generation in readiness for defuelling. Fuel remains within these reactors;
- A single operational Pressurised Water Reactor (PWR) (Sizewell B); and
- A twin EPR™ (using PWR technology) under construction (Hinkley Point C) in Somerset, England. Additionally
- A further twin EPR™ (Sizewell C) proposed for construction in Suffolk, England, licensed by NNB Generation Company (Sizewell C) Limited (NNB GenCo (SZC)) is also discussed.

A12. The safety of the UK's non-power generating facilities, including the first generation of NPPs in the UK, the Magnox reactors, are covered under the Joint Convention NR (Ref. A.7). The Joint Convention also addressed the final 2 reactors that were awaiting defuelling at the time of the UK's Eighth Convention NR (Ref. A.2); Wylfa and Calder Hall, which were confirmed as free of fuel in 2019.

A13. Management of the radioactive wastes and irradiated fuels that are generated within the UK's operating fleet of NPPs are also covered under the Joint Convention.

Overview of significant developments since the UK's eighth national report

A14. Since the last report, there have been significant developments in the UK and within the UK nuclear programme; most importantly the UK's exit from the European Union (EU) and the need for the UK to establish a domestic safeguards regulatory function to meet international safeguards obligations. Previously managed by Euratom, this is now regulated by ONR.

A15. Another change in ONR has seen the roles of Chief Executive (CE) and Chief Nuclear Inspector (CNI) being combined, discharged by a single individual. Changes have been introduced to the governance and leadership structure to better support the new CE/CNI role.

A16. Looking across the NPP fleet, the AGRs continue to face the challenges posed by ageing and obsolescence and various examples of these are included throughout this report to demonstrate how this is being safely managed. Two AGR sites (Hunterston B and Dungeness B) have ceased generation and are awaiting defuelling, and a third twin reactor AGR site (Hinkley Point B) is planned to cease generation later in summer 2022.

A17. For the NPPs under construction at Hinkley Point C, the nuclear island rafts are complete, civil engineering construction is well progressed, and installation of the electrical, mechanical, and heating, ventilation and air conditioning components has now commenced on the first of the 2 reactors.

A18. For reactors in pre-licensing stages, the Generic Design Assessment performed by ONR and the Environment Agency has been completed for the UK HPR1000 reactor design and a Design Acceptance Certificate (DAC) and Statement of Design Acceptability (SoDA) issued.

A19. Additionally, the government have been in commercial negotiations on the Sizewell C project, in Suffolk, since January 2021. These negotiations are ongoing and no decisions have been made. A nuclear site licence application has been received by ONR, which is due to be decided during 2022. The project is also subject to an ongoing application for a Development Consent Order, as well as other regulatory approvals.

A20. Looking further ahead, the UK continues to explore the potential benefits of advanced nuclear technologies (consisting of Advanced Modular Reactors (AMRs) and Small Modular Reactors (SMRs)) and has received a GDA application from Rolls-Royce SMR Limited.

A21. Finally, the UK, as with other Contracting Parties, has been focused on delivering a safe nuclear programme whilst managing the impact of the global COVID-19 pandemic.

Structure and basis of the UK's ninth national report

A22. This, the UK's ninth NR, is similar in both structure and content to the UK's eighth NR (Ref. A.2) and continues to follow the guidelines issued by the Convention (Ref. A.8). As such, this is a stand-alone document that provides sufficient background information on UK policy and practices and the legislative and regulatory framework to enable the reader to gain adequate understanding of the safe management of the UK's operational land-based civil NPPs. In doing this, it demonstrates compliance with the obligations in the Articles of the Convention.

A23. Given the maturity of the UK's arrangements, the UK's means of demonstrating compliance with the Convention has not changed significantly in many areas since the UK's eighth NR, and in some cases the first NR.

> A24. [Change] Where the means of demonstrating compliance has changed including the introduction of new regulations, it is highlighted in the same way as this paragraph.

A25. Where the text has not been highlighted in this way, it may have been revised to improve the presentation, but the means of demonstrating compliance has not significantly changed. The important changes are also summarised at the beginning of the relevant Articles.

A26. A range of examples are included to illustrate the practical application of the UK's nuclear safety arrangements during the reporting period. These cover the design, build and operation of the UK's NPPs, presenting tangible evidence of UK licensee's management of nuclear safety and the oversight of the UK's statutory regulators that hold them to account.

Example title [Example]

A27. Where examples are used, they are highlighted in the same way as this paragraph.

A28. The eighth RM was cancelled as a result of the COVID-19 pandemic. So that both the eighth and ninth review cycles can be effectively addressed, a joint eighth and ninth RM is scheduled for March 2023. This report continues to cover those issues raised during the seventh RM, along with the issues identified within the draft Country Review Report for the UK (Ref. A.9) written in preparation for conduct of the eighth RM (against the UK's eighth NR). The issues consist of **Challenges**, **Major Common Issues** and **Suggestions**, which are all addressed and highlighted within the text by referring to the type of issue in bold. Where the report text directly supports the continued consideration of the Vienna Declaration on Nuclear Safety (VDNS), this is highlighted by referring to the VDNS Principle in bold. Information has also been included within this report regarding the UK's response to the COVID-19 pandemic.

A29. All references take the form of Section/Article No.x, where "x" contains a link to the reference located at the end of the Section or Article as an endnote, for example "Ref. A.1" or "Ref. 9.1".

A30. Cross-referencing has been used throughout the report, in the form of bookmarks to help the reader navigate the report. These are highlighted in blue as a link.

A31. In accordance with the guidance, Section B includes general introductory remarks, a survey of the main safety issues and main themes of the report, and references to any matters not covered elsewhere in the report. The Articles are then addressed in turn from Article 6 – Existing Nuclear Facilities to Article 19 – Operation.

A32. In preparing this report, the UK has used information available up to 31 May 2022. The UK presentation to the joint eighth and ninth RM will be based on both the eighth (Ref. A.2) and this, the UK's ninth NR. The presentation will also be supplemented with information on any relevant developments since this report's authorship, up to the date of the RM itself scheduled for March 2023.

Section A references

A.1. Convention on Nuclear Safety (https://www.iaea.org/publications/documents/infcircs/convention-nuclear-safety), INFCIRC/449, July 1994.

A.2. The United Kingdom's Eighth National Report on Compliance with the Obligations of the Convention on Nuclear Safety (https://www.iaea.org/sites/default/files/national_report_of_the_united_kingdom_for_the_8th_review_meeting.pdf), Department for Business, Energy & Industrial Strategy, August 2019.

A.3. UK Government, Energy White Paper: Powering our net zero future (https://www.gov.uk/government/publications/energy-white-paper-powering-our-net-zero-future).

A.4. UK Government, British Energy Security Strategy (https://www.gov.uk/government/publications/british-energy-security-strategy/british-energy-security-strategy), 2022.

A.5. Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Material (https://www.iaea.org/sites/default/files/infcirc546.pdf), INFCIRC/546, December 1997.

A.6. A Guide to Nuclear Regulation in the UK (https://www.onr.org.uk/documents/a-guide-to-nuclear-regulation-in-the-uk.pdf), Office for Nuclear Regulation.

A.7. United Kingdom Seventh National Report on Compliance with the Obligations of the Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management (https://www.iaea.org/sites/default/files/uk_03052017_nr-7th-rm.pdf), Department for Business, Energy & Industrial Strategy, January 2017.

A.8. Guidelines regarding National Reports under the Convention on Nuclear Safety (https://www.iaea.org/sites/default/files/infcirc572r5.pdf). INFCIRC/572/Rev.6, January 2018.

A.9. Convention on Nuclear Safety 8th Review Meeting – 2020, Country Review Report for the United Kingdom, Country Group [No. 6]. Draft Version 2, March 2020.
[Web-link not available – See CNS secure portal for access]

Section B – Summary

B1. In accordance with the guidelines for National Reports (NR) (Ref. B.1), this section highlights the main developments in the United Kingdom (UK) since the UK's last NR (Ref. B.2). It provides only brief descriptions and mainly relies on cross-referencing to other parts of this report where more detail is held.

Changes relating to the regulatory body

B2. Office for Nuclear Regulation (ONR) is the UK's regulatory body for nuclear safety and was established as a Public Corporation in 2014 under Part 3 of the Energy Act 2013 (TEA13) (Ref. B.3).

B3. Key developments in ONR since the last report include:

- The establishment of a domestic safeguards regulatory function to meet international safeguards obligations, following on from the UK's decision to withdraw from the European Union (EU) and hence Euratom;
- The combination of the roles of Chief Executive and Chief Nuclear Inspector and (CE/CNI) along with additional changes to the governance and leadership structure;
- Digitisation and simplification of regulatory processes; and
- Implementation of a project to improve regulatory memory, knowledge management, capability and consistency in regulatory decision making.

B4. TEA13 provides the framework setting out the governance, responsibilities, powers, and enforcement duties of ONR. Section 118 of TEA13 requires that the Secretary of State for BEIS conducts a post-implementation review (PIR) of Part 3 of TEA13.

B5. The PIR is an independent review conducted on behalf of UK Government departments; the Department for Work and Pensions (DWP), to which ONR is an identified public corporation (Ref. B.4), and BEIS, which is accountable to Parliament for the UK civil nuclear regulatory framework and policies (Ref. B.5). The PIR considered ONR's purposes and functions, governance, and conduct, how ONR exercises its regulatory functions and whether it is fit for the future. The final report, providing the recommendations, findings and conclusions to this review, will be laid in Parliament and published mid/late 2022.

B6. There have been no significant changes to the environmental regulatory bodies.

International update

B7. The UK has been a member of the Convention since its establishment and has therefore been through the review process 7 times, noting that the eighth Review Meeting (RM) was cancelled. In addition, the UK regulatory system continues to be regularly peer reviewed through the IAEA's Integrated Regulatory Review Service (IRRS). Elements of the regulatory system have therefore been subject to extensive international peer review on multiple occasions.

B8. The paragraphs B9 to B29 are directly related to the **major common issue** on **international peer reviews** from the Seventh Convention.

Integrated Regulatory Review Service

B9. The UK has previously invited the IAEA to undertake IRRS peer review missions in 2006, 2009 and 2013. In 2014, a further mission was invited to review ONR's progress in addressing the open findings.

B10. In October 2019, the UK hosted a full-scope IRRS mission covering all facilities, activities and exposure situations present in the UK. For the first time the mission included all UK bodies regulating facilities and activities concerning ionising radiations, excluding defence. It also involved relevant government departments with responsibilities for policy and sponsorship of the relevant regulatory bodies. In total it involved collaboration between 15 regulatory bodies, and 11 government departments across the UK.

B11. The UK Government has welcomed the final report in its response, which can be read in full, along with the IAEA's mission report on the government BEIS website (Ref. B.6 and B.7).

B12. The UK will update the IAEA on progress at a follow up mission, which is scheduled for January 2024. This is in line with IAEA expectations for follow up missions and will support UK aims to maintain alignment with international good practice.

B13. In addition to hosting an IRRS mission, ONR has also performed the team leader role for an IAEA IRRS follow-up mission to review progress of the 2014 Mission findings at the Pakistan Nuclear Regulatory Authority Offices, Islamabad. The follow-up IAEA team comprised 9 experts who participated in Pakistan and 2 who contributed remotely due to COVID-19 related circumstances.

IAEA engagements

B14. In addition to the Convention and the IRRS missions, the UK is routinely involved in a wide range of international activities at senior strategic and working levels, allowing the UK to contribute to other countries' arrangements and continue to benchmark its own. Examples include taking on leadership roles in the production of Nuclear Energy Series (NES) reports.

Nuclear Energy Series report production involvement

B15. Consistent with their respective roles, ONR and EDF Energy NGL recently made a major contribution to the development of a new IAEA NES report, "Management of ageing and obsolescence of nuclear instrumentation and control (I&C) systems and equipment through modernisation" (Ref. B.8). The objective of the report was to highlight:

- Pertinent IAEA I&C system/equipment ageing and obsolescence management guidance and relevant good practice;
- Key ageing and obsolescence related issues that need to be taken into consideration when modernising I&C systems/equipment; and
- Strategies that could be employed to address such issues.

B16. This task was undertaken by a multinational working group of NPP operators and research institute personnel, with ONR and EDF Energy NGL personnel chairing and coordinating each of the sub-working groups. ONR was also responsible for coordinating the overall task; editing the final report, chairing the associated consultancy and technical meetings, and resolving technical review comments. This has resulted in the report being a source of relevant good practice (RGP) for UK licensees and other nations.

B17. ONR also contributed to the production of another IAEA NES report, "Introduction to systems engineering for I&C of nuclear facilities" (Ref. B.9). This report introduces systems engineering in a nuclear facility I&C context and considers weaknesses commonly seen in many projects (including insufficient interdisciplinary coordination, insufficient rigour in requirements identification, limited use of techniques such as modelling and simulation). It particularly aims to assist readers gain an understanding of the philosophy and methodologies of systems engineering and to provide guiding principles.

OSART and WANO missions

B18. As operator and licence holder for the UK’s operational NPP, EDF Energy NGL subscribes to a planned programme of peer reviews by the World Association of Nuclear Operators (WANO) and has been the subject of 2 IAEA Operational Safety Review Team (OSART) missions. Many of the criteria under review by WANO and OSART include aspects of plant operations that directly relate to safety. More information on past and planned missions can be found in paragraph 10.36 to 10.40.

Multinational Design Evaluation Programme

B19. ONR has continued to participate and play a leading role in the Multinational Design Evaluation Programme (MDEP), which works to harmonise regulatory practices and future standards, and shares the results of assessments of new reactor designs carried out by the national nuclear regulators.

B20. ONR has participated in 2 design specific working groups; the EPR™ Working Group (EPRWG) and HPR1000 Working Group; and one issue specific working group, the Vendor Inspection Co-operation Working Group (VICWG).

B21. At the end of 2021 the MDEP framework was updated and now only has 2 design specific working groups, one of which is the HPR1000 Working Group that ONR continues to participate in.

B22. The work of the EPRWG and the VICWG have been successfully transferred to the Organisation for Economic Co-operation and Development (OECD) Nuclear Energy Agency (NEA), which ONR also continues to support. For the EPRWG the focus is now on commissioning and early operational experience which is beyond the scope of MDEP. For the VICWG, the opportunities provided by participation in VICWG have increased from co-operation on vendor inspection activities, to sharing the outcomes of national vendor inspection programmes and developing common regulatory positions on areas of emerging risk. Also see paragraphs 13.9 and 13.10.

ENSREG Topical Peer Review on ageing management

B23. This is directly related to the **major common issue** on **international peer reviews** from the Seventh Convention.

B24. The EU's 2014 Nuclear Safety Directive (Ref. B.10) includes the requirement for the Member States to undertake a Topical Peer Review (TPR) every 6 years from 2017. As highlighted in the UK's eighth NR, the UK participated in the first review, which was run under the auspices of the European Nuclear Safety Regulators Group (ENSREG) on the topic of ageing management. All the information, including the UK National Assessment Reports (NAR) associated with the first TPR, can be found on the TPR website (Ref. B.11).

B25. The UK NAR demonstrated that the UK's operating NPPs and the NPPs under construction had ageing management programmes appropriate to the stages that they were at in their lifecycles and life-limiting corrosion issues in the ageing AGR fleet are dealt with through regulatory enforcement actions where appropriate (see paragraphs 6.44 to 6.50). Both licensees (EDF Energy NGL and NNB GenCo (HPC), latterly referred to as just NNB GenCo) demonstrated that they recognised international standards and guidance including IAEA safety standards. Furthermore, the TPR exercise found 2 good practices for the UK that exceed requirements to meet the appropriate international standards, namely:

- To establish the integrity of new or novel materials, sections of pipework are removed after a period of operation and inspected to confirm the properties are as expected; and
- Shielding in the core of PWRs with relatively high fluence is in use to preventively reduce neutron flux on the reactor pressure vessel wall.

B26. However, the TPR exercise acknowledged that whilst the licensees had adequate processes in place to manage ageing, it was not considered in an integrated manner. Improvements have since been put in place, which are reported in paragraph B27. Also, several secondary but beneficial improvements were identified through comparison with best practices. Subsequently, the licensees' own programmes for improvement included these items, which were agreed with ONR and, in turn, reflected in the UK Action Plan.

B27. In 2021, ONR reported to ENSREG the UK's progress with the Action Plan (Ref. B.12) noting the following:

- Actions on Overall Ageing Management Plans have been progressed with the production of ageing management strategies at both licensees;
- ONR has conducted CNI Ageing Management Interventions across UK licensees in 2021 and 2022. More information can be found in paragraphs 14.108 to 14.111;
- In the Electrical Cables and Concealed Pipework topic areas, the licensee updated the relevant technical guides. This included providing a

link between the cable condition monitoring guide and Control and Instrumentation (C&I) service management documents; embedding buried pipework inspection and management guidance within the overall corrosion management programmes (related information can be found in paragraphs 14.83 to 14.88); and ensuring that cognisance of building settlement findings would be taken when assessing the condition of concealed pipework; and

- In the Concrete Containment Structures and Pre-stressed Concrete Pressure Vessel topic area, the licensee updated its technical guides to recognise good practices in the use of opportunistic inspections (where areas are exposed for other purposes) and on how condition information can be collected using indirect investigation methods. The benefits of extending strain gauge monitoring for Sizewell B's pre-stressed concrete containment (also see paragraph 18.97) were recognised as a potential enhancement and have been added to the plans for a wider review in the context of Long-Term Operation.

B28. In 2021, following exit from the EU, the UK joined ENSREG as an observer country and voluntarily committed to participate in the second TPR exercise. This will be covering nuclear fire protection and is planned to take place from 2022 to 2025. In this context and through Western European Nuclear Regulators Association's (WENRA) working groups, ONR has actively contributed to the development of the technical specification. ONR specifically proposed to focus on fire analysis in addition to the practical implementation of fire safety. ONR also instigated an internationally coordinated sampling approach to facilitate coverage of the wider range of UK nuclear installations proposed by ENSREG for the second TPR.

B29. In summary, the first TPR concluded that the UK's ageing management arrangements were adequate, and subsequently the UK has progressed the suggested beneficial improvements to its ageing management processes through the National Action Plan. The UK remains committed to TPR, having actively contributed to preparatory activities towards the second TPR on fire protection and is committed to participate in the exercise as it commences in summer 2022.

B30. Some key benefits from taking part include:

- Opportunity to benchmark the UK's performance and high standards of nuclear safety versus other countries. This enables ONR and the UK to showcase the benefits of the UK's goal-setting/non-prescriptive regulatory regime, openness and transparency, and risk-based regulation. It also provides knowledge of alternative approaches that may be applied by other countries and may impact the UK nuclear sector.
- UK experts are given the opportunity to scrutinise and influence other countries' performance, seeking improvements in safety performance across installations in the EU where an accident could impact the UK.

- Opportunity for ONR and the UK to showcase the benefits of targeted sampling and application of graded approaches (focusing on areas where the risks are greatest or least well understood).
- TPR provides a platform for the UK nuclear sector and experts to benchmark their knowledge and experience against others across the EU. This provides tangible evidence of their world-leading expertise which is in turn recognised by standard-setting organisations such as the IAEA and WENRA. This is critical to ensure that such standard setting organisations are not unduly influenced or dominated by countries/regulators which, for their own domestic reasons have decided to phase out nuclear power.

Important safety challenges, ageing and obsolescence

B31. The UK is managing a fleet of NPPs which are ageing. Throughout the last reporting period there were several safety issues reported by the EDF Energy NGL fleet. Some of these issues can be attributed to ageing and obsolescence and are summarised below. This is linked to Challenge 8.1. More information can be found in Article 6 – Existing Nuclear Installations and Article 14 – Assessment and Verification of Safety.

Sizewell B control and instrumentation upgrade

B32. The Sizewell B Plant Control System and Distributed Computer System upgrade was successful completed during a Refuelling Outage in 2019. More information can be found in 14.97 to 14.98.

Carbon deposition – oxygen injection

B33. Advanced Gas-cooled Reactors (AGRs) are susceptible to developing carbon deposits on their heat transfer surfaces, including boiler tubes and nuclear fuel pins. Oxygen injection to address this issue for Reactor 2 at Heysham 1 has now been implemented. More information can be found in paragraphs 6.17 to 6.20.

Phase imbalance alarms and phase protection

B34. Electrical Phase imbalance faults at high voltages have the potential to cascade to lower voltages and affect multiple systems simultaneously. EDF Energy NGL has installed protection systems to protect motors and safety systems. More information can be found in paragraphs 6.37 to 6.40.

Graphite modelling and testing

B35 The ageing of the graphite cores of the AGR fleet and the associated core cracking has led EDF Energy NGL to develop improved test and modelling capability to predict the core response to seismic events. More information on this can be found in paragraphs 6.21 to 6.28.

Defuelling preparation at Hunterston B

B36 The end of power generation at Hunterston B took place in January 2022. The power station is now in the defuelling phase of operation. EDF Energy NGL has been preparing for the defuelling of Hunterston B throughout the final years of generation. More information on this issue can be found in paragraphs 6.58 to 6.62.

Graphite ageing at Heysham 2 and Torness

B37. EDF Energy NGL monitors the condition of the AGR reactor core graphite. The graphite brick cracking that takes place as graphite ages presents a set of different challenges depending on the core design. Heysham 2 and Torness have a different design to other AGRs. More information on this issue can be found in paragraphs 6.66 to 6.68.

Secondary and tertiary shutdown systems

B38. The third Periodic Safety Review (PSR) for the AGR fleet identified the need to upgrade some secondary (nitrogen) and tertiary (boron) shutdown systems. For more information on the programme of work see paragraphs 6.30 to 6.36.

Sizewell B thermal sleeve

B39. In 2021 during a refuelling outage at Sizewell B, an inspection of the reactor pressure vessel head identified that one of the thermal sleeves had become detached from the head assembly. This led to a programme of work to inspect all sleeves and make necessary repairs. More information on the resolution of this issue can be found in paragraphs 6.69 to 6.74 and 15.26 to 15.29.

Management of the asset for defuelling

B40. Operating requirements of the AGR plants change following the end-of-generation (EoG). Therefore, a programme to manage ageing and reliability for plants approaching defuelling was developed. For further information see paragraphs 14.78 to 14.82.

Sizewell B steam generator drain leak

B41. During a scheduled inspection at Sizewell B in November 2017, a leak was detected on the steam generator (SG) drain line. The drain lines on all 4 SGs were subsequently plugged. The licensee presented a justification to continue operating for the rest of the Station's design life to 2035. For further information see paragraphs 6.64 to 6.65.

Incidents, operational experience and lessons learned

B42. A summary of UK incidents and associated INES ratings can be found in Table 4 – Summary of Incidents and associated INES Ratings. The 2 most notable incidents are summarised below. More information on these, other UK and international incidents are available through the IAEA (Ref. B.13).

B43. Significant operational experience and lessons learned since the last operating period is identified under Table 5 – Examples of Learning from Operational Experience.

Incidents of note

Automatic trip of both reactors at Heysham 1

B44. On 22 July 2021, following a failure of the National Grid transformer located offsite, Heysham 1 experienced a complete loss of 400 kV power supplies. Both reactors were operating at nominal full power prior to the incident, and both tripped automatically. The back-up power supply required by the Limits and Conditions of Operation (LCO) was provided by the automatic start-up of 2 gas turbines. There are 4 gas turbines in total, and only one gas turbine is required to provide adequate electrical supplies to both tripped reactors. Adequate post trip cooling was established by the automatic start of one Emergency Boiler Feed Pump (EBFP).

B45. The LCO require a minimum of 2 EBFPs to be available when the reactors are operating at power. There are 4 EBFPs on site, any one of which can maintain effective post trip cooling for both reactors. One was out of service for planned maintenance and the 2 other EBFPs shutdown during their start sequence because of an automatic control system issue. These were started manually after 45 minutes. Post trip cooling was effective, and the reactors were safely shutdown. There were no radiological consequences as a result of this incident and no harm to workers or the public. This incident was rated an INES Level 2 event.

Dungeness B nitrogen injection pipework corrosion

B46. During April 2019 corrosion on some nitrogen injection pipework was discovered in underground lines at Dungeness B. After further assessment, more corrosion was discovered in other areas on this line. The damage was sufficient that upon uncovering of a section of the line, gas was heard to be escaping by staff. Workers withdrew at this point and were provided with radiological monitoring to ensure that they had not been personally contaminated by the release of the reactor CO2 gas. No workers were contaminated. This incident was rated an INES Level 1 event.

UK’s preparation for new nuclear

B47. The UK Government’s energy policy is to have a diverse mix of low carbon generating technologies and is dedicated to investing in new technologies to lead the global mission to tackle climate change. The Energy White Paper (Ref. B.14) and Ten Point Plan (Ref. B.15), published in late 2020, the Net Zero Strategy (Ref. B.16) published in October 2021, and the British Energy Security Strategy (Ref. B.17) published in April 2022 all highlight the key role of nuclear in delivering deep decarbonisation of the UK’s electricity system alongside other technologies, and state the UK Government’s objective to advance nuclear as a clean energy source. This includes large scale nuclear reactors and the development of the next generation of small and advanced reactors.

B48. In the Energy White Paper, the UK Government committed to bring a further (to Hinkley Point C) large-scale nuclear project to the point of Final Investment Decision (FID) by the end of this Parliament (no later than May 2024), subject to value for money and all relevant approvals. The UK Government is currently in negotiations with NNB GenCo (SZC) on the Sizewell C project in Suffolk, England. On 27 January 2022, the UK Government entered into a Combined Option agreement with NNB GenCo (SZC) to the value of £100m to support the development of Sizewell C. The UK Government is also committed to provide up to £385m in an Advanced Nuclear Fund for the next generation of (advanced) nuclear technologies (ANT). ANTs fall into one of 2 groups: Generation III water-cooled SMRs, similar to existing nuclear power station reactors but on a smaller scale, or Generation IV or beyond Advanced Modular Reactors (AMR). The fund aims to support the development of a SMR design and to build an AMR demonstrator by the early 2030s.

B49. The Net Zero Strategy provides a blueprint for decarbonising all sectors of the UK economy to meet the UK’s net zero target by 2050. In the

Net Zero Strategy, the UK Government specifically announced up to £1.7bn to support a large-scale nuclear project reaching FID in this Parliament, and a further £120m Future Nuclear Enabling Fund to help support the development of future nuclear projects.

B50. The British Energy Security Strategy builds on the UK Government's 2020 and 2021 publications by setting out the government's long-term ambition to increase plans for the deployment of nuclear power by up to 24 gigawatts by 2050. In addition to aiming to take one nuclear project to FID this Parliament, the UK Government intends to bring 2 projects to FID in the next Parliament, including Small Modular Reactors. This will be subject to value for money, relevant approvals, and technology readiness/maturity.

B51. The UK Government also enacted the Nuclear Energy (Financing) 2022 Act (Ref. B.18) to establish a new RAB funding model for large and small nuclear projects, which is intended to cut the cost of financing compared to the existing Contracts for Difference model, thereby reducing the cost to consumers and unlocking private investment.

B52. The UK Government recognises nuclear power generated in the UK limits exposure to volatile energy prices and ensures the UK's energy security and independence. This has grown in importance during 2022 in response to the global energy crisis.

B53. The UK Government also intends to publish a roadmap for new nuclear in 2022, focusing on what is needed to support the deployment of further new nuclear in the UK.

B54. In May 2021 BEIS published guidance for ANTs to enter the Generic Design Assessment (GDA) (Ref. B.19), the first stage of the UK's nuclear regulatory process, fulfilling the UK's Energy White Paper commitment to open GDA to SMRs.

B55. GDA entry is an open and ongoing process, with a standing invitation for nuclear companies to apply when they believe they are ready to do so. Reactors deployed in the UK must meet the UK's robust and independent regulatory requirements.

B56. GDA is a voluntary process and not a legal requirement of GB's licensing regime for new NPPs. However, the UK Government recognises that the GDA process offers efficiencies and therefore expects reactor designers to follow it.

New build and licensing

Update on Hinkley Point C

B57. Under its arrangements for compliance with Licence Condition (LC) 19 (construction or installation of new plant) (Ref. B.20) the licensee, NNB GenCo, divided the Hinkley Point C project into stages separated by hold points. These represent key project milestones where there is a step change in the latent risk if they are poorly conceived or executed, or where short comings in construction or commissioning having a greater impact upon nuclear safety. ONR specified that the licensee acquire ONR permission to proceed beyond the early construction hold points of:

- HP1.2.1 First Nuclear Safety Concrete – first pour of nuclear safety related concrete on site (unit 1 technical gallery);
- HP2.2.1 – Start of Pumping Station; and
- HP1.2.2 Nuclear Island Concrete – pouring of the unit 1 common raft concrete.

B58. ONR gave permission to allow the licensee to commence the given activities, with laying of the Unit 1 nuclear island concrete completed on 28 June 2019. Hinkley Point C construction is now well progressed (see figures B.1 and B.2).

B59. Since the UK's eighth NR, ONR has given permission for commencement of bulk mechanical, electrical, and heating, ventilation, and air conditioning (HVAC) component installation with these activities commencing on the nuclear island in November 2021.

Figure B.1: Construction at Hinkley Point C – Liner Lift

Figure B.2: Construction at Hinkley Point C – Site View

B60. Since granting this most recent permission, ONR has turned its focus to the update of its Intervention Strategy, delivery plan, and associated governance. This will cover the period to the end of the project, but with a key focus on the period to the next permissioning point. Lessons learned workshops have been held internally within ONR and jointly with NNB GenCo and the Environment Agency to inform this process. There is now a structure in place for the regulation of the next stage of the project.

Update on UK HPR1000

B61. In January 2017, the UK Government asked ONR and the Environment Agency to begin the GDA of the UK HPR1000 reactor design proposed for deployment at Bradwell-on-Sea, Essex, England. General Nuclear System Limited (GNSL) is a UK-registered company that was established to implement the GDA of the UK HPR1000 reactor on behalf of 3 joint requesting parties, collectively referred to as the GDA Requesting Party (RP): China General Nuclear Power Corporation (CGN), Électricité de France SA (EDF SA) and General Nuclear International (GNI). GNI is a UK subsidiary of CGN.

B62. The UK's eighth NR stated that ONR was, at the time, conducting Step 3 of the GDA of the UK HPR1000. Step 3 ended in February 2020 and ONR has since issued the GDA Step 3 Summary Report (Ref. B.21); this summarises the outcomes of ONR's assessment, at that point in the process.

B63. In February 2020 ONR progressed to Step 4 of the GDA, with a view to determining whether the designs were sufficient to support the issuing of a Design Acceptance Confirmation (DAC) and, by the Environment Agency, a Statement of Design Acceptability (SoDA). ONR completed Step 4 of GDA in January 2022, and ONR's Chief Nuclear Inspector granted the DAC for the UK HPR1000 nuclear reactor design (Ref. B.22) soon thereafter. ONR has now published its Step 4 technical assessment reports and a summary report on the GDA joint regulators' website (Ref. B.23), The Environment Agency also granted a SoDA (Ref. B.24).

Update on Bradwell B

B64. Bradwell Power Generation Company Ltd is a joint venture between GNI and EDF Energy Holdings Limited, created to deliver the Bradwell B Nuclear Power Plant project involving deployment of the UK HPR1000 reactor technology (Ref. B.25). ONR's UK HPR1000 regulatory team has had pre-licence application engagement with Bradwell Power Generation Company Limited (BRB GenCo) to ensure that it understands ONR's expectations as regards consideration of site suitability and the establishment of sufficient organisational capability commensurate with the issuing of a nuclear site licence and responsibly discharging the legal duties that this bestows.

Update on advanced nuclear technologies

B65. The UK Government's Nuclear Sector Deal (Ref. B.26) sets out a framework to support the development and deployment of ANTs.

B66. To meet the goals set by the UK Government, ONR and the Environment Agency developed a regulatory strategy based on 3 key areas:

- Develop knowledge, capability, and capacity to regulate ANTs;
- Engage Internationally with other regulators regarding regulation of ANTs; and
- Engage with the ANT industry.

B67. Since the UK's eighth NR, ONR has successfully developed a training capability for its inspectors for a range of AMR technologies, ensuring it can respond flexibly and quickly to provide a clear nuclear safety and security regulatory framework for the industry and government.

B68. Internationally, ONR has actively engaged in the IAEA's SMR Regulators Forum and NEA working groups to accelerate mutual understandings of the similarities and differences in regulatory requirements, and to look for equivalence of approaches across design assessment and licensing processes. The UK has provided multidisciplinary input and commentary to IAEA reviews of its safety standards and ONR has increased its bilateral engagements with other regulatory bodies to identify areas of commonality and potential harmonisation.

B69. The UK has continued to provide designers and vendors of ANTs access to the regulators as they develop their offerings ahead of entering formal safety assessment processes, GDA. BEIS has also funded engagements between industry and ONR on the regulatory expectations for supply chain management.

B70. Since the UK's eighth NR, BEIS, the Environment Agency, and ONR has updated their guidance for the assessment of generic reactor designs to provide more flexibility and to open it up specifically for ANT technologies (Ref. B.19). In March 2022, Rolls-Royce SMR Limited became the first design to enter this revised GDA process, commencing an assessment process ahead of intended future deployments in the UK and other international markets.

B71. In 2021, the UK Government stated its ambition to build a High Temperature Gas Reactor demonstrator by the mid-2030s. BEIS is actively engaging with industry bodies and potential vendors to determine the design and siting options for this endeavour. ONR and the Environment Agency are using learning from internal and international activities on ANTs to provide advice to BEIS on how to effectively regulate this undertaking in accordance with UK legislation and international safety standards.

Innovation

B72. ONR has developed and agreed a plan for delivering an approach-to-innovation, which includes how ONR will continue to position themselves as an enabling regulator of the nuclear industry and its supply chain. ONR is working to ensure that it supports the adoption of innovative solutions where it is in the interest of society and is consistent with safety and security expectations. ONR continues to trial this approach and will be engaging with the nuclear industry and its supply chain to support the adoption of innovative solutions in support of the existing fleet of operating reactors and UK new reactor developments.

Review of the ONR safety assessment principles

B73. In anticipation of future regulatory challenges, ONR has undertaken a review of its Safety Assessment Principles (SAPs) to consider their adequacy for assessing the novel aspects/characteristics of 4 AMR technologies: Molten Salt Reactors, High Temperature Gas Reactors, Sodium Fast Reactors and Lead Fast Reactors.

B74. The review concluded that the extant SAPs continue to provide a sound framework and basis for ONR inspectors to make consistent regulatory judgements on the safety of nuclear facilities including light water SMRs and those utilising AMR technologies. The review did highlight that additional guidance or information may be helpful to clarify how some of the SAPs cover potential faults and hazards specific to AMR technologies, as well as some changes in operating philosophy. However, given the uncertainty associated with which AMR technologies will be developed in the UK and on what timescales, the current SAPs have been judged to be adequate for near-term safety assessment activities associated with new NPP design and build. The need for additional guidance will be kept under review as part of periodic updates to the SAPs.

Knowledge management

B75. The UK continues to recognise knowledge management as an important issue. Progress on this is discussed below and is related to the response to the **major common issue** from the seventh RM on **knowledge management**.

Knowledge management within ONR

B76. To further improve knowledge management from the position reported within the UK’s eighth NR, ONR continues to deliver its Well-Informed

Regulatory Decisions (WIReD) project, which has now entered the delivery phase. ONR has:

- Established a secure common digital platform for storing all its regulatory data, which enhances ONR's capability to identify and utilise regulatory intelligence and operational experience data;
- Deployed a modern replacement for its legacy incident database, so that ONR now has a common platform to store regulatory information in one place;
- Introduced a new digital process for managing regulatory issues, removing barriers to collaboration and pooling of regulatory intelligence across ONR's safety, security and safeguards purposes; and
- Implemented a digital portal to simplify how dutyholders submit applications to ONR and view ONR's progress in their assessment, creating increased transparency on the progress of ONR activities and their outcomes.

Joint working with the Environmental Regulators

B77 ONR and the environment agencies work together to share relevant operational experience and regulatory intelligence. Where joint working occurs this is set out in a Memoranda of Understanding (MoU) (see paragraphs 7.68 to 7.69).

Knowledge management and retention within EDF Energy

B78. To manage its overall capability to support both existing operating NPPs and new nuclear projects during the phases of construction, operation, defuelling and decommissioning, EDF (NGL and NNB GenCo) is developing a common pool of resources, the Technical Services Organisation (TSO). More information can be found in paragraphs 11.41 to 11.43 and 12.21 to 12.25.

B79. More broadly, EDF has many processes that are routinely used to gather and manage knowledge. More information can be found under Article 11 – Human and Financial Resources.

Managing the transition to defuelling

B80. The transition of NPPs from generation to defuelling will have an impact on personnel, many of whom have spent many years supporting generation. Managing the human aspects of change is a significant focus area for EDF Energy NGL. More information can be found under Article 12 – Human Factors and within paragraphs 12.21 to 12.25.

Feedback on the seventh and eighth national reports

B81. The eighth RM was not held due to the COVID-19 pandemic. However, in preparation the Country Review Report for the UK (Ref. B.27) was drafted for the Convention. Contained within it was a range of updated requirements for this, the UK's ninth NR. These are addressed below in addition to the requirements from the seventh RM for the UK's eighth NR, which have all been treated as extant.

Rapporteur's report

B82. The rapporteurs' reports from the seventh RM identified challenges and suggestions for each Contracting Party to include in their eighth NR, and subsequently at the eighth RM.

B83. The draft Country Review Report written against the UK's eighth NR also identified Challenges and Suggestions; specifically to be addressed in the UK's ninth NR.

Challenges

B84. Three challenges were identified for the UK from the seventh RM. See figure B.3.

Figure B.3: Challenges Arising from Country Group Discussions from Seventh Convention on Nuclear Safety Review Meeting

Challenge	Response
Challenge 7.1: Regulating an ageing fleet of AGR reactors, including graphite weight loss and cracking of graphite bricks.	The draft Country Review Report for the UK for the eighth RM identified that this Challenge remained OPEN. Given that this is routine business and will continue to be required for the remainder of the AGR lifetimes, the UK considers this Challenge can be closed. For information on how it has been addressed see Challenge 8.1.

Challenge	Response
Challenge 7.2: Building capacity and capability to meet the needs related to embarking on a significant program of new NPP build activities.	The draft Country Review Report for the UK for the eighth RM identified this Challenge as CLOSED. The UK agrees with this position but notes that work will continue to be required against Challenge 7.2 dependent upon the type of reactors proposed for operation within the UK. This is covered under Article 8 – Regulatory Body and Article 11 – Financial and Human Resources.
Challenge 7.3: Providing clarity on the application of the regulatory process and decision in relation to filtered containment venting (FCV) system at Sizewell B.	The draft Country Review Report for the UK for the eighth RM identified this Challenge as CLOSED. Irrespective of this and by means of an update: EDF Energy NGL has set a date of 2024 to consider a possible lifetime extension for Sizewell B. The practicability of fitting FCV will be considered in parallel, in support of justifying any such extension. This is covered under paragraph 18.69 and within Article 19 – Operation with supporting information found in Annex 3 – SFAIRP, ALARP and ALARA.

B85. Four challenges were identified against the UK's from the draft country review report, in lieu of the eighth RM. See figure B.4.

Figure B.4: Proposed Challenges Arising from the draft Country Review Report for the United Kingdom's Eighth Report submitted for the Eighth Convention on Nuclear Safety Review Meeting

Challenge	Response
Challenge 8.1: Regulating an ageing fleet of AGR reactors including graphite weight loss and cracking of graphite bricks.	This is a repeat of Challenge 7.1 which was identified as remaining OPEN from review of the eighth NR. Work has continued on Challenge 7.1 and is covered under Section B – Summary, Article 6 – Existing Nuclear Installations, Article 7 – Legislative and Regulatory Framework and Article 14 –

Challenge	Response
	Assessment and Verification of Safety. Given that this is routine business and will continue to be required for the remainder of the AGR lifetimes the UK considers this Challenge can be closed.
Challenge 8.2: The UK to address possible concerns and challenges on nuclear safety regulation resulting from European Union (EU) exit before EU Exit occurs.	This is covered under Article 7 – Legislative and Regulatory Framework and Article 13 – Quality Assurance. Given the UK has now left the European Union, the UK considers this Challenge can be closed.
Challenge 8.3: The UK to have in place domestic safeguards before the UK leaves Euratom.	This is covered under Article 7 – Legislative and Regulatory Framework and Article 8 – Regulatory Body. Given the UK has now left the European Union and the new safeguards regime is in place the UK considers this Challenge can be closed.
Challenge 8.4: Managing corrosion and graphite brick cracking at the AGR stations.	Apart from the addition of corrosion, this Challenge is addressed as per Challenge 8.1. Corrosion is covered under Paragraphs 6.44 to 6.50 and more generally under Article 14 – Assessment and Verification of Safety.

Major common issues arising from country group discussions

B86. Several major common issues were identified for the UK from the seventh RM. See figure B.5.

Figure B.5: Major Common Issues Arising from Country Group Discussions from the Seventh Convention on Nuclear Safety Review Meeting

Common Issues	Response
Safety culture.	Safety culture in the UK is discussed under Article 10 – Priority to Safety and Article 12 – Human Factors.
International peer reviews.	International peer reviews that have taken place in the last reporting period, and planned international peer reviews, are discussed under the international update under paragraphs B7 to B29 and 10.36 to 10.39.
Legal framework and independence of regulatory body.	The legal framework is discussed in Article 7 – Legislative and Regulatory Framework and the independence of the regulatory body is discussed under 8.107 to 8.110.
Financial and human resources.	Financial and human resources are discussed for the regulatory body in Article 8 – Regulatory Body and for the licensees under Article 11 – Financial and Human Resources.
Knowledge management (generation transition).	Knowledge management by ONR, the environmental regulators, and licensees are discussed under Article 8 – Regulatory Body and Article 11 – Financial and Human Resources.
Supply chain. Quality assurance of Structures, Systems and Components (SSC), including Counterfeit Fraudulent and Suspect Items (CFSI). Anomalies in reactor pressure vessel (RPV) components.	Quality assurance is addressed under Article 13 – Quality Assurance, this includes consideration of SSC CFSI and an update against the UK's response to the anomalies in RPV components.
Managing the safety of ageing nuclear facilities and plant life extension.	This is covered under Challenge 8.1 at Figure B.4 – Challenges from the Eighth Convention.

Common Issues	Response
Emergency preparedness.	Emergency preparedness is discussed in detail under Article 16 – Emergency Preparedness and further information is available under 19.39 to 19.47.
Stakeholder consultation and communication.	Communications by ONR, the environmental regulators and the licensee are discussed under Article 8 – Regulatory Body and Article 9 – Responsibility of the Licence Holder.
Cyber security and computer-based system important to safety.	ONR adopts a holistic safety and security approach to the regulation of cyber security of computer-based systems important to safety (CBSIS). This is reflected in the UK's transition to outcome-focused security regulation, which aims to achieve more efficient and effective regulation of cyber security and information assurance (CS&IA). Safety and security specialists undertake joint compliance and permissioning activities and take enforcement action when needed. ONR's multi-disciplinary forum on the security of CBSIS provides opportunities for sharing intelligence and operational experience, and is a co-ordinating centre for regulatory activities, development of internal and external guidance, research activities, staff development and training. ONR continues to develop this area with a C&I and CS&IA Cooperative Working Strategy on Cyber Security where these specialisms have a mutual interest in achieving their regulatory purpose.

Suggestions

B87. Five Suggestions were identified for the UK from the seventh RM. See figure B.6.

Figure B.6: Suggestions Arising from Country Group Discussions from Seventh Convention on Nuclear Safety

Suggestion	Response
Suggestion 7.1: Listing all NPP safety-related legislation documentation (such as laws, regulations, standards, requirements, rules, and guides) adopted by the national regulator (with the year of	This information was included within the eighth NR under Article 7 – Legislative and Regulatory Framework and has been updated for the

Suggestion	Response
publication/adoption) in the report, especially those adopted since the sixth National Report.	ninth report. All new regulations that have come into force since the last convention have been highlighted with a text box to aid identification.
Suggestion 7.2: Listing major performance indicators of NPPs in 2013–2016 in a summary table.	This information was included within the eighth NR under Article 10 – Use of safety performance indicators and has been updated for the ninth report.
Suggestion 7.3: Adding annual financial budget of the national regulatory body in 2013–2016 in a summary table.	This information was included within the eighth NR under Article 8 – Provision of financial resources and has been updated for the ninth report.
Suggestion 7.4: Listing operational events and deviations in 2013–2016 in a summary table.	This information was included within the eighth NR under Table 4 – Summary of incidents and INES ratings and Table 5 – Examples of Learning from Operational Experience and has been updated for the ninth report.
Suggestion 7.5: Listing past (2013–2015) and upcoming (beyond 2016) domestic and international review activities conducted/to be conducted at NPPs in the UK in a summary table.	This information was included within the eighth NR under the international update now at paragraphs B7 to B29 and under Article 10 – International peer reviews which has been updated for the ninth report.

B88. One Suggestion was identified against the UK's from the draft country review report, in lieu of the eighth RM. See figure B.7.

Figure B.7: Proposed Suggestions Arising from the Draft Country Review Report for the United Kingdom's Eighth Report submitted for the Eighth Review Meeting.

Suggestion	Response
Suggestion 8.1: EDF fleet trends in Safety Performance Indicators (SPI) can be gleaned from (what was) figure 12, but it would be more useful if the SPIs were weighted and if there was an industry target for each SPI.	The relevant information has been updated from the text included within the eighth NR. The ninth NR now describes the application of weightings. See Article 10 – Use of safety performance indicators.

Experience with response to COVID-19 pandemic

B89. Within the CNS President's letter sent to all National Contacts (Ref. B.28) guidance was provided on the content of the ninth NR. The letter identified the need to report upon the response to COVID-19. See paragraphs B90 to B99.

Response to the COVID-19 pandemic

B90. The COVID-19 pandemic was a challenge to all regulators, licensees and dutyholders in the UK. However, during this time, the UK continued to deliver efficient and effective regulation of the nuclear industry whilst managing the impacts from the pandemic.

B91. ONR focused on maintaining the health and wellbeing of its staff and delivering its mission to protect society by securing safe nuclear operations. ONR set up an Incident Management Team (IMT) to monitor the emerging situation and to respond to government guidance as it was developed (see paragraphs 8.53 to 8.64). The environmental regulators acted similarly, with the Environment Agency, for example, establishing a Coronavirus Transformation Programme (CTP) to re-shape its regulatory programme (see paragraphs 8.66 to 8.67).

B92. During this time, Licensees and dutyholders faced some challenge meeting a few of the very specific requirements of some conventional health and safety legislation. This included Pressure Systems Safety Regulations 2000 (PSSR) and Lifting Operations and Lifting Equipment Regulations 1998 (LOLER) (see paragraphs 19.30 to 19.36), and the Ionising Radiations Regulations 2017 (IRR17); notably medicals to support classified worker status (see paragraph 15.46). The impacts were mitigated though the regulators development of Regulatory Position Statements (RPSs) and by ensuring that a risk informed approach was taken in the relatively few instances where requirements could not be met. This provided flexibility to defer some inspections/assessments. The RPS were time limited and only applied if the necessity arose as a consequence of COVID-19 pandemic related limitations or protection measures. The UK's environment agencies acted similarly (Ref. B.29). The RPSs were visible on regulatory web portals for openness and transparency, along with information on how the industry was being regulated during the pandemic.

B93. At the outset of the pandemic, EDF Energy NGL had a pandemic contingency plan in place and a set of principles for safe operation, which were originally developed in response to the swine flu pandemic of 2009. The pandemic contingency plan identified possible flexibilities in how EDF Energy NGL might demonstrate compliance with licence condition compliance arrangements, while ensuring nuclear safety was maintained (see paragraphs 10.72 to 10.77). The plan was updated in response to the COVID-19 pandemic and included arrangements to minimise the likelihood of onsite transmission of the virus, and monitor: staffing levels; supply chain; commodities, and the ongoing viability of each licensees emergency scheme. The arrangements were subject to continuous review by EDF Energy NGL using a Pandemic Working Group to enable risk informed decisions. As part of delivering the COVID-19 response EDF Energy NGL reported data to ONR, who collated similar data from all UK licensees, to enable it to report to the UK Government on a regular basis.

B94. NNB GenCo aligned with the EDF Energy NGL arrangements, adopting a risk informed approach to the health and wellbeing of its staff and also setting up a Pandemic Working Group (see paragraphs 10.68 to 10.71).

B95. COVID-19 had impacts on both licensees. Most significantly EDF Energy NGL's Sizewell B site had to enter a prolonged period of reduced power operation whilst electricity demand was reduced as a result of the pandemic, and because renewables generation at that time was high (see paragraphs 19.18 to 19.20). For NNB GenCo, construction work at Hinkley Point C continued but suffered some delays due to restrictions placed upon number of workers allowed on site.

B96. ONR aligned with UK Government legislation, guidance and social distancing policies and undertook a range of inspections remotely, only attending site when it was essential to do so. However:

- Meetings and regulatory interventions continued to take place remotely. Later, as the restriction eased, a hybrid approach was adopted (See paragraphs 8.53 to 8.63 and 13.21).
- Outages continued with reduced (but adequate) scope, subject to ONR agreement (see paragraphs 10.75) and 19.38).
- Emergency exercises continued with reduced scope by adopting a modular approach (see paragraph 16.38).
- Enhanced oversight of the supply chain was maintained to ensure quality was maintained and adequate stocks of key commodities remained available (see paragraphs 13.43 to 13.49).

B97. Whilst, the pandemic presented a significant challenge to the delivery of the IAEA safeguards inspections in the UK, the UK successfully completed these remotely to minimise the likelihood of COVID-19 transmission (see paragraphs 7.39 to 7.43 and 8.19).

B98. In the winter of 2020/21, ONR's CNI wrote to all licensees to determine preparedness for the potential challenges posed to nuclear safety and security and was content with the response received. Learning was shared with fellow regulators, industry, national and international forums, including IAEA and WENRA.

B99. Details of the responses, from an organisation perspective, can be found in:

- Article 8 – Regulatory Body (and Refs. B.30 and B.31) – ONR's response
- Article 10 – Priority to Safety – the licensees' responses; and
- Article 15 – Radiation Protection – the environmental regulators' response

Vienna Declaration on Nuclear Safety

B100. In response to the CNS President's letter sent to all Contracting Parties in December 2018 (Ref. B.32), the UK addressed all aspects of the Vienna Declaration on Nuclear Safety (VDNS) within the UK's eighth NR. Compliance is also demonstrated within this, the UK's ninth NR, and the key aspects of this are:

- **Principle 1** (new power plant design, siting, and construction):
  - Article 17 – Siting;
  - Article 18 – Design and Construction; and
  - Hinkley Point C design safety assessment in paragraphs 14.23 to 14.32.

- **Principle 2** (safety assessments and implementation of safety improvements):
  - Article 14 – Assessment and Verification of Safety;
  - Article 16 – Emergency Preparedness;
  - Article 18 – Design and Construction;
  - Periodic Safety Reviews (PSR) in paragraphs 14.33 to 14.40 and paragraph 17.13
  - Safety upgrades in paragraphs 6.16 to 6.40.
  - Assessment of plant lifetime extensions in paragraphs 6.41 to 6.42.
  - ONR SAPs in paragraphs 7.59 to 7.61 and Table 3 – Example Engineering Principles from the SAPs; and
  - Responding to operational occurrences and accidents in paragraphs 19.39 to 19.47

- **Principle 3** (considering IAEA safety standards and other good practices identified in the Review Meetings):
  - Quality management systems of regulatory body in paragraphs 8.72 to 8.73;
  - ONR Enforcement Policy Statement in paragraph 7.93 and 19.83 to 19.85;
  - Management systems in paragraphs under Article 13 – Quality Assurance;
  - Leadership and management for safety in paragraphs 10.17 to 10.20;
  - Safety performance indicators in paragraphs 10.21 to 10.24;
  - Safety culture Article 10 – Priority to Safety and Article 12 – Human Factors;
  - Mapping of IAEA standards including ONR SAPs in paragraphs 7.33 and 7.59, EDF Energy NGL Nuclear Safety Principles and NNB GenCo Nuclear Safety Design Assessment Principles in paragraphs 14.6 to 14.11;
  - Information on PSRs can be found in paragraphs 14.33 to 14.40 and 17.13;
  - Emergency planning and response in Article 16 – Emergency Preparedness;
  - Site evaluation for nuclear installations in paragraph 17.11; and
  - INES reporting in paragraph 19.67 and Table 4 – Summary of Incidents and associated INES Ratings.
  - Implementation of EC directives related to nuclear safety and radiation protection, emergency preparedness and response, and the safe management of radioactive waste and spent fuel. The requirements of these Directives were incorporated into UK law before EU Exit and continue to be part of the UK legislative and regulatory framework. See paragraphs 7.34 to 7.36.

B101. Principle 3 of the President's letter implicitly requests the Contracting Parties to address how they align with the good practices identified at the previous RM. The previous RM was the seventh meeting reviewing the UK's eighth NR, and the good practices are assumed to continue to apply to this, the UK's ninth NR. The UK position relative to the good practices is summarised in figure B.8.

B102. The definition of a Good Practice from INFCIRC/571 (Ref. B.33) is:

> " A Good Practice is a new or revised practice, policy or program that makes a significant contribution to nuclear safety. A Good Practice is one that has been tried and proven by at least one Contracting Party but has not been widely implemented by other Contracting Parties; and is applicable to other Contracting Parties with similar programs."

Figure B.8: Good Practices from the Seventh Review Meeting

Good Practice	UK Position
The first topical peer review was launched in a proactive manner, even before the date for transposition of the nuclear safety directive by EU Member States. (Euratom).	The eighth NR described how the UK was actively involved in the planning and preparation of the topical peer review (TPR) processes and defining the content. Information on the TPR has been updated under paragraphs B23 to B29.
The implementation of the European Instrument for Nuclear Safety for assisting non-EU countries. (Euratom).	The eighth NR stated that “the UK contributes to the funding of the European Instrument for Nuclear Safety”. Since the UK’s exit from the EU and Euratom, the implementation of the European Instrument for Nuclear Safety for assisting non-EU countries (Euratom) is not required.
The Canada Nuclear Safety Commission fosters openness and transparency in its regulatory process, for which it has launched a participant funding program that gives the public, aboriginal groups and other stakeholders the opportunity to request funding from the CNSC to participate in its regulatory process. The participants present their results directly to Commission members. The awarding of participant funding is done by a Board independent of the licensing and technical support branch of the regulator. The participant funding contributes to increasing safety by providing additional information to the Commission. (Canada).	The UK’s eighth NR stated that ONR fosters openness and transparency in its regulatory process through: - Regular attendance at site stakeholder group meetings and local liaison committees which are attended by members of the public; - Publishing documents such as guidance, inspection reports, and project assessment reports (PARs) on the ONR website; and - Webinars to inform the public on important topics.

Good Practice	UK Position
	Openness and transparency remains important to the UK and our position has been updated under paragraphs 8.79 to 8.87, 8.93, and Table 2 – Summary of Project Assessment Reports.
Extensive outreach to members of the public and to neighbouring and other countries and conduct of public hearings regarding licensing of nuclear facilities, as well as educational conferences. The extent of the outreach was well beyond that generally undertaken by other Contracting Parties. The thorough preparation for these outreach activities strengthened the licensing review. (Hungary).	The UK's eighth NR confirmed that in addition to regular site stakeholder groups attended by ONR, Hinkley Point C holds quarterly public forums at which siting issues can be discussed. This remains the case and the paragraphs 8.79 to 8.87 have been reviewed and updated to ensure they remain current.

Achievements, challenges, and planned improvements

B103. This section highlights the UK's achievements, challenges, and improvements planned over the next reporting period.

Achievements

B104. ONR has successfully implemented the UK State System of Accounting for and Control of Nuclear Material (SSAC), necessitated by the UK's decision to leave the EU and hence Euratom. This has entailed the recruitment and training of new safeguards staff, the development of a new regulatory framework for delivery of the new regime, and an accompanying Safeguards Information Management and Reporting IT System (SIMRS) to receive information from operators, and process and submit nuclear material accountancy information and other reports to the IAEA. See paragraphs 7.37 to 7.43.

B105. ONR has established a range of additional means to bring people into the organisation to supplement its experienced specialists. The number and type of recruits is managed by a strategic workforce planning tool. The new recruits come with a range of backgrounds and experience. However, when trained through a mixture of on-the-job training and classroom training in the ONR Academy, they progress to become warranted nuclear safety inspectors. See paragraphs 8.32 to 8.45 and 11.76 to 11.79.

B106. ONR has developed an Organisational Effective Indicator (OEI) framework, which is based on the OECD's NEA 'Ten Characteristics of an Effective Nuclear Regulator'. This shows how ONR operates and regulates in a manner that delivers effective outcomes for safety, security, and safeguards. See paragraphs 8.74 to 8.77.

B107. Hinkley Point C construction has progressed beyond nuclear island concrete to the commencement of bulk mechanical, electrical, and HVAC component installation.

B108. Like most countries, the UK must ensure the ongoing safety of its NPPs as they experience inevitable ageing and obsolescence. This has required the adoption of innovative approaches. Some examples of this are:

- Re-establishing a supply chain for Neutron Flux Detectors, which has delivered the first batch. The first detectors have been installed, and a lifetime supply contract has now been put in place. See paragraphs 14.101 to 14.104.
- An asset management programme has been established to recognise the changing requirements for systems as AGR NPPs cease generation and move into defuelling. The different plant conditions and operating requirements for systems has been assessed to deliver an asset programme which reflects future needs as well as current operating requirements. See paragraphs 14.78 to 14.82.
- Building on the success of the first Sizewell B dry fuel storage campaign, a second campaign was completed in 2020, which implemented improved practices to reduce collective radiation exposure. More information can be found in paragraphs 15.17 to 15.19.
- The repair of the thermal sleeves at Sizewell B in 2021 presented challenging radiological conditions. Development of specific working arrangements to deliver the thermal sleeve work programme allowed the programme to be delivered with a collective dose rate of 80% of the as-low-as-reasonably-achievable (ALARA) plan. For more information see 15.26 to 15.29.

Challenges

B109. The AGR NPPs are approaching the ends of their lives with final shutdown for the remaining stations scheduled for between 2022 and 2028. There are predominantly 2 issues that challenge reactor lifetimes; these are boiler corrosion and graphite brick cracking. The most significant issue currently is graphite brick cracking (See Article 6 – Existing Nuclear Installations), which requires the licensee to provide enhanced safety cases to justify continued operation post onset of cracking, which must be acceptable to ONR. Both licensee and regulator continue to work closely to ensure that the reactors can operate safely in the face of these challenges.

B110. An example of how work has been performed to manage AGR NPPs safely to the EoG in readiness for defuelling, relating to Dungeness B, can be found in paragraphs 14.54 to 14.58.

Planned improvements

B111. ONR will complete delivery of its WIReD project before the UK's tenth NR. The next steps will be:

- Digitisation of the higher-volume core regulatory purposes including Inspection, Permissioning and Assessment.
- Development of a new List-N portal for dutyholders, which will provide a common platform for industry and regulators to manage approval of third-party contractors holding sensitive nuclear information.
- Introducing a new dutyholder portal to provide a single point of contact for dutyholders to notify ONR of incidents, submit requests for permissions, obtain licence approvals, and to provide a secure encrypted route for exchanging documents and data collaboration.
- For ONR to continue to provide training and support to maximise the benefits of using WIReD. B112 More information on WIReD can be found in paragraphs 8.50 to 8.52.

B113. Several improvements are planned for the fleet of UK NPP over the next reporting period. These include:

- Reactor Protection Equipment Upgrades – This will ensure that Reactor Protection equipment is re-engineered and upgraded for Heysham 2 and Torness as part of the ongoing lifetime programme to deliver generation through to 2028;
- Heysham 2 and Torness Vessel Over-Pressure Protection Equipment – The programme recognises the lifetime risks associated with boiler corrosion and will deliver a vessel protection system; and
- Sizewell B Long Term Operation – A programme has been developed to assess the potential for any lifetime extension capability at Sizewell B. This approach is being built on the back of numerous successful Plant Life Extensions for the AGR fleet.

Areas of good practice

B114. This report identifies achievements, challenges, and proposed improvements throughout, only some of which are summarised in the previous paragraphs. The activities that are judged by the UK to represent good practices are:

ONR recruitment channels

B115. In addition to recruiting experienced specialists, ONR has a range of additional channels which have been used to bring people into the organisation, consisting of:

- Graduates;
- “Associates” – those with limited nuclear/high hazard experience that ONR can develop and grow;
- “Equivalence” – those with unique skills from other industry sectors who can undertake an ‘equivalence role’, which can lead to them becoming qualified to be nuclear inspectors; and
- Degree-level Apprentices – those who undertake a 5-year programme comprising a degree in nuclear engineering and science whilst working with ONR and going out on secondment to other parts of the industry.

B116. These pipelines are key to both growing the resource that will ultimately replace retiring inspectors, and also in increasing ONR’s diversity and inclusivity. See paragraph 8.32 to 8.45 and 11.76 to 11.79.

Organisational Effectiveness Indicators

B117. Over the past 3 years ONR has developed an OEI framework, which is based on the OECD’s NEA 10 Characteristics of an Effective Nuclear Regulator. This shows how ONR operates and regulates in a manner that delivers effective outcomes for safety, security, and safeguards. See paragraphs 8.74 to 8.77.

Production of an Approved Code of Practice and guidance

B118. To accompany the introduction of The Radiation (Emergency Preparedness and Public Information) Regulations 2019 (REPPIR) regulations, an Approved Code of Practice (ACoP) and associated guidance was published. An ACoP is intended for use by dutyholders – persons having legal responsibilities under the regulations – and translates the law into practical guidance. If the ACoP is followed, the dutyholder can assume that they are undertaking sufficient measures to comply with the law in respect of those specific matters on which the ACoP gives advice. The format is designed to clearly distinguish between the regulations, the ACoP (statutory guidance) and the (non-statutory) guidance. See paragraphs 7.49 to 7.53.

Implementation of UK State System of Accounting for and Control of Nuclear Material

B119. ONR has successfully developed and implemented the UK SSAC, which has subsequently received positive feedback from IAEA. UK SSAC activities are summarised under B104 and detailed under paragraphs 7.37 to 7.43.

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Section C – Reporting Article-by-Article

Article 6 – Existing Nuclear Installations

> Each Contracting Party shall take the appropriate steps to ensure that the safety of nuclear installations existing at the time the Convention enters into force for that Contracting Party is reviewed as soon as possible. When necessary, in the context of this Convention, the Contracting Party shall ensure that all reasonably practicable improvements are made as a matter of urgency to upgrade the safety of the nuclear installation. If such upgrading cannot be achieved, plans should be implemented to shut down the nuclear installation as soon as practically possible. The timing of the shutdown may take into account the whole energy context and possible alternatives as well as the social, environmental and economic impact.

6.1. Compliance with this Article of the Convention is demonstrated in a way that has not substantially changed since the United Kingdom’s (UK) eighth National Report (NR) (Ref. 6.1) (that is, in a way that has implications for Convention obligations).

Nuclear installations in the UK

6.2. There are 15 land-based civil Nuclear Power Plants (NPPs) within the UK that meet the definition of “operating” in Article 2 of the Convention, consisting of 14 Advanced Gas-cooled Reactors (AGR) and a single Pressurised Water Reactor (PWR). There are twin AGRs per site. Each site has its own nuclear site licence, except for Heysham 1 and Heysham 2, which are on the same licensed site. In total there are 6 AGR licensed sites (consisting of 14 NPPs) and one PWR licensed site within England and Scotland, for which EDF Energy NGL is the sole licensee. Two of those AGR sites, Hunterston B and Dungeness, B have now ceased generation but fuel remains on site and they remain under the definition of “operating”. The Hinkley Point B site is due to end generation prior to the reactors’ core burn-up safety case limits being reached, currently scheduled for summer 2022.

6.3. The locations of the reactors and their supporting engineering centres are indicated on the map shown in figure 6.1. Also shown are the locations of the twin reactor NPP under construction at Hinkley Point C and the site at Sizewell C where a further twin reactor NPP is planned. As Hinkley Point C is still under construction and Sizewell C is still yet to be licensed, neither are considered under Article 6.

6.4. The operating parameters for the NPP fleet are summarised in Table 1 – UK Civil Power Reactors’ Key Parameters.

Reactors outside the scope of the convention

6.5. The UK’s first NPPs, the Magnox reactor fleet, started generation between 1956 and 1971 and shutdown between 1989 and 2015. There were 26 Magnox reactors on 11 sites, all of which have all now been defuelled.

Figure 6.1: Location of UK Operating Reactors, their Supporting Engineering Centres and Planned Sites for EPR™ Construction

Number of reactor per type	AGR	PWR	EPR	Engineering
Construction or Project			4	
Operation	14	1		
Engineering Centre				2

Accessible version of Figure 6.1

A map of the UK showing the number of reactors by type, location and status. Details below:

	AGR	PWR	EPR
Construction or Project	-	-	- Hinkley Point C (x2) - Sizewell C (x2) **Total: 4**
Operation	- Dungeness B (x2) - Hartlepool (x2) - Heysham 1 (x2) - Heysham 2 (x2) - Hinkley Point B (x2) - Hunterston B (x2) - Torness (x2) **Total: 14**	- Sizewell B **Total: 1**	-
Engineering Centre	-	-	-

AGR: Advanced Gas-cooled Reactor
PWR: Pressurised Water Reactor
EPR: European Pressurised Reactor

Note: The term "Operation" is used to indicate an operational reactor as per the Convention's definition, which includes being in defuelling. Of the 14 operational AGRs identified, 4 (twin AGRs at Hunterston B and Dungeness B) have ceased generation, awaiting defuelling. Hinkley Point B is due to end generation in summer 2022.

Overview of safety assessments and safety upgrading of nuclear power plants in the UK

6.6. The safety of the UK's NPPs is assured through licensee compliance with licensing and regulatory regimes that place legal duties on the operating company (EDF Energy NGL) at each site. This, in turn, is subject to regulatory oversight by the independent statutory regulator (Office for Nuclear Regulation (ONR)), which both inspects and assesses compliance.

The legislative and regulatory framework is outlined in Article 7 – Legislative and Regulatory Framework and the 36 licence conditions (LC) attached to each site licence are summarised in Table 6 – Licence Conditions.

6.7. A safety case is fundamental to the safety of NPPs. Licensees must produce a safety case which justifies the safety and legal compliance of operation of the reactor, and sets out the safe operating parameters (i.e. conditions and limits) for the nuclear installation. Each NPP is required to undertake a Periodic Safety Review (PSR) at least every 10 years in accordance with LC15 (periodic review). This is discussed under Article 14 – Assessment and Verification of Safety.

6.8. The nuclear site licence requires that the safety significance of any proposed modifications is categorised by risk significance by the licensee. A modification cannot be implemented until the NPP operating company has produced an appropriate safety justification.

6.9. In addition to PSRs, the licence requires that each operating power reactor undertake a shutdown periodically under LC30 (periodic shutdown) for the purposes of examination, inspection, maintenance, and testing (EIMT). For AGRs, the operating period between shutdowns is up to a maximum of 36 months, and for Sizewell B the operating period is typically 18 months. After these shutdowns, the licensee must apply to ONR for a legal 'Consent' to restart the reactor, which takes the form of a Licence Instrument; a written permissioning document signed by a senior ONR inspector.

6.10. A safety concern on one reactor may have implications for other reactors in the EDF Energy NGL fleet. If such concerns are raised, either during a maintenance outage, refuelling or during normal operation, ONR has powers to require the operator to take remedial action including shutting down one or more reactors if this is deemed appropriate. In this latter situation the operator must seek ONR's permission to restart.

6.11 For information on safety assessments which have been carried out since the last CNS report refer to Table 2 – Summary of Nuclear Safety Assessments.

Safety upgrade programmes

6.12. The UK has been undertaking PSRs of its NPPs for many years as part of its regulatory process and as required by **VDNS Principle 2**.

6.13. A nuclear fleet investment differentiation strategy continues to be deployed to underpin EDF Energy NGL's declared lifetime stages. This recognises the different lifecycle stages of the nuclear assets and ensures that personnel and financial resources are optimised in a risk informed way.

6.14. For AGR NPPs, the investment profile is dominated by inspections (boilers and graphite) and plant reliability work. As some of the stations move closer to end-of-generation (EoG), the planned investment levels will change as the work changes to focus on maintenance and preparing for defuelling. The consideration of the need to ensure continued reliability of plant through the defuelling cycle is incorporated in EDF Energy NGL station plans. Also see paragraphs 14.78 to 14.82.

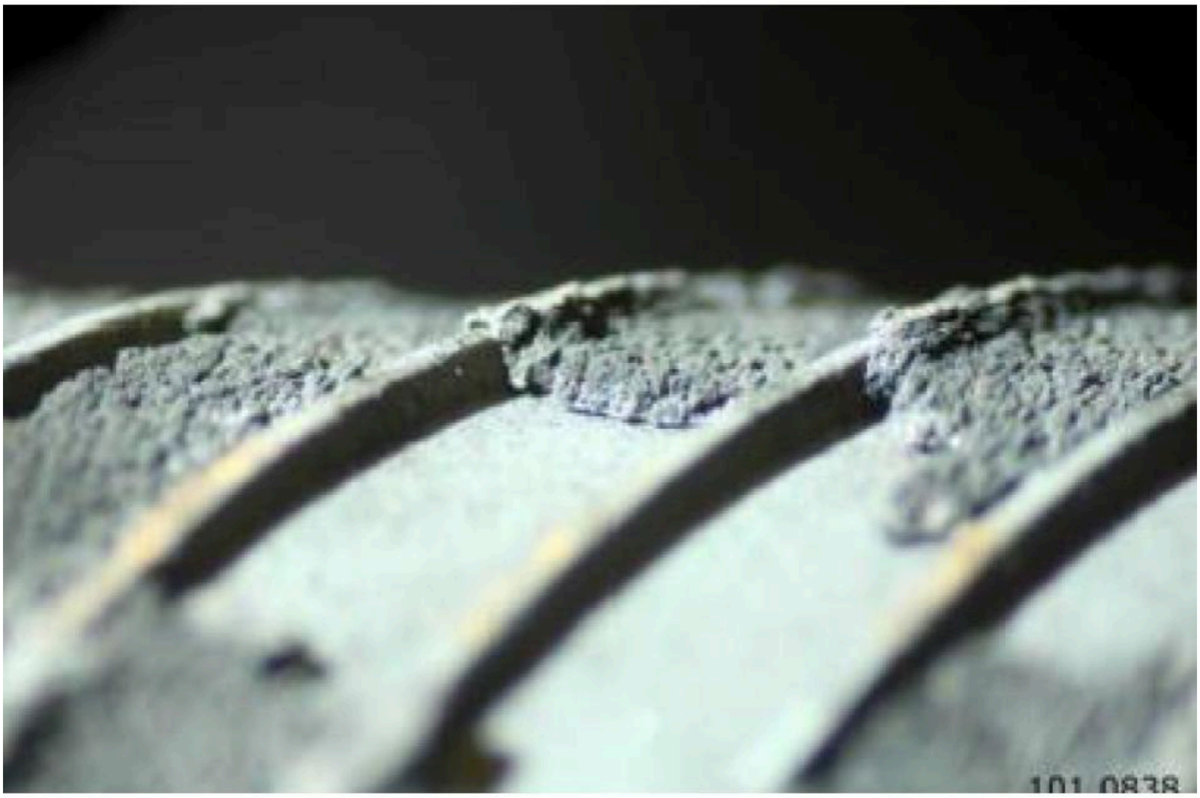
6.15. The PWR at Sizewell B is EDF Energy NGL's youngest nuclear power station (although it is now approaching 30 years of operation) and work on the site is focused on the development of a long-term operation programme to support the continued operation of the site.

6.16. Some examples of safety upgrades and research to support safe operation of the UK's NPPs are illustrated below.

Heysham 1 Oxygen injection [Example]

6.17. AGRs are susceptible to developing carbon deposits on their heat transfer surfaces. This includes boiler tubes and fuel pins (see figure 6.2). Due to lower resulting thermal conductivity, carbon deposition may lead to higher fuel clad temperatures during reactor operation which can weaken the fuel clad. The reactors of Heysham 1 and Hartlepool power stations have historically been more severely affected by carbon deposition, with carbon deposition implicated in several fuel pin failures dating back to 2016. Increased populations of weakened fuel clad also has the potential for worsening the radiological consequences in certain reactor faults. For the most severely impacted station, Heysham 1 Reactor 2, EDF Energy NGL implemented several countermeasures including reduced power operation (reduced to 90 %), channel overblowing and targeted refuelling. Additional coolant chemistry countermeasures were also explored.

Figure 6.2: Carbon Deposition on Fuel



6.18. An oxygen injection system was designed to remove the fuel pin deposition thereby bringing fuel closer to its as designed condition. Oxygen injection for the removal of fuel pin deposit had not previously been carried out on commercial AGRs. The techniques had been used at Heysham 2 and Torness to remove deposit on boiler tubes.

6.19. The main nuclear safety risk from core oxygen injection is generation of a combustible gas composition. The injection system was designed to prevent out of specification gas being admitted to the reactor with a high reliability. A safety case enabling oxygen injection for fuel pin carbon deposition removal from Heysham 1 Reactor 2 was assessed by ONR in 2019, with the activity subsequently permissioned and successfully implemented in October of the same year.

6.20. More recently in 2021, EDF Energy NGL has produced a safety case to justify the removal of reduced power counter measures at Heysham 1 Reactor 2, thereby returning the station to nominal full power operations. This has been based on successful oxygen injections reducing deposits, and coolant chemistry changes subsequently reducing the predicted weakened pin population, in conjunction with enhanced oversight arrangements to detect further increases in carbon deposition issues and enable mitigating actions.

Graphite programme – Investments in graphite test rigs [Example]

6.21. EDF Energy NGL continues to invest in its graphite programme as part of the lifetime management of the AGR fleet. The graphite shaker table experiment is one of the major research and development projects to support graphite lifetime (See figure 6.3).

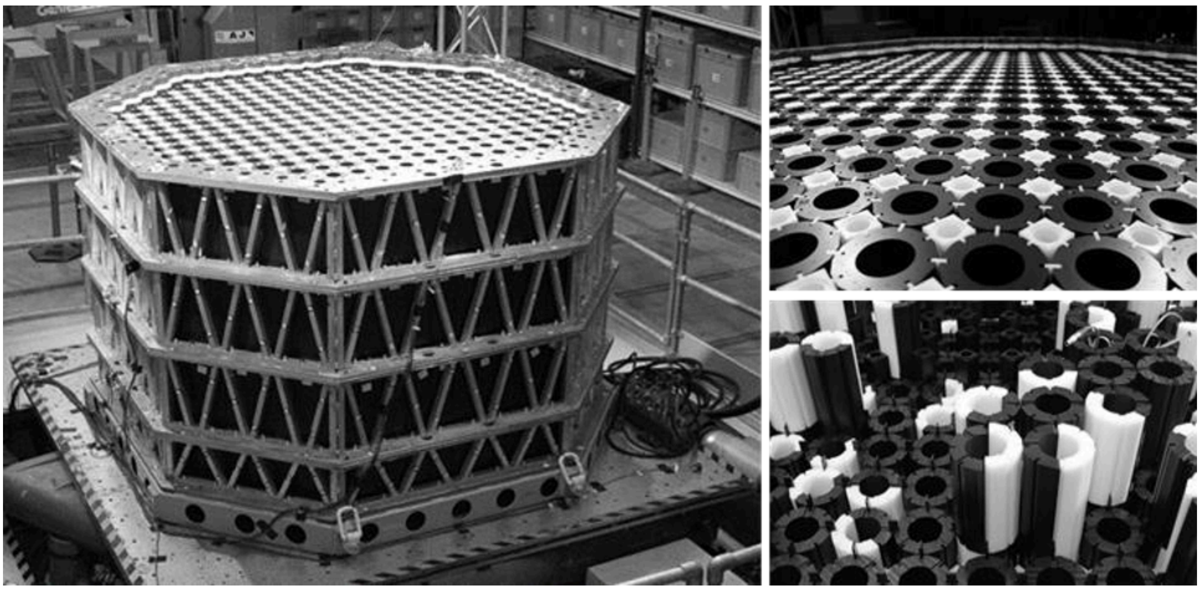
6.22. An example of this collaboration was the shaker table experiment at Bristol University. This won an Institute of Civil Engineering award in 2017. This unique and highly innovative and technically challenging earthquake engineering project provided evidence to underpin the safe operation with a degraded graphite core. The scientific challenge was to support complex modelling of the graphite core to ensure confidence that control rods would enter the core to shut the reactor down.

6.23. In a £6.5m programme, a high precision 1:4 sized physical model of the representative graphite core was developed over a period of 7 years. The information from the experimental programme provided essential validation of the numerical models that underpin seismic safety cases.

6.24. The bespoke rig contains over 40,000 components and 3,200 sensors in packages small enough to fit inside the bricks. It enables exploration of the non-linear dynamic responses of columns of bricks simulating channels in the reactors. Many patterns and types of different cracked bricks could be studied in numbers well in excess of those anticipated in the reactors themselves.

6.25. The rig development involved integration of high precision structural engineering and manufacturing, innovative sensor development, and cutting-edge data analysis at Bristol University. This has been recognised as one of the most complex shaker table experiments anywhere in the world.

Figure 6.3: Bristol University Shaker Table



Graphite programme – Research and development collaborative working [Example]

6.26. A group at the University of Glasgow has developed a unique physics-based modelling capability for predicting unstable crack propagation within graphite bricks, which will be applied by EDF Energy NGL to future safety cases. Using machine learning techniques, statistical analysis and graph theory, this project will further improve these physics-based models with data obtained from the real operating environment. Such techniques will also enable the objective selection of bricks to undertake further analysis, which are a key source of uncertainties. It will also be possible to classify bricks in terms of crack morphologies. Similarly, operational data will be supplemented with data from the physics-based models for improved decision making in supporting operational continuation.

6.27. At the University of Manchester, work is ongoing to predict the physical properties of graphite from observed microstructure. This project has arisen from the observation that for many metallic and ceramic materials, correlations between physical properties and microstructure are reasonably well established. These correlations assist component design and lifetime management. There is no model available to predict physical properties of nuclear graphite, based upon experimentally observed microstructure. One of the key reasons for this is the incredibly complex microstructure of nuclear graphite, particularly across dimension scales from nanometre to micrometre. Prediction of core state using Bayesian modelling is used to support an inspection strategy. This project concerns the ongoing development of a methodology, which aims to forecast the core state of reactors ahead of inspections.

6.28. At the Plymouth University pre-network modelling of graphite to investigate fluid flow properties is in progress. The programme involves the experimental characterisation of the pore structure of virgin and irradiated nuclear graphite, by a multi-technique approach. The percolation curves (obtained particularly by gas pycnometry, gas adsorption and mercury porosimetry) contain information about the void volume and pore size distribution of the material.

6.29. Much of the current EDF Energy NGL graphite research and development programme may also have benefit to next generation reactors that use graphite as a moderator.

Heysham 1 and Hartlepool Secondary and tertiary shutdown systems [Example]

6.30. The Secondary Shutdown System (SSD) at Heysham 1 and Hartlepool is an automated nitrogen-injection system which provides an independent, diverse, and fast-acting means of shutting down the reactor in the unlikely event of a Primary Shutdown System (PSD) failure (for example control rods not entering the core).

6.31. The SSD comprises of pressurised gas storage, distribution pipework and solenoid valves (see figure 6.4), to inject nitrogen directly into interstitial channels in the reactor core.

6.32. The system is initiated automatically in the event of a fast decrease in the top-dome differential pressure, or excessive rate of change of channel gas outlet temperatures. A Tertiary Shutdown System (TSD) provides a diverse long term shutdown capability, usually incorporating neutron-absorbing boron beads, injected directly into the reactor core.

6.33. The safety functions of an SSD system are to: • Rapidly shutdown the reactor following failure of any structure at the top of the core, which could interfere with control rod entry;

- Provide a diverse means of shutdown to that provided by the PSD system for frequent faults; and
- Hold the hot, pressurised reactor sub-critical in the medium-term following failure of the PSD system. Following initial shutdown, the SSD system will hold the reactor sub-critical over a period of several hours until secure long-term shutdown can be established by initiation of the TSD System.

6.34 The licensee undertook a programme of work to upgrade the SSD at Heysham 1 and Hartlepool NPPs, to provide seismically qualified fast-acting shutdown and long-term hold down for double reactor seismic faults (it previously only had the capacity to work on one reactor at a time).

6.35 The system modifications were:

- Remediation against any current system degradation;
- Provision of additional seismically qualified first and second stage nitrogen stores;
- Installation pipework to provide a dedicated nitrogen injection route for each reactor; and
- Seismically qualifying the existing SSD system.

6.36. The design concept for the SSD at Hartlepool and Heysham 1 included a 2-phase system – firstly having the capability to rapidly inject nitrogen to shut down the reactor, then secondly to control the flow of nitrogen into the reactor to hold the reactor down.

Figure 6.4: Secondary Shutdown System (Nitrogen Storage) at Hartlepool Power Station

Installation of phase imbalance alarms and modification of negative phase sequence protection [Example]

6.37. International and UK experience highlighted that electrical phase imbalance faults affecting one or more phases in 3-phase electrical supplies may result in excess currents in electrical motors. This, in turn, may lead to motors overheating and tripping via installed motor protection devices.

6.38. Phase imbalance faults occurring at high voltages (including grid supplies) may cascade to lower voltages and therefore have the potential to affect multiple motors simultaneously; this was observed at Dungeness B in 2014 and became subject to a root cause investigation. Protection against these faults has traditionally made claims on the operator to recognise the situation and act. To increase confidence in this, an additional phase imbalance alarm is being installed on the 11 kV distribution boards at all stations.

6.39. The whole EDF Energy NGL fleet was assessed and where improvements were identified at stations, existing negative phase sequence protection on the generator have been modified. The modification ensures that the trip function disconnects the unit boards from the grid. This separates the systems from the phase imbalance and allows the systems to operate on the secure station back-up power systems.

6.40. The plant modifications have been installed and the final safety cases are being completed prior to programme close out. The full programme of works is due to be completed in 2022.

End-of-generation of nuclear reactors

6.41. In the UK, both nuclear site licences and environmental permits have no time limit. Consequently, they continue in force, even after a licensee has decided to shut down an NPP permanently. The onus is on the licensee to demonstrate the plant continues to be safe to operate based on its assessment of the plant condition. The licensee must decide to shut down the NPP permanently and declare the end of the NPP's operational life when it is no longer able to justify safe operations to the satisfaction of ONR. Of course, an NPP may be shut down for a range of other reasons, for example fuel availability or commercial viability.

6.42. EDF Energy NGL is currently managing the UK fleet of AGRs through to their end of operating life when they will cease electrical generation (EoG) and eventually enter defuelling and decommissioning.

6.43. ONR will rigorously assess any additional safety case submissions that may be submitted by EDF Energy NGL to extend the operating life of the remaining AGR fleet beyond the currently declared closure dates. In doing, EDF Energy NGL will need to demonstrate appropriate levels of safety in accordance with international safety standards and principles. Figure 6.5 shows the fleet of reactors and the current closure dates.

Figure 6.5: AGR End-of-generation Dates

NPP Site	Commenced operations	EoG date
Hinkley Point B	1976	Summer 2022 (est.)
Hunterston B	1976	2022
Dungeness B	1983	2021
Heysham 1	1983	2024 (est.)
Hartlepool	1983	2024 (est.)
Heysham 2	1988	2028 (est.)

NPP Site	Commenced operations	EoG date
Torness	1988	2028 (est.)
Sizewell B (PWR)	1995	2035 (est.)

Note: Sizewell B has a planned EoG date of 2035 but EDF Energy NGL are seeking to justify an extension to 2055.

Dungeness B end-of-generation [Example]

6.44. In 2018 the 2 reactors at Dungeness B underwent a periodic shutdown to enable planned maintenance and inspections. Initial work discovered several issues, which included the identification of cracks in the main steam system and corrosion in general pipework across the site. As a result, the periodic shutdown was extended while these issues were addressed. The reactors would only have been permitted to return to service once ONR was satisfied that the issues identified had been resolved.

6.45. Cracking was discovered at several locations in the bore of the main steam pipework, some of which was significant enough to require repair or replacement of components. Samples of the crack sites were taken and analysis identified the crack mechanism as predominantly stress corrosion cracking (SCC). To understand the extent of this condition the main steam lines underwent a thorough visual inspection, which showed several other similar occurrences of cracking in the main steam lines and warming lines across different boilers. As a result, the system underwent a program of repairs and replacements so that both reactors had no cracking present in the main steam lines or warming lines, as required by the safety case.

6.46. In addition, the boiler flushing regime was adapted to ensure contaminants responsible for some instances of SCC were fully flushed from the system. ONR suggested additional inspections should be carried out on the bypass valves and these were found to have also cracked. The valves were repaired but needed to be replaced after a short period of operation to remain within safety limits. This resulted in EDF Energy NGL giving a commitment to replace these valves over a series of subsequent periodic shutdowns.

6.47. As a result of a fleet-wide intervention widespread steel corrosion was also discovered across the station prior to the periodic shutdown which was found to require significant repair work. In 2016, ONR had initiated several specific interventions to assess the adequacy of arrangements related to Dungeness B’s corrosion management programme. In 2018, ONR carried out an intervention to assess the adequacy of EDF Energy NGL's arrangements to manage the integrity of the concealed pipework. Whilst it was clear that some improvements had been made, this intervention found that there were several further substantial improvements required, generally related to uncertainty of the plant extent of condition and the basis for judgements made when allowing corroded plant to remain in service.

6.48. Dungeness B was considered an outlier compared to the other AGR stations because of the extent of concealed pipework and the potential impacts on redundancy in safety systems. During the intervention, ONR gained confidence that the other stations across the fleet could safely operate whilst improvements were being put in place.

6.49. ONR issued a Direction that required EDF Energy NGL to carry out a review and reassessment of safety at Dungeness B, addressing the corrosion of concealed systems. More than 300m of pipework associated with reactor cooling systems was renewed, along with renewal of numerous seismic pipework supports and remediation of CO2 storage vessels. EDF Energy NGL also identified several additional commitments to be fulfilled prior to a return to service of either reactor at Dungeness B to demonstrate to ONR that the risks posed by continued operation of the safety significant concealed systems were tolerable, and that risks had been reduced to as low as reasonably practicable (ALARP). Most significant of these commitments was a demonstration that the bulk water storage tanks affected by corrosion remained suitable for service until their planned renewal.

6.50. Although many issues had been overcome, further detailed analysis highlighted additional station-specific risks within some key components, including parts within the fuel assemblies. These issues required significant further investment for renewal or remediation work. As a result, in 2021 EDF Energy NGL decided that it would not seek to restart the reactors but to end generation and transition them into a defuelling preparation stage. The announcement of Dungeness B's EoG with immediate effect has required the station to develop its defuelling safety case, which is anticipated near the end of 2022. Defuelling operations are expected to take longer at Dungeness B than at other AGRs due to the operational conditions that are likely to be needed to safely remove the fuel elements from the 2 reactors.

Graphite programme – Hunterston B [Example]

6.51. EDF Energy NGL's Graphite programme is designed to manage the safe operation of the AGR Fleet over an extended life. Hunterston B was the lead reactor in terms of graphite ageing.

6.52. Hunterston B and Hinkley Point B have the highest core irradiation in the AGR fleet and therefore they have experienced the highest number of cracked graphite bricks. These reactors were pioneering the analysis of tolerance to cracking using for example, the evidence supplied by the Shaker Table on the seismic response.

6.53. Safety cases were put in place to support operation of Hunterston B up to late-2021/early-2022 and for Hinkley Point B up to mid-2022. These safety cases contained a significant margin between the graphite core state defined by inspection and the core state at which there remained high confidence that the control rods will enter the core and secure safe shutdown.

6.54. The evidence in these cases came from multidisciplinary teams covering a wide range of assessments; for example, assessing component strength of graphite via finite element modelling, radiolytic oxidation of the graphite in the ionised CO2 coolant, and graphite properties under neutron irradiation (gathered using a material test reactor to ‘age’ the graphite ahead of the AGRs).

6.55. The final inspections on the 4 reactors at Hunterston B and Hinkley Point B showed the number of cracked bricks was less than the assumed level in the safety case, supporting their continued operation. Hunterston B Reactor 3 stopped generating in November 2021 and Reactor 4 January 2022. Hinkley Point B Reactors 3 and 4 will stop generating in summer 2022 – before their safety case core burn-up levels are reached.

Transition to decommissioning

6.56. Once reactors reach their end of life, the extant reactor operational safety cases justify a limited degree of defuelling activities; intended for refuelling operations. Modified safety cases are then implemented to enable the reactors to be fully defuelled.

6.57. For stations that have, or are planned to cease generation, key activities include:

- Preparation of the final fuel management, reactor shutdown and defuelling safety cases, and activities to prepare the fuel route;
- Preparation of an integrated industry-wide approach to flask transport and management, as well as the receipt and management of the spent fuel at Sellafield, known as the AGR Operating Programme (AGROP), which will facilitate an increase in the number of flask movements during defuelling;
- Preparing the organisation for defuelling, which includes development of a ‘people management strategy’ and reinforcing the site fuel route function. Any changes are being managed in accordance with a management of change process;

- Optimisation of maintenance activities, including EoG outage activities. Any changes to the schedule will be managed through a modifications process and appropriate outage submissions;
- Assay and characterisation of wastes, in order to facilitate effective and efficient decommissioning;
- Work to support permissioning activities, such as complying with the Nuclear Reactors (Environmental Impact Assessment for Decommissioning) Regulations (Ref. 6.2); and
- Preparation activities to enable decommissioning, which may include clearance of non-safety or non-operational areas, and construction of waste management facilities.

Hunterston B early preparation for entering defuelling [Example]

6.58. EDF Energy NGL has been developing its Nuclear Decommissioning support for several years. This has allowed early defuelling preparation to take place at both Hunterston B and Hinkley Point B. The AGR fleet is following this early preparation approach by appointing Defuelling Managers as part of the station lead team (see Article 9 – Responsibility of the Licence Holder).

6.59. The preparation for defuelling and the defuelling execution activities have been added to the EDF Energy NGL Management System as a new Defuelling process. This allows an operating station to carry out additional defuelling preparation work in a controlled manner whilst safely preserving the operating capability.

6.60. The defuelling preparation timescales are linked to the expected lifetime and safety cases. The approach is to ensure the AGR power stations can move into defuelling with minimal delays following EoG.

6.61. Hunterston B is the lead defuelling station and EDF Energy NGL are deploying a lead and learn approach to ensure that the defuelling of the AGR fleet learns from previous defuelling experience, including the now-defuelled Magnox NPP fleet.

6.62. The benefits of this early preparation have been shown based on the plan for defuelling, which has allowed for the defuelling enabling works to be completed as far as possible in advance, with only a short duration outage needed to ensure the station plant systems are ready.

Overview of Safety Related Issues

6.63. Since the eighth National Report there have been several safety issues across the UK's operating fleet:

- Sizewell B steam generator drain leak – paragraphs 6.64 to 6.65;
- Seal ring groove wall debris at Heysham 2 and Torness – paragraphs 6.66 to 6.68; + Thermal sleeves at Sizewell B – paragraphs 6.69 to 6.73; and
- Boiler chemistry control at Dungeness B – paragraphs 14.70 to 14.73.

Sizewell B steam generator drain leak [Example]

6.64. During a scheduled inspection at Sizewell B in November 2017, a leak was detected on a Steam Generator (SG) drain line. Investigations revealed the welds connecting the drain line had been subjected to Primary Water Stress Corrosion Cracking (PWSCC). All defective material was removed, and it was confirmed that the channel head forging was not damaged. The drain lines on all 4 SGs were plugged with solid plugs which were welded to the outside of the SG Channel Head. ONR was satisfied with the repair method, testing and qualification work and the adequacy of the justification for RTS for 2 full cycles of operation.

6.65. After further assessment the licensee concluded that the repair was the solution which would ensure nuclear safety risks are ALARP. This conclusion was based on detailed structural analysis showing the drain line repair to be acceptable to American Society of Mechanical Engineers (ASME) fatigue analysis requirements and reaffirming that the channel head satisfies the Incredibility of Failure safety case. The licensee presented a justification to continue operating with the current repair for the rest of the Station 40-year design life to 2035. This justification has been assessed and accepted by ONR in June 2021 prior to RTS after the second full cycle of operation.

Graphite programme – Heysham 2 and Torness seal ring groove wall cracking [Example]

6.66. There is a slightly different design of graphite bricks at Heysham 2 and Torness compared to the other AGRs. Consequently, there is a possibility that subsequent operation after the bricks have developed a keyway root crack could lead to a further degradation where fragments of the graphite brick break off. These small bits of graphite could sit between the graphite fuel sleeve in the stringer, and the graphite fuel channel wall. There is a narrower section higher up in the overall channel and there could be an interference between these components during fuel discharge. By design there are safety systems in place to prevent damage to fuel stringers in the event of high loads when removing the fuel.

6.67. In response to this possibility a major programme has been put in place to better understand the likelihood of these events and the time in life these could occur. Also, the inspection frequency has been increased to ensure the state of the core is fully understood.

6.68. The first keyway root cracks have been observed at Heysham 2 and Torness and so has the first indication of a potential crack in the seal ring groove wall. Experimental support from a test rig would suggest entrainment of the debris to the site with narrow diameter is unlikely. Furthermore, tests with the debris in the worst location does not lead to a significant load increase in every circumstance. There is work underway to put this evidence into a revised safety case to support operation up to the EoG.

Sizewell B thermal sleeves [Example]

6.69. During Sizewell B Refuelling Outage 17 in 2021, inspection of the upper internals of the reactor pressure vessel head identified that one of the thermal sleeves had become detached from the head assembly and was resting on the upper internals.

6.70. Subsequent examination of the remaining thermal sleeves identified 13 instances of wear outside the acceptance criteria. A further 2 sleeves were identified for replacement as they could potentially fail during the next operating cycle (18 months).

6.71. The thermal sleeves do not in themselves fulfil a significant nuclear safety function, but failure of a thermal sleeve has the potential to leave a remnant ring of material, which could adversely affect control rod drop times.

6.72. A repair strategy was developed based on operational experience from around the world and the expertise of the original equipment manufacturer. The strategy and supporting safety cases were presented to ONR as part of the formal arrangements prior to restart.

6.73. The repair strategy chosen resulted in significantly reduced operator dose compared to other possible techniques (also see paragraphs 15.26 to 15.29).

6.74 Sizewell B has completed Refuelling Outage 17 and EDF Energy NGL is incorporating learning from the Thermal Sleeve event into its Long-Term Operating strategy for Sizewell B, which will manage the plant through to its EoG.

Article 6 References

6.1. The United Kingdom's Eighth National Report on Compliance with the Obligations of the Convention on Nuclear Safety (https://www.iaea.org/sites/default/files/national_report_of_the_united_kingdom_for_the_8th_review_meeting.pdf), Department for Business, Energy & Industrial Strategy, August 2019.

6.2. Nuclear Reactors (Environmental Impact Assessment for Decommissioning) Regulations 1999 (https://www.legislation.gov.uk/uksi/1999/2892/contents/made)

Article 7 – Legislative and Regulatory Framework

> Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of nuclear installations.
>
> The legislative and regulatory framework shall provide for:
>
> I. the establishment of applicable national safety requirements and regulations; II. a system of licensing with regard to nuclear installations and the prohibition of the operation of a nuclear installation without a licence; III. a system of regulatory inspection and assessment of nuclear installations to ascertain compliance with applicable regulations and the terms of licences; IV. the enforcement of applicable regulations and of the terms of licences, including suspension, modification, or revocation.

7.1. Since the last report developments under this Article are as follows:

- Departure of the United Kingdom (UK) from the European Union (EU);
- Implementation of the UK State System of Accountancy for and Control of Nuclear Material (SSAC), including updating of the Office for Nuclear Regulation's (ONR) Enforcement Policy Statement (EPS);
- Changes to the ONR Enforcement Management Model (EMM); and
- Introduction of new regulations relevant to nuclear safety, including:
  - Environmental Authorisations (Scotland) Regulations 2018 came into force in Scotland, replacing the Radioactive Substances Act 1993; and
  - Radiation (Emergency Preparedness and Public Information) Regulations (REPPIR) 2019.

7.2. Compliance with this Article of the Convention has not otherwise substantially changed since the United Kingdom's (UK) eighth National

Report (NR) (Ref. 7.1) (in a way that has implications for Convention obligations).

Enactment of the legislative framework of the United Kingdom

7.3. The Parliament of the United Kingdom, centred in Westminster, London, is the supreme legislative body in the UK. Parliament alone possesses legislative supremacy over all other political bodies in the UK and its territories.

7.4. Laws can be made by Acts of the UK Parliament, which are primary legislation. Acts can apply to the whole of the UK or to parts of it.

7.5. There are several Acts of Parliament that apply to the nuclear installations in the UK. Under the UK system of legislation all Acts of Parliament have equal status and must be complied with. Due to the continuing separation of Scottish law, many Acts do not apply to Scotland. Where this is the case, they are either matched by equivalent Acts that apply to Scotland alone or, since 1999, by legislation made by the Scottish Parliament relating to devolved matters. Nuclear safety is not a devolved matter, it is “reserved” to the UK Parliament in Westminster. Any nuclear safety legislation must be passed by the UK Parliament. However, certain topics, including protection of the environment and radioactive waste management, are a devolved matter and hence the Scottish Government has responsibility for this area. The same is true for Wales and Northern Ireland. Some laws passed by the UK Parliament only apply to Great Britain (GB) – consisting, England, Scotland, and Wales .

7.6. Secondary legislation, for example in the form of regulations, is a type of statutory provision in the UK legislative system. Regulations can be made by a Secretary of State or minister where primary legislation (in the case of the UK Parliament, an Act) gives the power to do so. The scope of the secondary legislation that can be made by the Secretary of State or minister is specified in the primary legislation containing the relevant power. The primary legislation may also include requirements about who must be consulted during the drafting of the secondary legislation, for example a requirement to consult the relevant regulatory bodies.

UK withdrawal from the EU

7.7. On 31 January 2020 the UK withdrew from the EU, and left Euratom. During the UK’s membership of the EU and Euratom, the requirements of European Directives were incorporated into UK law and European regulations had direct effect in the UK. Now the UK has withdrawal from the EU, this is no longer the case, apart from in Northern Ireland where relevant European law remains applicable under the Northern Ireland Protocol.

7.8. EU legislation regarding nuclear safety was fully transposed into UK law, save for amendments that ensured the legislation continued to be operable after the UK's departure from the EU. This included work to implement the new EU Basic Safety Standards Directive (BSSD), which replaces 5 prior EU Directives; and both Nuclear Safety Directives (NSD) (Ref. 7.2). Consequently, the impact of Euratom exit on nuclear safety was minimal but will be reassessed should the EU and UK nuclear safety legal frameworks diverge significantly in the future. Otherwise, future changes to legislation will be independent of any changes in EU law, again except for in Northern Ireland, which will remain aligned with specific EU legislation. The UK remains committed to keeping its legal and regulatory framework under review to ensure that it continues to reflect developments in internationally endorsed safety and environmental protection standards.

> 7.9. [Change] The UK's withdrawal from the EU and the Euratom Treaty had only one significant impact regarding compliance with the obligations of the Convention. The Nuclear Safeguards Act 2018 (Ref. 7.3) amended ONR's safeguards purpose, enabling implementation of the UK SSAC – a new domestic safeguards regime. This came into operation at the conclusion of the transition period prior to withdrawal from the EU on 31 December 2020.

Establishing and maintaining a legislative and regulatory framework

7.10. A wide range of legislation must be described to demonstrate compliance with the Convention. This section describes the key legislative and regulatory measures that apply directly to nuclear installations.

7.11. For these items it describes, where applicable, the primary and secondary legislation and licensing regimes.

7.12. The legislation governing nuclear safety at nuclear installations applies to Great Britain only. However, there are no nuclear installations in Northern Ireland, nor any planned.

7.13. The principal primary legislation for ensuring the safety of nuclear installations consists of the following Acts of Parliament:

- The Energy Act 2013 (TEA13) (Ref. 7.4);
- The Health and Safety at Work etc. Act 1974 (HSWA74) (Ref. 7.5); and
- The Nuclear Installations Act 1965 (NIA65) (Ref. 7.6).

7.14. The key features of each of the statutes above are summarised below, followed by other Acts considered relevant to the Convention.

The Energy Act 2013

7.15. TEA13 sets out the provisions which created the Office for Nuclear Regulation (ONR) as a statutory body, establishing its purposes, powers, and functions. ONR's purposes are those relating to regulating nuclear safety, nuclear-site health and safety, civil nuclear security, nuclear safeguards, and the transport of radioactive material.

7.16. TEA13 also allows for 'nuclear regulations' to be made to provide additional statutory requirements with respect to nuclear safety, security, safeguards and the transport of radioactive material.

7.17. TEA13 establishes ONR's ability to appoint inspectors and provides those inspectors with legal powers, which are necessary for ONR to meet its enforcement responsibilities under S.82 TEA13, described later in this section.

7.18. ONR was formally established as a statutory public corporation on 1 April 2014. Its regulatory functions were formerly carried out by other bodies. Within this report, the term ONR is used to denote not only the current regulatory body, but also any of its predecessor bodies.

The Health and Safety at Work Act 1974

7.19. HSWA74 applies to all work activities within the UK and hence is broader than nuclear safety. HSWA74 allows regulations to be made and there are many of these relating to industrial safety, radiation protection and radiation emergency preparedness.

7.20. Under HSWA74 a general duty is placed on every employer and the self-employed to conduct their undertaking in such a way as to ensure, so far as is reasonably practicable (SFAIRP), the health and safety at work of their employees and those affected by their work activities. The principle of SFAIRP is goal setting and is underpinned by the concept of Relevant Good Practice (RGP). RGP is the generic term used for those standards or approaches to managing risk that have been judged and recognised by ONR and the industry as satisfying the law when applied to a particular relevant case in an appropriate manner.

7.21. Legislation made ONR the enforcing body for the HSWA74 on GB nuclear sites, including new nuclear build construction work and any associated articles designed, manufactured, imported, or supplied for use on the site.

7.22. HSWA74 also allows ONR to appoint inspectors and to provide them with similar enforcement powers to those under TEA13.

The Nuclear Installations Act 1965

7.23. Under the NIA65 no site can be used for the purpose of installing or operating a nuclear installation unless a nuclear site licence is currently in force, granted by ONR. Only a corporate body, such as a registered company or a public body, can hold a licence and the licence is not transferable. Those parts of the NIA65 relevant to safety and licensing are 'relevant statutory provisions' of TEA13, which means they are enforced by ONR under that legislation.

7.24. NIA65 requires and permits ONR to attach such conditions to a site licence as it sees appropriate in the interests of safety or radioactive waste management. It is an offence under the law not to comply with the licence conditions (LC).

7.25. NIA65 also allows ONR to recover its costs associated with licensing and enforcement of the LCs from licensees.

The Environment Act 1995

7.26. Discharges and disposals of radioactive wastes from nuclear sites are regulated by environmental law. The key legislation for this is the Environment Act 1995 (EA95) (Ref. 7.7) and associated secondary legislation (for example the Environmental Permitting (England and Wales) Regulations 2016 (EPR16) (Ref. 7.8), and the Environmental Authorisations (Scotland) Regulations 2018 (EASR18) (Ref. 7.9), the latter having the broader scope of regulation of the management of radioactive waste, not just discharges and disposals). EA95 provides the regulatory framework for environmental protection. There have been some subsequent revisions to the framework. There is additional legislation in Wales, the Environment (Wales) Act 2016 (Ref. 7.10), which promotes sustainable management of natural resources in decision making. The environmental regulators for the countries of the UK with nuclear sites are:

- Environment Agency (EA) in England;
- Scottish Environment Protection Agency (SEPA) in Scotland; and
- Natural Resources Wales (NRW) in Wales.

7.27. EA95 also provided for the transfer of functions to the environmental regulators, including powers and duties in relation to radioactive substances regulation.

7.28. Generally, the Environment Agency, SEPA and NRW have regulatory responsibilities for a range of other activities on, or from, nuclear sites, including the regulation of the following, which are relevant to the Convention:

- Mobile high activity sealed sources (HASS) on nuclear sites, and all HASS owned by tenants on nuclear licensed sites;
- Abstraction from and discharges to controlled waters, including rivers, estuaries, the sea and groundwaters; and
- Requirements under the Control of Major Accident Hazards Regulations 2015 (COMAH) (Ref. 7.11) at nuclear sites, where ONR and the relevant environmental regulator are the Joint Competent Authority.

7.29. Annex 2 – The Environmental Regulatory Bodies provides more information on the mandates of the environmental regulatory bodies.

The Energy Act 2008

7.30. The Energy Act 2008 (Ref. 7.12) made provision for the management and disposal of waste produced during the operation of nuclear installations, including introducing a requirement for prospective operators of new nuclear power projects to prepare and submit a funded decommissioning programme (FDP) when they apply for a nuclear site licence.

7.31. A FDP makes provision for the treatment, storage, transportation and disposal of waste and for the decommissioning of the power station and the clean-up of the site. It also sets out estimates of the costs likely to be incurred in relation to the decommissioning of the site and the clean-up of the site and the construction and maintenance of an interim store built during the operation of the plant, and how those aspects of the programme are to be funded.

The Freedom of Information Act 2000

7.32. The Freedom of Information Act 2000 (FOI) (Ref. 7.13) establishes a general right of access, on request, to all types of recorded information held by all public bodies including ONR. It places a duty on public bodies to release any information they hold unless an exemption applies. This process must be completed within 20 working days. The Environmental Information Regulations 2004 (EIR) (Ref. 7.14) is a similar regime to that of the FOI but applies specifically to environmental information held by public authorities. The rights to information conferred by FOI and EIR apply to everyone, anywhere in the world. The FOI and the EIR are ‘reason blind’, which means that information can be requested for any purpose.

Obligations under international treaties, conventions, or agreements

7.33. The UK is committed to maintaining high levels of safety and contributes its expertise to the development of relevant international safety standards. Safety standards developed by international bodies such as the IAEA and International Commission on Radiological Protection (ICRP) are widely regarded as international good practice. The UK actively contributes to these and adopts them into its laws, regulations, and guidance (**VDNS Principle 2**). In so doing, the UK continues to demonstrate full compliance with the obligations in the relevant Conventions. The UK recognises the IAEA’s safety standards as the primary standards that its safety framework is measured against and routinely welcomes IAEA peer review missions (see paragraphs B9 to B13). This independent benchmarking ensures the UK benefits from sharing good practice and learning across IAEA member states, demonstrating the UK’s commitment to high safety standards.

Nuclear Safety Directives (Euratom)

7.34. Council Directive 2014/87/Euratom (Ref. 7.15) amending directive 2009/71/Euratom (Ref. 7.16), establishing a community framework for the nuclear safety of nuclear installations, was adopted on 8 July 2014, and was fully implemented by the UK on 15 August 2017. The new Directive, which arose as part of the Euratom Community's response to the EC's stress test process following the Fukushima accident, builds on the original Nuclear Safety Directives (NSD) intent, shared by the UK, that the highest standards for nuclear safety should be implemented and continuously improved in the Euratom Community. The requirements of the directive were implemented via minor amendments to ONR's TAGs and Technical inspection Guides (TIGs) and via a direction under the Energy Act.

Basic Safety Standards Directive (Euratom)

7.35. Council Directive 2013/59/Euratom (Ref. 7.17) lays down basic safety standards for protection against the dangers arising from exposure to ionising radiations (Basic Safety Standards Directive (BSSD)). It consolidates and repeals Directives 96/29 Euratom, 89/618/Euratom, 90/641/Euratom, 97/43/Euratom and 2003/122/Euratom (Refs. 7.18, 7.19, 7.20, 7.21 and 7.22).

7.36. In response to the Directive, the UK Government has brought in several new regulations, including for REPPIR 2019 (Ref. 7.23), and amended the Carriage of Dangerous Goods (Amendment) Regulations 2019 (CDG) (Ref. 7.24). The CDG amendments came into force on 21 April 2019 and the REPPIR 2019 Regulations on 22 May 2019. Also see Article 15 – Radiation Protection and Article 16 – Emergency Preparedness.

Safeguards

7.37. [Change] ONR became the independent domestic nuclear safeguards regulator on 31 December 2020, at the conclusion of the Brexit Transition Period. The Nuclear Safeguards (EU Exit) Regulations 2019 (Ref. 7.25) and the Nuclear Safeguards (Fissionable Material and Relevant International Agreements) (EU Exit) Regulations 2019 (Ref. 7.26) set out the detail of the UK's new domestic safeguards regime.

7.38. [Change] Implementation of the safeguards regime enables the UK to meet its international safeguards obligations, as set out in the UK-IAEA Voluntary Offer Agreement (VOA), and Additional Protocol. To date, the UK has fulfilled all reporting requirements, and effectively facilitated IAEA safeguards verification activities. In addition, the UK has delivered its own assessment and inspection activities.

Implementing UK State System of Accounting for and Control of Nuclear Material (Safeguards) [Example]

7.39. As set out in Section 72 of TEA13 one of ONR's statutory purposes is to enable and facilitate compliance by the UK with its international safeguards obligations. Under the UK's VOA with the IAEA, the UK is obliged to facilitate IAEA safeguards inspections and site visits at facilities in the UK that have been designated for that purpose.

7.40. The COVID-19 pandemic presented significant challenges to the delivery of IAEA safeguards inspections in the UK, as we sought to reduce risks of COVID-19 transmission, whilst continuing to meet our international obligations. ONR therefore undertook remote facilitation of several IAEA inspections at designated facilities where necessary. ONR worked successfully with the IAEA, UK Government, and the designated facilities in question to ensure suitable timeframes were agreed and all requirements for timely and safe access were met, in line with the latest public health guidance in response to the pandemic.

7.41. ONR has also successfully facilitated the installation of IAEA safeguards equipment at UK sites. This was a complex technical task involving import of equipment into the UK and installation within operational nuclear facilities in challenging timescales and circumstances.

7.42. Working with its supply chain, ONR implemented a robust nuclear material accountancy system which has enabled ONR to analyse and process hundreds of nuclear material accountancy reports from across the civil nuclear estate and submit these to the IAEA in accordance with ONR's safeguards agreement.

7.43. In the first 12 months of implementing the Nuclear Safeguards (EU Exit) Regulations 2019, ONR enabled the UK to meet all of its international safeguards obligations and delivered the required safeguards reporting on time. In addition, ONR delivered their planned assessment and inspection activities, despite the significant challenges posed by the COVID-19 pandemic.

National safety requirements and regulations

Secondary legislation

7.44. In common with all UK industries, nuclear installations must comply with non-nuclear safety specific regulations made under the HSWA74 in addition to nuclear regulations made under TEA13. The key regulations applicable to nuclear installations are set out below.

Ionising Radiations Regulations 2017:

7.45. The Ionising Radiations Regulations 2017 (IRR17) (Ref. 7. 27) are relevant statutory provisions of HSWA74. They provide for the protection of all workers and members of the public, whether on licensed sites or elsewhere, from ionising radiations. IRR17 came into force on 1 January 2018 and replaced Ionising Radiations Regulations 1999 (IRR99) (Ref. 7.28). IRR17 implemented the worker safety aspects of the European Council (EC) Directive establishing Basic Safety Standards (2013/59/Euratom) and includes the setting of radiation dose limits for employees and members of the public for all activities involving ionising radiation. IRR17 also implements EC Directive 90/641/Euratom. Also see Article 15 – Radiation Protection.

7.46. Under IRR17, employers must comply with:

- Regulation 5 – Notification of certain work;
- Regulation 6 – Registration of certain practices; and/or
- Regulation 7 – Consent to carry out specified practices.

7.47. The above 3 regulations together represent the UK's transposition 'of the graded approach' introduced in the EU Directive 2013/59/EURATOM. From January 2018, all employers who undertake work with ionising radiations on nuclear premises are required to either notify, register, or obtain consent via the ONR process in compliance with the IRR17.

7.48. The main change relevant to existing nuclear facilities is that the dose limit for exposure to the lens of the eye has been reduced from 150mSv to 20mSv in a year.

7.49. REPPIR is supported by a statutory ACoP and non-statutory guidance. The REPPIR ACoP is intended for use by dutyholders, that is persons having legal responsibilities under the REPPIR regulations. The format is designed to clearly distinguish between the regulations, the (statutory) ACoP and the (non-statutory) guidance, and explains that:

- The (statutory) ACoP "Gives practical information on how to comply with the law. If you follow the Code you will be doing enough to comply with the law in respect of those specific matters on which the Code gives advice. You may use alternative methods to those set out in the code in order to comply with the law. However, the Code has a special legal status. If you are prosecuted for breach of health and safety law, and it is proved that you did not follow the relevant provisions of the Code, you will need to show that you have complied with the law in some other way or a Court will find you at fault".
- Whereas, for the (non-statutory) Guidance: "Following the guidance is not compulsory and you are free to take other action. But if you do follow the guidance you will normally be doing enough to comply with the law. Health and safety inspectors seek to secure compliance with the law and may refer to the guidance as illustrating good practice".

7.50. Where REPPIR 2019 set out legal duties, the ACoP and guidance give practical advice on how to comply with those requirements.

> Radiation (Emergency Preparedness and Public Information) Regulations 2019:
>
> 7.51. [Change] REPPIR 2019 (Ref. 7.Error! Bookmark not defined.) came into force on 22nd May 2019 in GB and implements the radiation emergency requirements set out in Council Directive 2013/59/Euratom. The new REPPIR regulations, repealed and replaced REPPIR 2001 (Ref. 7.29).
>
> 7.52. [Change] Implementation of REPPIR 2019 ensured that arrangements were sufficiently flexible to respond to very low probability events and commensurate with the range of hazards for each facility in addition to other enhancements (see paragraphs 16.4 to 16.7 of Article 16 – Emergency Preparedness).
>
> 7.53. [Change] These regulations are supported by an ACoP and guidance (Ref. 7.30).

The Management of Health and Safety at Work Regulations 1999:

7.54. The Management of Health and Safety at Work Regulations 1999 (MHSWR99) (Ref. 7.31) are relevant as they place requirements on employers, and hence nuclear site licensees.

7.55. MHSWR99 are very wide-ranging. Where the requirements overlap with other health and safety regulations, compliance with the more specific regulations is normally sufficient for compliance with MHSWR99.

7.56. As part of the suite of supporting regulations to the HSWA74, the MHSWR99 sets the expectations on dutyholders in Regulation 5 to make appropriate arrangements for health and safety management. It also states that these should be prioritised and set in the appropriate context, for the size and complexity of the organisation and the hazards and risks present. This is consistent with Regulation 4, which requires the principle of prevention to be applied and then supported by Schedule 1 which defines the principles of control.

The Carriage of Dangerous Goods (Amendment) Regulations 2019:

7.57. The UN Model Regulations define classes of dangerous goods, with nuclear materials being Class 7. Dutyholders transporting Class 7 goods by road, rail, or inland waterway in GB must comply with the requirements of Regulation 24 and Schedule 2 of CDG 2019 and the Use of Transportable

Pressure Equipment Regulations 2009 (as amended on 21st April 2019 by CDG 2019). Regulation 24 and Schedule 2 have been amended to implement European Council Directive 2013/59/Euratom, known as the Basic Safety Standards Directive (BSSD – referred to hereafter as “the directive”).

Overview of regulations and guides issued by the regulatory body

7.58. To ensure that the regulatory interpretation of LCs is consistent, ONR has published a set of Technical Inspection Guides (TIGs) (Ref. 7.32). TIGs provide guidance to ONR’s inspectors on the purpose of LCs and inspection to monitor the adequacy of nuclear site licensees’ arrangements against legal requirements.

7.59. ONR inspectors use SAPs (Ref. 7.33), together with the supporting Technical Assessment Guides (TAGs) (Ref. 7.34), to guide regulatory decision making in the nuclear permissioning process. Underpinning such decisions is the legal requirement on nuclear site licensees to reduce risks SFAIRP. The use of these SAPs should be seen in that context. The SAPs incorporate the IAEA safety standards and other relevant international and national standards in accordance with **VDNS Principle 2**.

7.60. The SAPs and supporting TIGs and TAGs are all available to the public and provide nuclear site dutyholders with information on the regulatory principles against which the adequacy of their safety provisions will be judged by ONR inspectors. However, the SAPs and supporting guidance are not intended or sufficient to be used as design or operational standards as they reflect the non-prescriptive nature of the UK’s nuclear regulatory system.

7.61. Following the Fukushima accident, the SAPs were reviewed and revised to include the lessons identified relevant to the UK nuclear industry and were re-issued in 2014. The 2014 revision of the SAPs was completed in November 2014. The document was further revised in January 2020 to capture minor typographical corrections and to reflect changes to the UK’s nuclear regulatory framework since 2014, principally changes to statutory instruments.

Implementing the ONR Security Assessment Principles [Example]

7.62. To develop consistent regulation of safety and security, ONR introduced the Security Assessment Principles (SyAPs) in 2017. ONR uses the SyAPs (Ref. 7.35) in the same way as it uses SAPs, together with supporting TAGs, to guide regulatory judgements and recommendations when undertaking assessments of dutyholders’ security submissions such as site security plans and transport security statements. Underpinning the requirement for these submissions, and ONR’s role in their approval, are the legal duties placed on organisations subject to the Nuclear Industries Security Regulations (NISR) 2003 (Ref. 7.36) and as amended (Ref. 7.37).

7.63. The SyAPs provide the essential foundation for the introduction of outcome focused regulation for all constituent security disciplines: physical, personnel, transport, and cyber security and information assurance. This regulatory philosophy is aligned with ONR's mature non-prescriptive nuclear safety regime and provides dutyholders with a coherent regulatory approach applied by ONR across the UK civil nuclear industry. Introduction of SyAPs represents a pivotal shift away from prescription, which has been made possible by the significant improvements in security management capability and capacity developed within dutyholder organisations since the establishment of formal regulation under NISR 2003.

7.64. It was anticipated that the first issue of the SyAPs will take time to embed and reach full maturity. Implementation at this juncture is particularly beneficial given the diverse nature of the industry, which includes new build design and construction, power operations, and extensive decommissioning. The approach enables the dynamic nature of the threat to be accounted for and proactively responded to by the dutyholders. ONR recognises that learning from the new approach and the evolving threat, notably in the cyber area, may require the SyAPs to be refined on a periodic basis with the first revision scheduled to be published in 2022. The revision will build on the areas of human performance and management of changes to security standards, procedures, and arrangements.

7.65. The UK Centre for the Protection of National Infrastructure and the National Cyber Security Centre supported ONR in the development of SyAPs. The first issue of SyAPs has been informed and developed with extensive stakeholder engagement including a diverse range of industry dutyholders, the UK NDA and BEIS. Additional stakeholders who reviewed the SyAPs during their development include the ONR Chief Nuclear Inspector's Independent Advisory Panel, the UK Nuclear Industry Safety Directors Forum security sub-group and the IAEA International Physical Protection Advisory Service mission to the UK in 2016. This applies equally to the production of nuclear security TAGs which were shared extensively with the UK civil nuclear industry during their production.

7.66. After the initial phase of the production of the SyAPs and supporting TAGs, the second phase consisted of the industry's production of SyAPs aligned security plans by several Pilot Sites with the primary aim of sharing learning through regular engagement, workshops and a dedicated ONR and industry working group. This learning then informed the implementation of phase 3, which is the production of SyAPs-aligned security plans by all regulated dutyholders across the civil nuclear industry for ONR's assessment. It was evident during the initial stages of implementation that the major change to outcome-focused regulation required a significant change in culture and uplift in competence for both ONR and the industry. These changes represent some extensive challenges, which will require continuous development as SyAPs continues to be embedded.

7.67. Whilst the challenges of implementation should not be underestimated, there are some qualitative benefits that have already become apparent for ONR and the industry. These include greater understanding of security at all levels of dutyholder organisations, including senior management; greater integration and alignment with nuclear safety; a single regulatory approach; greater flexibility in approach and solutions and most importantly, greater ownership of nuclear security by the industry.

Memoranda of understanding with other regulators

7.68. The UK regulatory bodies each have defined legal powers and responsibilities and work together closely where there are areas of mutual interest. This is formalised through several Memoranda of Understanding (MoU) between ONR, the Environment Agency, SEPA and NRW, which have been adopted to ensure appropriate co-operation and coordination between these regulatory bodies to help achieve common goals in relation to delivering efficient and effective regulation to secure the highest levels of safety and environmental protection.

7.69. In line with the MoUs, ONR and the environment agencies routinely work closely and sometimes conduct joint inspections in areas with common interest. There is also joint regulatory guidance on the management of Higher Activity Waste (HAW) on nuclear licensed sites (Ref. 7.38), which presents what is regarded as relevant good practice to achieve compliance with the relevant legal requirements. Similarly, the environment agencies work closely to develop, where possible, joint guidance for UK operators (for example, the Guidance on requirements for authorisation of near-surface disposal facilities (Ref. 7.39). BEIS also provides strategic level coordination between UK Government, devolved administrations and regulators on the development and delivery of policy, legislation. Additional information can be found in paragraphs 8.94 to 8.99.

System of licensing

Nuclear Safety Directives

7.70. The EC Directive 2009/71/Euratom of 25 June 2009 (the ‘Nuclear Safety Directive’ (NSD)) (Ref. 7.40) establishing a community framework for the nuclear safety of nuclear power plants, was adopted on 2 July 2009 by publication in the Official Journal and implemented in the UK by 22 July 2011.

7.71. The Directive established a community framework to maintain and promote the continuous improvement of nuclear safety and its regulation, and to ensure high levels of safety to protect workers and the public.

7.72. The UK's fifth and sixth reports to the Convention (Ref. 7.41) reported on how the UK complies with the Directive utilising the system of licensing and licence conditions provided for in the NIA65.

7.73. The UK approach for compliance with this Directive remains unchanged. Council Directive 2014/87/Euratom amending directive 2009/71/Euratom (Ref. 7.42), establishing a community framework for the nuclear safety of nuclear installations, was adopted July 2014, and was implemented by all Euratom Member States in August 2017. In August 2017 ONR wrote to inform them that the UK has now implemented the Directive.

Nuclear site licensing

7.74. The safety of nuclear installations in GB is assured by a system of regulatory controls based on a licensing process. A nuclear site licence may only be issued to a corporate body and must be in force before a site may be used to install or operate a nuclear reactor or other specified installations or facilities.

7.75. ONR's publication "Licensing Nuclear Installations" (Ref. 7.43) provides guidance on how ONR regulates the design, construction, and operation of any nuclear installation in GB for which a nuclear site licence is required under the NIA65. Such installations include:

- nuclear power stations;
- nuclear fuel manufacturing facilities;
- nuclear defence facilities for weapons manufacturing and fuelling/maintenance of nuclear submarines;
- nuclear reprocessing facilities; and
- facilities for the storage of bulk quantities of radioactive matter which has been produced or irradiated during the production or use of nuclear fuel.

7.76. The sections of NIA65 relating to the licensing (Section 1) and attaching of conditions (Section 4) to the licence are "relevant statutory provisions" of TEA13 and subject to TEA13 arrangements for regulation and enforcement.

7.77. A nuclear site licence is granted for an indefinite period and, providing there are no material changes to the basis on which the licence was granted, it can cover the entire lifecycle of a site from installation and commissioning through operation and decommissioning to site clearance and remediation. The granting of a site licence brings an operating organisation, or potential operating organisation, into a more rigorous regulatory regime than would be achieved using more general health and safety legislation. The granting of a site licence does not automatically give permission for a proposed plant to be built and operated; further permissions are required for these activities. Routine regulatory inspection and assessment, and the Periodic Safety Review (PSR) process ensure that the licensing basis is maintained.

7.78. A nuclear site licence is issued to a corporate body based on a satisfactory outcome of regulatory assessment of an applicant's case including:

- the capability, organisation and resources of the applicant corporate body;
- the nature of the prescribed activities and the relevant safety case; and
- the nature and location of the site.

7.79. NIA65 places a requirement on ONR to consult the appropriate environment regulator before granting a new nuclear site licence. This is to ensure that granting a new licence will not conflict with the relevant environment regulator's environmental protection responsibilities or prejudice any legal process under environmental legislation. ONR has a discretionary power under Section 3(4) of NIA65 to direct a licence applicant to serve notice on the public bodies ONR specifies. These bodies will normally be local to the site in question and may include, for example, local authorities and emergency services. The intention of public body notification is to ensure that relevant public bodies who have statutory duties in relation to the site have an opportunity to be informed of the licence application and to advise ONR whether their duties may be affected by the licensable activities.

7.80. NIA65 requires ONR to attach to each nuclear site licence such conditions as it considers necessary or desirable in the interests of safety. Regulatory control of activities on a licensed site is exercised using these site LCs. ONR has promulgated 36 standard LCs that together form a legal basis for requiring high standards of nuclear safety (Ref. 7.44). The conditions are generally non-prescriptive but set goals for all aspects of managing and assuring nuclear and radiological safety. ONR requires that a prospective licensee provides evidence that it can comply with the LCs. Once a site licence has been issued, the site licensee must comply with the LCs. Each licensee develops licence condition compliance arrangements that best suit its activities, while demonstrating that safety is being managed properly. While the system gives flexibility to licensees, it secures high standards in a wide spectrum of nuclear facilities without being prescriptive or requiring detailed rule making by the regulatory body.

7.81. A licence is not transferable, but a replacement licence may be granted to another corporate body if that body demonstrates it is fit to hold a licence. Other circumstances that may lead to the need to relicense a site include changes to the site boundary and changes to the types of prescribed installation or facility for which the site is licensed. In considering an application for a replacement licence, ONR would take a proportionate approach and focus particularly on those aspects of the licensing basis which are the subject of the change.

7.82. A licence may be revoked by ONR or surrendered by the licensee. However, depending upon the circumstances, the licensee may be required to retain certain responsibilities for the site. This “period of responsibility” is ended only when a new licence has been granted for the site, the site is used by the UK Government for defence purposes and does not require a licence, or ONR has given written notice that, in its opinion, there has ceased to be any danger from ionising radiation from anything remaining on the site.

Sizewell C site licence application [Example]

7.83. NNB Generation Company (Sizewell C) Limited (NNB GenCo (SZC)) applied for a nuclear site licence on 30 June 2020 for proposed new nuclear power plants. NNB GenCo (SZC) seeks a licence to construct and operate 2 EPR^{TM}s at Sizewell in Suffolk.

7.84. Post Nuclear Site Licence application, ONR developed a programme of regulatory activities and an assessment strategy covering the expectations for a prospective licensee. During this phase, ONR’s focus is the assessment of the adequacy of the prospective licensee’s proposed arrangements, site suitability safety submissions and organisational capability.

7.85. The assessment of the adequacy of the prospective licensee’s application is conducted through a series of targeted interventions to gain confidence of the company’s development of the arrangements and organisational capability, and assessment of safety submissions.

System of regulatory inspection and assessment

7.86. ONR has responsibility for the day-to-day exercise of the nuclear licensing function. The regulatory functions are vested in the Chief Nuclear Inspector, as the authoritative regulatory head, who delegates specific functions as appropriate to nominated inspectors.

Inspections carried out to verify compliance with the licence and relevant regulations

7.87. Inspection is mainly undertaken on licensees’ premises. It entails inspection of licensees’ compliance with LCs and their corresponding arrangements and to ensure that operation remains within the boundaries of the safety case. Most routine site inspection is carried out by ONR’s site inspectors. ONR inspectors are not resident on site, however in general they will spend about 30 % of their time on site. Additionally, ONR undertakes team inspections on specific topics (see Article 14 – Assessment and Verification of Safety for more information).

Assessments carried out in support of permissioning activities

7.88. Before ONR can permission key activities, ONR assesses licensees' safety cases, on a sample basis according to potential consequences, to ensure that the hazards have been understood and will be properly controlled. ONR employs specialist assessors across a diverse range of technical disciplines to assess safety cases. Where necessary and appropriate, ONR may also employ Technical Support Contractors from external organisations to support assessment work. However, all regulatory decisions for which ONR is responsible are made by warranted ONR inspectors.

7.89. ONR examines aspects of the safety case against the expectations set out within the SAPs to establish whether the licensee has demonstrated that it understands the hazards associated with its activities and how to control them adequately.

Periodic safety reviews

7.90. Nuclear site licence condition LC15 (Periodic Review) requires the licensee to conduct periodic safety reviews (PSRs) at installations. This means that for many years, the UK has been regularly reviewing and re-assessing the safety of its nuclear installations and making improvements where necessary. ONR assesses the outcomes of licensees' reviews. It maintains oversight of safety significant issues and ensures a proportionate response is taken by licensees to implementing improvements.

Enforcement of applicable regulations and terms of licences

7.91. A wide range of enforcement powers are available to ONR. These powers arise from both TEA13 and HSWA74 and are broadly the same across both Acts.

7.92. Inspectors are appointed through a legal instrument in writing, referred to as a warrant. The warrant confers a wide range of powers to the inspector, such as the power of entry to premises at any time, power to take evidence into possession and power to have an incident scene left undisturbed.

7.93. ONR has an Enforcement Policy Statement (EPS) (Ref. 7.45) that defines enforcement as all interactions with those on which the law places duties. The EPS also sets out the purpose of enforcement, and the principles that should be applied across all enforcement activity. To ensure inspectors take consistent, proportionate, and transparent enforcement action, ONR is guided by the ONR Enforcement Management Model (EMM) (Ref. 7.46).

Enforcement management model

> 7.94. [Change] In 2018 ONR moved away from using the Health and Safety Executive's (HSE) EMM and introduced its own guidance. The ONR EMM remains close to the HSE model, however it has been redesigned to be more consistent for nuclear and non-nuclear applications, and the specific legislation relevant to these purposes. Consideration of dutyholder factors is an important element of the model and has the potential to escalate the recommended enforcement action from a defined baseline level.

7.95. The model follows a formal internal review process and ONR may also engage with other stakeholders including other regulatory bodies. The enforcement recommendation is recorded in a decision record, which is used to support and justify the associated enforcement action taken.

7.96. The purpose of the EMM is to:

- Provide a framework for making enforcement decisions;
- Ensure proportionate, consistent, and transparent enforcement decision making;
- Ensure the regulator is accountable for enforcement decision making;
- Adopt a risk-based criteria to target enforcement action; and
- Better equip inspectors to make decisions in complex cases and allow peer review of enforcement action.

7.97. The EMM enables ONR to coordinate enforcement management information more easily. Key enforcement powers that are available to ONR inspectors, as set out in HSWA74 and TEA13 are:

- Improvement Notice (IN) – if an inspector is of the opinion that one or more relevant statutory provisions (or applicable provisions for TEA13) is being contravened or has been contravened in circumstances that will continue or be repeated, they can serve an IN. The Notice requires that the stated improvements be made within a specified timescale.
- Prohibition Notice (PN) – if an inspector is of the opinion that an activity is being, or is likely to be, carried out that risks causing serious personal injury, they can serve a PN to immediately halt an activity.
- Prosecution – ONR inspectors have the power, in England and Wales, to institute proceedings in a court of law for an offence under any of the relevant statutory provisions, including failure to comply with an IN or PN.

In Scotland, an inspector can recommend that a prosecution be initiated to the Crown Office Procurator Fiscals Service. ONR's administrative arrangements require senior level approval to exercise this power.

7.98. ONR has other regulatory powers through the standard LCs, which are referred to as primary powers and are legally binding. There are 6 primary powers and they provide for regulatory control of certain activities. When used, they are done so through issuing Licence Instruments (LI) to the licensee. The primary powers are described below:

- Direction – a direction is issued by ONR when it requires the licensee to take a particular action, such as shutting down specified operations;
- Specification – this power gives ONR discretionary controls with regard to a licensee's arrangements;
- Notification – this power gives ONR the ability to request the submission of information by notifying the licensee of the requirement;
- Consent – this power is used to insert a legal hold-point before the licensee can carry out any activity which has been specified or directed to require Consent from ONR. Before being given Consent, the licensee must satisfy ONR that the proposed action is safe and that procedures necessary for control are in place;
- Approval – this power can be used to control a licensee's arrangements. Once formally approved by ONR, such arrangements or procedures cannot be changed without the licensee seeking approval from ONR; and
- Agreement – this power allows the licensee to proceed with a particular activity or course of action when ONR's agreement is given.

7.99. The powers through the licence and the primary legislation above are deemed sufficient to regulate nuclear safety. However, to ensure efficient regulation, the licensee's arrangements often incorporate further provisions, referred to as derived powers. For example, through derived powers given in the licensee's arrangements, the most significant category of modification proposals may be required to be submitted to ONR for agreement before they can be implemented. Similar controls could be achieved through primary powers, and the use of derived powers does not preclude use of primary powers. The use of these derived powers has the benefit of introducing more flexibility, efficient use of resource and reduction of bureaucracy. It also encourages enhanced self-assurance and internal regulatory control on the part of the licensee. ONR will only use derived powers when they are confident that the licensee's arrangements are robust and regularly sample checks the adequacy of the arrangements.

ONR appeals process

7.100. A licensee or licence applicant that is dissatisfied with a particular regulatory decision may raise concerns with the relevant ONR inspector and ONR senior management. If the matter is not resolved, there is the opportunity to appeal to ONR to reconsider the regulatory decision. The

ONR website details complaints procedures, including the appeal procedure (Ref. 7.47). Should issues not be resolved after consideration by the Deputy Chief Inspector, the appellant may request a 'decision review' to be undertaken by the Chief Nuclear Inspector.

7.101. Nuclear site licensees or other relevant dutyholders have the right of appeal to an employment tribunal in respect of Improvement and Prohibition Notices issued to them under TEA13 or HSWA74. More generally, within UK law, a judicial review can challenge the lawfulness of any decision or action by a regulatory body or any other public body. This challenges the way a decision has been made, but if the regulator has followed lawful procedures, the decision itself cannot be changed.

Environmental regulation

7.102. There are a range of enforcement powers available to the environmental regulators, which arise from both EPR16 (in England and Wales) and EASR18 (in Scotland) and are broadly the same across both pieces of legislation.

7.103. Individual inspectors are appointed through a legal instrument called a warrant and this document confers a wide range of powers on the inspector under Section 108 of EA95, such as the power of entry to premises at any time, power to take evidence into possession; and power to have an incident scene left undisturbed.

7.104. The Environment Agency has published the Enforcement and Sanctions Policy (Ref. 7.48), which explains how it makes enforcement decisions, the types of tools available and associated processes. These range, for example, from providing advice and guidance through to prosecution. Similarly, NRW has published regulatory guidance on its regulatory principles (Ref. 7.49) and NRW enforcement powers (Ref. 7.50), and SEPA has published enforcement policy and enforcement guidance (Refs. 7.51 and 7.52). Key enforcement powers that are available to the environmental regulators include:

- Providing advice and guidance;
- Issuing warnings;
- Arranging court injunctions and court orders;
- Agreeing Enforcement Undertakings (voluntary agreements);
- Serving Fixed and Variable Monetary Penalties (FMPs, VMPs);
- Serving Notices, which include Stop; Suspension; Enforcement; Prohibition; Compliance Restoration; and Anti-Pollution Works;
- Revoking an environmental permit;
- Issuing a variation of an environmental permit;
- Issuing a formal caution; and
- Prosecution.

Environmental regulators appeals process

7.105. Enforcement action (specifically the imposition of a sanction) can normally be appealed either through the criminal court process or through specific appeal provisions. The environmental regulators' notices set out the rights of appeal which apply in the specific circumstances of each sanction or provision. When considering any type of appeal against enforcement and sanctioning action it will usually be appropriate for the recipient to obtain independent legal advice.

Article 7 references

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7.2 ONR Website. UK implementation of Council Directive 2014/87/Euratom amending Directive 2009/71/Euratom establishing a community framework for the nuclear safety of nuclear installations (https://www.onr.org.uk/licensing.htm).

7.3 The Nuclear Safeguards Act 2018 (https://www.legislation.gov.uk/ukpga/2018/15/contents/enacted).

7.4 The Energy Act 2013 (https://www.legislation.gov.uk/ukpga/2013/32/contents/enacted/data.htm).

7.5 The Health and Safety at Work etc. Act 1974 (https://www.legislation.gov.uk/ukpga/1974/37/contents).

7.6 The Nuclear Installations Act 1965 (https://www.legislation.gov.uk/ukpga/1965/57/contents).

7.7 Environment Act 1995 (https://www.legislation.gov.uk/ukpga/1995/25/contents/england).

7.8 The Environmental Permitting (England and Wales) Regulations 2016 (https://www.legislation.gov.uk/uksi/2016/1154/contents).

7.9 Environmental Authorisations (Scotland) Regulations 2018 (https://www.sepa.org.uk/media/372002/easr-guide-to-standard-conditions.pdf).

7.10 Environment (Wales) Act 2016 (https://www.legislation.gov.uk/anaw/2016/3/contents/enacted).

7.11 Control of Major Accident Hazards Regulations 2015 (https://www.legislation.gov.uk/uksi/2015/483/contents/made).

7.12 The Energy Act 2008 (http://www.legislation.gov.uk/ukpga/2008/32/contents).

7.13 The Freedom of Information Act 2000 (http://www.legislation.gov.uk/ukpga/2000/36/contents).

7.14 The Environmental Information Regulations 2004 (http://www.legislation.gov.uk/uksi/2004/3391/contents/made).

7.15 European Council Directive 2014/87/Euratom (http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=uriserv%3AOJ.L_.2014.219.01.0042.01.ENG).

7.16 European Council Directive 2009/71/Euratom (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:172:0018:0022:EN:PDF).

7.17 European Council Directive 2013/59/Euratom (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2014:013:0001:0073:EN:PDF).

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7.19 European Council Directive 89/618/Euratom (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:31989L0618:EN:HTML).

7.20 European Council Directive 90/641/Euratom (http://www.translation-centre.am/pdf/Translat/EU_Direct/Energy/Dir_90_641_en.pdf).

7.21 European Council Directive 97/43/Euratom (http://www.bnra.bg/bg/documents/euroleg/31997l0043-en.pdf).

7.22 European Council Directive 2003/122/Euratom (https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32003L0122&from=EN).

7.23 Radiation (Emergency Preparedness and Public Information) Regulations 2019 (http://www.legislation.gov.uk/uksi/2019/703/contents/made).

7.24 Carriage of Dangerous Goods (Amendment) Regulations 2019 (http://www.legislation.gov.uk/uksi/2019/598/contents/made).

7.25 The Nuclear Safeguards (EU Exit) Regulations 2019 (http://www.legislation.gov.uk/uksi/2019/196/contents/made).

7.26 The Nuclear Safeguards (Fissionable Material and Relevant International Agreements) (EU Exit) Regulations 2019 (http://www.legislation.gov.uk/uksi/2019/195/contents/made).

7.27 The Ionising Radiations Regulations 2017 (http://www.legislation.gov.uk/uksi/2017/1075/contents/made).

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Article 8 – Regulatory Body

> Each Contracting Party shall establish or designate a regulatory body entrusted with the implementation of the legislative and regulatory

framework referred to in Article 7, and provided with adequate authority, competence and financial and human resources to fulfil its assigned responsibilities.

Each Contracting Party shall take the appropriate steps to ensure an effective separation between the functions of the regulatory body and those of any other body or organization concerned with the promotion or utilization of nuclear energy.

8.1. Since the last report, developments under this Article are as follows:

- The Office for Nuclear Regulation (ONR) has established a nuclear safeguards regulatory function;
- ONR has combined the role of Chief Executive and Chief Nuclear Inspector (CE/CNI) along with additional changes to the governance and leadership structure; and
- ONR and the environmental regulators have had to respond to the impacts of the COVID-19 pandemic.

8.2. Compliance with this Article of the Convention has not otherwise substantially changed since the United Kingdom's (UK) eighth National Report (NR) (Ref. 8.1) (in a way that has implications for the Convention obligations).

Establishment of the regulatory body

Legal foundation and statute of the regulatory body

8.3. These aspects are covered under Article 7 – Legislative and Regulatory Framework.

ONR's mandate, mission, and tasks

8.4. ONR regulates safety at 35 licensed nuclear sites in the United Kingdom (UK). These include the existing fleet of operating reactors and decommissioning power stations. In addition, ONR regulates the design and construction of new nuclear facilities and the transport of nuclear and radioactive materials. ONR has also now established a safeguards regulatory function that works with the International Atomic Energy Authority (IAEA) to ensure that safeguards obligations for the UK are met (see Article 7 – Legislative and Regulatory Framework for the amendments to legislation to address safeguards). ONR co-operates with international bodies on safety and security issues of common concern, including associated research. As an independent regulator, formed by statute to act in the interest of the public, ONR aims to take an enabling stance to government policy on nuclear growth and adopts a targeted and proportionate approach to the regulation of Great Britain's (GB) nuclear industry. ONR’s purpose is to regulate the safety and security of nuclear facilities, and the safeguarding of nuclear materials within its legal remit.

8.5. ONR’s role, captured in its mission statement, is to “Protect society by securing safe nuclear operations”. ONR has published its strategy and plans for the delivery of this on its website (Ref. 8.2). The vision for ONR over the lifetime of the current strategy is “To be a modern, transparent regulator delivering trusted outcomes and value”.

8.6. ONR delivers its strategy through core functions of licensing and permissioning of sites/ prescribed activities (i.e. authorisation), inspection and enforcement, review and assessment and ensuring the required standards of safety, security and safeguards are achieved. It deploys its inspectors to deliver these functions across the UK licensed sites for all its purposes. ONR is the legal enforcing authority for nuclear safety on GB licensed sites and acts in conformance with its Enforcement Policy Statement (EPS) (Ref. 8.3) – implemented in accordance with the United Kingdom’s (UK) Regulators’ Code (Ref. 8.4) and the regulatory principles required under the Legislative and Regulatory Reform Act 2006 (Ref. 8.5). It is the Enforcement Policy Statement (EPS) that explains how ONR will act with respect to regulating dutyholders.

8.7. ONR delivers its statutory obligations, in a manner consistent with international obligations, through its core regulatory functions which focus on the verification and assessment of safety, security and safeguards, in compliance with regulatory requirements. The core regulatory functions are:

- Development and/or provision of regulations and guides;
- Notification and authorisation (including registration and licensing);
- Regulatory review and assessment of facilities and activities;
- Regulatory inspection of facilities and activities;
- Enforcement;
- Emergency preparedness and response; and
- Communication and consultation with interested parties.

8.8. The core regulatory functions interact with one another; for example, regulations and guidance set out the regulatory requirements and expectations to be used in review and assessment of safety justifications, in the authorisation process, in carrying out inspections, and when determining enforcement actions. Similarly, the findings of regulatory review and assessment guide the approach to regulatory inspection, and regulatory inspection may identify areas for review and assessment. Both regulatory review and assessment, and regulatory inspection may influence the development of regulations and guidance.

8.9. ONR develops annual business plans for its regulatory activities which are intelligence led and which reflect its core regulatory functions and strategic priorities. The latest plan is given in Reference 8.6.

Enabling regulation

8.10. ONR's compliance with the principles of the UK Government's Regulators' Code (Ref. 8.7) is demonstrated through a regulatory philosophy that is to work in an enabling way with dutyholders (Ref. 8.8), whilst enforcing compliance with the law and regulatory requirements. Regular reviews of compliance with this code are conducted as a means of verifying our compliance with it.

8.11. ONR adopts an "enabling" approach with compliant dutyholders and other relevant stakeholders that seeks effective delivery against clear and prioritised safety (including nuclear safety, transport, and conventional health and safety) and security outcomes. The key principles of the approach are as follows.

- Constructive approach: Requiring regulators, dutyholders as well as other stakeholders (for example, the Department for Business, Energy & Industrial Strategy (BEIS) and the Nuclear Decommissioning Authority (NDA)) to focus on a common overall objective and work together to achieve the desired outcome;
- Communication: Having agreed priorities and real trust between all stakeholders and being clear about the outcomes that ONR is seeking to achieve;
- Independence: Adopting a multi-agency approach in terms of collaboration with stakeholders on agreed activities, whilst retaining a clear, transparent process and independent and objective regulatory decision making;
- Outcome focused: Focusing on the outcome sought, considering all relevant factors and acting proportionately;
- Risk appetite: Being clear that the risks involved are understood but actively managed in accordance with the requirements of UK legislation;
- Strong internal governance and robust assurance: Having strong and effective governance structures that are open and transparent. It is critical that regulatory decision making continues to be demonstrably robust and that appropriate assurance processes are in place; and
- Avoid passive acceptance and seek fit-for-purpose solutions: Not prescribing to dutyholders what to do but challenging their proposals if considered disproportionate or excessive.

8.12. This approach has and continues to prove very successful producing significant improvements to longstanding issues.

Examples of enabling regulation [Example]

8.13. Keyway root cracking: EDF Energy NGL identified a new debris generation mechanism on graphite fuel bricks at some stations following the onset of Keyway Root Cracking (See paragraphs 6.66 to 6.68). This debris generation mechanism had the potential to challenge fuel movements and fuel cooling. ONR and EDF Energy NGL ensured that regular interactions were arranged to discuss the potential for debris generation and the associated hazards, in parallel with safety case development. This ensured that the level of risk from the reactors continued to be as low as reasonably practicable (ALARP) (as required by UK legislation) but also that ONR was able to influence EDF Energy NGL to address regulatory expectations. The approach allowed reactors to continue operating safely with an enhanced inspection regime whilst safety cases for longer-term operation were being developed.

8.14. AGR graphite core seismic withstand: During a review by EDF Energy NGL of reactor building modelling and the graphite core response during an infrequent earthquake (a 1 in 10,000 year event), some issues were revealed which had the potential to undermine the safety case for the primary shutdown for some of the AGRs. Ensuring regular engagement with ONR, EDF Energy NGL demonstrated alternative ALARP arguments and judgements, which it was able to underpin sufficiently and which were accepted by ONR. To reinforce its judgement, EDF Energy NGL also developed a graphite core test rig to demonstrate control rod insertion into a deformed channel and allowed ONR to view tests via an interactive remote video session during COVID restrictions. The approach by EDF Energy NGL and ONR ensured that the consequences of an infrequent seismic event were well understood and that there was sufficient shutdown margin which allowed reactors to continue operating whilst a consolidated safety case was being developed.

Establishing a nuclear safeguards regulatory function

8.15. Following the UK's withdrawal from the European Union (EU), ONR has taken on responsibility for regulating the UK's safeguards obligations, formerly undertaken by Euratom. To undertake these new responsibilities, ONR has developed an effective safeguards regulatory capability, which has included recruiting and training personnel and developing appropriate processes and procedures.

Establishing a nuclear safeguards regulatory function [Example]

8.16. ONR employs compliance and system-based inspections, assessment, and enforcement as the main regulatory tools to seek and achieve compliance with the Nuclear Safeguards (EU Exit) Regulations 2019 (Ref. 8.9), which complemented the approach taken for regulating nuclear safety and security. This is in addition to the specific methodologies needed for the provision of accounting reports to the

IAEA, Nuclear Co-operation Agreements and Additional Protocol reporting. Working in this way gives ONR the opportunity to use a more varied range of evidence captured through regulatory activities for safeguards as well as safety and security, thereby achieving effective regulatory outcomes across all ONR's purposes. Under the new regulations, operators must submit Accountancy and Control Plans to ONR, which is a new and powerful additional tool for regulation of safeguards in the UK. The plans set out the operators' systems, processes and arrangements for accountancy and control of nuclear material, including safety and security measures that contribute to demonstrating effective nuclear material control. The assessment of these plans reinforces ONR's outcome-focused approach and provides evidence on operators' leadership and management, and organisational culture. Safeguards system-based inspections are focused on the systems and components key to ensuring nuclear material is well-controlled and accounted for, and enables ONR to obtain evidence that the systems are suitably maintained, adequately backed-up and operated by staff who are suitably qualified and experienced. The inspections aim to provide assurance that these systems are proportionate, appropriate and deliver the function(s) that operators claim within their arrangements. System-based inspections are therefore targeted at sites/facilities where effective nuclear materials accountancy and control is most dependent on systems and components, for example, facilities where nuclear material may be mobile and can change in its chemical or physical form.

8.17. Although system-based inspections in safeguards are new, they are a well-established part of ONR's safety inspection regime. Adopting this approach to safeguards and aligning these with system-based inspections already conducted across ONR's safety and security purposes promotes better coordination, and once matured, will enhance both the synergy between, and the effectiveness and consistency of, regulatory interventions on site.

8.18. As set out in Section 72 of The Energy Act 2013 (TEA13) (Ref. 8.10), one of ONR's safeguards purposes is to enable and facilitate compliance by the UK with its international safeguards obligations. Under the UK's Voluntary Offer Agreement with the IAEA, the UK is obliged to facilitate IAEA safeguards inspections and site visits at facilities in the UK that have been designated for that purpose.

8.19. The COVID-19 pandemic presented significant challenges to the delivery of IAEA safeguards inspections in the UK, as ONR sought to reduce risks of COVID-19 transmission, whilst continuing to meet international obligations. ONR therefore undertook remote facilitation of several IAEA inspections at designated facilities where necessary. ONR worked successfully with the IAEA, UK government, and the designated facilities in question to ensure suitable timeframes were agreed and all requirements for timely and safe access were met, in line with the latest public health guidance in response to the pandemic. ONR has also successfully facilitated the installation of IAEA safeguards equipment at UK sites.

8.20. This was a complex technical task involving the import of equipment into the UK, and installation within operational nuclear facilities in challenging timescales and circumstances. Working with the supply chain, ONR implemented a robust nuclear material accountancy system which has enabled the analysis and processing of hundreds of nuclear material accountancy reports from across the civil nuclear estate and submit these to the IAEA in accordance with ONR's safeguards agreement.

8.21. In the first 12 months of implementing the Nuclear Safeguards (EU Exit) Regulations 2019, ONR has enabled the UK to meet all of its international safeguards obligations and delivered the required safeguards reporting on time. In addition, ONR delivered its planned assessment and inspection activities despite the significant challenges posed by the COVID-19 pandemic.

Organisational structure of ONR

8.22. ONR was established under TEA13. The ONR Board is made up of non-executive and executive members with non-executive members always in the majority. The ONR Board's role is to provide leadership, set strategy, agree the overarching policy framework within which ONR operates as a regulator, agree and monitor resources and performance, and ensure good governance. See figure 8.1.

8.23. [Change] Since the UK's eighth NR, ONR's leadership team has been restructured to align with other regulators across the world and with its future operational needs, with a new combined post of Chief Executive and Chief Nuclear Inspector (CE/CNI). The restructuring also created new roles of Deputy Chief Executive (DCE), and a single Deputy Chief Nuclear Inspector who is also ONR's Executive Director of Regulation (DCNI/EDR) as shown in the figure 8.2.

8.24. [Change] An ONR Executive Team (OET) has been established for strategic direction and decision-making purposes.

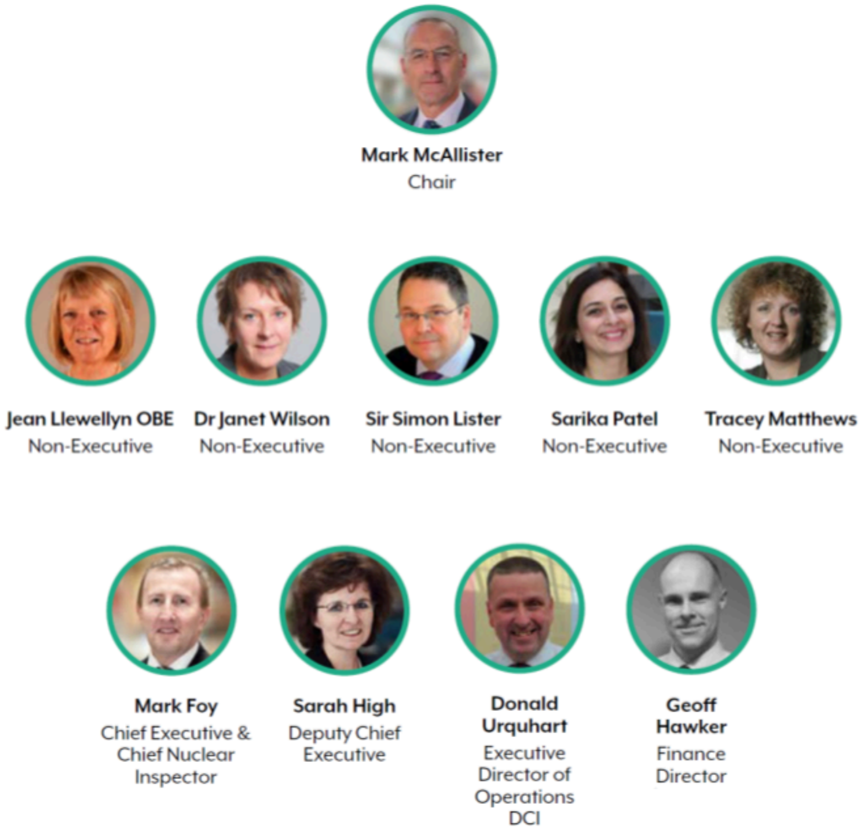
8.25. [Change] The wider Senior Leadership Team (SLT) sits beneath the OET and has delegated responsibility for the leadership and delivery of strategic improvement work and projects across ONR.

8.26. [Change] The appointment of multiple Deputy Chief Inspectors (DCIs) in ONR was historical and a potential source of wider confusion, both within and external to ONR. Consequently, role titles have been changed to provide more clarity on responsibilities.

a. the EDR is now the single DCNI; and
b. the previously appointed DCNIs, who lead each of the regulatory divisions and who report to DCNI/EDR, have been formally reappointed as Directors of Regulation.

8.27. [Change] The CNI remains a statutory appointment, with overall regulatory accountability to the ONR Board and Parliament. The DCNI/EDR has responsibility for leading and representing the delivery of ONR's regulatory work on behalf of the CNI.

Figure 8.1: ONR Board Structure



Accessible version of Figure 8.1

Chair:

- Mark McAllister

Non-Executive members:

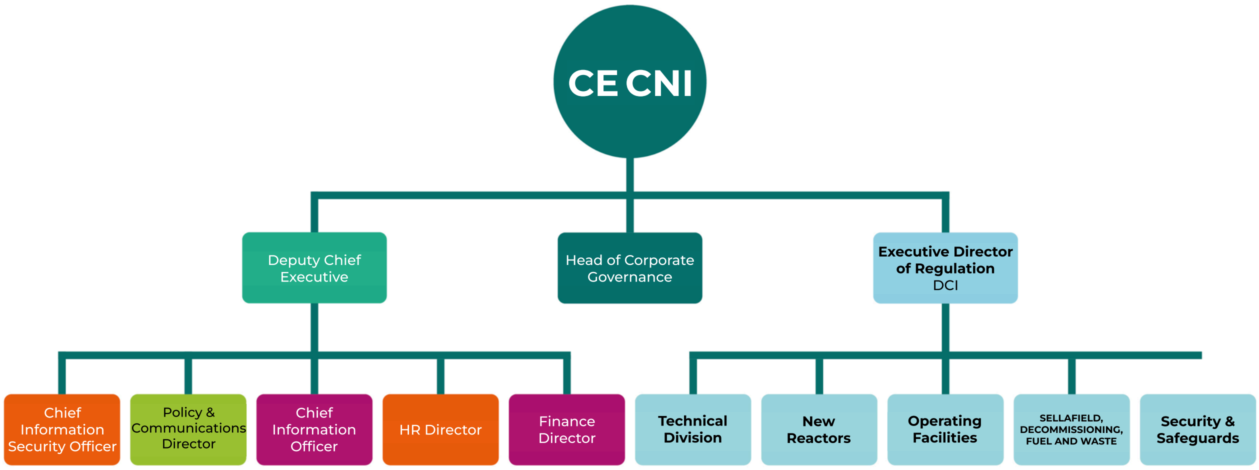
- Jean Llewellyn OBE

- Dr Janet Wilson
- Sir Simon Lister
- Sarika Patel
- Tracey Matthews

Executive members:

- Mark Foy - Chief Executive & Chief Nuclear Inspector
- Sarah High - Deputy Chief Executive
- Donald Urquhart - Executive Dector of Operations DCI
- Geoff Hawker - Finance Director

Figure 8.2: ONR Senior Leadership structure



Accessible version of Figure 8.2

Chief Executive / Chief Nuclear Inspector

Head of Corporate Governance

Deputy Chief Executive

Managing the following roles:

- Chief Information Security Officer
- Policy & Communications Director
- Chief Information Officer
- HR Director
- Finance Director

Executive Director of Regulation / DCI:

Leading the following divisions:

- Technical Division
- New Reactors
- Operating Facilities
- Sellafield, Decommissioning, Fuel and Waste
- Security & Safeguards

8.28. ONR delivers its core regulatory functions and other activities through its matrix management arrangements consisting of specialisms and divisions. ONR's arrangements provide for a flexible approach to nuclear regulation, ready to respond to the demands of an evolving nuclear industry, and an integrated ONR that does this efficiently and effectively.

8.29. ONR's inspectors/staff are assigned to specialisms, from which they are allocated to ONR's industry-facing regulatory divisions. The current ONR regulatory structure is shown in the figure 8.3. In addition, there are enabling programmes for corporate services and other assurance and support functions.

8.30. Effective delivery of ONR's core regulatory functions is managed across the Regulatory Directorate (RD), which is led by the DCNI/EDR. However, ultimate regulatory accountability still rests with the CNI. As a consequence the CNI and DCNI work very closely.

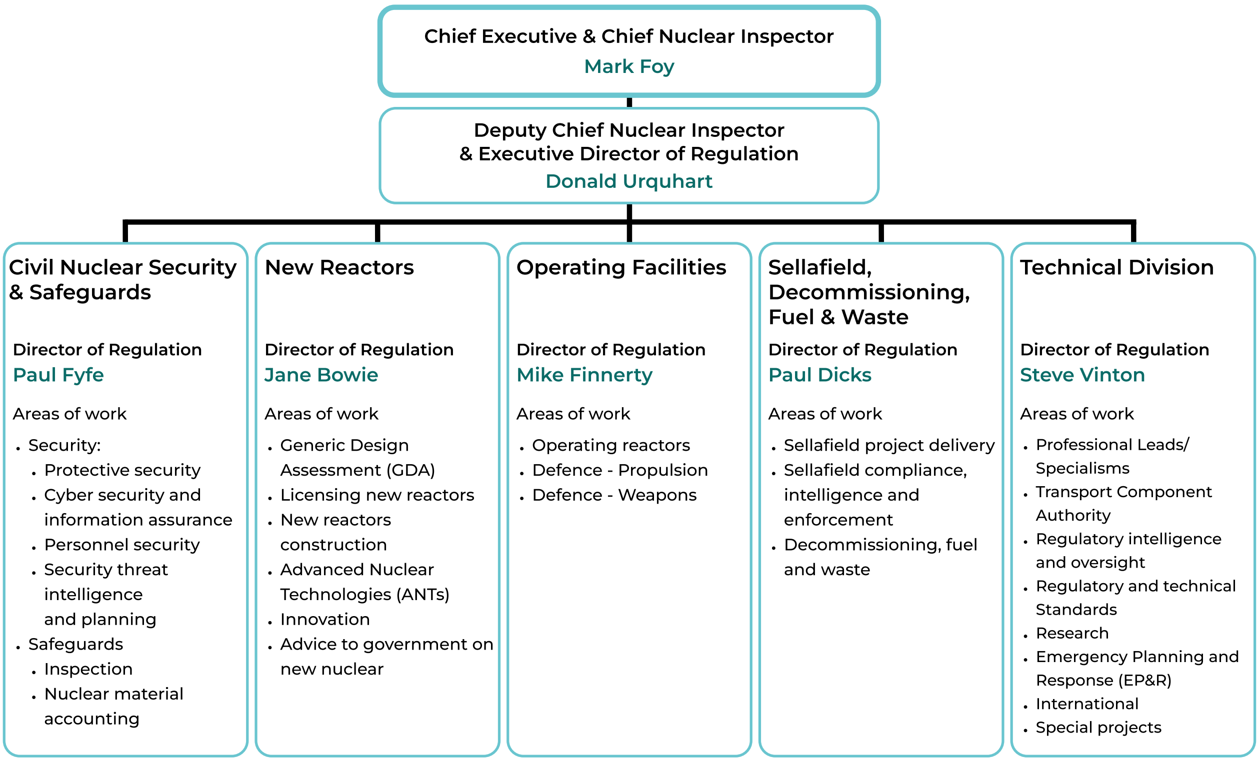
8.31. The RD is comprised of 5 Divisions, each of which is led by a Director of Regulation who report to the DCNI/EDR (and head of RD). The Directors of Regulation are responsible to the DCNI/EDR for the delivery of their business plans. The 4 Divisions that are relevant to the convention are outlined below.

- The Operating Facilities Division – regulates the safety of operating NPPs and safety on the nuclear sites that form an integral part to the delivery of the UK's nuclear deterrent and other maritime defences;
- The New Reactors Division – regulates the construction of Hinkley Point C NPP and undertakes the design assessment of potential new reactor designs planned for operation in the UK, as well as new reactor licensing. The division is also developing the capability and capacity to regulate developing Advanced Nuclear Technologies;
- The Technical Division – ensures that ONR is competently resourced to effectively regulate the UK nuclear industry against modern standards in an enabling manner. The division also governs ONR's wider cross-cutting regulatory functions including Emergency Preparedness and Response,

Research, ONR's Transport Competent Authority, Regulatory Intelligence, and a range of major projects; and

- Civil Nuclear Security and Safeguards Division – is responsible for approving security arrangements within the civil nuclear industry and enforcing compliance to prevent the theft or sabotage of nuclear or other radioactive materials, the sabotage of nuclear facilities, taking into account the full spectrum of protective measures, including physical protection, personnel security, cyber security and information assurance. ONR is the UK's safeguards regulator, and part of the UK State System of Accounting for, and Control of, Nuclear Materials. Within the Civil Nuclear Security Safeguards Division, the safeguards function enables the UK to meet its international safeguards obligations and implements domestic legislation.

Figure 8.3: ONR regulatory structure



Accessible version of Figure 8.3

Chief Executive & Chief Nuclear Inspector - Mark Foy

Deputy Chief Nuclear Inspector & Executive Director of Regulation - Donald Urquhart

Civil Nuclear Security & Safeguards:

Director of Regulation - Paul Fyfe

Areas of work:

- Security:
  - Protective security
  - Cyber security and information assurance
  - Personnel security
  - Security threat intelligence and planning
- Safeguards
  - Inspection
  - Nuclear material accounting

New Reactors:

Director of Regulation - Jane Bowie

Areas of work:

- Generic Design Assessment (GDA)
- Licensing new reactors
- New reactors construction
- Advanced Nuclear Technologies (ANTs)
- Innovation
- Advice to government on new nuclear

Operating Facilities:

Director of Regulation - Mike Finnerty

Areas of work:

- Operating reactors
- Defence - Propulsion
- Defence - Weapons

Sellafield, Decommissioning, Fuel & Waste:

Director of Regulation - Paul Dicks

Areas of work:

- Sellafield project delivery
- Sellafield compliance, intelligence and enforcement
- Decommissioning, fuel and waste

Technical Division:

Director of Regulation - Steve Vinton

Areas of work:

- Professional Leads/ Specialisms
- Transport Component Authority
- Regulatory intelligence and oversight
- Regulatory and technical Standards
- Research
- Emergency Planning and Response (EP&R)
- International
- Special projects

Provision of adequate human resources

8.32. ONR employs suitably qualified and experienced technical specialists as inspectors, as well as generalists and support staff to deliver the core regulatory work and other obligations. As of 31 December 2021, ONR consists of 419 regulatory specialists and 249 support staff.

8.33. ONR continues to recruit staff on a continuous basis as the age-profile of the inspector-cadre means that experienced inspectors are nearing the end of their careers and a number are retiring.

8.34. ONR's external recruitment campaigns continue to bring in specialist skills in an increasingly competitive market, which has also been impacted by the pandemic. ONR has successfully recruited 255 regulatory specialists since 1 April 2014, which has included some of its less resilient areas such as Human Factors and Electrical Engineering.

8.35. Although there have been successes in recruitment, maintaining staff levels and absorption and assimilation of new recruits remains a challenge. To assist with this, and to account for the additional ONR resources needed to regulate the UK nuclear new build pipeline, and business as usual activity, ONR has developed a strategic workforce planning tool which provides detailed resource requirements over the coming years. This will ensure that ONR has detailed recruitment and training plans in place that can be flexible, should demands change. In addition to permanent resource, ONR continues to employ secondees from across the nuclear industry, including from other countries (although limited throughout the pandemic). This provides opportunities to share best practice and provides insight into alternative regulatory regimes.

8.36. ONR's full year total expenditure figures over previous financial years are as follows:

- 2018/19 – £78.3M
- 2019/20 – £92.3M
- 2020/21 – £96.5M

Training of inspectors

8.37. All staff joining ONR directly into an inspector role are required to have a good honours degree, or equivalent, in an appropriate scientific or engineering subject and several years of experience in a relevant industry. This includes having the ability to be a chartered member of a relevant professional institution, thus being recognised as technical experts in their own discipline. The main purpose of the subsequent training given to ONR inspectors is to equip them with the detailed legal knowledge, skills and competency required to deliver core regulatory work.

8.38. To achieve this, inspectors receive training in 2 main areas:

- Mandatory core regulatory training, including refresher training; and
- Training to expand technical expertise and to gain a working knowledge of other essential technical disciplines.

8.39. New recruits also undergo operational training ('on-the-job training') where they carry out specific regulatory assignments under coaching and close supervision. The effectiveness of all training activities is evaluated initially and again after 3 months. This gives opportunities for trainees to evaluate training in the context of the practicalities of their job and provides better feedback to those developing the training courses.

8.40. ONR has also addressed the challenge of maintaining and growing knowledge management within the current environment of new technical developments, regulatory approaches, and an increasingly scarce and mobile nuclear workforce. ONR needs to transfer its wealth of experience to new inspectors and to acquire, develop and share new knowledge to maintain its ability to regulate effectively in the future. At the core of its approach is an ambition to always have the right people, with the right knowledge, using the right processes to achieve its objectives at the right time.

8.41. The ONR Academy launched in 2018 providing a single source for all learning and development within the organisation.

8.42. Since this time, ONR has increased the range of formal development on offer to include comprehensive management and leadership learning alongside the regulatory development programme. In addition to this, the ONR Academy offers learning in a variety of formats including online, blended and coaching, enabling flexibility for individuals to attend at a time and location that is convenient to them. Over 2500 training places have been filled from April 2020 to September 2021 with 276 virtual courses run during the same period.

8.43. Topics cover both regulatory and non-regulatory subjects, and all modules are available to all staff. Based on IAEA good practice, the Academy project has developed a regulatory competence framework (RCF) identifying what competences an inspector needs, along with an accompanying syllabus to show what training opportunities are linked to the competence.

Warrants for new inspectors

8.44. All inspectors are formally appointed by ONR through the issue of a warrant, which entitles them to exercise specified legal powers. Newly recruited inspectors are issued with a ‘limited warrant’, which does not confer the full scope of powers available through TEA13 and HSWA74 for example. This is in recognition that it takes time to train new recruits and for them to develop sufficient experience and competency to use all the available powers appropriately. The powers excluded from the limited warrant are those broadly associated with investigation and enforcement action, for which ONR mandates specific legal training. Following a period of training and sufficient and suitable on-the-job experience, which typically lasts 12 months, inspectors undergo an interview to demonstrate their competence and present further evidence of experience before being issued with a full warrant.

Other recruitment pipelines

8.45. In addition to recruiting experienced specialists, ONR has in place 4 additional successful pipelines to bring people into the organisation at different levels of experience and capability. Also see paragraphs 11.76 to 11.79.

- ONR sponsors and ultimately employs ‘Graduates’ (with 47 graduates being sponsored by ONR to date) who follow a formal development programme;
- ‘Associates’ (those developing their nuclear/high hazard experience (15 currently at this level)) while working for ONR;
- ‘Equivalence’ recruits with unique skills from other industry sectors who undertake an ‘equivalence development role’ that leads to them becoming nuclear inspectors (22 currently on the route with 26 achieving full nuclear inspector status to date); and
- Degree level apprentices, who undertake a 5-year programme comprising a degree in nuclear engineering and science whilst working with ONR and going out on secondment to other parts of the industry (currently 3 individuals on this route).

Continued professional development

8.46. Whist considerable effort is spent on the training of new recruits, ONR also has a refresher training programme to ensure that all staff maintain professional competencies. ONR's current policy is that any further training requirements should be discussed between individual inspectors and their managers in consultation with their professional lead. The professional leads have the responsibility for oversight of the application of regulatory standards in their specialism, for example structural integrity. Such training covers topics such as communication, influencing skills, change management and interpersonal skills, as well as the development of technical competencies.

8.47. In addition to regulatory and technical training, ONR has agreements in place for staff exchange schemes with other regulatory bodies. These schemes facilitate sharing and capture of best regulatory practices.

Re-warranting of inspectors

8.48. All inspectors' warrants are issued for a fixed period of 5 years. As the expiry date approaches, inspectors are required to complete a formal legal refresher training course and competence assessment process, which demonstrates continued and up to date knowledge and understanding of their powers and ONR's legal authorities.

Knowledge management

8.49. Key to improving knowledge management and the delivery of ONR's vision, mission and strategy, is recognising the importance of its people and the need to ensure knowledge is transferred throughout a person's career, rather than captured as they leave. Each nuclear specialism within ONR has a knowledge and skills matrix that defines core knowledge areas and the specialism technical competencies required for the specialism to operate effectively and support the work of ONR, the level of knowledge of specialism members is regularly assessed against these. ONR uses these assessment matrices to identify organisational vulnerabilities and knowledge gaps, to inform the way ONR develops and trains its people and better defines recruitment needs.

8.50. Since the UK's eighth NR (Ref. 8.1), progress continues to be made on implementing the Well-Informed Regulatory Decisions (WIReD) Project. ONR is seeking to achieve:

- Increased knowledge, productivity and connectivity of every inspector in ONR;
- Improved interfaces and transparency of its regulation for dutyholders; and
- Mitigate risks related to its regulatory memory, knowledge management, capability and consistency in decision making.

8.51. The purpose of WIReD is to modernise ONR's processes and systems to support the efficient undertaking of ONR's regulatory activities. This is an enabler to improving effectiveness, making ONR a better place to work and in making better informed regulatory decisions.

8.52. The WIReD project puts regulation, and the people who deliver it, at the centre of process improvements, supported by fit for purpose technology. As a result, ONR will have improved knowledge, productivity and connectivity. WIReD will make processes more efficient and easier to follow and information more accessible and integrated, resulting in greater consistency and transparency in ONR's regulation, modernising how it works with those it regulates.

Impact of the COVID-19 pandemic on ONR activities

8.53. The COVID-19 pandemic required ONR to respond to 2 key challenges:

- Maintaining the health and wellbeing of its staff; and
- Maintaining its regulatory activities to enable it to fulfil its regulatory purposes.

8.54. ONR's response to these challenges is given in the following case study.

ONR's response to COVID-19 [Example]

8.55. On the 16 March 2020, the UK Government issued its 'social distancing' advice, where staff were to work at home where possible; this was subsequently amended to 'must stay at home' later in March 2020.

8.56. ONR's existing formal incident management arrangements enabled ONR to manage events safely and effectively, they were quickly initiated and the Incident Management Team (IMT) met regularly to monitor the emerging situation and respond to government guidance. Organisational priorities were reviewed and re-focused where needed to ensure that ONR provided effective focus and support for staff to deliver the core regulatory purposes, keeping workers and the public safe.

8.57. The IMT met throughout the pandemic to manage ONR's continued response, ensure staff health and wellbeing to deliver ONR's mission and lead business continuity arrangements. Arrangements were put in place to enable every member of staff to work effectively from home, including providing the necessary equipment and support, to balance work and personal responsibilities. Managers were given training, tools and guidance enabling them to help staff work effectively and collaboratively in a remote environment, while supporting their health and wellbeing. Significant reprioritisation of planned regulatory work was undertaken, to ensure that effective regulatory oversight of the nuclear industry was maintained while protecting staff, dutyholders and other stakeholders in line with government restrictions and guidance.

8.58. Regulatory activities continued, initially on a virtual and remote basis. During periods of peak transmission, inspectors only attended site if there were matters of immediate public or worker safety, or security concerns or where an urgent interaction could not be undertaken remotely. Inspectors also attended site where it was critical to gain assurance on the safety or security of a specific undertaking, which justified the deployment of an inspector, including public reassurance.

8.59. A balanced and risk informed approach was adopted to inspections, mixing both remote, desk-based, and onsite inspections, while also making use of operators' own internal assurance functions where appropriate. This approach has been invaluable in enabling ONR to gain assurance of the ongoing safety and security of licensee and other dutyholder activities, on the effectiveness of pandemic control measures, and to inform regulatory decisions and permission appropriately.

8.60. Following the completion of the necessary risk assessments, on-site presence was increased. While staff have worked predominately from home, offices were made COVID-19-secure and some limited office working for essential business or personal reasons was possible throughout the pandemic.

8.61. Regular reporting from industry on the impact of the pandemic on its sites, covering operational resilience, emergency preparedness and response, security and supply chain resilience, gave assurance from the outset. It also informed regulatory assurance to government, the public and international stakeholders on the continued safety and security of the industry.

8.62. An important component of work through the year has been confirming the adequacy of health protection measures implemented by licensees and other dutyholders to ensure the health and wellbeing of their workers and the local communities. ONR's operational experience was shared domestically and internationally during the year, to help improve planning and to support response efforts of fellow UK regulators and international colleagues.

8.63. ONR's ability to respond to COVID-19 was demonstrably effective, with no detrimental impact on regulatory activity and business performance. A Government Internal Audit Agency and Regulatory Assurance (RA) review of ONR's response resulted in a 'substantial' assurance rating (highest rating achievable), giving confidence that ONR's framework of governance, risk management and control was adequate and effective, and mitigates the strategic risk around organisational resilience and pandemic response.

8.64. ONR recognised the significant impact that the COVID-19 lockdown had on dutyholders, especially around staffing levels on the sites and their ability to comply with the requirements of certain regulations during this period. Inspectors from across ONR worked to develop temporary Regulatory Position Statements (RPSs). These provided time-limited guidance to inspectors, outlining appropriate compliance arrangements for safe operations in respect of regulatory requirements that cannot reasonably be achieved during the lockdown. The RPSs were shared internally with inspectors through the relevant divisions to ensure a consistent approach and ONR also shared details of the RPSs with licensees to assist compliance with regulations.

8.65. Because of the effectiveness of the response, ONR took the opportunity to engage collaboratively and creatively with a large proportion of staff and dutyholders about how this could influence ways of working in the future. ONR launched a New Ways of Working (NWoW) project, which undertook extensive research and engagement to identify ways of harnessing the benefits of working at home and remotely, to inform how staff could work better in the future. The resulting recommendations have been assessed to take account of feasibility, prioritisation, benefit, and value adding outcomes. Once implemented, the recommendations will allow ONR to be a more agile and inclusive organisation, where engaged and empowered staff are trusted to work flexibly and securely to deliver ONR's mission and vision.

8.66. The environmental agencies also had to adjust to a 'new normal', adapting their ways of working to protect staff and industry. In responding to the challenge, the environmental regulators:

- produced regulatory position statements (Ref. 8.11), allowing some businesses temporary flexibilities to ensure they could continue to operate, whilst ensuring environmental protections remained;
- transferred staff and operations to remote working;
- prioritised the regulation of high-risk activities; and
- brought permitting activities back to pre-COVID-19 levels after an initial delay in processing.

8.67. The Environment Agency established a Coronavirus Transformation Programme (CTP), as COVID-19 forced the organisation to reflect, rethink, and reshape what it does, where it does it, and how. Similarly to ONR's NWoW, the Environment Agency's CTP will help re-imagine how work is performed in the future and to enhance a culture of inclusivity, equality, diversity, flexibility and wellbeing.

Provision of financial resources

Adequacy of financial resources:

8.68. Section 24A of Nuclear Installations Act 1965 (Ref. 8.12) enables ONR to recover costs from licensees and licence applicants for expenses associated with its nuclear site licensing, permissioning and inspection work. Licensees and licence applicants are charged according to the amount of ONR staff time applied to their sites or applications. Charges may also cover the costs of research and of nuclear safety studies commissioned to assist ONR and ensure that it has access to independent technical advice and information. Such costs are allocated to licensees according to the nature of the work commissioned.

8.69. ONR uses a work recording system to identify the effort and expenses of its staff attributable to each licensee. Where ONR cannot reclaim costs from the industry, it receives funding from the UK Government (currently approximately 5% of ONR's costs).

8.70. On an annual basis ONR publishes its annual report and accounts which provides information on its financial performance (Ref. 8.13). ONR's income could be significantly reduced should a major dutyholder experience financial difficulties. In this situation, the government has committed to ensure that ONR has sufficient resources to discharge its functions, thus underpinning the government's international duties to ensure that the regulator is adequately resourced. In such circumstances, ONR will provide the government details of the funding requirement, including the impacted dutyholder, the action taken and the outcome of that action.

8.71. Section 41 of EA95 (Ref. 8.14) provides the Environment Agency, Natural Resources Wales (NRW) and the Scottish Environmental Protection Agency (SEPA) with the power to impose financial charges for regulatory activities to recover the expenses incurred through regulation. Such expenses include those incurred in respect of a programme of waste and environmental monitoring carried out by the environment agencies. All agencies use a work recording system to identify the effort and expenses of its staff attributable to each licensee.

Quality management system of regulatory body

8.72. ONR has a web browser tool called HOW2, which includes its management system. The ONR management system is designed to comply with IAEA requirements in GSR Part 2 (Ref. 8.15) and as such, maps out all its regulatory and other processes, instructions, and guidance relevant to each of the main regulatory and other supporting processes and activities. It is reviewed regularly to ensure it is up-to-date and is readily available to staff.

8.73. Technical guidance for inspectors is contained in the suite of ONR Safety Assessment Principles (SAPs), Security Assessment Principles

(SyAPs), Technical Assessment Guides (TAGs) and Technical Inspection Guides (TIGs) (Refs. 8.16, 8.17, 8.18 and 8.19). All SAPs, SyAPs, TIGs and TAGs are regularly reviewed and updated and are also publicly available through the ONR website.

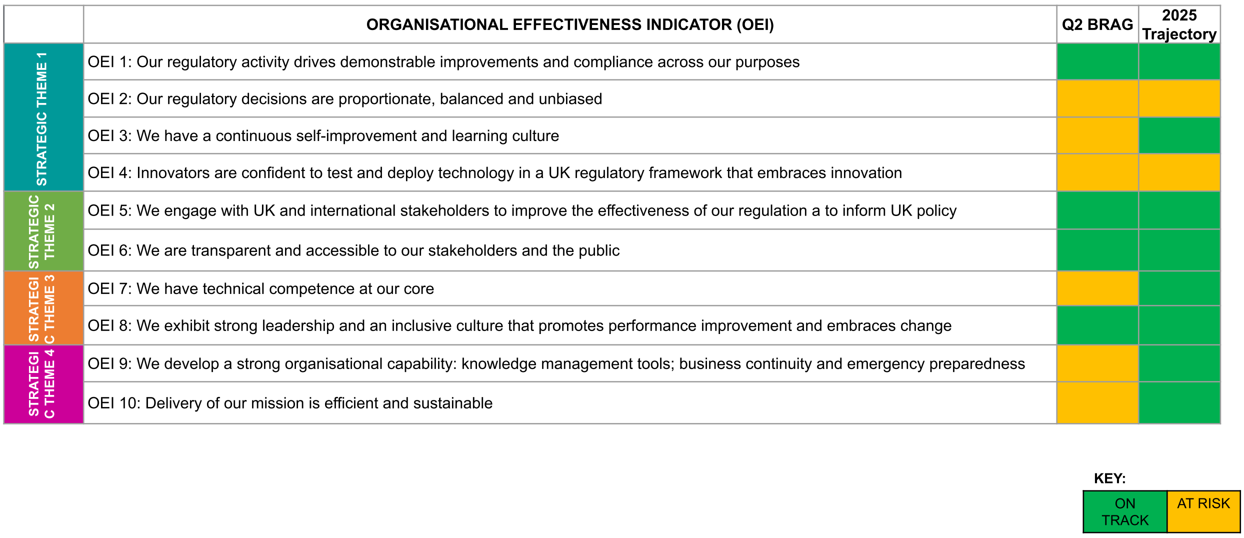
Monitoring ONR’s effectiveness

8.74. Characterising regulatory effectiveness is a challenge facing all regulators. In 2014, ONR supported the development of the NEA’s publication describing the Characteristics of an Effective Nuclear Regulator (Ref. 8.20). This publication suggests that each of the characteristics is a necessary feature of an effective nuclear regulator, but no one characteristic is enough on its own; it is the combination of these characteristics that underpins the effectiveness of a nuclear regulatory body.

> 8.75. [Change] Over the past 3 years ONR has developed an OEI framework, which is based on the OECD’s NEA ‘Ten Characteristics of an Effective Nuclear Regulator’. This shows how ONR operates and regulates in a manner that delivers effective outcomes for safety, security, and safeguards.
>
> 8.76. [Change] The OEIs are aligned to ONR’s 4 strategic themes and provide a broad evidence base to assure the ONR Board, government and the public of the efficiency and effectiveness of ONR’s regulation and wider organisational impact. The 10 OEIs are underpinned by sub-indicators, each with outputs and outcome-based measures attached. The consolidation of the outputs and outcomes indicate the extent that ONR’s Strategy 2020–25 has been achieved, evidenced through the management information.
>
> 8.77. [Change] During 2020/21, ONR worked to refine the framework so that the 10 OEIs fully align with the priorities in the Strategy 2020–25 and present clear outcomes against each. ONR will now focus on maturing the approach with greater emphasis on defining and reporting against the new output and outcome-based measures and indicators. Figure 8.4 sets out an example of ONR’s self-assessment against the 10 OEIs.

Figure 8.4: Organisational Effective Indicator Framework

OEI Performance – Mid Year 2021/22



	ORGANISATIONAL EFFECTIVENESS INDICATOR (OEI)	Q2 BRAG	2025 Trajectory
STRATEGIC THEME 1	OEI 1: Our regulatory activity drives demonstrable improvements and compliance across our purposes		
	OEI 2: Our regulatory decisions are proportionate, balanced and unbiased		
	OEI 3: We have a continuous self-improvement and learning culture		
	OEI 4: Innovators are confident to test and deploy technology in a UK regulatory framework that embraces innovation		
STRATEGIC THEME 2	OEI 5: We engage with UK and international stakeholders to improve the effectiveness of our regulation a to inform UK policy		
	OEI 6: We are transparent and accessible to our stakeholders and the public		
STRATEGIC THEME 3	OEI 7: We have technical competence at our core		
	OEI 8: We exhibit strong leadership and an inclusive culture that promotes performance improvement and embraces change		
STRATEGIC THEME 4	OEI 9: We develop a strong organisational capability: knowledge management tools; business continuity and emergency preparedness		
	OEI 10: Delivery of our mission is efficient and sustainable		

KEY: ON TRACK | AT RISK

Accessible version of Figure 8.4

OEI Performance – Mid Year 2021/22:

Strategic Theme	Organisational Effectiveness Indicator (OEI)	Q2 BRAG	2025 Trajectory
1	OEI 1: Our regulatory activity drives demonstrable improvements and compliance across our purposes	Green	Green
1	OEI 2: Our regulatory decisions are proportionate, balanced and unbiased	Amber	Amber
1	OEI 3: We have a continuous self-improvement and learning culture	Amber	Green
1	OEI 4: Innovators are confident to test and deploy technology in a UK regulatory framework that embraces innovation	Amber	Amber
2	OEI 5: We engage with UK and international stakeholders to improve the effectiveness of our regulation a to inform UK policy	Green	Green

Strategic Theme	Organisational Effectiveness Indicator (OEI)	Q2 BRAG	2025 Trajectory
2	OEI 6: We are transparent and accessible to our stakeholders and the public	Green	Green
3	OEI 7: We have technical competence at our core	Amber	Green
3	OEI 8: We exhibit strong leadership and an inclusive culture that promotes performance improvement and embraces change	Green	Green
4	OEI 9: We develop a strong organisational capability: knowledge management tools; business continuity and emergency preparedness	Amber	Green
4	OEI 10: Delivery of our mission is efficient and sustainable	Amber	Green

Note: BRAG = Blue/Red/Amber/Green (Complete/off-track/at-risk/on-track)

Integrated audit and assurance

8.78. ONR's Integrated Audit and Assurance Framework was introduced in 2017 and has proven very effective in delivering independent oversight and assurance throughout the organisation. ONR's assurance function provides assurance to the ONR Board and committees, CNI and the ONR Senior Leadership Team that it is appropriately delivering its regulatory purposes and functions. The 3 integrated tiers of assurance align with good practice and are set out below:

- Tier 1 – In addition to routine management information and performance data generated within the front-line operating units, ONR has also invested in a Regulatory Oversight Manager (ROM) within this first line of defence. The ROM delivers a structured plan of live reviews of regulatory activities to consider and review inspection practices and provide continuous improvement and learning;
- Tier 2 – ONR has established a Regulatory Assurance function (independent of the front-line operating units) that conducts risk-informed strategic reviews across ONR's purposes, regulatory processes, and decisions; and

- Tier 3 – The UK Government's Internal Audit Agency provides ONR (under contract) with risk-informed external audit coverage across its corporate functions.

Openness and transparency of regulatory activities

8.79. For ONR, openness and transparency mean adopting a presumption of disclosure of information on its regulatory activities and enhancing a 2-way engagement with stakeholders.

8.80. ONR publishes details of improvement notices and prosecutions on its website (Ref. 8.21), social media and via press releases to selected media. The full text of project assessment reports (PAR) and summaries of intervention records are also published on the ONR website, as are all guidance documents including SAPs, SyAPs, TAGs and TIGs.

8.81. ONR now publishes an annual CNI report on Great Britain's nuclear industry (Ref. 8.22). The first of these reports covered the period April 2018 to March 2019 and reports have since been published annually, each autumn, since 2019. The reports provide an independent, authoritative view of the nuclear industry's safety, security, and safeguards performance. It underpins ONR's commitment to being open and transparent and aligns ONR to similar practice by other UK regulators and international peers. It provides insight into industry's safety, security and safeguards performance and ONR's associated regulatory interventions, future focus and priorities.

8.82. ONR has well-established mechanisms for communicating with the public and interested groups including attendance at quarterly Site Stakeholder Groups and Local Liaison Committees. Non-routine site matters (for example enforcement letters, incidents, and safety shortfalls) are reported at these meetings and in the supporting ONR reports which are published on the ONR website. ONR also publishes a stakeholder e-newsletter (every 6–8 weeks by free subscription) which seeks to engender understanding of ONR's regulatory role and is promoted via the ONR website and site stakeholder reports. ONR also undertakes an annual stakeholder survey to seek views and feedback on its work and regulation. A list of the meetings ONR have attended, together with any presentation slides and associated materials, is included on the ONR website (Ref. 8.23).

8.83. At least twice a year, ONR holds meetings (in addition to other engagements), with nuclear-interest non-governmental organisations (NGO). Where needed, these are supplemented by meetings with local groups/interested parties, often in the vicinity of nuclear facilities, and topic-specific sessions. These can be face-to-face or virtual, via webinar for example, to generate an open dialogue and build public understanding on topics that are of interest to stakeholders and the public. This has included ONR's enabling regulation approach, international peer review, and external hazards. In addition, ONR responds to a large range of enquiries and questions from the public via its general enquires service.

8.84. ONR engages with the media through a combination of proactive and reactive methods, responding in an open and prompt manner wherever possible. ONR publishes news stories and issues press releases where appropriate to accompany key publications or announcements, supported by social media activity including short explanatory videos where helpful. ONR's press office is staffed 24 hours – during working hours for 'routine' enquiries and out of hours for urgent issues and emergencies.

8.85. ONR communicates with government through working and senior level contacts and via sponsorship teams within BEIS and the DWP, and with the MoD. ONR reports information on more serious incidents to government ministers. Determination of whether a minister must be informed is made by comparing the incident details against set ministerial reporting criteria. This information is published in quarterly statements of nuclear incidents at nuclear installations on the ONR website (Ref. 8.24).

8.86. Being accessible to stakeholders is important to ONR, so ONR have run a number of webinars to make it easier for interested parties to engage without having to travel (Ref. 8.25).

8.87. ONR also participates in a broad range of international initiatives including working with the Organisation for Economic Co-operation and Development (OECD) NEA and the IAEA to promote openness and transparency.

8.88. The environmental regulators also have well-established and broadly equivalent mechanisms for communicating and engaging with the public and interested groups including attendance at quarterly Site Stakeholder Groups and Local Liaison Committees. Non-routine site matters (such as enforcement letters, incidents) are reported at these meetings. The Environment Agency also has an extensive programme of engagement meetings with NGOs and communities around high public interest nuclear sites. These are both face-to-face and online. Public and stakeholder enquiries are also responded to through the Customer Contact Centre and via email. Regular eBulletins about nuclear regulation are issued to stakeholder lists – both national and local to sites.

8.89. The environmental regulators and the Food Standards Agency (FSA) publish a joint report annually on Radioactivity in Food and the Environment (RIFE) in the UK, which also includes estimated doses to the public. Also see Article 15 – Radiation Protection.

8.90. The Environment Agency also publishes an annual report, "Regulating for people, the environment and growth", that reports on its regulation work and the environmental performance of regulated businesses in England. Further details of the environmental regulators' activities promoting openness and transparency can be found in Annex 2 – The Environmental Regulatory Bodies.

External technical support

8.91. ONR does not use technical support organisations in the way that many other regulators do. Most of the expertise to regulate nuclear safety is available to ONR through its own staff. There are occasions, however, when specialist advice and/or additional resources are needed to provide flexibility to variations in workload, or where the specialism is not available in ONR. To accommodate this, ONR has framework agreements with outside bodies in specific technical areas, which enable support contracts to be placed quickly. Details of technical support contracts are published on the ONR website.

8.92. ONR recognises that with the scarcity of nuclear expertise, many of the companies contracted to deliver work on its behalf will also be bidding for and delivering work on behalf of licensees, prospective licensees, and/or GDA requesting parties. ONR has robust processes in place to avoid any conflicts of interest including the following.

- Consulting with and informing dutyholders on the use of a contractor for a particular piece of work, thus ensuring matters, such as conflicts of interest, are identified and addressed;
- Using contracted staff not engaged on licensee work, establishing a degree of separation within the contract organisation;
- Ensuring detailed work specifications are agreed at the outset;
- Implementing strong contract management procedures;
- Following ONR's openness and transparency agenda and ensuring relevant information about the use of contractors is put promptly into the public domain;
- Having detailed non-disclosure agreements in place; and
- All parties knowing that ONR owns the intellectual property rights resulting from external work undertaken on its behalf and will, where appropriate share reports and make findings available.

Advisory committees

8.93. In 2016, ONR introduced the CNI's Independent Advisory Panel (IAP) to provide independent advice to ONR on nuclear matters. The IAP is now well-established and meets twice a year, bringing together experts from across the nuclear industry, academic community, UK Government departments, other regulators, and NGOs who contribute to informed debate and provide advice on relevant topics. The discussions range from regulatory strategies and policy to implications of developments in new nuclear technologies and the regulation of innovation. More information on the IAP can be found on the ONR website (Ref. 8.26).

Interface with other agencies and regulators

8.94. Environmental regulatory bodies The environmental regulatory bodies (the Environment Agency, SEPA, and NRW) also have duties under the Convention. Annex 2 – The Environmental Regulatory Bodies provides more information on the authority, competence, and financial and human resources of the environmental regulatory bodies. The following section sets out the arrangements between ONR and the environmental regulatory bodies to ensure effective and efficient regulation of the GB nuclear industry.

8.95. ONR and the environment agencies work closely together to ensure the effective co-ordination of their respective regulatory activities. ONR has Memoranda of Understanding with the Environment Agency, SEPA and NRW (Ref. 8.27), the objective of which is to facilitate the minimisation of the overall health detriment due to radioactive waste management on licensed sites, from generation to disposal. Under NIA65, ONR is required to consult the Environment Agency, NRW or SEPA before:

- Granting a nuclear site licence; and
- Varying a nuclear site licence if the variation relates to or affects the creation, accumulation, or disposal of radioactive waste.

8.96. Similarly, the environment agencies must consult ONR (or HSE as appropriate) under EPR16 (Ref. 8.28) or EASR18 (Ref. 8.29) on proposed (new or varied) authorisations for disposals of radioactive waste including discharges to the environment from nuclear licensed sites.

8.97. In addition to their own routine inspection activities on nuclear licensed sites, the environment agencies carry out planned joint inspections with ONR on areas of shared regulatory interest and co-operate in the investigation of incidents where appropriate. Together with ONR, the environment agencies form the relevant Joint Competent Authority at nuclear licensed sites for regulation of the requirements of the Control of Major Accident Hazards Regulations (COMAH) (Ref. 8.30).

8.98. The Environment Agency and ONR has also established a joint programme office to provide a single point of contact for the GDA of nuclear power plant designs.

8.99. The environment agencies, together with ONR, have published joint guidance on the management of higher activity radioactive waste on nuclear sites (Ref. 8.31), which provides advice to nuclear licensees on the management of the safety and disposability of such wastes.

Responsibilities of other agencies and bodies

8.100. The UK Health Security Agency (UKHSA), formally Public Health England, is a non-departmental public body, whose statutory functions include the following:

- The advancement of the acquisition of knowledge about protection from radiation risks; and
- The provision of information and advice in relation to the protection of the community (or any part of the community) from radiation risks.

8.101. UKHSA has a UK-wide responsibility to provide advice and technical services to persons with responsibilities in relation to radiation hazards.

Reporting obligations

8.102. ONR must publish a report of its activities together with its audited accounts after the end of each financial year.

8.103. The annual report must meet the requirements set out in TEA13. The accounts are prepared in accordance with the relevant statutes and direction issued by DWP, and in accordance with the Treasury’s Financial Reporting Manual.

8.104. The annual report and accounts are laid in UK Parliament and published on ONR’s website.

8.105. In accordance with TEA13, ONR submits a strategy for carrying out its functions to the responsible government minister for approval. The strategy must be reviewed, and if necessary updated, at least every 5 years. Any revisions to the strategy must be approved by the responsible minister.

8.106. In accordance with TEA13, ONR must submit to the responsible minister for approval an annual plan. The annual plan must include key targets for the year and budgeting information so that resources allocated to achieve specific objectives can be readily identified.

Independence of the regulatory body

8.107. The information herein is directly related to the **major common issue** on **independence of the regulatory body** from the seventh RM.

8.108. ONR is sponsored by the DWP, ensuring independence from BEIS, which is the department responsible for ensuring energy supply including nuclear energy.

8.109. ONR’s independence as a regulator is ensured under TEA13, where ONR is given direct responsibility for the enforcement of nuclear safety, security, safeguards, site conventional health and safety, and nuclear material transport; collectively known as ONR’s “purposes”. Similarly, the environment agencies are responsible for the environmental protection regulatory system under EPR16 (Ref. 8.28) in England and Wales and EASR18 (Ref. 8.29) in Scotland.

8.110. ONR provides information and advice to ministers and the government on matters related to ONR purposes, but its regulatory functions operate separately from government and ministers. Furthermore, government cannot direct ONR with respect to regulatory functions in a particular case – ensuring that regulatory decisions are independent.

Article 8 references

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8.2 ONR Strategy 2020–2025 and Corporate Plan 2021/22 (https://www.onr.org.uk/corporate-publications.htm).

8.3 ONR Enforcement Policy Statement (https://www.onr.org.uk/documents/enforcement-policy-statement.pdf).

8.4 UK Regulators Code (https://www.gov.uk/government/publications/regulators-code).

8.5 Legislative and Regulatory Reform Act 2006 (https://www.legislation.gov.uk/ukpga/2006/51/contents).

8.6 ONR Regulatory Directorate Business Plan 2021/2022.
[No web link available – internal ONR document]

8.7 Regulators' Code (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/913510/14-705-regulators-code.pdf). April 2014

8.8 A Guide to Enabling Regulation (https://www.onr.org.uk/documents/2020/a-guide-to-enabling-regulation-2020.pdf). August 2020.

8.9 The Nuclear Safeguards (EU Exit) Regulations 2019 (http://www.legislation.gov.uk/uksi/2019/196/contents/made).

8.10 The Energy Act 2013 (http://www.legislation.gov.uk/ukpga/2013/32/contents/enacted/data.htm).

8.11 COVID-19 Regulatory Position Statements (https://www.gov.uk/government/collections/covid-19-regulatory-position-statements).

8.12 The Nuclear Installations Act 1965 (https://www.legislation.gov.uk/ukpga/1965/57/contents).

8.13 Annual Report and Accounts 2020/21 (https://www.onr.org.uk/documents/2021/onr-annual-report-and-accounts-2020-21.pdf).

8.14 Environment Act 1995 (https://www.legislation.gov.uk/ukpga/1995/25/contents/england).

8.15 IAEA GSR Pt 2 Leadership and Management for Safety (https://www.iaea.org/publications/11070/leadership-and-management-for-safety).

8.16 ONR Safety Assessment Principles 2014 (https://www.onr.org.uk/saps/saps2014.pdf).

8.17 ONR Security Assessment Principles 2017 (https://www.onr.org.uk/syaps/security-assessment-principles-2017.pdf).

8.18 ONR Technical Assessment Guides (https://www.onr.org.uk/operational/tech_asst_guides/index.htm).

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8.21 ONR Website (https://www.onr.org.uk/)

8.22 ONR Chief Nuclear Inspector’s Annual Report 2021 (https://www.onr.org.uk/documents/2021/cni-annual-report-2021.pdf).

8.23 ONR Website. ONR Events (https://www.onr.org.uk/events.htm)

8.24 ONR Website. Quarterly statements of nuclear incidents at nuclear installations (https://www.onr.org.uk/quarterly-stat/).

8.25 ONR Website. Quarterly statements of nuclear incidents at nuclear installations (https://www.onr.org.uk/webinars/index.htm).

8.26 ONR Website. Chief Nuclear Inspector’s Independent Advisory Panel (https://www.onr.org.uk/external-panels/cni-iap.htm).

8.27 Memorandum of Understanding between ONR and Environment Agency and SEPA (https://www.onr.org.uk/agency-agreements-mou.htm).

8.28 The Environmental Permitting (England and Wales) Regulations 2016 (https://www.legislation.gov.uk/uksi/2016/1154/contents).

8.29 Environmental Authorisations (Scotland) Regulations 2018 (https://www.sepa.org.uk/media/372002/easr-guide-to-standard-conditions.pdf).

8.30 under the Control of Major Accident Hazards Regulations 2015 (https://www.legislation.gov.uk/uksi/2015/483/contents/made)

8.31 The Management of Higher Activity Radioactive Waste on Nuclear Sites (https://www.onr.org.uk/wastemanage/waste-management-joint-guidance.pdf). July 2021.

Article 9 – Responsibility of the Licence Holder

> Each Contracting Party shall ensure that prime responsibility for the safety of a nuclear installation rests with the holder of the relevant licence and shall take the appropriate steps to ensure that each such licence holder meets its responsibility.

9.1. Compliance with this Article of the Convention is demonstrated in a way that has not substantially changed since the United Kingdom's (UK) eighth National Report (NR) (Ref. 9.1) (in a way that has implications for the Convention obligations).

Legislation assigning prime responsibility for nuclear safety to the licence holder

9.2 In the UK, the holder of a nuclear site licence is responsible for the safety of its nuclear installations and for the health and safety of both its workers and members of the public that may be affected by its operations.

9.3 The legislation assigning primary responsibility for safety to the licence holder is covered in detail in Annex 1 – Extracts from Legislation relevant to the Convention:

- Nuclear Installations Act 1965 (NIA65) Section 7 (Ref. 9.2); and
- Health and Safety at Work Act 1974 (HSWA74) Section 2 (Ref. 9.3).

9.4. To meet its legal obligations for managing nuclear safety adequately, the licensees have established policies and detailed arrangements that discharge their prime responsibilities. ONR requires that the licensee's safety policy and organisational structure are documented as part of the licensing process. EDF Energy NGL operates with an Integrated Management System framework. This framework accommodates nuclear, industrial, and environmental requirements. This allows EDF Energy NGL to manage all aspects of the operation of its sites within a single framework. In respect of environmental arrangements, EDF Energy NGL has specialists who own and manage the environmental processes within the framework.

9.5. Further information on how EDF Energy NGL is organised and manages its construction and operations to ensure safety can be found throughout this report but particularly under Article 6 – Existing Nuclear Installations, Article 10 – Priority to Safety, Article 14 – Assessment and Verification of Safety and Article 19 – Operation. EDF Energy NGL's safety policies are specifically discussed under Article 10 – Priority to Safety.

Ensuring that the licensee has appropriate resources

9.6. The nuclear site licence conditions require the licensee to have adequate human and financial resources in place to operate safely. This includes the engineering and technical resources, which for EDF Energy NGL is provided centrally. The resource requirements are baselined and reviewed on an annual basis to demonstrate that the company has suitable organisational structures, resources, and competencies in place to carry out safety-related activities effectively. The baseline statements include those required for effective on-site management of an accident and mitigation of its consequences. Baseline statements also provide a clear description of the currently intended staffing levels. This enables EDF Energy to assess and substantiate the potential impact of proposed organisation changes on safety.

9.7. The financial and human resources required to ensure the safety of the reactor sites throughout the lifetime of the plant are described in more detail under Article 11 – Financial and Human Resources.

Licensee structure – EDF Energy NGL

9.8. EDF Energy NGL, in addition to site-based staff, has a significant number of located at offices near Gloucester, England, and near Glasgow, Scotland, who set safety and operational standards, carry out reviews of safety and provide specialist support to EDF Energy NGL nuclear licensed sites. The licensee's responsibility for compliance with some LCs may be discharged by a central capability within the company, rather than site-based capability.

9.9. The regional chief nuclear officers are responsible for selecting station directors for operating stations, monitoring their performance, and ensuring that they have adequate corporate support. The operating nuclear fleet is divided organisationally into 2 regions. The 2 Chief Nuclear Officers of EDF Energy NGL report to the Managing Director. The Defuelling sites report via the AGR Defuelling Director who has the same role as a Chief Nuclear Officer for the Defuelling sites, and reports to the Managing Director.

9.10. All UK nuclear power plant sites have a designated Station Director, who has delegated responsibility for all day-to-day activities and operations. This includes responsibility for compliance with the nuclear site licence and environmental permits.

9.11. There are several key positions supporting the role of Station Director. These are responsible for leading teams to deliver plant operations, maintenance, work-management, engineering, defuelling preparation and technical and safety support. Each station has approximately 530 staff with an additional 200 persons employed by contracting companies involved in day-to-day operations. During outage periods, this figure increases by up to 1000 further contractors necessary to deliver specific engineering and maintenance activities.

9.12. The Technical and Safety Support Manager at each site leads a team with broad responsibilities covering nuclear safety, site security, industrial safety, radiation protection and environmental safety.

9.13. Independent oversight is provided by Independent Nuclear Assurance (INA) teams, located at each site. They have separate reporting lines through the safety, security, and assurance director to the managing director.

Licensee structure – NNB GenCo

9.14. NNB GenCo is a limited company, and as the licensee, has sole responsibility for the conduct of all activities affecting nuclear and radiological safety at Hinkley Point C. The NNB GenCo Board is responsible for effective governance of the project, including implementing EDF group policies so that nuclear safety risks are adequately managed and controlled. The executive arm of the licensee is headed by the Hinkley Point C Managing Director who is a member of the NNB GenCo Board. The Managing Director is accountable to the Board for the safe and secure delivery of the project, to time and cost, in accordance with specified quality and engineering standards. The project structure is designed to have clarity of objectives, across 3 aspects of the organisation:

- Direction – comprising core functions of Engineering, Technical and Delivery;
- Delivery – areas and programmes responsible for implementing the verified design; and
- Functions – supporting the delivery of Hinkley Point C and the schedule.

9.15. The Hinkley Point C safety case is key to the licensee’s demonstration that the nuclear safety risks arising during all phases of construction are compliant with the law and meet the prevailing standards. UK law requires risks to be reduced so far as is reasonably practicable (SFAIRP).

9.16. The Safety and Regulation Director is independent from the construction/delivery reporting line within Hinkley Point C and provides appropriate review and challenge in relation to nuclear safety. The Safety and Regulation Directorate provides regulatory, licensing, occupational health, and industrial safety, learning and environmental support by offering specialist expertise and guidance. The Directorate seeks to ensure that appropriate health and safety policies and standards are formulated and promulgated throughout the company.

9.17. As part of demonstrating high standards in nuclear, industrial, and environmental safety, NNB GenCo also has an internal regulator function. The function comprises of: Independent Assessment; Supply Chain Inspection; Independent Security Assurance; Independent Technical Assessment; and Hinkley Point C Site Inspection teams. A targeted programme of surveillance and independent assessments is carried out to provide assurance of the adequacy of arrangements and their implementation in site delivery, design and safety case, organisational capability, security, and supply chain capability for the Hinkley Point C project. The team provides regular reporting and insights to the project and escalates advice to higher levels of management if the resulting action is deemed to be insufficient in scope or urgency.

How the regulatory body ensures the licence holders discharge their responsibility for safety

9.18. The most frequent interfaces between the licensee and ONR arise through oversight activities, the assessment of safety cases, and inspections at licensed nuclear sites. ONR conducts inspections to check the operator's compliance with LCs and other health and safety legal requirements. ONR has a nominated site inspector for each of the operational NPP sites and for the Hinkley Point C construction site, to lead on this regulatory work. The nominated site inspector is the principal focal point for the licensee and any other dutyholders on site in relation to nuclear safety matters. The processes of assessment and inspection provide ONR with assurance that the licensee meets its responsibilities regarding the licence conditions and safety case.

9.19. ONR has established an intelligence led strategy for the targeted and proportionate regulation of reactors, which provides a framework for the regulatory activities associated with all 8 EDF Energy NGL sites. This is implemented through an Integrated Intervention Strategy and through intervention plans, which are produced annually. Additionally, inspection plans are produced for each site, outlining the scope of the planned inspections. The inspection plan identifies all planned System Based Inspections (SBI) and other compliance inspections for a 12-month period. SBIs are described further under Article 14 – Assessment and Verification of Safety.

9.20. In addition to compliance inspections and SBIs, additional reactive inspections, or inspections associated with intervention projects may also be appropriate. ONR inspectors may also carry out unannounced inspections at any time. Reactive inspections cannot be planned as part of the annual intervention plan. However, experience suggests that up to 25% of available inspection time is spent on reactive work. Reactive inspections often include responding to any events on the site following notification to ONR or otherwise recorded through the licensee's arrangements. ONR enforces the law through a graded approach, starting at verbal advice for minor non-compliances through to prosecutions in a court of law for serious breaches of the law.

9.21. The most frequent interfaces between the operators and the environmental regulators arise through the assessment of environmental safety cases and inspections at licensed nuclear sites. The environmental regulators conduct inspections to check the operator's compliance with permit conditions and other environmental safety legal requirements. Interventions also include; provision of advice and guidance, use of regulatory principles to ensure consistent regulatory judgements, themed inspections to ensure consistent application across the sector, joint inspections with ONR, enforcement and development of site environmental reviews to inform the annual plan of inspection or the use of strategic regulatory plans for longer term position on new build sites. The environmental regulators have nominated site inspectors for each of the operational NPP sites and for the Hinkley Point C construction site, to lead on this regulatory work. The nominated site inspector is the principal focal point for the operator in relation to environmental safety matters. The processes of assessment and inspection provide the environmental regulators with assurance that the operator meets its responsibilities regarding the permit conditions and environmental safety case. Also see Annex 2 – The Environmental Regulatory Bodies for more information.

Open and transparent communications

9.22. The information herein is directly related to the **major common issue** on **stakeholder consultation and communication** from the seventh Review Meeting (RM).

EDF Energy's transparency arrangements

9.23. EDF Energy NGL adopts a policy of openness and transparency and places importance on providing assurance to the public, that it can be trusted to act to the highest safety and environmental standards. EDF Energy NGL Station Directors write to local stakeholder groups regularly, providing updates on safety and operational performance and providing details of specific events reported through the recording processes. In addition, monthly newsletters are circulated to the community and local media and published on the company's website. The Hinkley Point C site team holds public forums quarterly to engage people neighbouring the site, a forum for all local stakeholders and a forum focused on transport challenges.

9.24. EDF Energy NGL's website provides daily updates on the status of all of its operating reactors, information on the power outputs, status of the reactor (at power/shutdown) and provides an indication of when the reactor is due to return to service (Ref. 9.4). The NNB GenCo website (Ref. 9.5) provides an overview of the technology, the benefits to the local community, and high-level updates on the progress of construction projects.

9.25. EDF Energy NGL has 5 visitor centres across the UK. The centres contain interactive exhibitions which provide information about nuclear power generation, helping visitors to understand how its power stations contribute to low carbon electricity generation, through interactive models and information panels. The power stations which have ceased generation (Hunterston B and Dungeness B) no longer have visitor centres. The locations where EDF Energy has multiple sites use a single visitor centre (Heysham 1 and Heysham 2, and Hinkley Point B and Hinkley Point C).

ONR and BEIS transparency arrangements

9.26. ONR has a policy of openness and transparency in its regulatory activities, including inspections and permissions. All relevant information is available to the public via publication on the ONR website (Ref. 9.6) and through the freedom of information and enquiries process (Ref. 9.7). ONR inspectors typically attend the quarterly or biannual local site stakeholder or community liaison meetings held near to each reactor site. These formal meetings are used to inform the local community, including local elected councillors, on matters in relation to the operation of the station. This includes reporting events that have occurred on site and updating on the generating status and planned outages for each site. ONR provides a report on its main regulatory activities on a quarterly basis, which is discussed as part of the meeting. ONR's quarterly reports are also published on its website (Ref. 9.8).

9.27. ONR also issues an annual report, the CNI report, which provides a judgement on industry performance and incidents reported throughout the year (Ref. 9.9).

9.28. The Department for Business, Energy & Industrial Strategy (BEIS) has established the BEIS Nuclear Non-Governmental Organisation (NGO) Forum in 2010 to provide a regular opportunity for representatives of nuclear-interested NGOs to have direct access to government policy and engage with decision makers including ministers. The intention is to provide a collaborative and deliberative atmosphere where nuclear issues can be discussed in an open and transparent manner; ensure policy-makers have access to the full range of evidence and perspectives and inform NGOs on government priorities and workstreams. The Forum meets 3 times a year.

During the height of the COVID-19 pandemic, the meetings were moved online. Meetings are now allowed to be either face-to-face or online. Each meeting is attended by the Nuclear Directorate Directors and senior management team. BEIS mnisters have, and aim to, participate in these meetings. The minutes are published on the UK Government website (Ref. 9.10).

Article 9 references

9.1 The United Kingdom's Eighth National Report on Compliance with the Obligations of the Convention on Nuclear Safety (https://www.iaea.org/sites/default/files/national_report_of_the_united_kingdom_for_the_8th_review_meeting.pdf), Department for Business, Energy & Industrial Strategy, August 2019.

9.2 The Nuclear Installations Act 1965 (https://www.legislation.gov.uk/ukpga/1965/57/contents).

9.3 The Health and Safety at Work etc Act 1974 (https://www.legislation.gov.uk/ukpga/1974/37/contents).

9.4 EDF Energy Nuclear Generation Limited. Nuclear Plant Status. https://www.edfenergy.com/energy/power-station/daily-statuses

9.5 EDF Energy. Hinkley Point C. Site Construction Status (https://www.edfenergy.com/energy/nuclear-new-build-projects/hinkley-point-c).

9.6 ONR Web Site (https://www.onr.org.uk).

9.7 ONR. Releases of Information (https://www.onr.org.uk/foi)

9.8 ONR. Quarterly Local Liaison Committee. Site Stakeholder Group Reports (https://www.onr.org.uk/llc).

9.9 Chief Nuclear Inspector's annual report on Great Britain's nuclear industry (https://www.onr.org.uk/documents/2021/cni-annual-report-2021.pdf), October 2021.

9.10 UK Government. Nuclear Non-Governmental Organisation forum (https://www.gov.uk/government/groups/non-governmental-organisation-forum).

Article 10 – Priority to Safety

Each Contracting Party shall take the appropriate steps to ensure that all organizations engaged in activities directly related to nuclear installations shall establish policies that give due priority to nuclear safety.

10.1. Since the last report, developments under this Article are as follows:

- Development and application of regulatory guidance to support specialist inspectors in undertaking assessments of safety culture, and diagnosing organisational problems in licensees which may be adversely affecting safety.

10.2. Otherwise, compliance with this Article of the Convention has not substantially changed since the United Kingdom's (UK) eighth National Report (NR) (Ref. 10.1) (in a way that has implications for the Convention obligations).

UK government policy

10.3. The UK has a well-established radiological and civil nuclear safety regime which demonstrates a long-term commitment to safety as a top priority. Its fundamental objective is to ensure an efficient and effective safety framework which protects the public, workers and the environment from the harmful risks of ionising radiation (Ref. 10.2). The UK legislative framework requires that those who create the radiation risk must ensure that risks are removed or limited so far as is reasonably practicable (SFAIRP) to ensure the safety of the public and those who work with the radiation. Those that fail to meet their legal obligations in any sector will be subject to proportionate enforcement action.

10.4. The UK has established a legal framework for safety that ensures all of its safety and environmental regulators have sufficient financial and human resources to carry out their functions effectively. UK Government departments and the devolved administrations work with regulators to regularly review the UK's legal framework to ensure that it remains effective and fit for purpose. The legal framework also gives regulators legal powers to take enforcement action to bring dutyholders back into compliance. Enforcement action is made public to support learning and transparency. Regulators work closely with employers by providing guidance to ensure compliance with relevant regulations.

10.5. The Department for Business, Energy & Industrial Strategy (BEIS) is responsible for establishing government policy in relation to the use of nuclear power. It also has responsibility for the regulatory framework in place to ensure that high standards of nuclear safety are observed in the UK, and that any international obligations related to nuclear safety are met. The Secretary of State for BEIS carries overall government responsibility for nuclear safety policy and legislation, and reports to parliament on this matter. ONR is the UK's statutory independent regulatory body for nuclear safety and provides advice to BEIS on nuclear safety matters when requested.

10.6. The Nuclear Installations Act 1965 (NIA65) provides the legal framework for nuclear safety. NIA65 sets out a system of regulatory control based on a robust licensing process administered by the regulator (the ONR). An important provision of NIA65 is that it requires the ONR to attach such conditions to a site licence as it considers necessary or desirable in the interests of safety. Under Section 4(10) of NIA65, contravention of any conditions attached to the licence is a criminal offence, and the licensee is liable for such contravention regardless of whether it was committed by the licensee or another person.

The regulatory body's priority to nuclear safety

10.7. This is directly related to the major common issue on safety culture from the Seventh Convention.

10.8. As the principal regulatory body for nuclear safety, ONR has core functions to licence, inspect, and assess nuclear installations to make judgements, on behalf of the public, that they are being managed and operated safely and within the law. ONR also regulates civil nuclear security, following a similar outcome-focussed approach, and recognises that a security event could have safety consequences to the public and workers.

10.9. In pursuit of its mission, ONR seeks to ensure that the operators of the nuclear sites have made, and are implementing, adequate arrangements for complying with all relevant legislation (see Article 7 – Legislative and Regulatory Framework).

10.10. The operators must be adequately resourced to underpin safe operations and maintenance, understand the hazards and risks that they are dealing with, and be committed to the adoption of relevant good practice (RGP) through continuously seeking and making reasonably practicable improvements to safety. RGP is the generic term used for those standards or approaches to controlling risk that have been judged and recognised by ONR and the industry as satisfying the law when applied to a particular relevant case in an appropriate manner. However, RGP is not enforceable whereas the requirements to reduce risks so far as is reasonably practicable is.

10.11. ONR has established an enforcement policy (Ref. 10.3) which provides guiding principles for enforcing the law. As recommended by IAEA safety guide GS-G-1.3 (Ref. 10.4), ONR adopts a graded approach to enforcement, with any regulatory action taken being commensurate with the seriousness of the identified safety deficiency or administrative gap. ONR has legal powers to prohibit or shutdown specified operations. The licensee for the UK's operating nuclear power plants, EDF Energy NGL, has a strong culture of making conservative decisions to shutdown reactors should a safety concern warrant such significant action. This is in line with VDNS Principle 3.

10.12. ONR's main aim is to regulate the nuclear industry's safety performance in a way that commands public confidence and trust. Further information on how ONR prioritises and focuses its attention on safety of the nuclear installations can be found in Article 8 – Regulatory Body and Article 14 – Assessment and Verification of Safety. Further information is also available in the ONR Strategy 2020–25 (Ref. 10.5) and Corporate Plan 2021–22 (Ref. 10.6).

Organisational leadership and management for a positive safety culture

10.13. The information herein is directly related to the major common issue on safety culture from the Eighth Convention.

10.14. ONR recognises that organisational and cultural shortcomings are common contributors to, or consistently identified as, underlying causes of accidents and serious events around the world – not just in the nuclear industry. The organisational and cultural aspects are often complex, but several common factors have been identified from event investigations and research studies and these include the following:

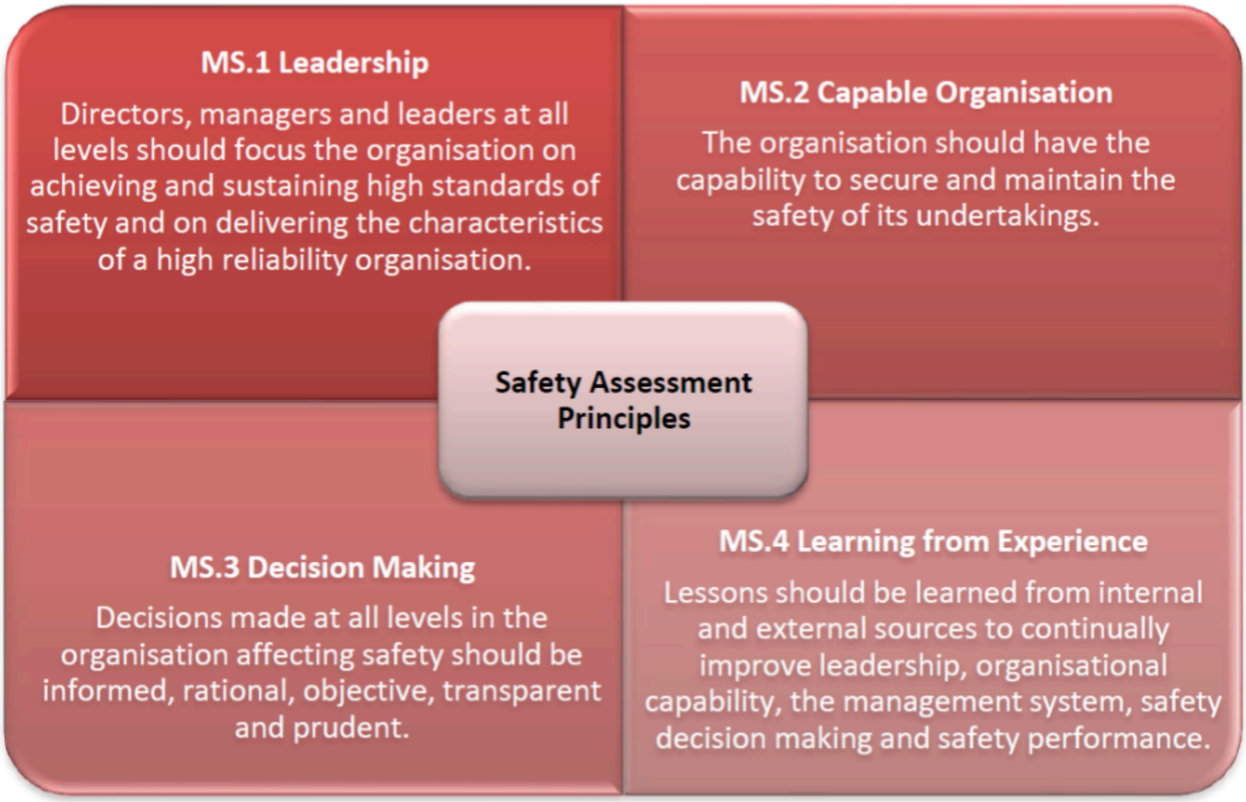
- Ineffective leadership;
- Inadequate management oversight and scrutiny of safety;
- Poor decision making and lack of effective challenge; and
- Failure to apply lessons from within and outside the organisation.

10.15. Leadership and cultural aspects of safety cannot be easily prescribed in laws, but poor leadership and culture is likely to impact adversely on safety outcomes. Management and organisation for safety is more easily prescribed and requirements are outlined in the UK, for example, through the Management of Health & Safety at Work Regulations 1999 (MHSWR99) (Ref. 10.7) and LC 17 (Management Systems) (Ref. 10.8). Most UK licensees have adopted the recommendations contained in IAEA safety requirements GSR Part 2 (Ref. 10.9) and its associated safety guides GS-G-3.1 (Ref. 10.10) and GS-G-3.5 (Ref. 10.11) for implementing effective safety management systems. This is in line with **VDNS Principle 3**.

10.16. ONR has adopted the collective term 'leadership and management for safety' (LMfS). This identifies important factors in the effective management of the nuclear hazards and for promoting a positive safety culture, thereby contributing to the safety of facilities and activities at nuclear installations.

10.17. ONR has established an annual process for assigning regulatory attention levels to each dutyholder, based on an assessment of the dutyholder's overall safety performance: 3 – Routine, 2 – Enhanced or 1 – Significantly Enhanced. This process includes, and extends well beyond an assessment of the dutyholder's performance in relation to LMfS, based on consideration of the 4 relevant Safety Assessment Principles (SAP) (see figure 10.1). The results of the assessment of dutyholder attention levels are published in the Chief Nuclear Inspector's (CNI) Annual Report (Ref. 10.12). An action plan is developed, where appropriate, to secure the return of the dutyholder to a routine attention level.

Figure 10.1: Leadership and management for safety SAPs



Accessible version of Figure 10.1

Safety Assessment Principles:

MS.1 Leadership: Directors, managers and leaders at all levels should focus the organisation on achieving and sustaining high standards of safety and on delivering the characteristics if a high reliability organisation.

MS.2 Capable Organisation: The organisation should have the capability to secure and maintain the saftey of its undertakings.

MS.3 Decision Making: Decisions made at all levels in the organisation affecting saftey should be informed, rational, objective, transparent and prudent.

MS.4 Learning from Experience: Lessons should be learned from internal and external sources to continually improve leadership, organisational capability, the management system, safety, decision making and safety performance.

10.18. The assessment of a dutyholder's performance in relation to LMfS may be informed by application of the following assessment methodologies.

- **LMfS Review** (Ref. 10.13). The purpose of an LMfS review is to provide insights which enable the development and resourcing of ONR's annual intervention plans, as well as to inform dutyholder attention levels. The LMfS review identifies and analyses information from a wide range of sources, including incident reports, safety performance indicators and inspections. The results of such reviews are fed into ONR's inspection planning process and have contributed to the identification of themed inspections on topics that warrant further regulatory attention. Recent examples (within the last 3 years) have included themed interventions on engineering governance, organisational learning, and the safety case anomalies process.

> - [Change]
> **Culture Assessment**
> (Ref. 10.14). ONR has recently published a flexible framework of qualitative research methods which enable specialist inspectors to undertake targeted assessments of safety and security culture, assessments of culture change, or to diagnose organisational problems which may be adversely impacting upon safety or security outcomes. Such assessments typically involve a team of inspectors carrying out reviews of documents, interviews, and observations of activities on-site, followed by structured data analysis, to provide an insight into the culture of an organisation. ONR's approach to these assessments is enabling and collaborative in nature, fostering a common understanding between the regulator and dutyholder of the issues which may be underlying poor safety performance, which is then used to drive prioritised improvement plans at a strategic level. ONR's experience of carrying out such assessments to date, outside the civil nuclear power sector, has been positive of the value they add over and above routine inspections and licensee self-assessment activity.

10.19. Another important aspect of ONR's strategy on LMfS is the corporate inspection function. The purpose of corporate inspection is to look at a licensee's organisation, including central or corporate functions and ensure regular interactions with directors and senior management. This focuses on the oversight and management of activities within the scope of the nuclear site licence and complements site-based activities. Corporate inspection embodies the concept of regulatory leverage, applying regulatory effort and attention to promote improvement in the areas of the licensee's organisation where it is most likely to be effective for example, in corporate functions or in the attitudes, actions and behaviours at the higher levels of management. Corporate inspectors are in place for both UK reactor licensees, EDF Energy NGL and NNB GenCo. Corporate bodies may also be subject to assessment of dutyholder attention levels, as per the process described above.

10.20. ONR's specialism group on Human and Organisational Capability is well established. The group is responsible for oversight and coordination of ONR's plans and activities on LMfS, Licensing, Human Factors, Supply Chain and Quality (see Article 13 – Quality Assurance). This includes ownership of ONR's suite of guidance in related topic areas. Members of the group take the lead in liaising with relevant nuclear industry working groups and encouraging licensees to share ideas and good practices to drive continual improvement. Current areas of focus for the ONR corporate discipline group include the following:

- **Leadership and Culture**. ONR's Chief Nuclear Inspector has identified leadership and culture as a priority theme (Ref. 10.12). ONR continues to influence and engage the UK industry on safety culture through the Safety Directors' Forum, considering the requirements of GSR Part 2. ONR has published new guidance for inspectors on safety leadership (Ref. 10.15) and has commissioned research in cooperation with industry to develop a validated safety culture model and an associated survey instrument;
- **Nuclear Safety Governance**. ONR recognises that the system by which licensee boards direct and control the activities of their organisations has a significant influence on nuclear safety outcomes. ONR is developing new guidance for inspectors on nuclear safety governance, considering guidance on corporate governance from the UK Financial Reporting Council (Refs.10.16 and 10.17). ONR continues to undertake interventions to examine board oversight of nuclear safety;
- **Supply Chain** (see Article 13 – Quality Assurance); and
- **Safety Culture of the Regulatory Body**. ONR recognises that the culture and practices of the regulatory body have a significant influence on the safety culture of the industry, and by inference the safety performance, of licensees. ONR contributes to work by international bodies, such as the Nuclear Energy Agency's Working Group on Safety Culture, in this area. ONR has also commissioned an independent

assessment of its own culture, to complement the self-assessments it has undertaken to date, and this assessment will take place during 2022.

Use of safety performance indicators in the UK

10.21. International experience, particularly following major events, has reinforced the usefulness of Safety Performance Indicators (SPI) to manage and prioritise safety. The use of SPIs is not mandatory in the UK but is recognised as good practice by ONR, and by the licensees. In consultation with industry, ONR developed a framework for using SPIs, largely based on the model set out in IAEA TECDOC 1141 (Ref. 10.18). Pilot projects were undertaken to further refine the approach. This is in line with **VDNS Principle 3**.

10.22. The UK nuclear industry's Safety Directors Forum subsequently published a good practice guide entitled 'Development and use of Safety Performance Indicators' (Ref. 10.19). The purpose of this guide is to help nuclear operators develop, implement, and use SPIs as part of their management of safety arrangements and to present examples of proven effective practices.

10.23. SPI related data is collected, collated, and analysed routinely at the EDF Energy NGL nuclear power plants. The information is used both on the sites and in the corporate centre as a contribution to the management information routinely considered by managers and leaders within EDF Energy NGL. Where adverse trends or generic safety issues are indicated by the SPI data, sites will investigate the causes and put in place any necessary corrective actions.

10.24. SPI data is made available to ONR inspectors should they wish to examine it and some of the information is included in the routine interactions between ONR, the station and the EDF Energy NGL corporate centre. Each NPP site holds an annual review meeting with ONR, which follows a generic agenda structured around key themes to demonstrate the safety performance of the site over the past year. Prior to the meeting, a comprehensive information pack is produced, which includes relevant SPI data to illustrate aspects of safety performance, including trending. Actions may be placed on the licensee at these meetings when significant adverse trends are indicated. An example of SPIs can be seen in figure 10.2.

10.25. EDF Energy NGL uses a Performance Management process to set business objectives and the associated SPIs and Key Performance Indicators. There is an annual process which determines the suite of metrics and sets appropriate targets and goals.

10.26 The suite of metrics consists of:

- Tier 1 metrics – Results based measures focused on safety performance, operational reliability, and financial contribution (See figure 10.2);
- Tier 2 metrics – Leading measures focused on improvement actions, and enablers to deliver Tier 1 performance; and
- Tier 3 metrics – Fleet Programme process measures, which track specific focus areas of the fleet programme and are reviewed by the relevant fleet manager and peer groups.

10.27. The content of the Tier 1 and Tier 2 suites are reviewed every year to ensure they are aligned to business objectives and reflect current business activities. The goals and targets are normally set to align with the WANO/INPO upper quartile performance. The overall suite and other fleet performance monitoring arrangements are reviewed against the IAEA Safety Performance Indicator framework to ensure all components of the nuclear safety attributes in the IAEA framework are covered adequately.

10.28. The Performance data against the Tier 1 and Tier 2 metrics is reviewed weekly by the senior management team. The metrics are published internally so the safety performance of the company is available to all staff.

Figure 10.2: Safety Performance Indicators for the EDF Energy NGL Fleet

No.	Indicators	2012	2013	2014	2015
1	Number of significant nuclear safety events graded 1 or greater on INES per reactor[1]	1.55	1.19	1.14	1.16
2	Number of significant nuclear safety events (0 or greater on INES) per reactor[1]	11.90	11.60	10.8	10.03
3	Number of significant events per reactor: Non-compliance with technical specifications	1.52	1.34	1.55	1.24
(3)	Number of significant events per reactor: Reactivity	-	-	-	-
4	Number of alignment errors[2] per reactor	1.78	1.22	1.41	1.74
5	Number of trips per reactor (for 7,000 hours of criticality[3]): Automatic	0.55	0.59	0.53	0.66

No.	Indicators	2012	2013	2014	2015
(5)	Number of trips per reactor (for 7,000 hours of criticality[3]): Manual	0.03	0.03	0.07	0
6	Average operational collective dose per nuclear unit in service (in man-Sv)	0.67	0.79	0.72	0.71
7	Exposure of individuals: Number of individuals with doses above 20 mSv	0	0	0	0
(7)	Exposure of individuals: Number of individuals with doses between 16 and 20 mSv	2	0	0	0
(7)	Exposure of individuals: Number of individuals with doses between 14 and 16 mSv	22	18	5	2
8	Number of significant radiation protection events	114	116	113	109
9	Availability (%)	79.7	78.0	80.9	80.8
10	Unplanned unavailability (%)	2.8	2.6	2.4	2.48
11	Occupational accident rate Tfg (per million hours worked)[4]	3.5	3.3	3.2	2.7
12	Occupational accident rate LTIR (per million hours worked)[4]	-	-	-	-

[1] Excluding ‘generic’ events
[2] Any configuration of a system or its utilities that deviates from the expected situation and is a cause of a significant event (statistical data reviewed in 2018)
[3] Average value for all reactors, exclusing external causes, unlike the WANO parameter which is based on the median value
[4] Accident rate for EDF SA and its contractors

The operator’s priority to nuclear safety

10.29 In the UK there is a single licensee, EDF Energy NGL, for all operating civil nuclear power plants. Additionally, 2 new nuclear reactors are currently under construction by NNB GenCo. The following sub-sections provide further information on how EDF Energy NGL and NNB GenCo demonstrate their commitment and priority to safety (figure 10.3).

Figure 10.3: EDF Energy NGL focus on priority to safety reiterated at site entrance

Organising and managing for safety in EDF Energy NGL

10.30. EDF Energy NGL is part of the wider EDF group and it shares group-wide common commitments that give priority to safety. These include:

- An overriding priority is placed on nuclear safety at every stage of the plant lifecycle. That priority is the responsibility of all and is demonstrated via the individual commitment of all staff.
- Recognising the importance of establishing a strong nuclear safety culture among its staff and contractors. This is characterised by: people having a questioning attitude and being free to raise safety concerns; using error prevention techniques; reporting safety incidents and adverse conditions in a timely and transparent way; being conscious of risks; and continually assessing them. The company values encourage strong, independent oversight and challenge, as set out in para 10.32.
- Recognising that excellence in everything it does is underpinned by equipment reliability, human performance, and efficient work

management, as these are important drivers of nuclear safety and reliability.

- Promoting continuous improvement using the full range of knowledge and services within the company, and within international organisations. Operational experience is collected, analysed, reported, and acted upon. The company has committed both to receive international peer reviews and to provide peers for such reviews in other countries.

10.31. The commitment to give priority to nuclear safety is clearly established within EDF Energy NGL company policies (Ref. 10.20). These policies are implemented through the organisation's integrated management system; the management system and detailed arrangements are structured to meet the IAEA requirements contained in GSR Part 2 (Ref. 10.21). Further information can be found on the EDF website (Ref. 10.22).

10.32. The ultimate responsibility for setting policy and ensuring that the company operates safely and complies with legislative and regulatory requirements lies with the EDF Energy NGL Board which monitors safety performance routinely. Specifically, safe management of operations of the reactor fleet resides with the EDF Energy NGL executive team headed by the managing director, supported by the 2 regional chief nuclear officers, the chief technical officer, and the safety, security, and assurance director alongside directors in areas such as nuclear decommissioning, finance, human resources and legal affairs. The safety, security and assurance director is independent from the operational reporting line within EDF Energy NGL and provides appropriate review and challenge to operations in relation to nuclear safety. To reinforce their independence, the director has an additional direct reporting line to the EDF inspector general for nuclear safety, who is part of the wider EDF group.

10.33. The safety and assurance division includes Independent Nuclear Assurance, Regulatory Interface and External Oversight and Health Safety and Environment, which supplies specialist expertise and guidance in emergency planning, radiological protection, environment, industrial safety and occupational health. The division seeks to ensure that appropriate health and safety policies and standards are formulated and promulgated throughout the company. It provides advice and monitors the effectiveness of aspects of the management system, which are designed to implement the health and safety policy. The monitoring programme includes independent on-site inspections and reviews of the health of various systems and periodic review of SPIs.

10.34. In addition, each of the EDF Energy NGL NPPs has a station director who is responsible for effectively implementing the company's safety policy and standards on the licensed site.

10.35. On significant matters related to nuclear safety, the EDF Energy NGL power stations seek and take advice from the licensee's Nuclear Safety

Committee (NSC), which usually meets monthly; this is a requirement of LC13 (nuclear safety committee) and is constituted to include independent members with extensive experience and knowledge in the field of nuclear safety. If the licensee rejects the advice of the NSC, there is a requirement to notify ONR and outline the reasons for the rejection.

Review and challenge to EDF Energy NGL processes and procedures:

10.36. EDF Energy NGL recognises the benefits from external peer review, internal challenge and self-assessment to existing arrangements and practices, and for enhancing its safety culture. EDF Energy NGL regularly invites scrutiny from its international peers and has established internal company arrangements and processes that provide challenges to the sites' management teams on the efficacy of its leadership and management for nuclear safety.

International peer reviews:

10.37. The information herein is directly related to the major common issue on international peer reviews from the Seventh Convention.

10.38. EDF Energy NGL subscribes to a planned programme of peer reviews by the World Association of Nuclear Operators (WANO). Many of the criteria under review by WANO include aspects of plant operations that directly affect safety. The peer review programme identifies strengths, which are shared between the UK nuclear operators and internationally with other WANO members. It also identifies improvement areas that are followed-up during subsequent review missions. In line with its WANO membership obligations and recognition of the benefits of receiving these reviews, EDF Energy NGL has undertaken to have each nuclear installation reviewed every 4-years with an interim follow-up visit to review progress. EDF Energy NGL also undertakes to receive a review of its corporate support functions with the next mission scheduled in 2024. There also will be a pre-start-up review at Hinkley Point C conducted by WANO in 2024.

> 10.39. [Change] In February 2018, the AGR NPP at Torness hosted a full scope OSART mission. There was then a follow up mission from the 2 to 6 September 2019 at Torness, and progress was judged satisfactory. EDF Energy NGL has sought, through BEIS, a further OSART mission at Heysham 2 in 2023 (25 September to 12 October 2023).
>
> 10.40. [Change] By these means, performance continues to be benchmarked against international standards and good practices are shared. The final reports of the OSART missions have been made publicly available through government (Ref. 10.23) and IAEA, ONR, and EDF Energy websites. For the nuclear new build project at Hinkley Point

> C a pre-operational OSART is under consideration and will likely be requested in 2024.

Internal challenge and independent assessment:

10.41. EDF Energy NGL has set up arrangements to provide for challenge within the company, including from organisational groups independent from those directly involved in plant operations. At each site there are permanent inspectors from the corporate internal regulatory function who are independent from the site. These independent inspectors carry out inspections and other reviews of plant operations, processes, and procedures. They provide regular reports to the station director and advise on safety and the safe conduct of activities. They also escalate advice to higher levels of management if the resulting action is deemed to be insufficient in scope or urgency.

10.42. As part of maintaining EDF Energy NGL's ISO 9001 quality management certification, there are third party compliance audits carried out by Lloyds Register each year. In addition, audits are carried out against ISO 14001, ISO 45001, and ISO 55001 to maintain certification. Furthermore, each site has a programme of planned and reactive audits, with the outputs from these and other assurance activities being considered regularly by a central scrutiny process to identify any company-wide generic issues. For more information, refer to Article 9 – Responsibility of the Licence Holder and Article 14 – Assessment and Verification of Safety.

Self-assessment within EDF Energy NGL:

10.43. Self-assessment is regularly carried out at all levels within the company to evaluate and assess performance of the work, leading to identification of strengths and areas for improvement. This is supported by the benchmarking process that provides a standardised methodology for an efficient evaluation by an individual or team. This enables any good practices and improvements to be recorded and shared with other stations.

Taking actions to improve safety:

10.44. All the review and challenge activities referenced above, and other processes, may identify a need to take corrective or remedial actions to improve the plant, processes or procedures to enhance safety. To manage these actions, EDF Energy NGL has a comprehensive corrective action programme and process that documents, reviews, evaluates and initiates remedial action to correct non-compliances or other anomalous findings. This process allows any member of staff to identify an issue or problem by raising a condition report. The report requires management review to determine its significance to safety and the extent to which further investigation into the matter is necessary. Once corrective actions are identified, the corrective action programme process provides a company-wide method to track the actions to a satisfactory conclusion. For the most significant actions, additional effectiveness reviews are included following their implementation.

Enhancing safety culture in EDF Energy NGL:

10.45. The information herein is directly related to the major common issue on safety culture from the Seventh Convention.

10.46. EDF Energy NGL has defined its nuclear safety culture using the IAEA safety series document INSAG-4, (Ref. 10.24) and has developed a framework that characterises specific aspects of a healthy safety culture, based largely on WANO and Institute of Nuclear Power Operations (INPO) recommendations. The 10 traits identified are as follows:

- Personal accountability: All individuals take personal responsibility for safety;
- Questioning attitude: Individuals avoid complacency and continuously challenge existing conditions and activities in order to identify discrepancies that might result in error or inappropriate action;
- Effective safety communications: Communications maintain a focus on safety;
- Leadership safety values and actions: Leaders demonstrate a commitment to safety in their decisions and behaviours;
- Decision making: Decisions that support or affect nuclear safety are systematic, rigorous, and thorough;
- Respectful work environment: Trust and respect permeate the organisation;
- Continuous learning: Opportunities to learn about ways to ensure safety are sought out and implemented;
- Problem identification and resolution: Issues potentially adversely impacting safety are promptly identified, fully evaluated, and promptly corrected;
- Environment for raising concerns: A safety conscious work environment is maintained where personnel feel free to raise safety concerns without fear of retaliation, intimidation, harassment, or discrimination; and
- Work processes: The process of planning and controlling work activities is implemented so that safety is maintained.

10.47. The health of nuclear safety performance and culture is assessed typically biennially (every other year) by the licensee.

10.48. EDF Energy NGL also reviews its safety culture using a nuclear safety culture survey. This is an important opportunity for employees to provide views and recognise the progress made. It helps with the ongoing assessment and trending of nuclear safety culture and is a valuable tool in allowing EDF Energy NGL to listen to the views of their staff and drive forward improvements in nuclear safety.

Safety culture during outages on EDF Energy NGL Sites:

10.49. The information herein is directly related to the major common issue on safety culture from the Seventh Convention.

10.50. The success of outages and post-outage operation is dependent upon safety being an integral part of the working arrangements and safety management systems. Team leaders increase the safety awareness of individuals by looking to continuously improve safety performance in all areas.

10.51. During the planning stages of the outage process a defence-in-depth plan is drawn up to always maintain nuclear safety during the outage. This plan contains a schedule showing the significant work activities and the availability status of nuclear safety related plant during the execution phase of the outage. This schedule is used to indicate periods of vulnerability to various types of event, such as loss-of-grid or individual system failures. The schedule highlights which key systems should remain available throughout each stage of the outage.

10.52. Pre-outage training includes references to operational experience from the previous outage season and covers basic principles of nuclear professionalism. The expectations for the defence-in-depth plan are communicated to all station personnel. Awareness training on the standards required for plant given protective status is also provided to all personnel having access to the plant during outage execution. Operations staff receive training on shutdown faults and the expected operator response, using the simulator for fault response training where appropriate.

10.53. At least weekly throughout the outage, a safety forum reviews the previous 7 days safety performance. Representatives from each work team (both staff and contractors) are present, relevant safety statistics are presented and trends reviewed. Findings from regular inspections are also presented at this Forum. These inspections are focused on the observation of work, monitoring and reinforcement of the safety standards being applied and the identification and control of any hazards present in the area. Where necessary, actions (such as the production and circulation of a safety brief) are placed to address any safety concerns.

Decision-making processes at stations:

10.54. Working in the nuclear industry means it is important to define processes which help personnel to make sound decisions, particularly those related to safety. The EDF Energy NGL processes are linked in an Operational Risk Management Model which shows how the various elements of the decision-making process are connected along with the interactions with the various supporting tools.

10.55. The main components are:

- Conservative decision-making: Predominately used by the operations department for making high quality, safe decisions when faced with uncertain and dynamic operating conditions. It is the process for ensuring a conservative view is taken of an unknown plant state such that safety overrides commercial issues. Actions are taken to place the plant in a safe known state, reviewing decisions on a regular basis;
- Operational decision-making: Used when degraded conditions exist that result in continued reductions in safety margins over a period of days, weeks, or even months, in order to return the plant to a known safe state and within action thresholds defined in safety procedures;
- Safety case anomalies process: Used when the plant differs from the condition or configuration assumed in the safety case;
- Troubleshooting and technical fault finding: A standard and systematic approach for use by all NPP station staff involved in troubleshooting and technical fault finding;
- Mitigation of operational risk: This process describes the response to periods of reduced plant availability or heightened operational risk both during ‘at power’ and shutdown operations and the necessity to apply additional risk mitigation measures;
- Event recovery: Outlines the framework and key roles required to facilitate a safe and effective recovery from significant degraded conditions; and
- Operational Safety Review Committee: Provides oversight and review of operational risk and decision-making processes.

10.56. There is also special guidance on planning and performing tasks that if carried out incorrectly could have a significant impact on nuclear, radiological, environmental safety or incur generation losses and tasks which fall into the category of infrequently performed tests or evolutions.

10.57. In response to the licence conditions there is a requirement for operational NPPs to have arrangements in place to identify limiting conditions of operation (LCO) made in the interests of safety. These are directly related to the requirements of the safety case and therefore define the safe operating envelope for the installation. Additional information on LCOs can be found under Article 14 – Assessment and Verification of Safety and Article 19 – Operation.

10.58. EDF Energy NGL also has arrangements to deal with conditions that are identified that may not have been previously analysed or that may challenge the claims and justifications made in the safety case. Such conditions may become apparent, for example, from periodic plant inspection or maintenance activities, from safety case reviews or from unanticipated operational occurrences. As the plants approach the end of their design lives, the chance of ageing related phenomena that may affect safety increases.

NNB GenCo (HPC)’s measures to implement arrangements for safety

10.59. This is directly related to the major common issue on safety culture from the Seventh Convention.

10.60. NNB GenCo has an extensive framework of arrangements to ensure the ongoing development of a strong nuclear safety culture throughout the Hinkley Point C Project. These arrangements have drawn from the approach of EDF and EDF Energy NGL proven practice, as well as from benchmarking of international best practice, namely, that of the IAEA and WANO organisations.

10.61. The NNB GenCo nuclear safety policy identifies the standards, commitments and accountabilities to achieve nuclear safety-related objectives and includes the development of a strong nuclear safety culture to ensure the overriding priority is afforded to nuclear safety by all personnel. Underlying processes and procedures exist to ensure implementation of the policy requirements and expectations.

10.62. A nuclear baseline (an organisational structure that identifies the posts that must be filled by persons that are suitably qualified and experienced in nuclear safety) is in place to demonstrate compliance with the nuclear site licence conditions. The nuclear baseline is routinely updated, identifying those roles within the organisation that have a direct or indirect impact to nuclear safety. There is a well-developed system in place for assessing, recording and (where required) improving personnel competency in order to ensure nuclear safety. The baseline also identifies those positions that have an intelligent customer role. NNB GenCo performs its intelligent customer role through deployment of its review and acceptance process to oversee and accept the work done by contractors on its behalf.

10.63. The project induction, undertaken by all personnel, includes an introduction to nuclear safety culture, human performance and error reduction techniques, organisational learning and CFSI (Counterfeit, Fraudulent and Suspect Items). Additionally, several, more detailed, levels of training are available to NNB GenCo personnel, and a similar training provision is expected of contract partners. A series of nuclear safety culture webinars have been well-attended and web content on the topic has been recently redeveloped to provide a library of resources for interested parties.

10.64. Organisationally, by way of nuclear safety oversight, the NSC considers and provides advice as required to the NNB GenCo Board on all matters which may affect nuclear safety or radiological matters on or off the nuclear licensed site. The Independent Nuclear Assurance function within the Safety and Regulation Directorate provides an internal regulation function, assessing activities across the Hinkley Point C project, and advising the NNB GenCo Executive. Compliance against the 36 LCs is monitored through the Nuclear Compliance Group chaired by the Safety and Regulation Director and recently received a positive report from the Inspector General for Nuclear Safety of EDF Group. NNB GenCo is also subject to ongoing independent scrutiny by ONR.

10.65. NNB GenCo has an established project culture, aimed at developing a common set of attitudes and behaviours across all teams working on the HPC project to ensure effective and efficient team working to support nuclear construction excellence. This includes the project values, life-saving rules, quality commitments, nuclear safety culture awareness, use of organisational learning and leadership development. A continuous improvement plan is in place, which has been endorsed by the Hinkley Point C Executive, with progress against the plan tracked routinely. ONR has been engaged in the scope of the improvement plan and is maintaining ongoing regulatory oversight.

10.66. NNB GenCo periodically assesses nuclear safety culture arrangements within the Hinkley Point C supply chain. Collaborative working arrangements are established to support suppliers in addressing any shortfalls in their nuclear safety culture arrangements, and nuclear safety culture training/workshops are held for supplier representatives who, in turn, can convey this learning to personnel within their organisation. A 'Community of Best Practice' meeting has been established in which key NNB GenCo and contract partner stakeholders actively discuss and challenge the implementation of nuclear safety culture improvement initiatives. Additionally, a steering group meets regularly at executive level to ensure appropriate organisational focus on the topic.

10.67 An organisational learning programme is in place which includes a bespoke tool for personnel to raise learning reports, actions, audit findings and observations on a range of issues. Learning reports are reviewed at a weekly screening meeting, categorised and actions assigned and tracked. There is a strong focus on learning from experience, which can be demonstrated through the application of lessons learned from sister EPR™ plants and from Unit 1 to Unit 2. Regarding site construction, mock-ups and trial runs are routinely used to demonstrate capability and to provide opportunities to learn from experience, prior to nuclear safety-related construction activities.

Approach to pandemic planning and COVID-19 response – NNB GenCo [Example]

10.68. Throughout the pandemic, Hinkley Point C has at all times followed government COVID-19 policy and guidance. It has taken a risk informed approach with the health and well-being of its people, and the community, as its overriding priority. This cautious and reflective approach has been a mainstay throughout Hinkley Point C's pandemic response.

10.69. Hinkley Point C has engaged and aligned with EDF holistically with all associated business units via regular Pandemic Working Groups and Health Cell meetings. These include engagement with the company medics and physicians to ensure medical guidance is at the forefront of all discussion. The UK Health Security Agency (UKHSA) (was Public Health England) have been in regular consultation throughout the pandemic and has remained supportive of Hinkley Point C's approach. UKHSA has commended Hinkley Point C for robustness of measures, strategy, and reactiveness in reaction to any localised and national events of interest. ONR has been regularly updated of the site status and offered reporting in line ONR expectations; ONR has been consistently, and remains, supportive of Hinkley Point C's measures and approach.

10.70. At a more localised level Hinkley Point C site-based Pandemic Working Groups and Pandemic Response Teams have been organised, driving decisions and intelligence from the front line. Hinkley Point C site's Covid Cell and occupational health team have been mainstays from early in the pandemic and operated an established testing regime and track and trace function managing all testing, vaccination, travel, and isolation policy that combine with individual site-based risk assessments to make up the COVID-19 Hinkley Point C Governance model and infrastructure. Above this the Crisis Management Team consisting of Hinkley Point C Executive and Company Doctors advise and lead the HPC response and decision-making process, meeting regularly and by exception, as necessary. HPC has developed key trigger point criteria to guide deployment and release of all COVID-19 defence measures, giving a structured 'step up – step down' framework to manage and justify change. These key criteria are, positive case rate, local hospitalisation rate and vaccination percentage of the workforce.

10.71. Since October 2021, Hinkley Point C has implemented plans for a 'COVID-19 Managed Project'. This allows enduring and sustainable protective controls – moving from 'crisis' to 'managed' phase of the pandemic response. This offers the continued priority on health and safety of Hinkley Point C's people and project while remaining observant with government policy and guidance.

Approach to pandemic planning and COVID-19 response – EDF Energy NGL [Example]

10.72. EDF Energy NGL already had an established Pandemic Contingency plan. This was initially developed in 2009 following the

Swine flu outbreak in April 2009, in response to the World Health Organisation declaring its first Public Health Emergency of International Concern. The EDF Energy NGL arrangements remained in place and were further revised and enhanced in response to global learning including Avian Flu (H5N1), resulting in the Pandemic Capability that existed at the time of the discovery of COVID-19. The pandemic contingency arrangements were designed to be used for any circumstance where there would be a large-scale absenteeism.

10.73. The COVID-19 pandemic, which started to impact on the UK in early 2020, resulted in EDF Energy NGL putting its pandemic response arrangements into practice. This included implementing specific changes and mitigations, including:

- Remote working for staff;
- Testing and monitoring arrangements for sites;
- Contact tracking and tracing for sites;
- Isolation arrangements for any cases detected on site;
- Reduced site workforce to separate shifts; and
- Site isolation capability, where staff could remain on site for prolonged periods including rest periods.

10.74. The overall impact on EDF Energy NGL was managed throughout the various phases of the pandemic and the response taken was based on regional risks and variant tracking.

10.75. Required station outages were still undertaken with reduced scope which was discussed and agreed with ONR. The focus was on maintaining safety inspection and maintenance whilst minimising the number of personnel on site, including reduced numbers of external contractors.

10.76. The UK Government vaccination programme rapidly reduced the risk of hospitalisation for the UK population, including nuclear personnel. Tracking the vaccination status of personnel allowed the risks to be more accurately monitored and permit appropriate risk mitigation to be maintained.

10.77. EDF Energy NGL is currently returning to normal operations. However, there have been some benefits gained through the development of remote working capability which is providing benefits to both staff and the nuclear generation business; aspects of this may be retained.

Article 10 references

10.1 The United Kingdom's Eighth National Report on Compliance with the Obligations of the Convention on Nuclear Safety (https://www.iaea.org/sites/default/files/national_report_of_the_united_kingdom_for_the_8th_review_meeting.pdf), Department for Business, Energy & Industrial Strategy, August 2019.

10.2 GOV.UK. How we regulate radiological and civil nuclear safety in the UK (https://www.gov.uk/government/publications/how-we-regulate-radiological-and-civil-nuclear-safety-in-the-uk).

10.3 ONR Enforcement Policy Statement (https://www.onr.org.uk/documents/enforcement-policy-statement.pdf).

10.4 Regulatory Inspection of Nuclear Facilities and Enforcement by the Regulatory Body (https://www-pub.iaea.org/MTCD/Publications/PDF/Pub1130_scr.pdf), GS-G-1.3, IAEA, 2002.

10.5 ONR Strategy 2020–25 (https://www.onr.org.uk/documents/2020/onr-strategy-2020-2025.pdf).

10.6 ONR Corporate Plan, 2021–22 (https://www.onr.org.uk/documents/2021/onr-corporate-plan-2021-22.pdf).

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10.8 ONR Licence Condition Handbook (https://www.onr.org.uk/documents/licence-condition-handbook.pdf).

10.9 Leadership and Management for Safety, GSR Part 2 (https://www-pub.iaea.org/MTCD/Publications/PDF/Pub1750web.pdf), IAEA, 2016.

10.10 Application of the Management System for Facilities and Activities (https://www-pub.iaea.org/MTCD/Publications/PDF/Pub1253_web.pdf), GS-G-3.1, IAEA, 2006.

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10.13 Leadership and Management for Safety Reviews (https://www.onr.org.uk/operational/other/td-hoc-gd-002.pdf), TD-HOC-GD-002, ONR, January 2022.

10.14 Examining Culture in Organisations: Guidance on Using Qualitative Methods in Organisational Research (https://www.onr.org.uk/operational/other/td-hoc-gd-001.pdf), TD-HOC-GD-001, ONR, November 2021.

10.15 Safety Leadership (https://www.onr.org.uk/operational/tech_asst_guides/ns-tast-gd-107.pdf), NS-TAST-GD-107, ONR, April 2022.

10.16 The UK Corporate Governance Code (https://www.frc.org.uk/getattachment/88bd8c45-50ea-4841-95b0-d2f4f48069a2/2018-UK-Corporate-Governance-Code-FINAL.pdf), Financial Reporting Council, July 2018.

10.17 The Wates Corporate Governance Principles for Large Private Companies (https://www.frc.org.uk/getattachment/31dfb844-6d4b-4093-9bfe-19cee2c29cda/Wates-Corporate-Governance-Principles-for-LPC-Dec-2018.pdf), Financial Reporting Council, December 2018.

10.18 Operational Safety Performance Indicators for Nuclear Power Plants (http://www-pub.iaea.org/MTCD/publications/PDF/te_1141_prn.pdf), TECDOC 1141, IAEA, 2000.

10.19 Development and use of Safety Performance Indicators (http://www.nuclearinst.com/write/MediaUploads/SDF%20documents/SPI/SPI_Good_Practice_Guide_v2.pdf), A UK Nuclear Industry Good Practice Guide.

10.20 EDF Energy Nuclear Generation: Our Journey towards Zero Harm (https://www.edfenergy.com/sites/default/files/our_journey_towards_zero_harm_2015.pdf).

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10.23 Operational safety review, Torness nuclear power station, 2019 (https://www.gov.uk/government/publications/operational-safety-review-torness-nuclear-power-station-2019).

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Article 11 – Financial and Human Resources

> Each Contracting Party shall take the appropriate steps to ensure that adequate financial resources are available to support the safety of each nuclear installation throughout its life.

> Each contracting Party shall take the appropriate steps to ensure that sufficient numbers of qualified staff with appropriate education, training and retraining are available for all safety-related activities in or for each installation, throughout its life.

11.1. Compliance with this Article of the Convention is demonstrated in a way that has not substantially changed since the United Kingdom's (UK) eighth National Report (NR) (Ref. 11.1) (in a way that has implications for the Convention obligations).

11.2. The information in this Article is directly related to the major common issue on financial and human resources from the Eighth Convention.

Legal requirements

11.3. The principal legal requirement for nuclear site licensees to have adequate resources is contained in licence condition (LC) 36 (organisational capability) (Ref. 11.2). This requires the licensee to provide and maintain adequate financial and human resources to ensure the safe operation of the licensed site.

The provision of adequate financial resources for nuclear safety and security

11.4. ONR has issued guidance on how the licensee can comply with the requirement for adequate financial resources. The essence of this guidance is that ONR gains confidence that licensees provide and maintain adequate financial resources to fulfil their obligations in respect of safety, by demonstrably understanding and managing the hazards and risks associated with their undertakings. This means that they are reducing risk so far as is reasonably practicable (SFAIRP) and implementing improvements in a timely manner, maintaining an adequate organisational capability, assessing what financial resources are necessary to continue to meet those needs and assigning those resources accordingly. Although it has not yet happened, if a safety issue could not be resolved to the satisfaction of the inspector, and financial resource issues were identified as a possible factor, ONR would seek to limit operations to ensure safety is maintained whilst seeking external advice on the issue before taking a decision on appropriate enforcement action.

11.5. Regarding the financial responsibilities of the operator for potential damages to the public or the environment – under Section 19 (Ref. 11.3) of the Nuclear Installations Act 1965 (NIA65), the government approves a nuclear operator's third-party liability insurance (or other financial arrangements). ONR seeks assurance from the Department for Business, Energy & Industrial Strategy (BEIS) on the issue of liability before issuing a nuclear site licence. Should an operator's arrangements change, approval of new arrangements must be sought from the government.

11.6. When issuing a licence to an organisation for the first time, ONR seeks advice from BEIS that the prospective licensee has the resources to be a nuclear site licensee for the activities envisaged. NIA65 permits only a corporate body to be a nuclear site licence holder. This provides assurance of continuity of commitment even if that company is taken over by, or merges with, another company.

Financing safety improvements during operational life

11.7. The costs of making any necessary safety improvements during the operating life of a nuclear installation are treated as part of the installation's normal operating costs. The principal elements of operating costs comprise:

- Maintaining and enhancing safety;
- Fuel (including the cost of new fuel and treatment of irradiated fuel);
- Materials and services (the cost of engineering, including contractors, and consumable spares for maintaining the nuclear installations, and other miscellaneous charges such as insurance);
- Staff costs (salaries and pension provisions); and
- Depreciation (representing the proportion of the fixed assets written off in relation to the accounting life).

11.8. EDF Energy NGL's focus on asset management aims to optimise investment to improve and maintain safety performance and manage risk. Processes include strategic lifetime planning and short, medium, and long-term investment planning. Directors and heads of function plan and control the financial resources necessary to achieve safety standards, meet liabilities, maintain an effective management system, and achieve the company's objectives.

Financing radioactive waste management at nuclear installations

11.9. The audited accounts of UK nuclear installation operators include details of waste management costs and the provisions made to meet these costs. The costs associated with managing Higher Activity radioactive Waste (HAW) – High-Level Waste (HLW), Intermediate-Level Waste (ILW) and Low-Level Waste (LLW) that cannot currently be disposed of – that is destined for disposal at a Geological Disposal Facility (GDF) comprise of:

- Costs actually incurred during the operational phase; and
- Liabilities associated with the management of ILW and HLW before ultimate disposal during the decommissioning phase such as interim storage until a GDF is available and conditioning of waste to make it suitable for interim storage and disposal.

11.10. The cost of managing radioactive waste during the operational phase is an operational cost spread across the materials, services, and staff costs in the reported accounts. The materials and services costs in the accounts include costs associated with disposal of LLW where the operator of the waste facility sets a price that reflects all operational and liability cost considerations – this includes costs associated with obtaining Letters of Compliance (LoC) with respect to HAW from Radioactive Waste Management (RWM), Nuclear Waste Services (Ref.11.4) which give confidence that the waste meets the expected criteria for acceptance at a future GDF.

11.11. All disposals of radioactive waste, including those to the environment, are undertaken in accordance with regulatory authorisations. The environment agencies and ONR recover costs in granting, monitoring, and enforcing the authorisations or permits from the operator.

11.12. In 2018 the UK Government published its Industrial Strategy Nuclear Sector Deal (Ref. 11.5) which included a target for industry to reduce the cost of decommissioning by 20 percent compared with 2018 costs, by 2030.

Financing decommissioning programmes

11.13. UK Government policy is that all nuclear operators take the necessary steps to ensure that decommissioning work is adequately funded. These arrangements are set out in a Funded Decommissioning Programme (FDP). Under the Energy Act 2008 (Ref. 11.6), it is a criminal offence for the operator to use a site, or permit another person to do so, without an FDP that has been approved by the Secretary of State. After the FDP is approved, the operator is required to make annual and quinquennial (5-yearly) reports to the Secretary of State to enable monitoring of the operator’s waste and decommissioning liabilities and the financial provision made for them. This may result in modifications being made to the FDP.

11.14. EDF Energy NGL, as a private company and site licensee, is solely responsible for decommissioning its plants. However, there are agreements in place to provide the Secretary of State for BEIS with an option to acquire its nuclear power stations for a nominal sum after they are closed, either to continue to operate them if this is safe to do so, or to decommission them, for example by adding them to the NDA’s portfolio of sites. An agreement has been signed between the Secretary of State for BEIS and EDF Energy which will see EDF Energy carry out defuelling but following fuel free verification, the sites will then be transferred into the NDA’s (Ref. 11.7) portfolio.

11.15. For the existing fleet of operating reactors currently operated by EDF Energy NGL, the Nuclear Liabilities Fund (NLF) has been established to cover the costs of decommissioning and the discharge of certain nuclear liabilities not covered under contract with third parties. The NLF is underwritten by the UK Government and administered by trustees appointed by BEIS and EDF Energy NGL. EDF Energy NGL is required to make payments into this fund; financial details of EDF Energy NGL's liabilities and the NLF are set out in the respective companies' annual accounts. The fund is backed by the government and the UK taxpayer and is managed in line with the NLF agreement. The value of the fund in 2020 was circa £14.8 billion.

11.16. The funding arrangements for decommissioning EDF Energy NGL's nuclear power stations and discharging its uncontracted liabilities are contained within the NLF agreement. Under this agreement, EDF Energy NGL is required to produce plans that look forward on both a 3-year timescale and lifetime basis for the decommissioning of its stations, including the necessary pre-closure planning work. These are subject to review and approval by the NDA. EDF Energy NGL also produces an annual report describing changes in the estimated costs of decommissioning and uncontracted liabilities over the previous financial year. This is also subject to review and approval by the NDA. Uncontracted liabilities include some costs associated with spent fuel storage and removal, for example, funding of the dry fuel storage facility at Sizewell B. The NDA must also agree to any EDF Energy NGL station life extensions.

> 11.17. [Change] EDF Energy's role in defuelling has now been agreed and the government will exercise the option to transfer the sites to the NDA portfolio of sites following fuel free verification. EDF Energy's Nuclear Decommissioning Directorate has developed an organisation and arrangements to prepare sites for defuelling, to defuel the sites, and is working with the NDA to develop the arrangements to transfer the sites following Fuel Free Verification (FFV). The activities to prepare and defuel qualify for NLF funding if they are a qualifying liability under the NLF agreement, and:
>
> - The safety cases to permit the commencement of defuelling operations are in preparation;
> - Improvements to fuel route plant and process have been identified to speed up spent fuel- handling to the higher rates required during defuelling;
> - A staffing strategy and organisation structure is in development for both station and central functions in preparation for defuelling activities. This includes development of the safety case management for transition into defuelling from generation; and
> - Operational experience from the nuclear decommissioning sector has been gathered via interactions with EDF SA, Magnox, and other industry partners. This has been used to inform plans and preparation activities.

> 11.18. [Change] There is a cross-industry collaborative programme to prepare for and execute AGR defuelling led by EDF Energy NGL; the Advanced Gas-cooled Reactor (AGR) Operating Programme (AGROP). Other delivery partners include Sellafield Ltd (Ref. 11.8), Direct Rail Services (Ref. 11.9) and the NDA. Ultimately governed by BEIS, the programme aims to maximise the value to the UK through safe and optimised AGR defuelling. Utilising the existing spent fuel route from the AGR sites, the programme will establish the capability to move all nuclear fuel safely and efficiently from the 14 AGR reactors into pond storage at Sellafield prior to ultimate disposal within a geological disposal facility.

11.19. For new nuclear power stations, the Energy Act 2008 requires that operators have secure financing arrangements in place to meet the full costs of decommissioning and their full share of waste management and disposal costs. These arrangements are set out in an FDP which is approved by the Secretary of State prior to construction of the new nuclear power plant commencing. The FDP is subject to annual and quinquennial reviews.

11.20. For Hinkley Point C, the FDP was approved by the Secretary of State in accordance with the requirements of the Energy Act 2008, and comprises of:

- The Decommissioning and Waste Management Plan (DWMP), which sets out the operator's plans for dealing with its liabilities (covering decommissioning, spent fuel management, waste management and waste disposal) and its costings for specific aspects of those plans; and
- The Funding Arrangements Plan (FAP), which sets out how the operator will make financial provision to meet the costed liabilities in the DWMP. It is in the form of a contract between the operator and the independent fund company that has been set up to hold monies for the plant's decommissioning and clean up. The FAP sets out the roles and responsibilities of the fund and how payments to the fund will be calculated. It also explains how the priority of FDP payments is achieved over payments to investors.

The provision of adequate human resources for nuclear safety and security

Regulatory approach and background

11.21. Several UK licence conditions set requirements on management of human resources and training.

- LC36 includes a specific requirement for the licensee to provide and maintain adequate human resources to ensure safe operation.

- LC10 (training) requires the licensee to make and implement adequate arrangements for suitable training of all persons on site who have responsibility for any operations which may affect safety.
- LC12 (duly authorised and other suitably qualified and experienced persons) requires the licensee to make and implement adequate arrangements to ensure that only suitably qualified and experienced persons perform duties that may affect safety. This includes the appointment of duly authorised persons to control and supervise specific safety related operations.

11.22. ONR's nuclear safety inspectors review the capability and arrangements of licensees against these licence conditions supported by ONR's guidance in relevant TIGs and TAGs (Refs. 11.10 and 11.11), considering particularly whether the organisation has the capacity and capability to secure and maintain the safety of its operations.

11.23. In addition, the HSWA74 (Ref. 11.12) places responsibility for health and safety on every employer on the licensed site, for example, on EDF Energy NGL sites, all contracting companies also have legal responsibilities. These responsibilities include ensuring the competence and training of staff with safety related roles. Specific requirements are included in the MHSWR99 (Ref. 11.13) in particular, Regulation 13 on capabilities and training.

11.24. ONR expects the licensee to show that provision of adequate resources, delivery of training and the means of assuring competence are set out in policies, plans and processes which are supported by commitments from senior managers.

Regulatory expectations for organisational capability

11.25. ONR has produced guidance to set out its expectations regarding a 'capable licensee' in its TAGs, TIGs and SAPs (Refs. 11.14). These guides address areas such as: managing organisational change, developing a 'nuclear baseline', organisational capability, training and competence management, intelligent customer capability and the use of contractors, the role of licensees' own internal advice and challenge functions, supply chain and design authority. It has also worked with the nuclear industry to develop a good practice guide entitled 'Nuclear Baseline and the Management of Organisational Change' (Ref. 11.15).

11.26. ONR expects that the licensee should be able to identify and maintain the core capability that it needs to maintain effective management for nuclear safety. It expects the licensee to have, within its own organisation, sufficient competent persons to be able to always maintain control and oversight of safety. This includes technical (for example, design authority, intelligent customer, engineering, and safety case capability), operational and managerial elements. Together, they combine to ensure that the safety case for the installation is understood, maintained and delivered, and that the site, and plants or projects are operated in accordance with the safety case and the conditions of the nuclear site licence. ONR also requires the licensee to provide evidence that it is sustaining a capable design authority.

11.27. ONR expects that changes to the licensee's organisation (including structure, staffing, resources, or competences) should be subject to proportionate and systematic evaluation to ensure they do not adversely affect the capability of the organisation to deliver safety and security.

11.28. Prospective new nuclear licensees are required to submit a safety management prospectus (SMP) which sets out and demonstrates how their organisational structures, resources, capabilities, governance, and management arrangements are suitable to manage nuclear safety. Together with the nuclear baseline the SMP is regarded by ONR as the safety case for the organisation's capability. ONR's expectations in this area are set out in "Licensing Nuclear Installations" (Ref. 11.16).

Regulatory expectations for training and qualification

11.29. ONR's approach is to seek confidence that the licensee has implemented effective arrangements for training and competence assurance for all personnel whose activities may impact upon safety. This should cover both licensee employees and others, such as contractors, whose actions could impact upon nuclear safety. It does this by assessing the adequacy of, and compliance with, licence condition arrangements, notably LC10. ONR's expectations are set out in the associated ONR TAG, 'Training and Assuring Personnel competence'.

11.30. ONR looks for clear links between an individual's post and roles and the training required. For example, within EDF Energy NGL, training profiles have been developed for both posts and roles which set out 'essential' and 'performance' training requirements. ONR also regards the design, control, and maintenance of training records as an essential requirement in support of LC10 and LC12. ONR inspectors routinely assess training outcomes during system-based inspections (SBI) which assess whether systems will perform the safety functions claimed in the safety case. SBIs are explained under Article 14 – Assessment and Verification of Safety.

11.31. LC7 (incidents on the site) requires the licensee to develop adequate arrangements for the notification, investigation and reporting of incidents on site. Licensees' arrangements for investigations include determination of whether deficiencies in resources, training, or competence, are a causal factor or a root cause. The licensee must then identify any necessary preventative and corrective actions. ONR expects the licensee to have robust management arrangements for conducting reviews of all available sources of internal and external operational experience and to adjust training provision accordingly.

EDF Energy NGL approach to human resources

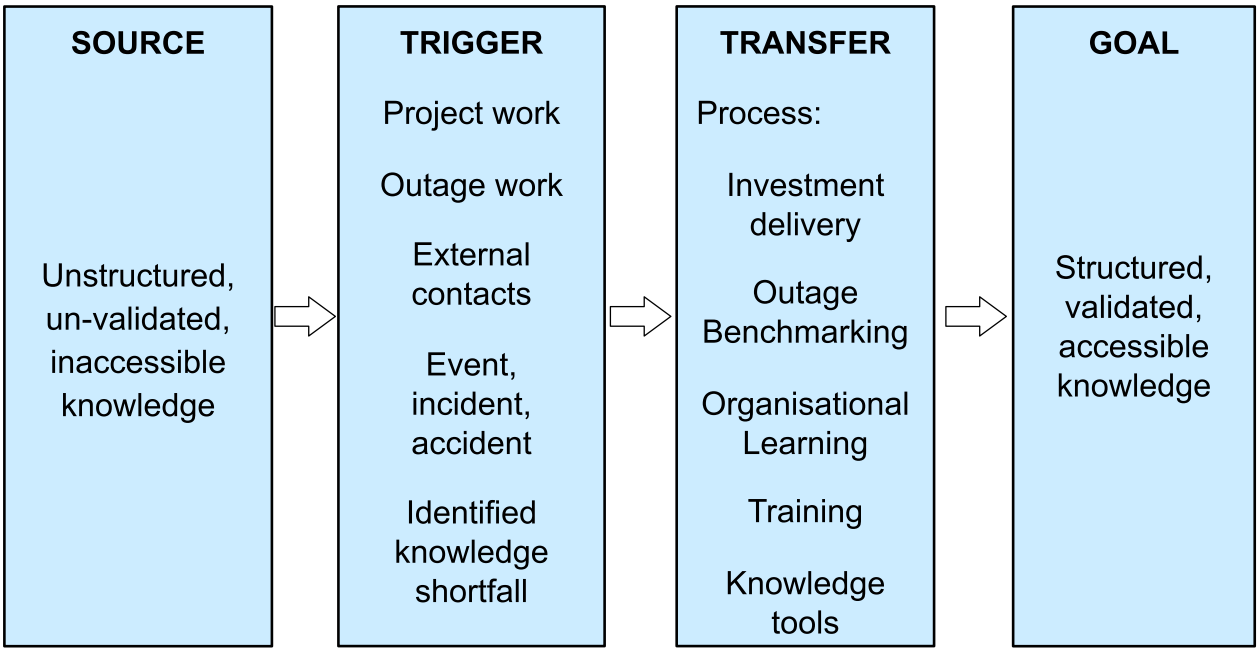
Organisational capability:

11.32. Operational nuclear power plants in the UK produce baseline statements of their resource requirements to ensure nuclear safety. Analysis of resource requirements is completed for both posts and roles. This information is analysed to identify potential vulnerabilities such as 'singleton' posts (posts that only one individual is currently qualified to fill) or demographic challenges. It enables development of succession plans and associated activities such as knowledge management. Resilience of senior managers is monitored, considering experience and length of time in post. Workforce planning is conducted at a local level and aggregated into company-wide plans.

Example knowledge management and retention:

11.33. The information herein is directly related to the major common issue on knowledge management from the Seventh Convention. 11.34. Within EDF Energy NGL, there are many processes which are routinely used to gather and manage knowledge as part of normal daily activities. Knowledge management is a specific process, requiring additional personnel, and tools, to manage which can be initiated by several different triggers. Once initiated the aim is to use existing processes to ensure knowledge becomes easily accessible for the future. The knowledge management process is shown graphically in Figure 11.1.

Figure 11.1: Knowledge Management Process



Accessible version of Figure 11.1

1. **Source**: Unstructured, un-validated, inaccessible knowledge.
2. **Trigger**: Project work; Outage work; External contacts; Event, incident, accident; Identified knowledge shortfall.
3. **Transfer**: Process - Investment delivery; Outage Benchmarking; Organisational Learning; Training; Knowledge tools.
4. **Goal**: Structured, validated, accessible knowledge.

11.35. From figure 11.1 it can be seen that there are many “Triggers” which should initiate the relevant process to “Transfer” relatively unstructured or inaccessible source knowledge into a more structured or accessible format. Many knowledge collection and management tools have been developed to support this. These include handover techniques and both interview and questionnaire-based approaches that provide an adequate level of guidance to support knowledge management associated with personnel movement. These tools may be used without requiring expert facilitators.

11.36. It is not possible to capture all knowledge, so a risk based, graded approach is needed to ensure that available resources are focused on the areas or individuals where the greatest risk exists. In many cases a very simple qualitative approach will be adequate. Managers/supervisors will be able to review their teams and identify possible risks based on factors such as:

- Age/Length of experience;
- Singleton suitable qualified and experienced personnel (SQEP);
- Involvement in specific projects;
- Stated retirement plans; and
- Career development plans.

11.37. A more formal risk assessment tool is also available for use in cases where it is beneficial, perhaps to provide more guidance where an initial qualitative overview identifies several ‘at risk’ individuals.

11.38. The goal of knowledge management is to ensure that acquired knowledge becomes, or remains, shared and accessible. Hence, whenever possible, the knowledge is built into existing documentation or training material and so becomes accessible using companywide methods/processes.

11.39. EDF Energy NGL's engineering and technical capability comprises staff at both operating NPPs and at central headquarter locations (see figure 6.1 under Article 6 – Existing Nuclear Installations). These staff provide the in-house resources available to respond to requirements for technical analyses. Where it is economic and practicable, technical services may be procured from suitably qualified and experienced specialists in other utilities or organisations, under appropriate contractual arrangements.

11.40. Management of change is one of EDF Energy NGL's 36 key management system processes. It includes specifications covering development of the nuclear baseline statements and application of the management of change process itself. Governance is provided at both site and corporate levels. An example of a staff retention issue and how it was managed is described below.

EDF Energy NGL staff retention [Example]

11.41. The end-of-generation (EoG) of the AGR power stations and the resultant changes in the requirements for central support functions, has resulted in greater uncertainty for qualified and experienced EDF Energy NGL personnel. EDF Energy NGL as the licensee for the AGR power stations and the PWR at Sizewell B, has had to manage resourcing needed whilst many personnel have been offered attractive financial packages and potential longer-term security from other nuclear companies.

11.42. EDF Energy NGL took several actions to maintain sufficient qualified and experienced personnel to continue to operate and support the fleet of reactors. The development of a people strategy, which included the conventional thermal power plants, along with the nuclear fleet, allowed the identification of personnel who could quickly transfer to other roles. The central support functions, which support the EDF Energy NGL fleet, contains the knowledge and skills which are needed to support other UK reactors in the future including Hinkley Point C. To maintain, share and develop skills, EDF Energy has created a Technical Services Organisation (TSO) which allows qualified and experienced personnel to support multiple licensees, including EDF Energy NGL and NNB GenCo, thereby providing greater certainty regarding future employment and opportunities for development and progression. Each licensee supported by the TCO retains control and ownership of safety via its Intelligent Customer roles.

11.43. The renaissance in the nuclear industry within the UK, which is helping the UK achieve a net zero carbon emission target before 2050, is creating additional need for a skilled and qualified workforce to deliver several nuclear projects. EDF Energy continues to invest in training and development to ensure it can continue to have the skilled workforce needed in an expanding industry.

11.44. EDF Energy NGL has developed a long-term people strategy outlining its resource needs through to the end of operation and beyond, to the next life cycle phases. The company is active in developing ‘pipelines’ through apprenticeship and graduate recruitment programmes.

11.45. The decision about whether to use contracted personnel on work which may affect nuclear safety is based on several considerations. EDF Energy NGL’s guidance asks for several questions to be addressed as part of the decision-making to ensure that the nature of the work is suitable and that safety can be appropriately controlled by the licensee.

Training and competence:

11.46. Within EDF Energy NGL, the training and qualification process is one of EDF Energy NGL’s top tier management system processes. It includes:

- Analysis of jobs and tasks;
- Development of training methods;
- Delivery of training assessment of trainees against desired outcomes;
- Refresher training as required;
- Regular evaluation of training; and
- Ensures that staff are SQEP for the roles being undertaken.

11.47. The content of initial training programmes is based on fleet analysis of job performance requirements including industry guidance, regulatory requirements, and management expectations. These are collated in programme specific task-to-training matrices, and site-specific programme content is included in these matrices. For operations and maintenance training programmes, training needs are derived from a task-to-training matrix. Training is identified at a component level and a difficulty, importance and frequency rating applied by suitably qualified and experienced reviewers to determine the extent of refresher training needed. For engineering support personnel (including system, design, component, safety group and procurement engineers), training programmes are derived from competency requirements. Competency training matrices identify initial and continuing training requirements at competency level. Site specific programme content is also included in these matrices.

11.48. All new recruits follow a standard company induction process for basic training. Each staff member has a post and training profile (PTP), which outlines the experience, qualifications and training required to perform that role. Recently recruited staff will follow a training programme which has been systematically derived and may include, depending on programme, classroom training, on job training, mentoring, practical workshops, self-guided and digital, online learning.

11.49. Dedicated full-time certified training instructors at NPPs are selected on the basis that they have proven competence and experience. Subject matter experts who are employed in the work area in which they provide training are also utilised as instructors. Computer-based simulators are available on site for all operating reactors and form part of the training of plant operators. The simulators, which have been progressively updated, can simulate a range of potential accident scenarios and fault sequences. International operational experience is routinely reviewed by EDF Energy NGL and assessed by the relevant curriculum review committee to ensure that this is integrated into initial and continuing training wherever appropriate.

11.50. Simulator training takes place at a frequency defined within the EDF Energy NGL task-to-training matrix that is derived using a systematic approach. The training is assessed, reviewed, and updated as per the systematic approach, the change of stations from generation to defuelling will mean different requirements placed on operation personnel and training requirements have been updated to reflect the new defueling requirements. EDF Energy NGL has completed the training for operators at Hunterston B and Hinkley Point B and is currently training operators for the next stations to enter defueling. The change has also been incorporated into emergency arrangements, to ensure that emergency arrangement training reflects the changing operating mode.

11.51. Mock-ups of plant items are also utilised to allow rehearsal of practical skills under controlled conditions. Emphasis is placed on training that enables staff to implement accident management strategies, utilising appropriate instrumentation and items of plant that are qualified for operation in severe accident environments.

11.52. Retraining of the licensee’s personnel may be considered when an individual fails a training or interview assessment. Retraining of personnel may also occur when a gap in performance or gap to excellence is identified using EDF Energy NGL’s organisational learning tools and processes. A change in plant, job scope or process would also trigger a request for an individual to be retrained. Additionally, EDF Energy NGL’s systematic approach to training identifies specific tasks of nuclear safety significance, which are routinely retrained at a set frequency.

11.53. Procedures for assessing competence prior to undertaking a safety related role are part of the arrangements made under LC10, which addresses training. For operations and maintenance personnel for example, training programmes within EDF Energy NGL also include on-the-job training and training performance evaluation as part of the qualification process.

11.54. Duly authorised persons (DAP) are identified as individuals who are in direct control or supervision of operations or activities that could impact on the safety envelope of the facility. Their appointments are therefore subject to additional management controls covering areas such as appointment and assessment. This is to ensure that they understand the basis for safety to ensure that operations remain within the safe operating envelope. However, the general principle that persons whose activities may impact upon nuclear safety should be appropriately trained, and their competence adequately assured, is similar for SQEPs and DAPs.

Training of external personnel:

11.55. When licensees use contractors for safety related work, they must satisfy themselves that the contractors have the appropriate qualifications and training to undertake the tasks safely. The training of contractors' staff so that they comply with site safety rules is part of the contractual agreements for such work. When safety analysis work and/or inspection work (for example, non-destructive testing and examination) is contracted to organisations external to the licensee, the licensee acts as an 'intelligent customer' and provides appropriate oversight and control.

Improvements to training programmes:

11.56. Within EDF Energy NGL, a series of training review committees (at operational, tactical and strategic levels) ensures that initial and continuing training programmes are kept up to date, for example, taking into account operational experience (OPEX), self-identified training needs or as a result of changes to plant configuration arising from plant modifications. Plant modification proposals, made under the arrangements under LC22 (modification or experiment on existing plant) must identify where instructions and procedures need to be changed and the associated training needs. For large modifications that need stage 'Consents' to be granted by ONR, evidence of satisfactory training is likely to be a requirement prior to a Consent being granted to bring the modified plant into routine service.

11.57. OPEX is used to improve the effectiveness of training in many ways, for example:

- Personal OPEX – anecdotes based on instructors' personal experience or an event/situation they are familiar with;
- Handouts of 'Event Reports', 'Learning and Just-In-Time (JIT) Briefs' which are read by the trainees and then discussed;
- Event Reports, Learning Briefs and JIT Briefs are utilised as case studies for group syndicate exercises;
- Event Reports, Learning Briefs and JIT Briefs are converted into laminated posters and positioned around training rooms to raise trainee awareness and to stimulate thinking and discussion;

- OPEX folders are maintained containing a chronological selection of historical and current OPEX relating to specific training sessions/topics;
- Props exhibiting 'real life' damage, for example, burnt out electrical props from actual events showing what can really happen;
- OPEX is utilised to set-the-scene at the start of training sessions – thereby reinforcing the relevance of the training session/topic;
- Bespoke training sessions are delivered on Windscale, Three Mile Island, Chernobyl and Fukushima during engineering support personnel and maintenance courses;
- Other non-nuclear OPEX events such as the Kegworth air disaster, Buncefield oil depot fire and the Severn Tunnel rail accident are utilised on operations courses; and
- The use of WANO Significant Operational Experience Reports – predominantly on operations courses.

11.58. Training provision within EDF Energy NGL also takes account of feedback from trainees and their line managers. The company's training arrangements are subject to rigorous self-evaluation as well as review by the licensee's internal assurance function and quality department as well as routine and team inspections by ONR inspectors. Oversight of the training and qualification process is provided by a fleet performance improvement manager who meets regularly with a peer group comprising station and corporate performance improvement managers. Corporate and station training specialists also meet as a peer group to share good practice, monitor performance, and identify improvements.

Training programme accreditation:

11.59. EDF Energy NGL's accreditation process of its operations and technical training programmes (including maintenance) has involved a comprehensive station self-evaluation, an accreditation team visit and then a challenge process at the Training Standards Accreditation Board, comprising international representatives and training specialists. This process has provided an independent view of the organisation's training programmes measured against 6 Institute of Nuclear Power Operations' (INPO) objectives. Since 2011, all 8 of EDF Energy NGL's stations and the central engineering function have achieved full accreditation for all of their operations and technical programmes.

> 11.60. [Change] In August 2021, EDF Energy NGL approved a 'simplified approach to fleet training governance' management of change that proposed to replace the training accreditation process outlined above with a peer review process. The change in approach was justified on the basis that EDF Energy NGL has a well-established and mature training organisation. In addition the change in business purpose as AGRs approach defuelling and decommissioning provides the

> opportunity to simplify training processes and requirements while maintaining the principles of the systematic approach to training.
>
> 11.61. [Change] The new process replaces a pass/fail audit style approach with one based on risk and performance that focuses on previously identified themes. It is more flexible and agile as it replaces a 4-yearly training interaction with a combination of quarterly programme health reports, use of the Fleet Elevation tracker to manage shortfalls and builds on the Governance, Oversight, Support, Perform approach and observations of training. The intervention comprises a 4-day review conducted by a fleet-led team of 6–8 personnel selected for their expertise from across the fleet, rather than a 2-week review conducted by a team of 15–20 personnel including international subject matter experts. Assessment is based on the WANO maturity model that EDF Energy NGL has adapted for training and considers how far the station is from ‘world class’.

11.62. The new approach has been implemented at Heysham 1 in November 2021 and is due to be applied at Hartlepool in March 2022 prior to a formal post implementation review being conducted to review its effectiveness. The Heysham 1 final report assessed the new approach to be successful based on significantly less burden on the station combined with high levels of station engagement and the ability of fleet subject matter experts to focus on exploring potential issues in detail. It was reported that the fleet was proactive in volunteering team members and the approach provided significant benchmarking opportunities across the fleet. It was noted also that the approach should be improved in terms of more pre-work with the station to review current performance and greater use of technology to support the intervention.

Hinkley Point C operational capability

11.63. The Hinkley Point C operational capability requirement is set by the Pre-Operations directorate, because Hinkley Point C is still under construction. The Pre-Operations directorate key deliverables include:

- Defining the future operations culture and staffing requirements;
- Building on experience and learning from EDF SA and China General Nuclear Power Corporation (CGN); and
- Building operations team capability in preparation for commercial operation.

11.64. This work is being carried out in a team incorporating experience from NNB GenCo and EDF Energy NGL, principally Sizewell B, EDF Energy NGL Human Resources, and the Nuclear Skills Alliance (NSA). This work is directly related to Challenge 2 from the Seventh Convention.

11.65. The NSA is a structured collaboration between EDF Energy NGL and NNB GenCo. The NSA brings together technical training teams into a single function to deliver the technical skills and competences to support EDF Energy's existing and new nuclear businesses. The NSA is responsible for delivery of technical training to the existing nuclear generation fleet, and the future technical training needs to operate Hinkley Point C.

11.66. To meet this need, the NSA is developing the training programmes needed to support the training of staff for operations at Hinkley Point C. The systematic approach to training (SAT) is used to ensure that these programmes provide efficient and effective training which meets the operational capability requirements. The pre-operations deputy director is Hinkley Point C's intelligent customer and custodian of the arrangements to meet LC10 and LC12. Oversight is provided by the joint EDF Energy NGL/Hinkley Point C Programme Board.

11.67. Formation of the NSA, a structured collaboration between Hinkley Point C and EDF Energy NGL training teams, facilitates access to the SAT-derived, accredited, training programmes that serve the current fleet. Although there are design differences between the EPR™ design at Hinkley Point C and other EPR™s across the world, significant benefit can be obtained from international EPR™ operational experience. The operational experience shared by CGN (Taishan) and EDF SA (Flamanville 3) has yielded useful methods, media and material which can support the development of training solutions for operations at Hinkley Point C.

11.68. Analysis of the existing Flamanville 3 programmes in maintenance, engineering support and technical and safety has begun to determine the extent to which they apply to Hinkley Point C. The operations programme used to train and qualify main control room operators has already commenced, and the first groups of EPR™ operators have already commenced their simulator training. This group takes advantage of the availability of the Flamanville 3 reference simulator, procedures, and expertise. In parallel, the SAT development of the Hinkley Point C reference training programme necessary to authorise personnel before first operations at site has started.

11.69. For areas with significant technical differences between Hinkley Point C and the Flamanville 3 EPR™ design that would impact the EPR™ training programmes (for example the additional safety features of the Hinkley Point C EPR™ or its digital control and instrumentation systems), a specific focus is applied, acknowledging the additional effort likely to be needed to develop training for skills in these areas. The Hinkley Point C Project Integrated Work Schedule includes the activities needed to develop these staff, procure the Hinkley Point C reference simulators and complete site training facility. These are key deliverables of NSA on behalf of the Pre-Operations Directorate.

Maintaining and enhancing the national nuclear skill base

11.70. Existing operations, decommissioning and clean-up, together with the current programme of new nuclear build, means the nuclear industry has a sustained recruitment demand and continued requirement for skills training and reskilling of the workforce. In line with the publication of the British Energy Security Strategy (Ref. 11.17), the UK Government will continue to work with industry to maximise both the capability development and economic benefits to the UK.

11.71. Employers have sought a skills partnership with government that is strategic, across the UK, covers all parts of the sector and represents views on the skills needs and solutions. Most importantly, this partnership needed to be led and driven by employers themselves and in late 2015 the Nuclear Skills Strategy Group (NSSG) was successfully formed.

11.72. The NSSG is the lead strategic skills forum representing the nuclear industry's skills demands in the UK. Its purpose is to secure the required supply of suitably qualified and competent personnel for the current and future needs of the UK's nuclear sector by providing the strategic direction on skills infrastructure, processes, and training provision. The NSSG published its updated Nuclear Skills Strategic Plan in 2020 (Ref. 11.18).

11.73. The Nuclear Workforce Assessment 2021 (NWA) report (Ref. 11.19) produced by the NSSG looks at a range of scenarios for civil electricity generation over the next 2 decades. The NWA 21 predicts a peak mobilisation of new workers (Construction and Engineering Construction) into the UK nuclear sector in the next 2 or 3 years. This recruitment pressure will be further exacerbated by non-nuclear construction activities which pull on similar skill sets. For medium to high activity scenarios, a predicted decline in decommissioning activity in the UK is offset by a shift to nuclear manufacturing jobs, particularly beyond 2030. The high activity extends this demand to 2050 and beyond, making the difference between a net decline in the UK nuclear workforce under the low and medium scenarios, and a stable or slightly expanding population. The UK Government, industry and training providers recognise that there are substantial challenges to be overcome. The existing nuclear workforce is ageing, and attrition rates are high. The UK Government is addressing the threat of skill shortages through a collaborative approach with industry. The National College for Nuclear officially opened in February 2018 with 2 hubs: one in the Northwest and the other in the Southwest of England. The college, set up with UK Government and industry funding, operates through a 'virtual college model' aiming to deliver industry-specific courses.

11.74. The UK Government has committed to a target of 40 % women in nuclear by 2030. Increased diversity enhances the quality of the skills available to the nuclear sector, boosting innovation and productivity through greater diversity of thought.

11.75. The NDA has a statutory duty as set out in The Energy Act 2004 (Ref. 11.20) to take appropriate action to ensure that adequate skills are available for it to carry out its duties. It has a budget allocated annually to develop the skills needed to deliver its objectives through a skills and capability strategy. The National Nuclear Laboratory (NNL), a £250m purpose-built facility based in Cumbria, England, demonstrates the government's commitment to protect and grow the UK's national nuclear technology capability and skills base. The NNL holds a significant breadth of technology expertise; around 600 staff manage a wide range of radioactive and non-radioactive experimental programmes, as well as offering a wide range of analytical services. In addition, the government is funding a trial of an Advanced Nuclear Skills and Innovation Campus (Ref. 11.21) to aid the development of UK skills and capability.

11.76. ONR employs suitably qualified technical specialists as inspectors, as well as generalists and support staff to deliver the core regulatory work and other obligations. As of December 2021, ONR employed 668 staff with the safety and security technical cadre being approximately two-thirds of this.

11.77. ONR's external recruitment campaigns continue to bring in specialist skills in an increasingly competitive market and during the ongoing pandemic. In addition to recruiting experienced specialists, ONR has successfully introduced new pipelines to bring people into the organisation. Also see paragraphs 8.32 to 8.45.

- ONR sponsors and ultimately employs graduates;
- Associates – those with less nuclear/high hazard experience that ONR can develop and grow;
- Equivalence – those with unique skills from other industry sectors to undertake an 'equivalence role' which can lead to them becoming nuclear inspectors; and
- Degree level apprentices – who undertake a 5-year programme comprising a degree in nuclear engineering and science whilst working with ONR and going out on secondment to other parts of the industry.

11.78. These pipelines are key to ONR; not only in growing the resource that will ultimately replace retiring inspectors, but also in increasing ONR's diversity and inclusivity. To support the skills that ONR needs, the ONR Academy was launched in 2018 providing a single point of focus for all learning and development within the organisation. Since this time, ONR has increased the range of formal development capability on offer to include management and leadership learning alongside the regulatory development programme. In addition to this, the ONR Academy offers learning in a variety of formats including online, blended and coaching, enabling flexibility for individuals to attend at a time and location that is convenient to them. Topics cover both regulatory and non-regulatory subjects, and all modules are available to all staff. Based on IAEA good practice, the Academy project has developed a regulatory competence framework (RCF) identifying what competences an inspector needs, along with an accompanying syllabus to show what training opportunities are linked to the competence.

11.79. All of these actions taken together will help to ensure that the UK has the skilled personnel required to support the nuclear sector. Also see Annex 2 – The Environmental Regulatory Bodies.

Article 11 references

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Article 12 – Human Factors

> Each Contracting Party shall take the appropriate steps to ensure that the capabilities and limitations of human performance are taken into account throughout the life of a nuclear installation.

12.1. Under this Article, compliance with the Convention is demonstrated in a way that has not substantially changed since the United Kingdom's (UK) eighth National Report (NR) (Ref. 12.1) (in a way that has implications for the Convention obligations).

12.2. However, since the UK's eighth NR, Human Factors expectations in relation to Security Assessment Principles (SyAPs) (Ref. 12.2) have been maturing and are now broadly consistent with those relating to safety, albeit applied in a proportionate way. In acknowledgement, expectations in relation to compliance with security are incorporated into Article 12 by adding "… and security" after the word "safety" where appropriate. However, it is noted that licensees and dutyholders arrangements to meet these requirements are less mature and this is recognised and reflected in ONR's regulation of these areas.

Human factors in the design and assessment process

12.3. The UK's nuclear installation licensees and regulators recognise that human performance plays a vital role in ensuring safety and security. Human Factors are concerned with all aspects of human performance, and the factors affecting this performance, which can impact on safe and secure operation.

12.4. ONR's Safety Assessment Principles EHF series (Ref. 12.3), the newly established SyAPs and Technical Assessment Guides (TAG) (Ref. 12.4) set out ONR's expectations for licensees' treatment of Human Factors. Many of the licence conditions (Ref. 12.5) and therefore the Technical Inspection Guides (TIG) (Ref. 12.6) have strong Human Factors components.

12.5. Human Factors analyses are applied proportionally to all activities and functions related to nuclear safety and security. Dutyholders employ Human Factors specialists to ensure that Human Factors principles and methods are appropriately integrated into the areas of engineering design, safety analysis, operations and security. These specialists are also used to manage Human Factors work carried out in support of these areas by the supply chains. ONR currently has a team of over 30 human and organisational factors specialists and supplements this with supply chain specialist support when required.

12.6. Where new nuclear installations are proposed, ONR expects Human Factors engineering, and safety and security analysis to be carried out as part of the design, safety, and security case process. This confirms that the design takes due account of the needs of the user and supports the demonstration that the risk from human error is reduced as low as reasonably practicable. ONR expects, as stated within ONR's TAGs (Ref. 12.4), the engagement of Human Factors specialists at an early stage of the design process. This is to ensure effective Human Factors integration into the design such that it takes account of human capabilities and limitations and thus supports reliable human actions.

12.7. ONR also expects, as stated within ONR's Safety Assessment Principles (SAP) (Ref. 12.3) and TAGs, that the design of 'user interfaces', including systems, structures, components and equipment, follows good Human Factors practice ensuring that their design is compatible with human psychological and physical characteristics. This enables their associated tasks to be performed reliably and efficiently. For new designs, a structured Human Factors engineering design process is adopted and relevant standards applied. The user interface for the reactor main control room is based on a comprehensive and systematic allocation of function and task analysis, which identifies the operational requirements during normal, transient and fault conditions. A similar graded process is adopted for the design of new systems, structures, components, and equipment to ensure that the risk of examination, inspection, maintenance and testing errors are reduced to as low as reasonably practicable.

12.8. The design of the reactor control room enables the operator to carry out tasks and deliver safety functions during normal operations, postulated fault conditions and, where practicable, severe accidents. Appropriate provisions are provided in the control room and at emergency locations to enable the monitoring of plant state in relation to safety, and to take any necessary safety actions. Due attention is also given to the specification and design of local control stations, and to the design of equipment having the potential to impact upon plant safety (for example, maintenance and testing equipment and computer-based systems used to present operating instructions).

12.9. ONR requires that all nuclear installations be re-assessed as part of the PSR process (see Article 14 – Assessment and Verification of Safety). Human Factors analyses form an integral part of these reviews. In addition, proportionate Human Factors analysis is expected in licensees' plant modification processes. Where shortfalls in ergonomic standards are identified, licensees are expected to consider reasonably practicable improvements to provide a demonstration that the risk from human error is ALARP. The user interfaces of existing nuclear installations are subject to scrutiny during the PSR and any plant modification processes to ensure that they remain fit for purpose, and that operator actions are properly supported. Risk important structures, systems and components and equipment are also considered during PSR and plant modification processes to ensure they remain fit for purpose with respect to supporting related operator actions.

12.10. As part of the safety and security case supporting the operation of a nuclear facility, ONR expects licensees to consider the allocation of function analysis to appropriately allocate safety and security functions between human operators and the technology. Where safety and security functions are allocated to human operators, the expectation is that these are recorded, designed and substantiated appropriately. In general, where a plant failure or incorrect operation leads to a need for safety system operation, UK plants are designed so that they are rendered safe by the action of passive or engineered features. These generally offer greater reliability than the human operator, especially where rapid safety system operation is needed. Similar expectations exist when designing for security. Where operator safety and security actions are identified, and it is not reasonably practicable to provide an engineered safety or security system, analysis of the operator actions is used to demonstrate that the tasks required can be performed safely, securely, and reliably in the time available. Where the analysis identifies the need for improvements to human, and hence system reliability, these are considered as part of the ALARP review process. This is explained in the ONR's SAPs (Ref. 12.3).

Human error identification and reduction

12.11. ONR's SAPs and supporting TAGs cover identification, prevention, detection, and correction of human errors in operation, security, and maintenance of nuclear installations. This is achieved through the integration of Human Factors into the safety and security analysis process, such that important human actions are identified within the fault, hazard, and engineering schedules, security analysis, and in the Probabilistic Safety Analysis (PSA). Important human actions to inspect and maintain the structures, systems, and components, monitor the plant, diagnose faults, make decisions and implement necessary safety and security actions are subject to proportionate task and error analysis. These analyses take account of the physical, physiological, and cognitive demands that may be placed on the operator and on teams of operators. They address the potential consequences of failure to perform the safety and security actions successfully, and the potential for recovery from error. The analyses take account of, and form primary inputs to inform decisions on, plant staffing, on equipment and on other facilities which are provided to support the operator. In particular, the analyses are an important input to the design of the structures, systems and components (including user interfaces and security systems) and provide a basis for developing procedures and the content of personnel training. They influence the way in which the job is organised, as well as being used to determine and demonstrate the feasibility of individual tasks. Ergonomics principles are applied to support reliable human performance and inform the design of the working environment, including factors such as access, noise, thermal and lighting conditions, and communications facilities. Issues related to fitness for duty, such as shift working patterns and working hours (particularly periods of extended hours) are also taken into consideration.

12.12. The PSA undertaken on the nuclear installations provides quantitative assessments of the risk to safety arising from plant designs and operations. The PSA highlights significant contributors to risk and considers the impact of human actions on safety. The licensees ensure that, where operator actions are identified and modelled in the PSAs, suitable methods are used to assess the potential errors associated with these actions and to determine the consequent human error probabilities. This is based on structured qualitative analysis of the operator actions and performance shaping factors which influence them. In response to recommendations raised in the Chief Nuclear Inspector's (CNI) report on the Fukushima accident (Ref. 11.7), licensees have, and continue to, extend their PSAs and assessments of human actions to include those included within severe accident guidelines.

12.13. Quantitative estimates of human error probability are produced for the significant human errors defined during the error identification process and these are supported by structured qualitative analysis. Errors modelled include those during maintenance activities that could later lead to equipment failure, operator errors which initiate events, and errors during post fault recovery. They also include errors of omission and errors of commission. The probabilities derived are informed by the qualitative analysis which identifies psychological factors (for example, stress, personal experience, and knowledge) and task-specific factors (for example, the physical environment, training, working practices, time constraints, adequacy of procedures and user interface). Dependencies between actions are also considered. The potential for impact of dependencies between separate operator actions activities (either by the same or by different operators) is assessed and the results are factored into the PSA. The potential for recovery from previous errors is also examined. This is especially pertinent where long timescales are available to take corrective action. As well as demonstrating that risks are tolerable, licensees also use this analysis to identify reasonably practicable improvements that may be made to ensure that the risk from human error is reduced to ALARP.

Methods and programmes of the licensee for analysing, detecting, and correcting human errors in the operation and maintenance of nuclear installations

12.14. Details of the licensee's Human Factors methods and programmes are presented in 2 parts, the methods and programmes employed by EDF Energy NGL – which is responsible for operating both the AGR NPP fleet and the PWR at Sizewell B – and relating to NNB GenCo – which is currently developing the design and assessment of the NPP in-build at Hinkley Point C.

12.15. Since the UK's eighth NR, the Human Factors teams within EDF Energy NGL and NNB GenCo have been combined as part of a Technical Services Organisation (TSO). The TSO holds the technical expertise, seconded from EDF Energy NGL and NNB GenCo, and supplies services via contract to each of the client licensees. This allows the Human Factors teams to be deployed flexibly across both NNB GenCo and EDF Energy NGL.

12.16. The TSO supports the Technical Client Organisation (TCO), which is defined by a joint set of arrangements between the licensee organisations and the TSO in EDF Energy, agreeing that they will act collaboratively to address the development of skills and resolution of technical challenges through the development of a common strategy. These arrangements are governed by the TCO Steering Group, which represents all parties.

EDF Energy NGL – human factors capability

12.17. EDF Energy NGL includes consideration of Human Factors within its Nuclear Safety Principles, which inform and govern the way in which it designs and operates its nuclear power stations. These include, but are not limited to, requirements in relation to preventing ‘human initiated faults’, consideration of the human within ‘protective systems’, and ensuring that safety important operator actions are feasible and can be reliably performed.

12.18. The EDF Energy NGL Nuclear Safety Principles are implemented through several supporting processes with Human Factors considerations integrated within the design, project, and safety case processes. This ensures that proportionate Human Factors analyses are undertaken to support activities and functions which relate to nuclear safety. The approach taken to integration of Human Factors within EDF Energy NGL is graded to ensure that the level of Human Factors effort, and the prioritisation and scope of Human Factors activities undertaken, are proportional to the safety significance of the work.

12.19. EDF Energy NGL has a team of Human Factors specialists who support delivery of their processes, and they work side by side with staff outside the discipline such as architect engineers, designers, safety case engineers, and operators to ensure that Human Factors considerations are appropriately implemented and addressed. Human Factors considerations are also included, as appropriate, as part of support functions including Organisational Learning and Internal Assurance.

> 12.20. [Change] Specific examples of recent Human Factors initiatives run by EDF Energy NGL include the following.
>
> - Dedicated Human Factors specialists supporting investigations to ensure suitable consideration of Human Factors;
> - Deployment of the Human Performance Evaluation Tool (HUET), which can be used as a standalone tool or in support of wider investigations;
> - Implementing improvements to the procedure writing process to enhance work instructions and procedures;
> - The ongoing use of the human performance fleet dashboard to identify performance trends, monitor station improvements, provide a fleet wide thematic analysis on coaching in the field, events and incidents;
> - Integration of human performance specialists into fleet working groups to ensure that human factors considerations are included in the scope of work; and
> - The Nuclear Excellence programme draws together several different areas, with the goal of delivering event free and error free

performance. The development of Nuclear Excellence has included ensuring appropriate leader training to be intrusive and identify situations where errors are more likely to occur.

Managing human factors aspects for entering end-of-generation/defuelling [Example]

12.21. The AGR Power station fleet is preparing for end-of-generation (EoG). The transfer from a generating to a defuelling phase of operation was recognised as having a significant potential impact on staff if not properly managed.

12.22. EDF Energy has built on the experience of Magnox decommissioning and its own experience gained from the closure of coal power stations, to develop a programme to ensure that the human aspects of moving a power station, which has operated for many decades, to the defuelling lifecycle will be suitably managed.

12.23. A programme of engagement with station personnel to understand their circumstances and future aspirations has allowed EDF Energy to manage the human resources on the power station to ensure that, where possible, station personnel have a clear understanding of the future and can continue working within EDF Energy.

12.24. The strong links between EDF Energy NGL and NNB GenCo has allowed the identification of future roles for EDF Energy NGL staff within the Hinkley Point C site and organisation. The timing of Hinkley Point C and the closure of the AGR fleet allows a planned transfer of personnel who can remain at a generating AGR station until such time as there are similar operational roles available elsewhere.

12.25. The central technical roles which support the AGR fleet are also factored into the end-of-generation (EoG) plans. The development of a TSO as a single central organisation which can provide technical expertise to multiple licensees, allows for EDF Energy NGL to retain sufficient capability and capacity whilst allowing the same resource to support other licensees. The TSO can provide technical expertise; however, the Intelligent Customer must remain within the licensee. Also see Article 11 – Financial and Human Resources for further information on the TSO.

12.26. EDF Energy NGL has undertaken several initiatives to improve procedure quality, use and adherence, including development of a corporate working group overseen by the Human Performance Fleet Lead. Effective procedures minimise the potential for error and contribute to event free operation. The EDF Energy procedure writer’s guide for operations and maintenance procedures is being used to produce enhanced and optimised procedures.

12.27. EDF Energy NGL enshrines procedural adherence within its arrangements, whilst also encouraging a questioning attitude in relation to maintaining safety. Procedures are verified and validated to ensure they are fit for purpose, so that they support reliable and effective task performance. Failure to follow procedures may result in serious safety consequences and where appropriate may lead to disciplinary action. Where procedures cannot be followed as specified, work is stopped, made safe, and the procedure changed using the document change process.

12.28. Prior to assigning a task or conducting a pre-job briefing, supervisors review unfamiliar procedures to ensure that the task is assigned to someone who is a suitably qualified and experienced. As part of the pre-job briefing or setting to work process, supervisors specify the procedures to be used by staff and communicate adherence expectations, including the identification of hazards and risks. Detailed guidance is provided and is graded according to the nature of the task and on the procedure to be followed. This ranges from ‘information use’ through to ‘continuous use’ where the procedure is required to be followed explicitly step by step using place-keeping and a range of specified human performance tools.

Self-assessment of managerial and organisational issues by the operator

12.29. This is directly related to the major common issue on safety culture from the Seventh Convention.

12.30. EDF Energy NGL adopts approaches to assessing and monitoring nuclear safety performance. EDF’s Human Factors team play a key role in supporting this assessment process. Stations are held to account by their chief nuclear officer. Governance and oversight are also delivered via several fleet managers/fleet leads who are responsible for the company’s key processes. The leads monitor the health of the process and report via a series of delivery teams to the Executive Management Team, escalating issues as appropriate. The Human Factors team supports in the delivery of solutions to address identified issues. Fleet leads can also provide targeted support to sites as necessary. Other assessment activities include:

- A biennial (2-yearly) safety culture assessment of all sites, leading to identified improvement programmes if necessary; and
- EDF Energy NGL’s internal regulatory function undertakes management and leadership reviews of power stations in parallel with the Nuclear Safety Review Boards and selected central support departments. A programme of nuclear safety culture reviews has commenced based on the IAEA model of safety culture and an adapted version of the OSART framework. The fleet has now completed the programme of reviews.

12.31. EDF Energy NGL deploys Nuclear Safety Review Boards to supplement its programme of internal reviews and WANO peer reviews. The Nuclear Safety Review Board provides independent external advice and counsel to each station director and the chief nuclear officer on any issues related to the nuclear safety, operational performance, and management of the power station. It also provides independent external advice on long term strategies for improvement and reviews the effectiveness of the company's internal oversight function.

12.32. The Boards take the form of a week-long review of operations and management at each NPP every 2 years. The Boards are chaired by and contain independent members who have a track record either as a power station operator, regulator, or key nuclear industry supplier.

NNB GenCo – human factors capability

12.33. The strategy for implementing Human Factors on the Hinkley Point C project is described in the Hinkley Point C Human Factors Management Plan (HFMP) which is the lead document for all Human Factors integration, planning and strategy documentation for the project. It describes the project arrangements to ensure Human Factors considerations are appropriately integrated in all stages, up to the Commercial Operation Date. All other Human Factors strategy and planning documents are subordinate to the HFMP.

12.34. The HFMP is produced and owned by the TSO Human Factors Team. The HFMP defines the expected scope of the Human Factors programme and what is necessary to deliver effective Human Factors. It specifies the Human Factors methods, tools, and processes to be followed. In addition, the HFMP provides a basis for estimating Human Factors resource requirements and describes the associated roles and responsibilities.

12.35. The HPC Human Factors Programme is scoped to achieve 2 goals.

- To ensure that Human Factors is sufficiently integrated in the design of HPC to ensure that the risk of a nuclear safety significant incident as a result of human action or inaction is reduced ALARP.
- To provide a clear, evidence backed, explanation of how the first goal has been achieved as a part of the nuclear safety case.

> 12.36. [Change] To ensure that Human Factors is effectively implemented across all aspects of the design of Hinkley Point C, the Human Factors programme has been subdivided into several targeted work-streams to address the following 3 elements.
>
> - Integration of Human Factors into the design including civil work and building layout, mechanical and electrical systems design, human

machine interface and control room design);

- Integration of Human Factors into safety studies including human reliability analysis and the substantiation of Human Based Safety Claims; and
- Integration of Human Factors into operational documentation, development, commissioning, and decommissioning, including validation and Integrated Systems Validation.

12.37. Each design work-stream follows a 3-step process that involves assessing and screening of structures, systems, and components according to nuclear safety risk and complexity of human actions to assign a Human Factors risk significance level to each. The Human Factors requirements and design inputs are then defined according to the Human Factors risk rating. Finally, as the design work is completed, it is assessed for Human Factors compliance both via Hinkley Point C's review and acceptance processes and, for more significant Human Factors risk aspects, via dedicated Human Factors tests and trials.

> 12.38. [Change] The Hinkley Point C Project has a core Human Factors team drawn from EDF's TCO to support the Hinkley Point C Design Authority. The Design Authority is supported by sub-contractors delivering packages of Human Factors work responsible for: defining the Human Factors strategy; providing the overall Human Factors assurance for the project; monitoring the effectiveness of all Human Factors engineering in the Hinkley Point C scope, as well as providing much of the analysis for the integration of Human Factors into safety studies, operational documents and commissioning; and working closely with the Hinkley Point C Design Authority engineers who are developing the Human Factors sections of the Hinkley Point C safety case.

12.39. The principal coordination of the Human Factors technical input to the Hinkley Point C design is provided by a Responsible Designer Human Factors team. This team is responsible for the implementation of the Hinkley Point C Human Factors strategy across the design scope, including oversight of the supply chain. The supply chain is responsible for the detailed design of the structures, systems and components and Human Factors integration into that design. The level of Human Factors risk associated with the structures, systems and components within the contractors' scope determines the Human Factors expectations and requirements.

Arrangements for the feedback of experience in relation to human factors and organisational issues

12.40. EDF Energy NGL has developed an integrated ‘organisational learning’ process which aims to identify and manage performance gaps in behaviours, plant, processes, or organisation, proactively as well as reactively and by using lessons learned from internal and external operational experience. Elements include the Corrective Action Programme, which is used to identify and resolve adverse conditions, OPEX and self-assessment/benchmarking. All stations and the TCO have performance improvement teams including organisational learning specialists.

12.41. Human performance improvement plans are produced at each site. Plans identify areas of operations susceptible to human error, either latent or active, based on previous OPEX, recent performance standards or planned work activities and tasks.

12.42. [Change] Specific examples of human and organisational factors initiatives run by EDF Energy NGL which have informed, or been informed by, learning from experience include the following:

- Work to optimise the quality of event investigation and the implementation of the significant adverse condition investigation review panel. EDF recognise the importance of HF in event investigation, thus include HF expert representation on the most significant event investigations, with a view to identifying HF root causes and solutions. The HF capability also provides support and feedback to lead investigators in the field;
- Learning from other organisations includes EDF HF involvement in intra and inter-industry groups. HF learning from these extra-EDF sources is used to enhance the consideration of HF within periodic safety reviews;
- Use of independent external organisations to assess organisational safety culture;
- Development and extension of EDF Energy NGL human factors arrangements to promote more consistent and risk informed application of human factors within safety cases. New processes have been developed to support safety case development, ensuring that potential latent errors resulting from previous human performance issues are identified and corrected;
- A revised approach to the consideration of human factors as part of periodic safety reviews, with a focus on optimisation of processes and ongoing assessment; and
- Consideration of Human Factors issues when changing site status from generation to defuelling. For example, proactively capturing

> individual aspirations to ensure that these are recognised when planning a station's change in generation status. This approach recognises the Human Performance detriment that employment and career uncertainty can bring.

12.43. UK licensees have a system for reporting receipt and assessment of reports of nuclear plant events and are members of WANO, and as such, share operational experience internationally. In addition, ONR operates the IAEA's incident reporting system on behalf of the UK and shares reports/learning. Nuclear utilities co-operate in programmes of peer evaluation and operational experience feedback. They also participate in WANO and IAEA, which give an international perspective on performance levels.

Regulatory review and control activities

12.44. ONR SAPs, SyAPs, TIGs and TAGs form the basis against which the regulatory assessment of Human Factors is carried out. They identify, explicitly, the need for a nuclear licensee to consider a comprehensive set of influences on human performance. These address areas such as Human Factors integration, allocation of function, human machine interfaces, workspaces and work environment, procedure design and administrative control, staffing levels and task organisation and human reliability analysis.

12.45. Some aspects of Human Factors are specifically addressed by the nuclear site licence conditions, for example, the licence conditions for training, duly authorised and suitably qualified and experienced persons, and operating instructions. However, in addition to these, other licence conditions also have Human Factors implications, which together, address a range of Human Factors topic areas. Compliance with the licence conditions is monitored as part of each nuclear site inspector's normal duties. To ensure this is done effectively, ONR's inspectors have access to formal training to help them to identify Human Factors concerns, which enables them to discuss these with the licensee or raise them with ONR's specialist Human Factors inspectors.

12.46. ONR's Human Factors inspectors proactively identify areas of the licensees' operations for examination based on their awareness of issues identified through a variety of sources. These include national and international operational experience, developments in Human Factors techniques and research, discussions with other UK regulators, the licensee's personnel and other international regulators, and intelligence gathered during historical inspection and assessment activities. ONR may carry out targeted inspections of Human Factors-related issues. Such inspections provide confidence that the licensee's Human Factors analyses are implemented in practice. ONR also maintains exchange arrangements on Human Factors, and other technical areas, with regulatory bodies and research establishments in other countries.

> 12.47. [Change] ONR’s Human Factors team also provides support to ONR’s assessment of nuclear industry security arrangements.

12.48. Regulatory assessment of the licensee’s or Requesting Party’s treatment of Human Factors is made throughout the life cycle of a nuclear installation. When a safety or security case is submitted to ONR, nuclear site inspectors, project inspectors and Human Factors specialists agree on the scope of any Human Factors assessment work appropriate to the case in question. By requiring that Human Factors be integrated into the design process, ONR has ensured that licensees place considerable emphasis on the inclusion of Human Factors analysis in the early stages of plant design to ensure that the design properly reflects the capabilities and limitations of human performance, and that reliable operator performance is adequately supported.

12.49. As part of its wider regulatory vires, ONR publishes a research strategy (Ref. 12.8) and a Regulatory Research Register (Ref. 12.9), the aim of which is to address regulatory knowledge gaps and thus improve ONR’s ability to make robust, supportable, regulatory decisions. The Human Factors topic is well represented within this strategy and the Regulatory Research Register, demonstrating ONR’s recognition of the importance of Article 12 of the Convention.

> 12.50. [Change] Current Human Factors research topics include:
>
> - ONR-RRR-048 – Human Reliability Data for Modern Control Room Environments;
> - ONR-RRR-096 – The efficacy of peer checking;
> - ONR-RRR-110 – Development of Guidance on the Use of Electronic Procedures;
> - ONR-RRR-111 – Human Performance During Severe Accidents; and
> - ONR-RRR-119 – Enhanced Decision-making.

12.51. ONR and industry have identified a national shortage of Human Factors capability within the UK. To address this, ONR is actively working with the industry and the UK Chartered Institute of Ergonomics and Human Factors (CIEHF) to develop new and innovative approaches to enhancing Human Factors capability within the nuclear sector.

Article 12 references

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12.2 ONR Security Assessment Principles, 2017 (https://www.onr.org.uk/syaps/security-assessment-principles-2017.pdf).

12.3 ONR Safety Assessment Principles, 2014 (https://www.onr.org.uk/saps/saps2014.pdf).

12.4 ONR Technical Assessment Guides (https://www.onr.org.uk/operational/tech_asst_guides/index.htm).

12.5 ONR Licence Condition Handbook (https://www.onr.org.uk/documents/licence-condition-handbook.pdf).

12.6 ONR Technical Inspection Guides (https://www.onr.org.uk/operational/tech_insp_guides/index.htm).

12.7 Chief Nuclear Inspector's report on lessons from Fukushima (https://www.onr.org.uk/fukushima/final-report.htm).

12.8 ONR Research Strategy (https://www.onr.org.uk/documents/2019/onr-research-strategy.pdf)

12.9 ONR Regulatory Research Register (https://www.onr.org.uk/research/regulatory-research-register.htm).

Article 13 – Quality Assurance

> Each Contracting Party shall take the appropriate steps to ensure that quality assurance arrangements programmes are established and implemented with a view to providing confidence that specified requirements for all activities important to nuclear safety are satisfied throughout the life of a nuclear installation.

13.1. Compliance with this Article of the Convention is demonstrated in a way that has not substantially changed since the United Kingdom's (UK) eighth National Report (NR) (Ref 13.1) (in a way that has implications for Convention obligations).

13.2. The information in this Article is directly related to the major common issue on quality assurance and supply chain from the Seventh Convention.

13.3. This Article has been addressed by considering the requirements in the International Atomic Energy Agency (IAEA)'s Safety Standard GSR Part 2, 'Leadership and Management for Safety' (LMfS) (Ref. 13.2). The scope of GSR Part 2 covers management system requirements for nuclear facilities, activities using sources of ionising radiations, radioactive waste management, the transport of radioactive material and radiation protection.

13.4. Pending the issue of supporting guides for GSR Part 2 by the IAEA, cognisance is still taken of the Safety Guides: GS-G-3.1 (2006), 'Application of the Management System for Facilities and Activities' (Ref. 13.3), which provides guidance on implementing the generic management system requirements; and GS-G-3.5 (2009), 'The Management System for Nuclear Installations' (Ref. 13.4). This is in line with VDNS Principle 3.

13.5. In the UK, there is currently one licensee who is operating Nuclear Power Plants (NPP), namely EDF Energy NGL. A 2-unit nuclear power station is currently being constructed on a licensed site, Hinkley Point C, by NNB GenCo. In addressing this Article, the key features of the quality assurance arrangements developed and deployed by these 2 licensees is described in overview.

Regulatory requirements for quality assurance programmes/quality management systems of the licence holders

13.6. The UK applies a graded and risk informed approach to management system requirements for the operation of each nuclear facility, proportionate to the risks associated with achieving safe outcomes. This is achieved within the UK by the Office for Nuclear Regulation (ONR) attaching 36 licence conditions (LC) (Ref. 13.5) to the site licence of all operators of nuclear facilities. One of the LCs relates directly to management system requirements, LC17 (management systems).

13.7. LC17 places a duty on licensees to establish and implement management systems which give due priority to safety. In addition, LC17(2) identifies that the licensee shall, within its management system, make and implement adequate quality management arrangements in respect of all matters which may affect safety.

13.8. The Energy Act 2013 (TEA13) (Ref. 13.6), also identifies ONR as the enforcing authority in relation to articles for use at work that are designed, manufactured, imported, or supplied for UK nuclear applications. This gives ONR the power to inspect suppliers to UK nuclear licensed sites. ONR selects suppliers and contractors for inspection based on risk criteria. For instance, the nuclear safety significance of their products and activities; the extent of such work undertaken by the suppliers and contractors across UK nuclear installations; intelligence of their performance, garnered from the licensees, and the wider national and international nuclear and other high-risk industries.

13.9. ONR currently chairs the Nuclear Energy Agency's Convention on Nuclear Regulatory Activities' Vendor Inspection Co-operation Working Group (VICWG). The International Atomic Energy Agency (IAEA) is invited to participate in the working group's activities. Its main objectives are:

- To maximise results obtained from regulators' efforts in inspecting vendors; and
- To explore opportunities for international harmonisation in quality assurance and quality management codes and standards.

13.10. The VICWG interacts with several Standards Development Organisations (ISO, AFCEN, etc.) and the World Nuclear Association's (WNA) working group on Co-operation in Reactor Design Evaluation and Licensing.

13.11. The UK Nuclear Site License, License Condition 17, require that, "The licensee shall, within its management systems, make and implement adequate quality management arrangements in respect of all matters which may affect safety". In assessing the adequacy of the Licensees' quality management systems ONR makes use of the relevant good practices set out in established international standards such as, for instance, IAEA Safety Standard GSR Part 2 and ISO 9001. The use of these standards by ONR is detailed in ONR's inspection guidance documents. Both the licensees considered in this report have achieved, and maintain, third party certification of their integrated management systems to ISO 9001.

13.12. ONR's dedicated site inspectors assesses the ongoing adequacy of the licensees' quality management systems as part of their inspection programmes. The site inspectors are supported by dedicated quality specialist inspectors assigned to the NGL Corporate ONR Inspection Team and to the HPC new build programme.

13.13. An element of these arrangements is supply chain management and securing quality through the supply chain. These arrangements, which include control of purchase of items and services and contract management activities, are fundamental for ensuring that the licensee applies appropriate levels of control, oversight and assurance throughout all organisations in its supply chain. ONR has developed and published guidance for its inspectors on procurement and contract management. Details are given in ONR TAG-77 'Supply chain management arrangements for the procurement of nuclear safety related items or services' (Ref. 13.7). ONR carry out targeted inspections of suppliers to the licensees, see 13.47.

13.14. ONR does not certify suppliers. It is the responsibility of UK licensees to establish adequate arrangements in respect of matters which may affect safety. This includes establishing adequate supply chain and quality management arrangements to ensure that suppliers can meet specified requirements that align to the required standards.

13.15. In producing the ONR Safety Assessment Principles (SAPs) (Ref. 13.8) and the supporting TAGs and TIGs (Refs. 13.9 and 13.10) ONR take cognisance of relevant IAEA Standards and Guidance. The SAPs, TAGs and TIGs provide a framework to guide regulatory decision-making in the regulatory permissioning process. The fundamental importance of leadership and management for safety (LMFS), and the adequacy of the licensees quality management arrangements are recognised throughout these documents.

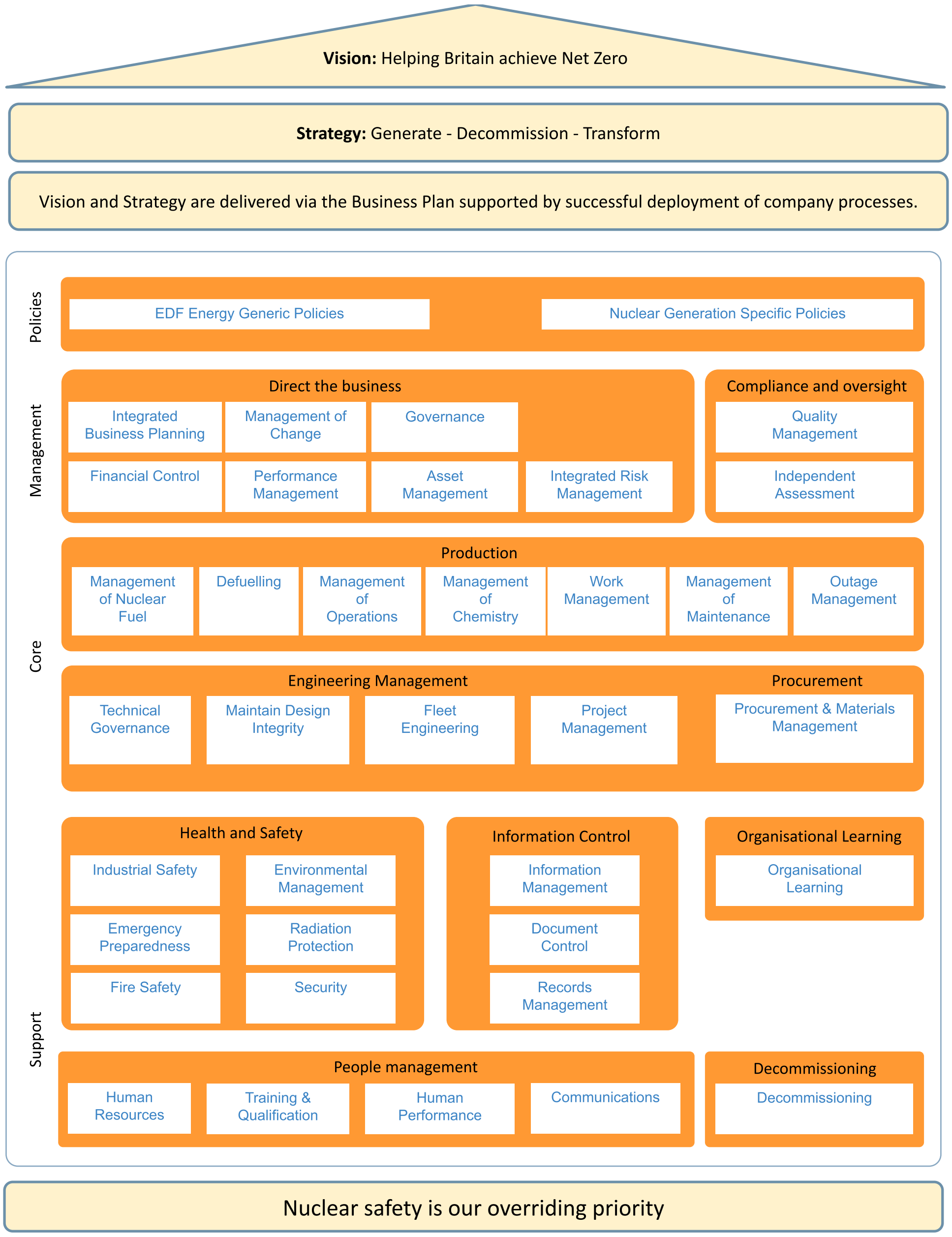
Overview and status of licensees' integrated management systems

13.16. EDF Energy NGL uses an integrated management system approach. It promotes a consistent approach to areas outside of the quality/safety management system including environment, security, transport and safeguards, and other business activities, to reduce the likelihood of incompatible arrangements.

13.17. EDF Energy NGL's integrated management system is mature. However, it continues to be developed to address changing circumstances (such as shutdown and defuelling of stations and associated organisational changes) and to address improvement opportunities.

13.18. EDF Energy NGL's management system has fleet-wide, third-party certification from an accredited external organisation to various international standards. Internal independent oversight of the system is provided by the internal regulator and assurance functions (see figure 13.1).

Figure 13.1: EDF Energy NGL's management system



Accessible version of Figure 13.1

A diagram illustrating EDF Energy NGL's management system.

Vision: Helping Britain achieve Net Zero

Strategy: Generate - Decommission - Transform

Vision and Strategy are delivered via the Business Plan supported by successful deployment of company processes.

Policies:

- EDF Energy Generic Policies
- Nuclear Generation Specific Policies

Management:

- Direct the business -
  - Integrated Business Planning
  - Management of Change
  - Governance
  - Financial Control
  - Performance Management
  - Asset Management
  - Integrated Risk Management
- Compliance and oversight -
  - Quality Management
  - Independent Assessment

Core:

- Production -
  - Management of Nuclear Fuel
  - Defuelling
  - Management of Operations
  - Management of Chemistry
  - Work Management
  - Management of Maintenance
  - Outage Management
- Engineering Management -
  - Technical Governance
  - Maintain Design Integrity
  - Fleet Engineering
  - Project Management
- Procurement -
  - Procurement & Materials Management

Support:

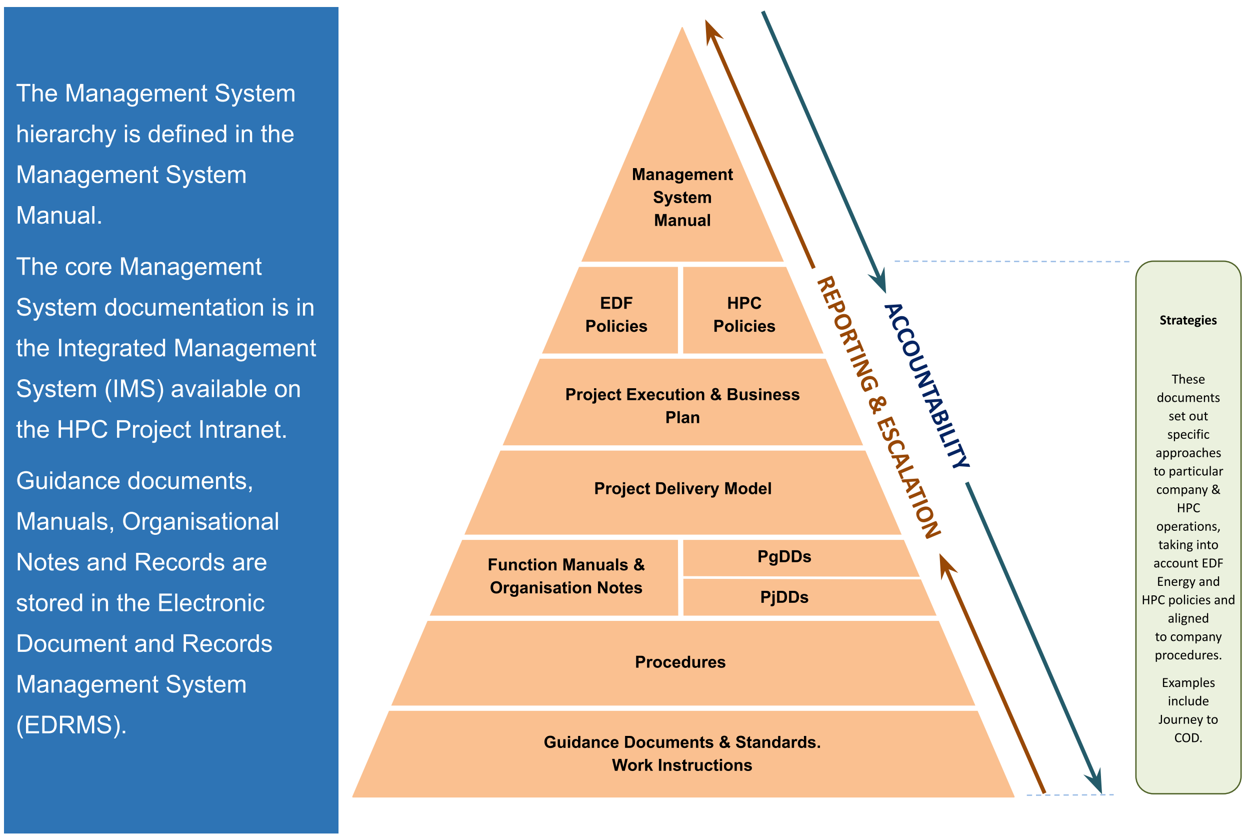
- Health and Safety -
  - Industrial Safety
  - Emergency Preparedness
  - Fire Safety
  - Environmental Management
  - Radiation Protection
  - Security
- Information Control -
  - Information Management

  - Document Control
  - Records Management
- Organisational Learning
  - Organisational Learning
- People management -
  - Human Resources
  - Training & Qualification
  - Human Performance
  - Communications
- Decommissioning -
  - Decommissioning

Nuclear safety is our overriding priority.

13.19. For the NPPs under construction at Hinkley Point C, NNB GenCo has a mature integrated management system which encompasses quality, environment, safety, and security to ensure it meets regulatory, legal and EDF requirements. In accordance with its approved integrated management strategy, the strategy continues to evolve to meet project phase demands including mechanical installation and commissioning and has an internal governance group providing oversight and direction (see figure 13.2).

Figure 13.2: NNB GenCo's management system



Accessible version of Figure 13.2

A pyramid diagram illustrating the NNB GenCo's management system.

Starting from the top, or point, of the pyramid to the base, the pyramid is broken into 7 sections stacked on top of each other. Reporting and escalation increases as you move up to the top and accountability decreases as you move down to the base.

From top to base:

1. Management System Manual
2. EDF Policies / HPC Policies
3. Project Execution & Business Plan
4. Project Delivery Model
5. Function Manuals & Organisation Notes / PgDDs & PiDDs
6. Procedures
7. Guidance Documents & Standards / Work Instructions

2-7. Strategies: These documents set out specific approaches to particular company & HPC operations, taking into account EDF Energy and HPC policies and aligned to company procedures. Examples include Journey to COD.

The Management System hierarchy is defined in the Management System Manual.

The core Management System documentation is in the Integrated Management System (IMS) available on the HPC Project Intranet.

Guidance documents, Manuals, Organisational Notes and Records are stored in the Electronic Document and Records Management System (EDRMS).

13.20. EDF Energy NGL sets out how quality is achieved through all applicable stages of the NPPs' life cycles via its Nuclear Generation Management System Manual.

13.21. Both licensees have responded effectively to the COVID-19 pandemic. They have implemented arrangements aligned with government guidance, which have allowed work to progress throughout the various national lockdowns without detriment to quality or safety. ONR has observed adherence to pandemic control measures on the sites and is content with both licensees' responses and protection of their workforces.

ONR's regulatory presence was reduced over the lockdown periods to protect staff, and to reduce the risk of onward transmission, although ONR did continue to undertake inspections, including remotely where appropriate. ONR has increased its site attendance substantially since national restrictions were relaxed and has now re-established most routine inspection work on the sites.

Main elements of quality management systems

Graded application of management system requirements

13.22. The application of management system requirements is graded by the licensees to provide a hierarchy of controls to activities depending on the safety significance and the related risk of the activities carried out. This approach ensures that appropriate and proportionate levels of controls are in place (including scrutiny, supervision, inspection, monitoring, documentation, training, audit, and surveillance) with respect to the safety significance of the activities undertaken, items procured or aspects of the plant design itself.

Documentation of the management system

13.23. The management systems are developed by the licensees to demonstrate compliance with the nuclear site licence conditions, pertinent legal requirements, and national and international quality management standards. The arrangements are subject to periodic review to ensure the management system arrangements remain fit for purpose and identify opportunities for continual improvement.

13.24. The licensees describe their management system documentation in hierarchical structures; see figures 13.1 and 13.2. The top tier includes policies, organisational structure, and the mission or principal objectives. The second tier contains processes and procedures. The third tier normally contains working level documentation, such as post profiles, instructions, drawings, technical procedures, and training material.

Planning

13.25. The licensees develop business plans for the various stages in the plant life cycle, for example, design, construction, commissioning and testing, operation, and decommissioning. The licensee identifies where the achievement of business plans requires the input of other organisations. Responsibility is retained by the licensee for the achievement and effectiveness of the plans and where appropriate, measurable objectives and targets are set for the achievement of performance. There are frequent and structured reviews of safety performance against specified performance indicators. These review processes include the monitoring of targets and the implementation of corrective actions.

Responsibility and authority for the management system

13.26. The management systems are authorised for use by the licensees' senior management and are mandatory for all employees and persons working on their sites. licensees' arrangements include processes to inform senior management of the suitability, adequacy of and level of compliance with the management system. The licensees identify the key responsibilities and accountabilities of personnel who carry out the work in related documents.

Process management

13.27. The licensees have identified and defined the processes required to achieve their objectives and process owners are allocated to ensure that processes are maintained. To optimise the effectiveness of processes, the licensees ensure that processes are planned, documented, assessed, reviewed, and improved. Work performed under each process is carried out under controlled conditions using approved procedures and instructions which are subject to periodic review. The licensees retain overall responsibility and intelligent customer capability where processes are contracted to other organisations.

Performance monitoring

13.28. Monitoring and measurement of performance is a fundamental element in the EDF Energy NGL management system. EDF Energy NGL employs multi-layered oversight, audit and review approaches to measure conformance including self-assessment, task-independent audit and review, and external independent audit and review. Some of the latter is carried out by third party organisations. Functional oversight is provided by the fleet managers and process owners. In addition to the audits and reviews carried out by the licensee, ONR, as part of its regulatory activities, carries out inspections of the licensee's arrangements.

13.29. Audit and assessment arrangements are embedded within topic areas. Results are used to monitor overall performance, compliance and identify improvement opportunities related to the topic area. Improvement activities are communicated throughout the fleet using the organisations reporting mechanisms.

13.30. NNB GenCo has a comprehensive quality performance monitoring regime which is integral to and supports the project progress and risk management arrangements. The Quality Department provides regular input into various of project reports, such as:

- Weekly Managing Director's Dashboard;
- Project Review Report;
- Performance Review; and
- Regulatory Topic RAG (Red/Amber/Green) report.

13.31. These reports show the high-level performance metrics related to quality across the programmes for manufacturing, construction, and installation.

Independent assessment

13.32. EDF Energy NGL deploys diverse means of independent assessment of its management system arrangements, including the procurement of nuclear safety related items and services.

13.33. The following are some of the activities undertaken by the EDF Energy NGL internal organisation and external independent bodies:

- An overall oversight programme which includes management system compliance auditing and regulatory oversight by the internal regulator;
- EDF Group Inspector General Annual Report (an EDF Group corporate requirement); and
- Internal control self-assessments of their processes.

13.34. Fleet-wide third-party certification of EDF Energy NGL's management system which has been maintained from Lloyd's Register Quality Assurance (LRQA) Ltd and consists of annual assessment visits for the following.

- ISO 9001:2015 (quality) (Ref. 13.11);
- ISO 14001:2015 (environment) (Ref. 13.12);
- ISO 45001: 2018 (occupational health and safety) (Ref. 13.13);
- ISO 55001: 2014 (Ref. 13.14) (asset management which covers the requirements for the planned and systematic arrangements for managing ageing plant and obsolescence); and
- WANO peer reviews.

13.35. The building of the 2 NPPs at Hinkley Point C is a major project involving thousands of workers and activities. NNB GenCo carries out, on a graded approach basis, audits, inspections, and surveillance of activities associated with design, procurement, manufacturing, delivery, storage, construction, testing and commissioning, and hand over to operations. Responsibilities for carrying out these quality control activities are detailed in the 'Guide to HPC Project Quality' along with the reporting lines and functions responsible for considering the outcomes from these quality control activities and taking the appropriate corrective and preventive actions.

13.36. NNB GenCo's independent internal regulator function provides oversight and assurance of Hinkley Point C's project performance against the required standards of safety, quality, environmental performance, security, and health and wellbeing, which is a key feature in the UK nuclear industry and a notable expectation of ONR. The Internal Regulator activities include the following elements:

- Independent Assessments of the organisation and its processes and procedures;
- Independent Technical Assessment of the safety case, design, design change and design process;
- Independent Site Inspections;
- Supply Chain Inspections; and
- Independent Security Assurance Inspections.

13.37. NNB GenCo maintains independent certification of its management system by LRQA to standards:

- ISO 9001:2015 (quality) (Ref. 13.11); and
- ISO 14001:2015 (environment) (Ref. 13.12).

Management system review

13.38. The licensees (EDF Energy NGL and NNB GenCo) carry out periodic reviews of their management systems in accordance with the international quality standards, which is to ensure the continued effectiveness of their arrangements and to provide a basis for continued improvement.

13.39. For EDF Energy NGL, information from several sources is taken into consideration, including the licensee's performance, supplier performance, results from all forms of audits and assessments, performance of processes, non-conformances and corrective actions, lessons learned from other licensees and operators, and opportunities for improvement. The reviews identify weaknesses and obstacles to good performance and determine where changes and improvements are required to be made to policies, objectives, and processes.

13.40. For NNB GenCo, management system reviews are carried out at least annually for the main disciplines of Quality, Safety, Environment and Site and cover the requirements from internal standards. The outputs in terms of performance and actions are monitored using the project action tracking tool to resolution. In addition to discipline management system reviews HPC has introduced an overall annual HPC IMS review which takes a more strategic review of its effectiveness. Monthly performance and escalation items are via the Project Review Report and covers IMS audit and self-assessment schedule achievement.

Improvement

13.41. The licensees use several processes to support continual improvement of their management systems. Once the need for improvement is identified, work is planned to ensure that it is properly resourced. Depending on the scale of the improvement, it may be included in the business plan or a specific improvement plan to ensure that its progress is monitored to completion.

13.42. The licensees actively support various nuclear safety related working groups and forums which have been established to improve safety performance such as the UK Safety Director's Forum (SDF) and its associated specialist sub-groups (see example below).

Supply chain quality working group [Example]

13.43. The UK Nuclear Industry Safety Directors' Forum (SDF) sponsors several workstreams to advance and improve performance and assurance across the nuclear sector. The Supply Chain Quality Working Group (SCQWG) was constituted in November 2014 and comprises key UK nuclear licensees, the MoD, and ONR. The group is considered the primary method of the overall SDF achieving its strategic 'Continuous support to transformational change on supply chain management and performance', Objective 5.

13.44. The vision of the SCQWG is to assist members in achieving 'Right First-Time delivery of nuclear safety related goods and services'. The purpose of the SCQWG is to provide guidance to the widest range of UK nuclear operators and suppliers. The SCQWG meets on a quarterly basis and has generated several Good Practice Guides which are considered relevant good practice (RGP) across the UK nuclear industry. The SCQWG has improved the awareness of the licensees of the existing and emerging safety risks within the nuclear supply chains and of the mitigating actions which the licensees need to take.

13.45. So far, the group has developed the following guidance (Ref. 13.15):

- Supply Chain Quality – Good Practice Guide;
- Supply Chain Mapping – Good Practice Guide;
- Counterfeit, Fraudulent and Suspect Items (CFSI) – Video; and
- CFSI – Risk guide/leaflet.

13.46. The group is developing CFSI training material, that will be made available to licensees with the option to freely rollout across their organisations and supply chains. The group share supply chain Operational Experience from within and outside the UK nuclear industry. The group members present at various forums and functions throughout UK industry.

13.47. On an annual basis the SCQWG develops a Critical Supplier List. The aim of this Critical Supplier List is to assist ONR in identifying and targeting key vendors for regulatory engagement and inspection.

13.48. During the COVID-19 pandemic, the group considered the risks presented by COVID-19 in terms of the potential impact to supply and the challenges to oversight of suppliers and associated inspection activities during the pandemic. ONR observed the group responding effectively to the challenges presented by COVID-19 and adapting its supply chain management approaches where appropriate to manage impacts. The group continues to meet remotely.

13.49. Whilst the SCQWG is limited to licensee members, a separate industry group under the Nuclear Industry Association (NIA) has been created called the NIA Quality Group. The Quality Group's membership comprises quality and supply chain leaders from key suppliers and from within their extended supply chain. This group's first formal meeting was in November 2021. It aims to function in a manner similar to the SDF SCQWG but with the membership consisting of suppliers.

Audits of vendors and suppliers

13.50. EDF Energy NGL has arrangements to effectively manage its supply chain to assure itself of the quality of the items and services supplied and ensure that safety is not adversely affected. An integral part of these arrangements is the evaluation and selection of suppliers and contractors, including the suitability of contractors to comply with the requirements of the licensee's management systems.

13.51. Work at EDF Energy NGL sites carried out by contractors is subject to supervision and monitoring by an appointed field supervisor, to ensure safety, quality, and environmental performance. The appointment of the field supervisor is the responsibility of each site's maintenance manager and is dependent on the complexity and location of the works.

13.52. Field supervisors have specified training requirements and are responsible for the following:

- Ensuring that the work supports safe and reliable operation of the plant and maintains full compliance within agreed safety, quality, and environmental standards and expectations;
- Ensuring the relevant safety documents have been issued to the work parties under the EDF Energy NGL Safety Rules and that the associated requirements have been communicated to the work teams;
- Ensuring that the working parties are set to work using the EDF Energy NGL setting to work process and pre-job brief process; and
- Ensuring the work parties fully understand and comply with the site requirements and procedures for working in radiation-controlled areas, including:
  - Monitoring the work, and the health and safety performance, throughout the duration of the contract;
  - Ensuring that the working parties comply with the maintenance standards and expectations for work site management, procedure use

and adherence compliance, management of foreign material control and the management of measurement and test equipment control; and

- Ensuring all accidents are reported in accordance with site procedures and arrangements.

13.53. Hinkley Point C project has arrangements to effectively coordinate the audit of its supply chain. Audits and assessments are managed in a single tool to optimise planning, reporting, management of findings and trend analysis. An integral part of these arrangements is the evaluation and selection of suppliers and contractors, including the suitability of contractors to comply with the requirements of the licensee management systems and contract requirements.

13.54. The supply chain management arrangements, including the audit and inspection of vendors and suppliers to the Hinkley Point C project has been an area of significant regulatory focus for ONR as NNB GenCo's supply chain activities continue to increase. NNB GenCo has been developing and implementing significant improvement plans, based on operational experience, to enhance its arrangements for supply chain manufacturing surveillance and lifetime quality records (LTQR) across the Hinkley Point C project.

13.55. ONR's regulatory approach has focused on seeking assurance that NNB GenCo oversight arrangements are effective in securing sustainable improvements in producing systems and components to the required quality standards, supported by robust quality assurance and record management arrangements. As the supply chain activities at Hinkley Point C will peak at the end of 2022, ONR quality, supply chain and technical specialists are undertaking an extensive programme of inspections at suppliers of safety related systems and components at factories in the UK and overseas.

Quality of supplied items

13.56. The quality and completeness of LTQRs provided by UK and international suppliers to Hinkley Point C was identified as an issue by ONR in 2019 (see example below).

Hinkley Point C – The quality and completeness of lifetime quality records [Example]

13.57. ONR expects that the licensee, NNB GenCo, ensures that adequate manufacturing and construction records are produced for Hinkley Point C and provided to the required timescales.

13.58. Since the ramp-up in construction and equipment, issues relating to the quality and completeness of records for plant construction and equipment manufacture were being highlighted at various stages of manufacture and construction, with various suppliers/contractors on-site and throughout the supply chain.

13.59. Since such records are evidence that the equipment and facility will meet the safety case requirements, there was the potential for shortcomings in LTQRs to adversely impact ONR's regulatory decisions on subsequent permissioning activities.

13.60. HPC carried out a review of Life Time Quality Records (LTQRs) in 2019, which identified significant shortfalls. ONR had also identified shortfalls in the quality and completeness of LTQR's. ONR were not satisfied that NNB GenCo was taking effective actions to address issues. Consequently, ONR took enforcement action, placing a Level-2 Regulatory Issue on NNB GenCo in October 2019.

13.61. In response, the licensee (NNB GenCo) developed a quality record improvement strategy and quality record improvement plan.

13.62. Through dedicated meetings with the licensee, review of evidence and targeted interventions, ONR concluded that, the licensee has put in place suitable arrangements, responsibilities, and resources to improve the management and delivery of right first-time LTQRs on-site and within the supply chain. ONR continues to monitor performance in this area.

13.63 Quality issues were reported in the UK's eighth NR under Article 13, relating to material supplied by Creusot Forge and Kobe Steel. The issues have since been resolved to ONR's satisfaction as detailed below.

Le Creusot Forge anomalies [Example]

13.64. In the UK's eighth NR ONR detailed the quality records shortfalls which were reported in 2017 at Le Creusot Forge in France, and the potentially adverse impact that these issues had for the UK's existing Pressurised Water Reactor at Sizewell B and for the new NPPs under construction at Hinkley Point C.

13.65. Extensive corrective actions were taken by the supplier and interested parties including EDF SA, EDF Energy NGL, NNB GenCo, the French Nuclear Regulator ASN, and ONR.

13.66. ONR's Chief Nuclear Inspector and a team of 5 inspectors, at that time examined areas such as resources, training, safety culture and management of non-conformances (Ref. 13.16). ONR was able to confirm that significant progress had been made by Le Creusot Forge in improving the safety and quality culture and that actions taken to tackle the main issues of concern were either completed or close to completion. ONR has continued to monitor the ongoing improvements at Le Creusot Forge, particularly relating to primary circuit forgings destined for the new NPPs being constructed at Hinkley Point C.

13.67. The improvement in this supplier's quality performance was considered by ONR as part of its regulatory assessments carried out in support of the recent granting of regulatory permission to bring these components to site for installation.

13.68. However, the adequacy of the licensees' supply chain management arrangements continues to be considered as part of routine regulatory engagements.

Kobe Steel [Example]

13.69. In the UK's eighth NR, ONR detailed the actions it initiated in response to the reported quality issues with Kobe Steel. 13.70. In June 2016 a quality issue was detected at Shinko Wire Stainless Company, Ltd. (part of Kobe Steel's Iron and Steel business). As a result, Kobe Steel launched an internal review of key manufacturing facilities and service locations.

13.71. Given the initial findings, in August 2017, Kobe Steel conducted a further self-inspection across its entire business group of all products shipped during the previous year. The assessment confirmed multiple business locations were engaged in inappropriate conduct including improper handling of test data. The self-inspection identified examples of employees working in multiple departments, including manufacturing and quality assurance, being involved in inappropriate conduct over a long period.

13.72. ONR became aware of the counterfeit, fraudulent, suspect items (CFSI) event from its domestic and international regulatory activities in October 2017.

13.73. Evidence indicated that the implicated materials/products (including copper, aluminium, steel wire, stainless steel wire and heavy steel plate) associated with the Kobe Steel Group event in 2017 had probably not impacted the UK nuclear industry. However, ONR requested that potentially affected UK licensees carry out investigations into their own arrangements, and that of their suppliers, to assess the potential impact from the Kobe Steel event.

13.74. The licensees confirmed that they had not been impacted by the Kobe Steel incident. The licensees shared their findings at a UK licensees' supplier forum to ensure a common understanding of the risks and potential impact. The veracity of the collective responses was reviewed and considered by ONR Supply Chain Specialist Team who concluded that the UK NPP fleet had not been adversely affected by the Kobe Steel Event.

13.75. As the risks from products supplied by Kobe Steel were identified as low, ONR did not perform specific inspections or activity to verify the licensees' submissions – this is fully in line with ONR's regulatory principles. However, the adequacy of the licensees' supply chain management arrangements continues to be considered as part of routine regulatory engagements.

UK leaving the European Union

Maintaining supply chains

13.76. On 29 March 2017, the UK formally notified the EU of its intention to withdraw.

13.77. This started a period of negotiation between the UK and the EU. This negotiation period allowed EDF Energy to put in place arrangements and contingencies to ensure that key European supply chain risks were managed.

13.78. EDF Energy NGL secured sufficient supplies of key components, including nuclear fuel, to ensure that operation and maintenance activities were unaffected.

13.79. The link between EDF Energy NGL in the UK and EDF in France helped to ensure that potential issues were mitigated. This included using the EDF Group as a source of uranic material to secure the fuel supply chain.

UK conformity assessment

13.80. The UK leaving the EU resulted in the potential for changes in standards as the UK developed its own conformity assessment arrangements.

13.81. EDF Energy NGL supply chain already contains equivalence and obsolescence arrangements, which were associated with management of aging plant. These arrangements have been used to ensure that UK and European sourced components remain fit for purpose and acceptable for use within of EDF Energy NGL's NPPs.

13.82. The age of the AGR power stations meant that many of the components were designed before the development of European standards and conformity assessment. The return to UK conformity assessment is manageable under current arrangements.

13.83. Sizewell B is a US-designed reactor and uses many components that are designed to ASME requirements.

Article 13 references

13.1 The United Kingdom's Eighth National Report on Compliance with the Obligations of the Convention on Nuclear Safety (https://www.iaea.org/sites/default/files/national_report_of_the_united_kingdom_for_the_8th_review_meeting.pdf), Department for Business, Energy & Industrial Strategy, August 2019.

13.2 IAEA Safety Standard GSR Part 2, Leadership and Management for Safety (https://www-pub.iaea.org/MTCD/Publications/PDF/Pub1750web.pdf).

13.3 IAEA Safety Guide, GS-G-3.1 (2006), Application of the Management System for Facilities and Activities (https://www-pub.iaea.org/MTCD/Publications/PDF/Pub1252_web.pdf).

13.4 IAEA Safety Guide, GS-G-3.5 (2009), The Management System for Nuclear Installations (https://www-pub.iaea.org/MTCD/Publications/PDF/Pub1392_web.pdf).

13.5 ONR Licence Condition Handbook (https://www.onr.org.uk/documents/licence-condition-handbook.pdf).

13.6 The Energy Act 2013 (https://www.legislation.gov.uk/ukpga/2008/32/contents).

13.7 Supply Chain Management Arrangements for the Procurement of Nuclear Safety Related Items or Services (https://www.onr.org.uk/operational/tech_asst_guides/ns-tast-gd-077.pdf).

13.8 ONR Safety Assessment Principles, 2014 (http://www.onr.org.uk/saps/saps2014.pdf).

13.9 Technical Assessment Guides (https://www.onr.org.uk/operational/tech_asst_guides/index.htm).

13.10 Technical Inspection Guides (https://www.onr.org.uk/operational/tech_insp_guides/index.htm).

13.11 ISO 9001:2015 Quality Management Systems Requirements (https://www.iso.org/standard/62085.html)

13.12 ISO 14001:2015 Environmental Management Systems (https://www.iso.org/standard/60857.html).

13.13 ISO 45001:2018 Occupational Health and Safety Management Systems (https://www.iso.org/standard/63787.html).

13.14 ISO 55001: 2014 Asset Management – Management System – Requirements (https://www.iso.org/standard/55089.html).

13.15 Supply Chain Quality Working Group (https://www.nuclearinst.com/SCQ) (nuclearinst.com)

13.16 Hinkley Point C – Chief Nuclear Inspector's Inspection of EDF NNB GenCo (HPC) Ltd's Supply Chain Management Arrangements (https://www.onr.org.uk/intervention-records/1718/hinkley-point-c-17-014.htm).

Article 14 – Assessment and Verification of Safety

> Each Contracting Party shall take the appropriate steps to ensure that:
>
> I. comprehensive and systematic safety assessments are carried out before the construction and commissioning of a nuclear installation and throughout its life. Such assessments shall be well documented, subsequently updated in the light of operating experience and significant new safety information, and reviewed under the authority of the regulatory body.
>
> II. verification by analysis, surveillance, testing and inspection is carried out to ensure that the physical state and the operation of a nuclear installation continue to be in accordance with its design, applicable national safety requirements, and operational limits and conditions.

14.1. Compliance with this Article of the Convention is demonstrated in a way that has not substantially changed since the United Kingdom's (UK) eighth National Report (NR) (Ref. 14.1) (in a way that has implications for the Convention obligations).

14.2. Significant portions of this Article demonstrate compliance with **VDNS Principle 2**.

Legal requirements for safety assessment and safety verification

14.3. The Office for Nuclear Regulation's (ONR) Licence Conditions (LC) (Ref. 14.2) require the licensee to put in place arrangements to ensure that an adequate safety case is produced and maintained before construction and throughout the life of a nuclear installation. The conditions require the licensee to verify that the installation is operated and maintained within the limits and conditions identified in the safety case. The LCs (see Table 6 – Licence Conditions) most relevant to safety assessment and/or safety verification and hence the Convention consist of:

- LC13 (Nuclear Safety Committee);

- LC14 (Safety documentation);
- LC15 (Periodic review);
- LC16 (Site plans, designs and specifications);
- LC19 (Construction or installation of new plant);
- LC20 (Modification to design of plant under construction);
- LC21 (Commissioning);
- LC22 (Modification or experiment on existing plant);
- LC23 (Operating rules);
- LC24 (Operating instructions);
- LC27 (Safety mechanisms, devices and circuits);
- LC28 (Examination, inspection, maintenance and testing);
- LC29 (Duty to carry out tests, inspections and examinations); and
- LC30 (Periodic shutdown).

14.4. In addition, important to the competency, capability and control and supervision of personnel who are involved in safety assessment and/or safety verification are LCs 10 (training), 12 (duly authorised and other suitably qualified and experienced persons), 26 (control and supervision of operations) and 36 (organisational capability). The licensee must also have arrangements for compliance with relevant statutory provisions of the Health and Safety at Work Act 1974 (HSWA74) (Ref. 14.3). Examples include the Management of Health and Safety at Work Regulations 1999 (MHSWR99) (Ref. 14.4), which require the licensees to make assessments of the health and safety risks of their activities, and the Ionising Radiation Regulations 2017 (IRR17) (Ref.14.5), which provide for the protection of all workers and members of the public from ionising radiations, as well as other appropriate legislation (see Article 7 – Legislative and Regulatory Framework or further details).

Assessment of safety

14.5. In addition to nuclear site licensees, those with dutyholder responsibilities in terms of assessment of safety of potential new nuclear power stations include:

- Requesting parties for a Generic Design Assessment (GDA), (discussed in paragraph 14.24 to 14.32);
- Organisations intending to apply for a nuclear site licence (prospective licence applicant); and
- Organisations that have applied for a nuclear site licence (licence applicant).

Safety assessment by the dutyholder: the safety case

14.6. To comply with LC23, each Nuclear Power Plant (NPP) must have a valid safety case, which is essentially a written demonstration that relevant standards and legal requirements have been met and that risks have been reduced so far as is reasonably practicable as required by UK law.

14.7. LC14 requires that arrangements be made for the production and assessment of safety cases consisting of documentation to justify safety during the design, construction, manufacture, commissioning, operation, and decommissioning phases of the installation. Therefore, the safety case is not a one-off series of documents but a living framework which underpins all safety-related decisions made by the dutyholder.

14.8. ONR does not prescribe the format of safety cases but ONR's SAPs (Ref. 14.6) and TAGs, including NS-TAST-GD-051 (Ref. 14.7), set out what ONR expects a safety case to demonstrate. The safety case should demonstrate in writing that the plant, its processes, activities, and any modifications:

- Identify all credible faults and hazards;
- Meet any relevant design safety requirements and criteria;
- Conform to relevant good nuclear engineering practice and to appropriate standards and codes of practice or other relevant good practice;
- Are adequately safe during all modes of operation and fault conditions;
- Are, and will remain, fit for purpose;
- Give rise to a level of nuclear risk to both public and workers which is ALARP; and
- Have a defined and acceptable operating envelope, with defined limits and conditions, and the means to keep within the envelope (safety management).

14.9. During the operational and decommissioning phases, the nuclear power plant safety case is updated as necessary to reflect changes to plant or procedures and respond to challenges arising from operational experience, new safety analysis, techniques, research findings, plant modifications, plant ageing and the outcome of Periodic Safety Reviews (PSR).

14.10. EDF Energy NGL has developed its own Nuclear Safety Principles that set out the deterministic and probabilistic acceptance criteria against which it judges each safety case. Similarly, NNB GenCo has developed Nuclear Safety Design Assessment Principles. In addition to their nuclear safety principles, the dutyholders conduct their assessment in line with a range of British, European, and international standards. This is in line with **VDNS Principles 2 and 3**.

14.11. The magnitude, complexity, and evolution of the safety case through the life of each plant requires the implementation of robust systems to manage its development. The licensees put systems in place to properly manage the changes to the safety cases to ensure that these accurately reflect the as-built and as-operated plant. Thus, the documentation that forms the safety case is subject to appropriate management systems required by LC17 (discussed in paragraph 13.7), and any changes to the safety case are regulated as modifications under LC22 or LC20.

Safety assessment by the dutyholder: safety analysis

14.12. The analyses of normal operating conditions show that resultant radiation doses due to ionising radiations, both to members of the workforce and the public, are, and will continue to be, below regulatory limits and, furthermore, are ALARP (see Article 15 – Radiological Protection).

14.13. The accident analyses use the complementary approaches of design basis analysis (DBA), probabilistic safety analysis (PSA) and severe accident analysis (SAA), as appropriate. The dutyholders prepare an analysis of faults that could initiate accident sequences (initiating faults) and the defences available at the plant to mitigate the predicted consequences. A comprehensive fault schedule that includes internal initiating events as well as internal and external hazards is the starting point of both deterministic and probabilistic safety analyses.

14.14 The deterministic approach is used in the analysis of design basis accidents to demonstrate the capability of the safety systems. As part of this approach, the dutyholders are expected to ensure that a small change in design basis parameters does not lead to a disproportionate increase in radiological consequences (cliff-edge effects). Analyses are also undertaken for more severe faults outside the design basis, and of severe accidents which could lead to large releases of radioactivity. These severe accident analyses include study of the potential failures of the physical barriers to the release of radioactivity, analysis of the magnitude and characteristics of the releases, identification of the accident management strategies to reduce the risk, together with the necessary equipment, instrumentation, and accident management procedures. Additional information regarding the accident analyses undertaken for UK NPP can be found under Article 18 – Design and Construction.

14.15. It is a requirement of dutyholders that internal hazards on nuclear facilities be identified and their effects considered in safety assessments. Internal hazards are those hazards to plant, structures and personnel which originate within the site boundary but are external to the primary circuit in a reactor. The dutyholder needs to demonstrate control over internal hazard initiating events. Internal hazards include internal flooding, fire, toxic gas release, collapses, dropped loads, impacts from vehicular transport and explosion/missiles.

14.16. The safety assessment should demonstrate that threats from internal hazards are either removed or tolerated and minimised. This may be done by showing that structures, systems, and components important to safety are designed to meet appropriate performance criteria, and by the provision of safety systems, which mitigate the radiological consequences of fault sequences. Assessment of internal hazards is also discussed in paragraphs 18.33 to 18.36.

14.17. In addition, the safety assessments must demonstrate that threats from external hazards are removed, minimised, or mitigated. For each type of external hazard identified as applicable to a particular site, a design basis event is defined. A frequency of 1×10^{-4} per year (conservatively defined) is considered reasonable in the UK (SAP EHA.4) for defining the severity of the design basis event for natural hazards. However, due attention should be paid to providing adequate capacity for events beyond the design basis, and 'cliff edge' effects should be avoided as far as practicable.

14.18. For all external hazards, the safety case demonstrates that the design has sufficient robustness to allow shutdown and cooling of the reactor from any operating state, and integrity (and cooling as required) of any other facility at the nuclear power plant where significant amounts of radioactive material are expected to be present (for example facilities for handling spent nuclear fuel). Further information regarding the assessment of external hazards can be found in paragraphs 18.47 to 18.55.

14.19. The PSA provides a comprehensive, systematic analysis of the plant response to a fault condition and the numerical analysis of the risk from the plant, to support the demonstration of safety. ONR's SAPs expect PSA to be performed as part of the fault analysis and design development and analysis, and to be used to inform the design process and help ensure the safe operation of the site and its facilities. The PSAs for all operating reactors within the UK are "living PSAs" and updated periodically, or if there are significant changes to plant or operations that require a more frequent update. The updates include revisions to initiating event frequencies, plant reliability data, hazards analysis and other modelling aspects.

14.20. The PWR at Sizewell B has a full scope Level 1, 2 and 3 PSA. The Level 1 PSA is updated to provide an estimate of the core damage frequency as part of the living PSA programme, and this is used to provide revised Level 2 and 3 dose/risk information.

14.21. The PSAs for the AGR fleet are hybrid PSAs. They include a Level 1 PSA and elements of a Level 3 PSA in the form of off-site dose estimates to a person in 5 dose bands (the dose bands are those shown in Target 8 of ONR's SAPs). As a result of the UK response to the Fukushima accident, a Level 2 PSA was produced for one AGR that is representative of the fleet. EDF Energy NGL took the lessons from that study and carried them through to the other UK AGRs via an ownership report. Significantly, this study provided EDF Energy NGL with further evidence that for AGRs, the time for accident response is far more than that possible for PWR designs (of the order of hours rather than minutes). Each AGR station also has a specific fuel route PSA.

14.22. For new build reactors (for example Hinkley Point C), Level 1, 2 and 3 PSAs are being carried out, consistent with international expectations. ONR expects that all new reactors will have a living PSA programme in line with relevant good practice.

NNB GenCo approach to safety assessment

14.23. This section gives evidence in support of UK's compliance with **VDNS Principle 1**.

14.24. In line with ONR regulatory expectations, as captured in the licence conditions for safety documentation and operating rules of the site licence, the Hinkley Point C project produces safety assessments to support the design, construction, commissioning and (future) operation of the facility. These assessments are produced against a well-defined set of arrangements for their production and assessment, formalised within the Hinkley Point C project procedures.

14.25. The starting point for the Hinkley Point C safety assessments was the combination of a generic assessment of the UK EPR^{TM} design, combined with site specific elements related to the Hinkley Point C site. The UK EPR^{TM} reactor design was subject to the UK Generic Design Assessment (GDA) process and a Design Acceptance Confirmation (DAC) and Statement of Design Acceptability (SoDA) were issued when this process was completed in 2012.

14.26. The GDA process is now a 3-stage process, and although it consisted of 4 stages for the assessment of the EPR^{TM}, the scope of assessment remains the same. The requesting parties for the UK EPR^{TM} design were EDF and AREVA (now Framatome). The design assessed during GDA was based upon the Flamanville 3 (FA3) EPR^{TM} design as it was at the start of GDA. Modifications to this design occurred during GDA from feedback from the GDA assessment and this became the initial design for Hinkley Point C. The FA3 design has remained the Hinkley Point C reference design with modifications and learning continuing to flow from FA3 to Hinkley Point C. The completion of the GDA process resulted in the identification by the regulators of 714 GDA Assessment Findings (AFs) that needed to be resolved by the future licensee. Currently 366 of the 714 have been closed.

14.27. The site-specific elements of the Hinkley Point C site were brought together with the GDA safety assessment, through the addition of site-specific modifications, and resulted in the production of a Pre-Construction Safety Report (known as PCSR 2012). Whilst this document was not used to justify the commencement of any site activities at that time, it was an important starting point for the Hinkley Point C safety assessments with the combination of the generic and site-specific elements.

14.28. In accordance with LC19, the Hinkley Point C project has been split into numerous phases of construction with associated hold-points, some of which require ONR permission. Where these have a significant nuclear safety risk associated with them, Hinkley Point C has produced further safety assessments to justify the activities being undertaken. For Hinkley Point C reactor 1, to justify the commencement of construction of First Nuclear Safety Concrete (FNSC), the Hinkley Point C Technical Galleries, Construction Safety Justification 1 (CSJ-01) was produced. This built upon PCSR 2012 and provided supplementary assessment. To justify start of pouring Nuclear Island Concrete (NIC) and support all further construction activities through to commissioning, PCSR3 was issued in 2017, along with supplementary safety reports issued in 2018; these supported start of pouring NIC in 2018. The next full scope safety submission for Hinkley Point C will be the Pre-Commissioning Safety Report (PCmSR), demonstrating readiness to load nuclear fuel into the core and to perform active commissioning of HPC.

14.29. A key element of the site-specific parts of the Hinkley Point C safety case relates to internal and external hazards. The GDA only included generic aspects in relation to hazards as it was not written for a specific UK site. Therefore, Hinkley Point C has had to develop the site-specific aspects of the safety case, taking account of the local geology, meteorology, and general site characteristics. This has included major programmes of site data collection and historical record analysis followed by detailed interpretation and conversion into data to be used in the Hinkley Point C design (for example the Hinkley Point C Probabilistic Seismic Hazard Assessment (PSHA)). In addition, UK specific methodologies have had to be developed using the French reference hazards as a starting point but adding UK specific expectations for Hinkley Point C. In some areas, such as internal flooding, this has led to different methodological approaches between the UK and France. In turn, this has led to further design differences between Hinkley Point C and FA3.

14.30. A further key part of the site specific Hinkley Point C safety case is in relation to the fault studies and the starting point for HPC is the GDA fault studies. The development of the Hinkley Point C fault studies has taken account of modifications that have been made to the Hinkley Point C design. In addition, the fault studies carried out for Sizewell B have been interrogated to understand any UK specific approaches that might be adopted for Hinkley Point C. A further key evolution for the presentation of the fault studies at Hinkley Point C, when compared to the FA3 reference design, is the production of a fault and protection schedule (F&PS). This is a normal expectation in the UK context and has been an important development for Hinkley Point C linking the fault studies to the lines of protection and levels of diversity, among other things.

14.31. Since the UK EPR^{TM} is an evolutionary design, with many decisions on fundamental safety approaches dating back to the 1990s, the assessment that risks have been reduced as low as reasonably practicable (ALARP) needs to largely build on the evolutionary developments and the use of operational experience (OPEX) and learning from earlier plants. Where further decisions have then been made that alters the UK EPR^{TM}design in a more specific UK direction, these are underpinned by additional optioneering and assessment that risks have been reduced ALARP. Fundamentally, the UK EPR^{TM} design being built at Hinkley Point C already presents a very low risk in relation to nuclear safety frequency targets and there are few, if any, major changes that might be made that could be considered as reasonably practicable.

14.32. Strong configuration management is fundamental to maintaining a good quality safety case that is aligned to the current Hinkley Point C design. The FA3 design was used as a starting point for Hinkley Point C but has itself continued to evolve and this has included important learning for Hinkley Point C. At the same time, the HPC design has evolved in other directions to take account of UK specificities in relation to codes, standards, and UK practice. These have been managed using the Hinkley Point C configuration control processes and introduced in batches that are termed Reference Configurations (RC). For Hinkley Point C these have been RC0 (Hinkley Point C starting RC), RC1 (including extensions RC1.1 and RC1.2) and RC2. The Hinkley Point C PCSR3 was written against RC1.2 and the Hinkley Point C PCmSR will be written against RC2. Any safety significant changes to the Hinkley Point C design undergo formal safety assessment against Hinkley Point C's arrangements for LC20 (modification to design of plant under construction). The LC20 arrangements require the production of updates to the Hinkley Point C safety assessment (generally in the form of supplementary documentation to be subsumed into the main safety case at a later point).

Safety Assessment by the dutyholder: safety reviews

14.33. This section gives evidence in support of UK's compliance with VDNS Principles 2 and 3.

14.34. Major safety reviews are carried out by licensees, every 10 years (or more frequently, if necessary, for example following a major event). The legal basis for PSRs in the UK is embodied in the licence conditions. LC15 requires licensees to "make and implement adequate arrangements for the periodic and systematic review and reassessment of safety cases." PSR is therefore a well-established practice in the UK. ONR's PSR TAG sets out what ONR expects to see in the PSR.

14.35. The purpose of the review is to revalidate the extant safety case, to ensure the plant and operations remain adequately safe and fully reflect the site licence requirements. This is achieved by reviewing the previous 10 years of operation together with considering changes in activities or plant conditions that impact on nuclear safety over the following 10 years. The review takes into consideration compliance with modern standards and potential impact of ageing and obsolescence.

14.36. There has been a requirement for licensees to undertake PSRs since the introduction of the standard nuclear site licence in 1990. ONR ensures that licensees comply with this requirement and judges the adequacy of the PSR that has been undertaken. ONR can, as it deems necessary, direct licensees to undertake a further review at any time. The programme for the UK's nuclear installations' PSRs is given in figure 14.1 below.

14.37. The PSRs aim to confirm that plant condition and the arrangements are adequate to maintain safety until at least until time of the next review. As stated above, PSRs complement the normal operational monitoring of safety, and proper management of ageing effects, which is also regulated by ONR. Therefore, although the PSRs may conclude that the arrangements are adequate for another 10 years; operation will be dependent upon a robust safety case underpinned by continuing satisfactory results from routine inspections. Should any inspection or safety-related factor emerge in the interim period that may cast doubt upon the continuing validity of the safety case (and hence, of the safety of reactor operations), this would require the licensee to resolve the matter to ONR's satisfaction or to suspend power generation.

14.38. EDF Energy NGL has completed the third round of decennial (10 yearly) PSRs (PSR3) for the AGR fleet and a third PSR for Sizewell B is scheduled for 2024. The approach taken for PSR3 is closely aligned to the latest International Atomic Energy Agency (IAEA) guidance on PSRs (SSG-25) (Ref. 14.8) and the focus was on the adequacy and effectiveness of the normal business arrangements in place to ensure plant safety. The main changes included in PSR3 are:

- Better use of company processes to deliver PSR evidence where practicable and enable continuous improvement;
- A more integrated approach to managing PSR recommendations within the overall station risk portfolio;
- Provision of a more robust statement on the management of risk over the PSR period; and
- Alignment of the review structure to international practices as recommended in IAEA guidance, SSG-25. This is in line with **VDNS Principle 3**.

14.39. The ONR findings from its assessments of the completed PSR reports for each station are published on the ONR website (Ref. 14.9).

Figure 14.1: Status of Periodic Safety Reviews at EDF Energy NGL Stations

NPP Sites	Operational Since	1st Review	2nd Review	3rd Review
Hinkley Point B	1976	1996	2006	2016
Hunterston B	1976	1996	2006	2016
Dungeness B	1983	1997	2007	2017
Heysham 1	1983	1998	2008	2018
Hartlepool	1983	1998	2008	2018
Heysham 2	1988	1999	2009	2019
Torness	1988	1999	2009	2019
Sizewell B (PWR)	1995	2005	2014	Planned for 2024

Safety assessment by the dutyholder: improvements as a result of safety assessments and reviews

14.40. The results of the PSRs have produced, and continue to produce, worthwhile improvements to safety. Since the UK's eighth NR, several projects arising from previous periodic reviews, or from event-driven reviews have delivered improvements in nuclear safety at EDF Energy NGL power stations. Examples include:

- Extensive inspections of the reactor peripheral shield walls at Heysham 2 and Torness following discovery of unexpected cracking. The inspection programme has provided significant confidence that the shield walls are in generally good condition with very low occurrence of cracking that is likely to have been present since very early on in life;
- Ongoing projects to enhance the secondary shutdown systems at Heysham 2 and Torness, and Hartlepool and Heysham 1, to mitigate the potential for primary shutdown reliability to be affected by late life effects of graphite core brick cracking (see Article 6 – Existing Nuclear Installations); and
- Enhancements to the detection of, and protection against transmission system single phase faults at all the AGRs. This followed identification of design weaknesses against this fault mechanism which were not previously recognised within the safety cases (see Article 6 – Existing Nuclear Installations).

Regulatory review of dutyholders' safety submissions

14.41. ONR assesses the safety of proposed and existing sites and nuclear installation designs through review of the licensees' (or requesting parties' in the case of GDA) safety submissions.

14.42. In the UK, there are different regulatory requirements for nuclear safety, security, and the environment. To ensure that there are no inconsistencies in what the regulators do, safety, security and environmental regulators work as an integrated team whenever possible. They attend programme meetings together, often conduct interventions together and share reports when there are mutual interests. They also meet with the dutyholders together. The GDA process is a successful example of joint working between the nuclear regulators.

14.43. When licensees submit requests for permission to carry out activities supported by safety submissions, or a GDA requesting party submits a generic design and safety case for regulatory assessment, ONR sets standards for the reviews and assessments using the guidance in the SAPs and TAGs.

14.44. In its assessment of safety cases, ONR seeks assurance that the ALARP principle has been met, as this is required by law. To aid in this judgement ONR inspectors make use of the SAPs numerical targets which set the deterministic and probabilistic criteria to be used when considering whether radiological hazards are being adequately controlled and risks reduced to ALARP (for further details, see paragraphs 695 to 767 of the SAPs (Ref. 14.6)).

14.45. It should be noted that ONR does not approve the codes and standards chosen by the dutyholders. The choice of codes or standards to underpin the design and safety case is a matter for the dutyholder. ONR will assess the safety case and among other things will take a view on the standards that have been used. Where a standard is well known to ONR or an internationally recognised standard has been used, for example, ASME III, there is unlikely to be any examination of the standard itself; however, the standard's application may be reviewed. Where the standard being used is new or unfamiliar to ONR, then the dutyholder will be asked to justify its use.

14.46. In its appraisal of a nuclear power plant safety case, ONR's inspectors seek certain attributes in the licensees' safety submissions. The safety case should be intelligible, valid, complete, evidential, robust, integrated, balanced, and forward looking.

14.47. ONR specialist inspectors have the capability to commission analysis work from several Technical Support Contractors (TSC). This work is used to support their technical assessment of safety case submissions. TSCs do not make regulatory judgements but provide expert reliable advice to ONR inspectors. Funding for the work is charged directly to the relevant dutyholder.

14.48. The output of the assessment by an inspector from a particular technical discipline is captured in an assessment report, which is signed off by the head of the relevant technical discipline. ONR project or site inspectors bring together and integrate the findings from assessment reports covering each of the relevant technical areas and provide an overall conclusion regarding the adequacy and acceptability of the assessed safety case, leading to a recommendation as to whether permission should be granted for the requested activity. This is formally documented in a project assessment report (PAR). To ensure openness and transparency of regulatory decisions, PARs are published on the ONR website (Ref. 14.10) (also see Table 2 – Summary of Nuclear Safety Assessments).

14.49. The mechanics of assessment in GDA (Ref. 14.11) are similar to the process described in the paragraphs above. The regulators (ONR and environmental regulators) publish Regulatory Observations (raising potential regulatory shortfalls) and Regulatory Issues (identifying serious regulatory shortfalls) raised by the GDA assessment team as well as the technical assessment reports.

14.50. In its assessment of nuclear power plant fault analyses, ONR uses relevant SAPs and TAGs, other guidance such as WENRA and industry relevant good practice (RGP). The Basic Safety Objectives (BSOs) of the SAPs numerical targets are used as benchmarks that reflect modern standards and expectations. Thus, ONR refers to the BSOs when judging whether analyses are demonstrating adequate results for new reactors.

14.51. In line with wider international guidance, ONR expects the severe accident analysis to form part of a demonstration that potential severe accident states have been ‘practically eliminated’. For this, the safety case should show either that it is physically impossible for the accident state to occur or that design provisions mean that the state can be considered extremely unlikely with a high degree of confidence.

14.52. Ultimately, ONR seeks confirmation that the level of risk is reduced in so far as is reasonably practicable and that it would be disproportionate whether in terms of money, time, or trouble to reduce risk further by implementing additional improvements. The document Risk Informed Regulatory Decision Making (Ref. 14.12) sets out ONR’s risk-based framework for making regulatory decisions. It discusses the tolerability of risk concept, which is at the centre of the framework, and its relationship to the law.

14.53. The approach adopted by ONR and described above meets the **Vienna Declaration on Nuclear Safety Principle 1** which requires that new nuclear power plants are designed consistent with the objectives of preventing accidents.

ONR’s handling of Dungeness B issues and shutdown [Example]

14.54. From Autumn 2018 until the decision by EDF Energy NGL to cease generation at Dungeness B power station on 6 June 2021, both reactors remained shut down and fully fuelled whilst a range of people, plant, and process challenges to operation were identified and addressed. Throughout this time a multi-disciplinary team of ONR inspectors remained engaged with the station and EDF Energy NGL's central technical organisation to advise the licensee whilst they explored and identified the most appropriate options that would return them to compliance and a robust operating position.

14.55. Due to the complexity of the issues faced, ONR took the decision to place Dungeness B in enhanced regulatory attention (see paragraph 10.17). This enabled the necessary resources to be allocated by ONR to support the licensee and, where necessary, hold them to account for any additional shortfalls. The team from ONR was enhanced by an additional site inspector (or recovery inspector) who had the role of overseeing, advising, and encouraging performance improvements at the station, which included ensuring the very high standards of leadership and safety culture we expect at an operating reactor site, and work by the station to improve work planning and delivery and equipment reliability. ONR also allocated a project inspector to provide oversight on a range of safety cases being produced by EDF Energy NGL with the aim of demonstrating a robust, safe operating position (these covered topics such as corrosion, main steam system integrity, boiler steam shut off valves, fuel stringer neutron scatter plugs, reactor diagrid integrity, and several others). Together these measures ensured that ONR had a proportionate, balanced and targeted permissioning and regulatory strategy that made best use of available resources, and included regulatory hold points where considered necessary, whilst overseeing extensive improvement plans and a portfolio of approximately 20-30 safety cases being produced by the licensee.

14.56. In June 2021, EDF Energy NGL took the decision to cease generation at Dungeness B and immediately enter the defuelling preparation phase. For other stations in the fleet (Hunterston and Hinkley Point B), closure dates had been well established, with plans in place to prepare defuelling safety cases and manage the staff changes that would be required. These plans were not in place for Dungeness B. As a result, ONR initially kept the station in enhanced attention and re-prioritised our regulatory focus upon areas with the most risk. These risks differed to an operational power station, primarily due to very low decay heat levels, but still with fully fuelled cores.

14.57. Permissioning and inspection strategies were then targeted upon EDF Energy NGL's defuelling preparations for Dungeness B (fuel route maintenance, fuel handling safety cases, organisational capability). ONR's ability to adapt its strategy considering the EoG decision has enabled EDF Energy NGL to prepare an initial defuelling safety case efficiently, this will be subject to assessment by ONR towards the end of

2022. In parallel with defuelling safety case production, ONR are engaged with EDF Energy NGL to ensure that defuelling outage scope and delivery at the station remains adequate to comply with their ongoing license condition obligations.

14.58. ONR continues to maintain suitable oversight of the station, gaining confidence that EDF Energy NGL has demonstrated the plant remains in a safe condition and configuration. ONR has been encouraged by the station's response and its refocus to safe defuelling from power generation. The station demonstrated that it met agreed performance criteria, which included a wide range of performance areas (people, plant, process). This demonstration included a major ONR-led, jointly run intervention examining leadership and safety culture which showed that significant improvements had been made over 2 years. In March 2022, ONR took the decision to return Dungeness B to routine regulatory attention – this is a significant milestone for all involved and represents safety improvements that have been delivered over an extensive range of complex issues. A technical case study on the basis for enhanced attention can be found in the ONR Chief Nuclear Inspectors Annual Report 2021 (Ref. 14.13).

Verification of Safety

Examination, inspection, maintenance, and testing

14.59. LC28 requires licensees to ensure that all aspects of the plant that may affect safety receive regular and systematic examination, inspection, maintenance, and testing (EIMT). The purpose of this is to ensure the plant remains capable of performing the functions required by the safety case, with the required level of reliability. This licence condition also lists other requirements, including preparation of a maintenance schedule and notification, recording, investigation and reporting of any matters revealed by EIMT that indicate that the safe operation or safe condition of the plant may be affected.

14.60. Significant amounts of EIMT can only be undertaken during shutdown conditions and in general this is carried out every 18 months (PWR) or 3 years (AGR) in accordance with arrangements made under LC30 (periodic shutdown). Restart following these planned shutdowns requires Consent from ONR. As reactors approach EoG the reactors may shutdown more frequently (for instance to allow additional inspections of ageing AGR graphite cores).

14.61. To justify operation until the next identified shutdown, the licensee is required to carry out analyses to predict that failures due to ageing processes, such as creep or fatigue, are unlikely in the defined next period of operation. Non-destructive testing, sample testing monitoring, plant inspection results and any modifications completed during the outage are used widely to support these analyses.

14.62. The licensees' overall EIMT strategies are to ensure that their nuclear installations are kept within the safety case and in accordance with overall requirements for their designs. Safety objectives of these overall strategies include:

- That the integrity of all safety-related plant meets plant operating conditions;
- That the reliability of plant remains within safety case assumptions;
- That plant operation within safety case assumptions can be demonstrated; and
- That sufficient safety-related plant is always available to comply with the safety case.

14.63. In the design phase, diverse and redundant safety systems are provided to ensure their availability during postulated active and passive failures, and planned and unplanned maintenance activities. These include issues such as the time taken to perform preventive maintenance and the time taken to correct defects.

14.64. It is ONR's expectation that PSA should be used as an input to prepare the maintenance schedule. For the current operating reactors, PSA has been used to inform the maintenance schedule by identifying risk significant systems/components to be included and informing the EIMT intervals. PSA continues to be used to inform modifications to the maintenance schedule. ONR also expects licensees to use PSA to support plant configuration control, including maintenance planning. This is further discussed under Article 18 – Design and Construction and Article 19 – Operation.

14.65. LC25 and LC28 require licensees to maintain adequate records of EIMT. This is subject to inspection via the ONR site inspection programme.

Surveillance of compliance with operational limits and conditions and configuration management

14.66. LC23 requires "…the licensee shall, in respect of any operation that may affect safety, produce an adequate safety case to demonstrate the safety of that operation and to identify the conditions and limits necessary in the interests of safety.". These (and relevant operating instructions) are in the form of technical specifications for the operating reactors in the UK. This is discussed in paragraphs 19.12 to 19.17.

14.67. EDF Energy NGL power plants have systems for verifying that the plant remains within the safe operating envelope defined by the technical specifications, and thus, within the envelope of the power plant safety case. Systems for routine compliance monitoring check that they are complying with their technical specifications including plant surveillance, maintenance and administrative checks. EDF Energy NGL also has an internal plant-focused safety department (an ‘internal regulator’) which undertakes inspections at site to verify that the limits and conditions are being complied with, and that routine surveillances are being conducted.

14.68. The licensees have systems to ensure that deviations from operational limits and conditions are documented and reported. Where events of non-compliance occur, these are investigated by the licensees and reported to ONR in accordance with the arrangements under LC7 (incidents on the site). ONR responds to incidents in accordance with principles established by the ONR Enforcement Policy Statement. An example of how these processes responded to an event at Dungeness B is discussed below. See 19.60 to 19.82.

14.69. PSA-based methods are used to support plant configuration control at all the operating plants in the UK. Newer AGRs (Heysham 2 and Torness) use a PSA based risk indicator to contribute to decisions on plant configuration. Sizewell B employs a risk monitor tool, ‘RiskWatcher’, to assess changes in risk (core damage frequency) due to unavailability of components or changing environmental conditions. It is used by the work management department as part of work planning to highlight potentially avoidable peaks in risk. It is also used by operations staff to monitor ‘on-line’ risk as planned maintenance activities are executed and to assess the risk implications of emergent defects on safety related components. This allows mitigating actions to be ‘risk informed’ and an assessment of the continued release of planned maintenance activities to be made. The use of these tools helps licensees to ensure and verify that risks are always managed.

Dungeness B chemistry excursion [Example]

14.70. Between the 14 and 28 May 2021 Dungeness B was warmed up to 190°C to complete a campaign of lifting and lowering of Neutron Scatter Plugs. This was required to support safety case development and understanding of plant condition. During this period, issues were encountered with the feedline dosing system for the boilers, which resulted in an inability to inject hydrazine into the feedwater. A further issue was encountered with a defect on a nitrogen blanketing gauge. Action Level 1 and 2 conditions were therefore entered for pH, conductivity, oxygen, and hydrazine.

14.71. Following completion of the campaign, EDF Energy NGL’s Central Technical Organisation (CTO) Fleet Chemistry predicted that an abnormal level of stress corrosion cracking (SCC) had occurred within the boilers. It is estimated 45 microns of SCC damage was caused to the superheater tube walls, which accounts for approximately 25 % of remaining SCC margins.

14.72. A root cause investigation was undertaken to identify the cause of the event. This identified that there was some culture of acceptance of risk and tolerance to poor plant performance in relation to chemistry control. ONR follow-up enquiries concluded that there were inadequate arrangements and practices at the station relating to boiler feedwater chemistry control, including the physical condition of relevant plant and the use of operating rules and instructions that did not adequately reflect the risk to the plant. As a result, ONR issued a Direction to Dungeness B under Licence Condition 15 to review and reassess these arrangements. ONR also concluded that the quality and implementation of fleet-wide arrangements by the licensee were contributory factors. These are controlled by the corporate body and may apply at other stations. ONR therefore issued EDF Energy NGL with an enforcement letter to conduct a review considering fleet implications.

14.73. EDF Energy NGL has subsequently produced improvement plans for Dungeness B and the wider AGR fleet in response to the Direction and enforcement letter. These include strengthening of arrangements for implementation of chemistry limits and conditions, plant and instrumentation improvements and training. EDF Energy NGL is taking action to implement these improvements, with follow-up from ONR inspectors planned.

Ageing management programmes

14.74. The discussions in the sections below relate directly to the response to **Challenge 8.1** from the Eighth Convention.

14.75. ONR expects that licensees will take account of ageing from the design stage, through the operational life of the station and to the completion of decommissioning. This is reflected in ONR’s SAPs, where EAD.1 to EAD.5 set out specific expectations regarding plant ageing and degradation. Specifically, EAD.2 states that adequate margins should exist throughout the life of the facility to allow for the effects of material ageing and degradation processes on structures, systems, and components. In addition, EAD.3 states that, where material properties could change with time and affect safety, provision should be made for periodic measurement of the properties.

14.76. There are many structures, systems and components which are subject to ageing. ONR monitors and reviews developments through routine interactions with the licensees, and during periodic shutdowns where inspection work may be undertaken to establish the current condition and confirm the rate of degradation. As the stations approach end-of-generation (EoG), ONR intends to focus more on the management of plant ageing to ensure margins of safety are maintained.

14.77. EDF Energy NGL has several ageing and obsolescence programmes. These programmes reflect the safety requirements during generation and defuelling. Recent successes from these programmes can be seen with the Sizewell B control and instrumentation upgrades (See Example below) and the successful manufacture and installation of Neutron Flux detectors, which required the recreation of the supply chain to create the components, fully assemble and test the detectors.

14.78. In preparing for defuelling operations, EDF Energy NGL has created a 'Management of the Asset' programme to ensure that the lifetime management strategy for the AGR systems reflects the changes in operating requirements of the various plant systems.

14.79. EoG will lead to a change in plant requirements, with some systems no longer required for managing the reactor safely. The fuel route components, which will support defuelling will have an increased requirement. The Management of the Asset programme recognises this change and manages the transition between generating and defuelling phases of operation.

14.80. The requirements of the plant will change throughout defuelling and the programme incorporates the changing safety requirements as reactors change.

14.81. Aging and Obsolescence programmes have been established in EDF Energy NGL for several years, identifying identical replacements with the same function and operating intent. The programmes are developing to recognise that the required function of systems will change over time and the required replacement during defuelling could be different to the generating requirements.

14.82. Examples of these ageing and obsolescence management programmes are given below.

Structural integrity

14.83. EDF Energy NGL has established technical standards for corrosion management and guidelines for corrosion assessment and remediation. Such arrangements are required by LC28 for the regular and systematic examination, inspection, maintenance and testing (EIMT) of all plant that may affect safety.

14.84. ONR routinely monitors the adequacy of the licensee's arrangements for corrosion management, for example by reviewing a sample of them during the regular periodic shutdowns, in accordance with LC30 to enable EIMT in accordance with the plant maintenance schedule. When a plant is shutdown, LC30 allows ONR to require that its consent be obtained before it is restarted. If significant shortfalls in corrosion management are identified, consent for restart may be denied until they are rectified.

14.85. ONR also conducts themed interventions on corrosion management. These may come about as a result of ONR strategy or following reports of incidents on a particular site.

14.86. One such ONR intervention began in 2016 to address the risk of corrosion in Structures, Systems and Components (SCC) that are normally concealed because they are either buried or normally covered by insulation. It was introduced as a result of reported failures and near misses on AGR sites and, more generally, due to uncertainty about material condition of such systems because they are normally concealed.

14.87. Throughout this intervention, ONR inspectors collected evidence in a series of targeted site inspections and technical meetings to inform their conclusions and judgements. This has resulted in proportionate enhancements in the licensee's corrosion management of concealed systems. Several shortfalls were identified, and action taken to address them.

14.88. Across the AGR fleet this has resulted in more inspections by EDF Energy NGL, both of concealed pipework and storage vessels, which has led to several repairs and replacement of some components. For Dungeness B Power Station, where some particularly significant shortfalls were discovered, ONR issued a Direction (see paragraph 7.98) to restore and promote sustained compliance with LC28. As a result, several hundred metres of pipe were replaced while the reactors at that station remained safely shutdown. More broadly, this has resulted in revision of the licensee's guidance for corrosion management, for example to better address uncertainty relating to plant condition and the basis for judging whether corroded plant can safely remain in service.

14.89. Most identified shortfalls have now been resolved through continued regulatory engagement and proportionate enforcement action and the intervention is now drawing to a close.

14.90. Another example of ageing in AGRs is the potential for creep damage accumulation. The reactor is designed to produce steam at temperatures well over 500°C, which places several components within the range where creep damage may occur. This was recognised at the design stage and creep life damage calculations are undertaken for many components within the boilers and steam pipework. These are then confirmed by inspection during LC30 periodic shutdowns. Before deciding whether to grant consent to restart the reactor, ONR reviews this information to satisfy itself that the components will remain within the limits defined in the safety case for the next period of operation.

14.91. In Sizewell B's PWR reactor, a surveillance programme is in place to confirm the rate of irradiation embrittlement of the reactor pressure vessel (RPV). This uses surveillance capsules placed near the core that are periodically removed from the RPV and the specimens inside tested. This degradation mechanism is recognised and allowed for at the design stage of PWR reactors, but in the UK the surveillance capsule also includes compact tension fracture toughness specimens as well as the more typical Charpy Impact specimens. These allow a direct measurement of the change in fracture toughness. ONR maintains a direct interest in this programme, and the results from the programme, to ensure that the plant remains within its safe operating envelope. The most recent capsule was removed from the Sizewell B reactor in 2016 and has been analysed. Further surveillance capsules have been inserted and have the capacity to underpin long term operation and any possible life extension.

Electrical engineering

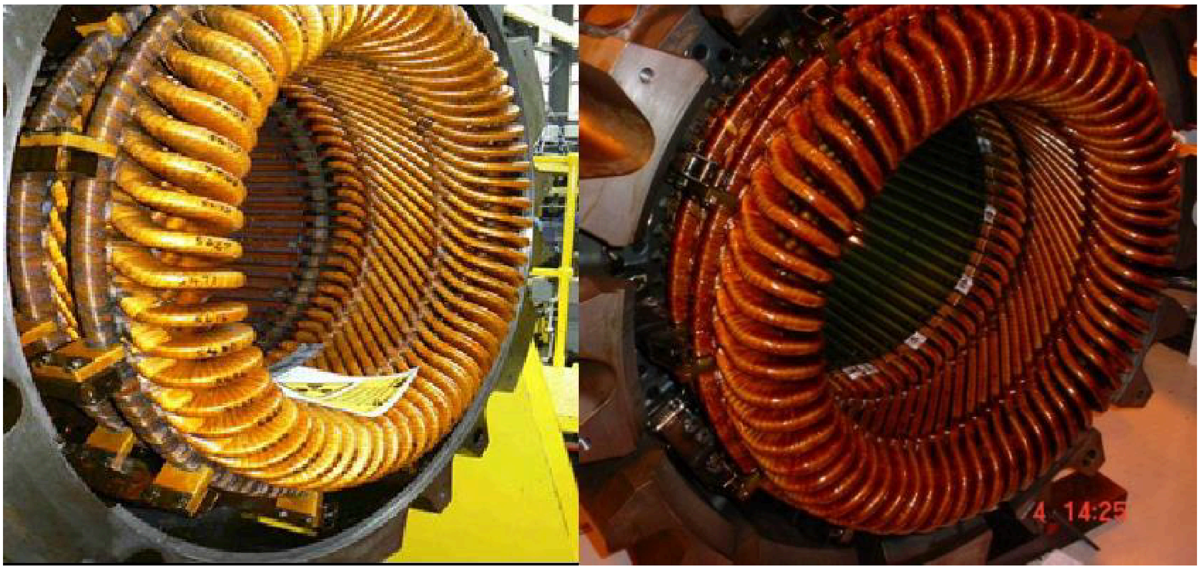
14.92. An example of electrical component ageing that applies to the AGR fleet is the gas circulator motor stator winding insulation thermal life capability monitoring regime. In an AGR the gas circulators force carbon dioxide gas around the primary circuit to cool the fuel.

Gas circulator motor winding [Example]

14.93. It is recognised that the usual methods of partial discharge testing and insulation resistance checks on their own may not give a sufficient indication of insulation ageing because the gas circulators operate in a carbon dioxide environment. Therefore, to obtain a better understanding of the motor stator winding insulation condition, the winding temperature of each individual stator and its running hours are monitored. Based on this information, the remaining thermal life capability of the motor stator insulation is determined. This approach is being used to ensure that Gas Circulator capability is maintained as stations approach EoG and that sufficient capability remains to meet any defuelling requirements.

14.94. ONR monitors the condition as part of LC28. With the AGR fleet approaching EoG, EDF Energy has been developing a safety case to manage the Gas Circulator lifetime through to the end of defuelling. The photographs are examples to show the material condition of the non-connection (drive) end of 2 separate gas circulator motor stators (one rewound and one aged). See figure 14.2.

Figure 14.2: Drive end of a rewound stator (left) and aged stator (right)



Control and instrumentation

14.95. A wide range of Control and Instrumentation (C&I) equipment and systems can be affected by ageing and obsolescence; recent examples of which include:

- Neutron flux detectors;
- Computer-based data processing and control systems; and
- Reactor protection systems equipment such as relays and in-core thermocouples.

14.96. Inadequate management of ageing and obsolescence of C&I equipment and systems can have a significant detrimental impact on nuclear safety. It is ONR's expectation that licensees will have robust and proactive arrangements to enable ageing mechanisms and equipment obsolescence issues to be identified and mitigated before associated failures occur. These arrangements should include periodic equipment condition inspections, trending of test results and active engagement with the supply chain. ONR has actively engaged with licensees to encourage them to develop such arrangements.

Sizewell B control and instrumentation upgrade [Example]

14.97. At Sizewell B, a major mid-life control and instrumentation system upgrade was completed in mid-2019. This involved upgrading the existing process control system and distributed computer system using modern technology to ensure that the medium to long term security and reliability of the systems can be maintained. It should be noted that these systems do not control any Category 1 Safety Equipment at Sizewell B, nor control plant which is required to achieve safe shutdown following design basis faults. However, they do provide the data processing and control functions for the majority of Safety Category 2 and 3 controls, alarms, indications, and logs on the station.

To minimise operational disruption, the existing system architecture and the field wiring and cabinet ‘footprints’ (as much as possible) were retained. Changes to the operator interfaces were also minimised to avoid the potential for new human factor issues to be introduced. The project also required amendments to a wide range of documentation (such as operating and maintenance procedures) and involved operator, system engineering and maintenance training.

14.98. A period of Commissioned Operational Service (COS) was completed, during which any remaining issues related to the testing and commissioning activities were resolved, in parallel with a 1000-hour soak test. The transition from COS to Routine Operational Service (ROS) was then approved by the Project Safety Review Group (PSRG) and Nuclear Safety Committee (NSC) in July 2020. To secure support for the system for the lifetime of the station, a Long-Term Support contract was placed with the original equipment manufacturer (OEM) (Westinghouse) in January 2020. This will ensure that the key areas of obsolescence management and knowledge retention are maintained such that a major system upgrade is not required again.

14.99. ONR has also encouraged licensees to share ageing and obsolescence OPEX and to take a cross-system/fleetwide approach to developing associated guidance and mitigation strategies. ONR has recently seen good examples of cross-system and fleetwide guidance that has been produced by licensees for issues such as printed circuit board tin whiskers and dendrite growth, tantalum capacitor ageing and neoprene insulation degradation and breakdown. ONR has also reviewed ageing and obsolescence management strategies, which have ranged from reinforcing existing systems to replacing all items of vulnerable equipment on an OPEX-informed periodic basis.

14.100. The checking of licensees’ ageing and obsolescence arrangements, and their application also forms an integral part of ONR’s C&I inspections and PSRs. ONR also discusses ageing and obsolescence inspection and PSR findings with licensees on a frequent basis, including at quarterly meetings. Examples of obsolescence issues being addressed on the AGR fleet are discussed below.

Phased reinforcement programme for the reactor protection systems at Heysham 2 and Torness [Example]

14.101. Reactor protection systems at AGR stations take input from in-core neutron flux detectors specially designed to withstand the high pressures and temperatures. The detector OEMs were Plessey and Centronic with the United Kingdom Atomic Energy Authority (UKAEA) acting as Detector Design Authority. ULTRA Nuclear Control System are a modern-day manifestation of both UKAEA and Plessey. However, procurement of detectors since station commissioning has been erratic with the effect that a robust supply chain no longer existed.

14.102. Recognising this and noting the onset of degradation in performance with several in-core flux detectors across the AGR fleet, EDF Energy NGL established the AGR neutron flux detector programme to manage both operation and supply chain components.

14.103. Detectors were produced to General Specifications. These were not simply specifications but also include manufacturing, production, qualification and testing information in addition to functional requirements. The General Specifications were improved based on the learning from the operation of the original units. This approach has allowed common faults from the original units to be engineered out.

14.104. The principle of maintaining equivalence between the existing detectors and the replacement detectors was adopted. The replacement detectors have now been delivered and a number have been installed. The supply chain has now provided sufficient detectors to meet current AGR lifetime requirements.

Licensee oversight arrangements

14.105. EDF Energy NGL operates in accordance with a single unified management system that integrates safety, health, environmental, security, quality and economic objectives. The management system defines the responsibilities of key post holders, the line management organisation and the main interfaces between the company and other organisations.

14.106. EDF Energy NGL's management system draws on best practice, as defined in the IAEA Safety Requirements and domestic standards whilst also ensuring that the requirements of the nuclear site licences are fulfilled.

14.107. EDF Energy NGL operates a "defence-in-depth" approach towards oversight in order to monitor performance and conformity to both its internal standards and external regulations. EDF Energy NGL operates a multi-layer model with increasingly independent oversight being exercised through:

- Management accountability – responsibility for ensuring compliance with the management system arrangements and thereby maintaining safety lies with the line management;
- In-process oversight through peer checking and self-assessment – company processes include arrangements for any inspection, testing, verification and validation activities, including their acceptance criteria and the responsibilities for carrying them out;
- Functional oversight – review and audit by company experts. Each process is assessed by the responsible champion each year to provide assurance that it is working effectively and to identify opportunities for improvement;

- Independent internal oversight from the independent nuclear assurance (INA) function which reports to the Board independently of the operating arm of the company and has an independent reporting route to the EDF Group Inspector General for Nuclear Safety. INA has a team of 3 evaluators based at each power station. They also have a central team providing independent assessment of significant plant and safety case changes and support for fleet-wide and corporate audits and inspections;
- Each station has a Nuclear Safety Committee (NSC) that advises on safety matters. The committee is required to consider all significant changes to the safety case (including plant modifications and changes to organisational structure) before they are submitted to ONR. The membership of the NSC consists of the station director, senior safety officers of the company and independent safety experts;
- The Nuclear Safety Review Board takes the form of a week-long review of operations and management at each nuclear power plant. Each station is reviewed every 2 years. Each Board includes external members with a track record either as a power station operator, regulator or key nuclear industry supplier;
- The Inspector General for nuclear safety and radiation protection reports to the Chief Executive Officer of EDF Group and provides high level oversight of nuclear activities across EDF Group, including EDF Energy NGL; and
- External oversight is sought from and provided by the following bodies:
  - WANO peer reviews are periodically performed on each of the EDF Energy NGL stations. The peer review frequencies have been aligned across the industry with routine reviews now being completed on a 4-year cycle. The defuelling and decommissioning plants will not participate in the peer review cycle; and
  - An OSART follow-up review took place at Sizewell B in 2017. Torness hosted a full-scope OSART mission in 2018 and a follow up mission at Torness was concluded in 2019. A further OSART mission at Heysham 2 is anticipated in 2023.

Chief Nuclear Inspector's themed inspection on ageing management [Example]

14.108. ONR introduced Chief Nuclear Inspector (CNI) themed inspections in 2017, which are designed to examine regulatory matters that are strategic or broader in nature than more routine regulatory inspection activities. With the management of ageing assets remaining a challenge for most dutyholders across the nuclear sector, ONR conducted an ageing management themed intervention across all UK nuclear facilities. As part of this exercise, ONR evaluated EDF Energy NGL's arrangements following queries from internal and external stakeholders regarding the lack of a consistent approach for demonstrating the effectiveness of the ageing management process. In response, an ageing management improvement programme was developed by EDF Energy NGL resulting in the establishment of a fleet working group and station guidance documentation.

14.109. At ONR's request, a self-assessment document was produced by EDF Energy NGL focusing on 4 themes:

- Strategies for the characterisation, monitoring, trending and analysis of ageing;
- Commitments to ensure ongoing organisational capability to support specialist safety cases and substantiate on-going safe operation;
- Methods to identify and manage obsolescence in facilities; and
- Commitments to ongoing investment in plant, people and processes concerned with ageing management.

14.110. Following ONR's evaluation, which included a series of site inspections at Sizewell B power station, ONR determined that the EDF Energy NGL arrangements for ageing management had been adequately implemented in line with ONR's expectations.

14.111. EDF Energy NGL was able to demonstrate to ONR appropriate lifecycle governance and its management of risks arising from the ageing of its nuclear safety and security related structures, systems and components.

14.112. For NNB, all major safety submissions including any submitted for permissioning by ONR, are subject to a rigorous internal governance process. As well as the potential for all documentation to be subject to scrutiny by the Hinkley Point C Design Authority, which owns the Hinkley Point C safety case, separate independent challenge forms additional layers of a barrier model approach to ensuring high quality submissions. As part of the Safety Directorate, the Independent Technical Assessment (ITA) team provide an internal regulator function undertaking independent assessment of submissions. All major safety submissions are also submitted for advice from the Nuclear Safety Committee (NSC). The NSC advises the Hinkley Point C Board in these matters. Its endorsement is part of the decision-making process to allow submission of major safety submissions to the regulator as part of the permissioning process.

Verification of safety: regulatory review and control of activities

14.113. An ONR inspector (or team of inspectors) is allocated to the nuclear installation site before the start of construction. During the construction and commissioning phases, the site inspector(s) will conduct frequent inspections and discussions with the licensee, witness key tests and check test reports.

14.114. Once the reactor is operational, the nuclear site inspector(s) allocated to the site spend about 30 % of their working time on their site.

They ensure that the licensee is complying with the licence conditions and the arrangements made under them. ONR's approach is to ensure that inspectors do not remain at only one site for an indefinite period. Instead, there is a periodic change, normally after a few years, for several reasons, ranging from changing regulatory priorities to career development. This also serves to ensure the continued independence of ONR inspectors.

14.115. Individual site intervention plans are produced according to generic templates based on a matrix that includes the licence conditions and relevant legislation, the key safety systems and structures (derived from the safety case) and themes based on recent operational experience feedback. Before the start of each year, the plan is modified, as necessary, to take account of feedback, regulatory issues and developments affecting the plant. Unplanned and reactive inspection work is also integrated, as necessary, into the site inspection activities throughout the year. Site inspectors are supported by other ONR inspectors who carry out specialist assessments or inspections as necessary.

14.116. Site intervention plans are produced, monitored, and reviewed within an integrated intervention strategy (IIS), the purpose of which is to ensure that ONR focuses its resources where they are most needed and that the planning process is transparent to stakeholders. The IIS considers issues of local environment, priorities and changes in the industry. The site intervention plan is enhanced to include other factors that ONR considers to be important to the overall safety of the site. These include:

- Any site related work arising from progressing outstanding PSR requirements or other reviews of the safety case;
- Emergency arrangements;
- Strategic themes important for safety such as organisational resilience and supply chain;
- Operational experience and organisational learning; and
- Leadership and management for safety (also see Article 12 – Human Factors).

14.117. Team inspections that address specific or more generic aspects of the safety of the nuclear installations are carried out at the plants and at the licensee's corporate centres. For such inspections, a multi-disciplinary group of inspectors will visit the site or centre. They report their findings to the operator, so that improvements are made, where appropriate.

14.118. Reactive inspections are undertaken in response to specific events where operational matters may affect safety. Further investigation may be undertaken by ONR inspectors and appropriate regulatory action taken, in line with its Enforcement Policy Statement (Ref. 14.14) and the regulatory strategy for the site. From time to time, ONR inspectors also undertake unannounced inspections and out of hours inspections.

14.119. LC29 requires licensees to carry out and report the results of tests, inspections and examinations specified by ONR. This condition may, where used, be regarded as a verification activity by the nuclear regulator or to intervene to improve knowledge or secure a safety improvement.

14.120. ONR also carries out programmes of system-based inspections (SBIs), which are intended to establish that the basic elements and requirements of a site/facility safety case are met in practice, that the systems are fit for purpose and that they will fulfil their safety functional requirements. A programme of SBIs has been used to ensure that each of 30 identified systems is inspected on each power station during a 5-year period.

14.121. Each SBI is undertaken by a small team of inspectors from appropriate disciplines. The SBI typically takes place over a 2-day period and includes document review, discussions with licensee staff and plant walk-downs. SBIs are structured around compliance with 6 licence conditions; these cover training, operating rules, operating instructions, safety mechanisms, maintenance, and leakage of radioactive materials.

14.122. Once the inspection is complete, an overall judgement is made by ONR's inspection team as to whether the relevant safety systems and structures adequately fulfil the requirements of the safety case. All but one SBI completed in the period since the last CNS report concluded that the relevant structures, systems, and components have fully met the requirements of the safety case. For the SBI judged not to have met the safety case, the issues were related to adequacy of procedures. The licensee was formally notified of the identified shortcomings and the resolution is being tracked through ONR's issues database.

14.123. Broadly, the outcomes of ONR's SBI interventions have allowed ONR to gain high confidence that the safety systems of the operating reactor fleet continue to deliver the function required by the reactor safety cases.

14.124. ONR has recently reviewed its SBI programme following its first 5-year cycle which was completed in 2018. The original list of 30 safety systems and structures for the EDF Energy NGL fleet of AGRs has been reviewed and consolidated. Some were removed where it was deemed more effective that the inspection be delivered under specific licence conditions. In addition, several SBIs have been drawn together to look at potential common mode failures between systems, ageing management and to take account of synergies between systems (for example, a more holistic look at the fuel route rather than inspections of specific parts of the process). These SBIs will be carried out by larger, multi-disciplinary teams of specialist inspectors to get a fuller picture of the system and its interactions. The PWR SBIs at Sizewell B have not yet been reviewed.

14.125. In addition to the SBIs, ONR has developed a new intervention approach to inspect the licensees' arrangements for ageing management. This is in recognition of the increased failure potential of aged plant based on operational experience. This will be carried out at 3 stations.

Article 14 references

14.1 The United Kingdom's Eighth National Report on Compliance with the Obligations of the Convention on Nuclear Safety (https://www.iaea.org/sites/default/files/national_report_of_the_united_kingdom_for_the_8th_review_meeting.pdf), Department for Business, Energy & Industrial Strategy, August 2019.

14.2 ONR Licence Condition Handbook (https://www.onr.org.uk/documents/licence-condition-handbook.pdf).

14.3 The Health and Safety at Work etc Act 1974 (https://www.legislation.gov.uk/ukpga/1974/37/contents).

14.4 The Management of Health and Safety at Work Regulations 1999 (https://www.legislation.gov.uk/uksi/1999/3242/contents/made).

14.5 The Ionising Radiations Regulations 2017 (https://www.legislation.gov.uk/uksi/2017/1075/contents/made).

14.6 ONR Safety Assessment Principles, 2014 (https://www.onr.org.uk/saps/saps2014.pdf).

14.7 ONR Technical Assessment Guides (https://www.onr.org.uk/operational/tech_asst_guides/index.htm).

14.8 IAEA Safety Standards (https://www.iaea.org/resources/safety-standards/search).

14.9 ONR Periodic Safety Reviews (https://www.onr.org.uk/periodic-safety-review/index.htm).

14.10 ONR Project Assessment Reports (https://www.onr.org.uk/pars/)

14.11 GDA Step 4 report on the Structural Integrity of the UKEPR (https://www.onr.org.uk/new-reactors/reports/step-four/technical-assessment/ukepr-si-onr-gda-ar-11-027-r-rev-0.pdf).

14.12 Risk Informed Regulatory Decision Making (https://www.onr.org.uk/documents/2017/risk-informed-regulatory-decision-making.pdf).

14.13 ONR Chief Nuclear Inspector's Annual Report 2021 (https://www.onr.org.uk/documents/2021/cni-annual-report-2021.pdf).

14.14 ONR Enforcement Policy Statement, April 2020 (https://www.onr.org.uk/documents/enforcement-policy-statement.pdf).

Article 15 – Radiation Protection

> Each Contracting Party shall take the appropriate steps to ensure that in all operational states the radiation exposure to the workers and the public caused by a nuclear installation shall be kept as low as reasonably achievable and that no individual shall be exposed to radiation doses which exceed prescribed national dose limits.

15.1. Compliance with this Article of the Convention is demonstrated in a way that has not substantially changed since the United Kingdom's (UK) eighth NR (Ref. 15.1) (in a way that has implications for the Convention obligations).

15.2. A summary of the laws and regulations relevant to nuclear safety, environmental and radiation protection can be found under Article 7 – Legislative and Regulatory Framework.

Protection and safety optimisation

15.3. Optimisation is the process of determining what level of protection and safety makes exposures to ionising radiations, and the probability and magnitude of potential exposures, as low as is reasonably achievable (ALARA). In the UK, the as low as reasonably practicable (ALARP) principle is used and is fundamental to all health and safety legislation. The widely used International Commission on Radiological Protection concept, ALARA, is equivalent to ALARP (see Annex 3 – SFAIRP, ALARP and ALARA for a more detailed discussion of these concepts). As part of the demonstration that risks have been reduced ALARP, dutyholders must consider all relevant factors relating to engineering, operations, and management of safety. These expectations are often referred to as relevant good practice (RGP) and include an option adopted elsewhere in similar circumstances and the extent to which this option has worked in practice. This can often provide strong indications of what the ALARP solution might be. Where RGP is not clearly established, the operator must assess the significance of the risks (both their extent and likelihood) to determine what action is required.

15.4. Some irreducible risks may be so serious that they cannot be permitted. At the other extreme, some risks may be so trivial that it is not worth incurring significant time, trouble, or cost to reduce them further. The licensee must take measures to reduce risk unless the detriments in terms of time, trouble, and cost of taking particular actions are clearly excessive (in gross disproportion) compared with the benefit of the risk reduction. Financial equivalent values can be used in the ALARP analyses, noting that the cost benefit analysis is only one input to the ALARP decision.

15.5. Licensees are required by IRR17 (Ref. 15.2) to restrict exposures to the lowest reasonably practicable level by applying the hierarchy of control principles in order of priority. The 5 principles are elimination, substitution, engineering controls, administrative controls, and personal protective clothes/equipment. For example, this requires use of shielding, physical separation, containment, ventilation, and warning devices, where these are reasonably practicable, before considering how exposures can be further reduced by the application of systems of work or personal protective equipment.

15.6. A dose constraint is a prospective restriction on the individual dose delivered by a source of ionising radiations, which serves as an upper bound on the dose in optimising the protection and safety of persons who may be affected by the source. IRR17 Regulation 9 requires employers to use dose constraints, where appropriate, in the planning stage of radiation protection. This is achieved through good planning of work activities to restrict individual exposures so far as is reasonably practicable (SFAIRP). In general, the UK licensees (EDF Energy NGL and NNB GenCo) have considerable experience in developing dose databases that provide accurate dose forecasts for planned tasks.

15.7. IRR17 does not specify a level of dose below which optimisation is always regarded as satisfied. The duty on the employer (for nuclear sites this is generally the licensee but may also include other employers with staff working at the site) given in Regulation 9(1) is to restrict, SFAIRP, the extent to which employees and other persons are exposed to ionising radiations. This requirement has no lower dose boundary and is satisfied when the radiation exposures are deemed to be ALARP.

Dose limitation

15.8. The Office for Nuclear Regulation’s (ONR) Safety Assessment Principles (SAP) (Ref. 15.3) include some lower numerical effective dose targets for normal operation called Basic Safety Objectives (BSO) of 1 mSv/year for employees working with ionising radiations, 0.1 mSv/year for other employees on the site, and 0.02 mSv/year for any person off the site. The BSO is that dose value below which the regulator will not normally seek further improvements if it is satisfied by the licensee’s arguments. However, the objective does not represent a notional value of optimisation and an employer at a nuclear licensed site should still seek further dose reductions below the BSO if these were reasonably practicable. In addition, the SAPs include some higher numerical dose targets for normal operation called Basic Safety Levels, some of which are also dose limits in IRR17. There are levels of 20 mSv/year for employees working with ionising radiations (which is also the dose limit for employees in IRR17), 2 mSv/year for other employees on the site, and 1 mSv/year for any person off the site (which is also the dose limit for other persons including the public in IRR17). In practice, doses recorded for employees at nuclear installations are usually well below dose limits for normal operations and even peak doses have only been a fraction of the limits for several years.

15.9. IRR17 also allows for an effective dose limit to an individual worker of 100 mSv in any period of 5 consecutive calendar years. This is subject to a maximum dose of 50 mSv in any one year, but only if the licensee can demonstrate to ONR's satisfaction that an annual limit of 20 mSv is impracticable for that person.

15.10. IRR17 also sets a limit for employees on equivalent dose to the lens of the eye of 20 mSv in a calendar year or, where permitted by ONR, 100 mSv in 5 years subject to a maximum limit of 50 mSv per year. IRR17 also sets a limit on equivalent dose to the skin of 500 mSv in a calendar year and sets lower effective dose limits for employees under the age of 18 years as well as other persons who are not employees.

15.11. If an employee is likely to receive a radiation dose greater than three-tenths of a relevant dose limit in a year (for example, 6 mSv in the case of whole-body exposure), IRR17 Regulation 21 requires the employer to designate that employee as a classified person. For classified persons, the employer must arrange for any significant doses (internal or external) they receive to be assessed by a dosimetry service approved by the Health and Safety Executive (HSE) (Ref. 15.4). HSE also approves dosimetry services to co-ordinate individual doses and to produce and maintain dose records for classified persons. HSE has a computerised system that receives and processes the annual dose summaries for classified persons. Dose records are kept until the person has (or would have) reached the age of 75 years.

15.12. Where designated classified persons receive exposure from multiple sites operated by different employers, the "outside worker" provisions of IRR17 may apply. In such cases, classified persons are required to carry radiation passbooks, which contain personal identification details together with their current cumulative dose. Information in the radiation passbook enables the licensee to properly control the cumulative dose of the worker, which may have been accrued on different sites.

15.13. Under IRR17 Regulation 9, if an employee has a recorded whole-body dose greater than 15 mSv (or a lower dose established by the employer) for the year, the employer must carry out an investigation. The purpose of this investigation is to establish whether sufficient action is being taken to restrict exposure to ionising radiations, SFAIRP.

15.14. IRR17 Regulation 26 requires that, where a licensee suspects or has been informed of an exposure in excess of a dose limit, ONR is notified, whether this arises from a single incident or from dose accumulated over time. The employer undertaking work with ionising radiations must carry out a thorough investigation.

15.15. Assessment of intakes of radioactive material by workers and the resultant doses is carried out by means of air sampling (personal and area), bio-assay, and in-vivo monitoring. IRR17 includes regulations to ensure that appropriate steps are taken for the assessment of internal exposure.

15.16. An example of EDF Energy NGL’s control of doses received by workers is discussed below.

Dose and contamination control during the second Sizewell B dry fuel store campaign [Example]

15.17. The second dry fuel storage campaign at Sizewell B took place from early to mid-2020, against the backdrop of the COVID-19 pandemic. The positive dose control measures from the first campaign were incorporated into the arrangements for the second. More challenging collective dose exposure goals were set for the casks in the second campaign, and these had a higher heat load of fuel than the first campaign and inclusion of irradiated core components for the first time.

15.18. The use of real-time gamma and neutron electronic dosimetry, integrated with the Radiological Protection remote monitoring system of CCTV cameras, teledosimetry units and radio communications, proved invaluable to manage collective and individual radiation exposure. Teams were able to see “what good looked like” from video footage and supervisors were able to observe and coach team members in the high gamma and neutron areas. Key activities such as unbolting a lifting attachment from a hot cask lid, involving a worker transiting over an area of up to 200 mSv per hour, showed cask on cask dose reduction with workers able to critique their own performance from video and teledosimetry records.

15.19. Lessons learned from the first campaign, such as better welding cable management, helped reduce individual and collective radiation exposure. The second campaign of 7 casks was completed for just under 80 % of the collective radiation exposure of the first campaign, with each cask delivered for a lower dose than the previous one. The final 3 casks were delivered with “best ever” doses for Sizewell B and below the original dry fuel storage system stretch design target. The maximum individual dose was 1.3 mSv, considerably below the maximum individual dose in the first campaign. Contamination control performance was also strong, with zero Electric Power Research

Institute (EPRI) Level 2 or Level 3 personal contamination events during the campaign.

15.20. Up to 2019 most of the dose on EDF Energy NGL sites related to vessel entry work which was largely undertaken by contract staff. No further vessel entry campaigns are anticipated. In 2020 doses were lower as work was deferred due to the COVID-19 pandemic. In 2021 much of the dose was related to the Sizewell B outage, including the thermal sleeve replacement work. For EDF Energy NGL sites, which are all operational sites, data for all employee and contractor doses for 2015–2021 is given in figure 15.1 below.

15.21. The total collective dose to all persons working on EDF Energy NGL sites during calendar year 2021 was 0.55 manSv, 0.22 manSv to employees, and 0.33 manSv to contractors.

15.22. No person exceeded the statutory annual dose limit of 20 mSv specified in IRR17, nor the EDF Energy NGL dose restriction level of 10 mSv. No worker has exceeded the company dose restriction level of 10 mSv per annum since 2006.

15.23. The maximum individual dose received by an EDF Energy NGL employee in 2021 was 2.3 mSv. The maximum individual dose received by a contractor in 2021 was 5.9 mSv. In 2021, the average dose received by EDF Energy NGL employees was 0.047 mSv and by contractors was 0.053 mSv.

15.24. Electronic Personal Dosimeters (EPD) are used at all EDF Energy NGL sites as the legally approved dosimeter to make assessments of individual radiation exposure.

Figure 15.1: Doses at EDF Energy NGL Sites

Exposure Type	2015	2016	2017	2018	2019	2020
Employees: Collective dose (man-mSv)	308.64	318.780	259.448	255.763	253.349	153.056
Employees: Average dose (mSv)	0.056	0.059	0.047	0.045	0.046	0.033
Employees: Maximum	6.827	5.188	5.542	5.693	4.156	2.587

Exposure Type	2015	2016	2017	2018	2019	2020
dose (mSv)						
Contractors: Collective dose (man-mSv)	674.44	535.114	313.249	560.684	460.724	62.102
Contractors: Average dose (mSv)	0.074	0.069	0.040	0.065	0.061	0.011
Contractors: Maximum dose (mSv)	7.781	3.993	4.168	4.682	4.372	1.660
Total Collective Dose (mSv)	983.08	853.894	572.697	816.447	714.073	215.158

15.25. An example of good dose management practices is discussed below.

Replacement of thermal sleeves under the Sizewell B reactor pressure vessel head [Example]

15.26. Although Sizewell B was familiar with recent light water reactor industry operational experience about the potential wear of stainless-steel thermal sleeves, the extent of wear observed in the 2021 Refuelling Outage was unexpected and necessitated the priority replacement of 15 thermal sleeves. Thermal sleeves penetrate the underside of the reactor pressure vessel head (RPVH) and are used to support alignment of Control Rod Drive Shafts, plus they provide thermal shielding for the Control Rod mechanisms.

15.27. There were 3 main areas of work:

- Use of an Electro-Discharge Machine (EDM) for cutting and removing the defective thermal sleeves and remnants from inside the Control Rod Drive Mechanism adapters;
- Installation of replacement compressible thermal sleeves; and
- Supporting remote camera inspections of internal surfaces under the RPVH.

15.28. The radiological conditions were challenging, with whole body gamma radiation dose rates under the RPVH increasing vertically from approximately 5 to over 30 mSv/hour. Installation and configuration of the EDM required operatives to perform multiple “jumps” under the RPVH. The EDM could generate significant airborne contamination so a suitable access enclosure with filtered extract was constructed with lead blanket “shadow shielding” in key areas to permit operatives to perform maintenance work on the EDM in low dose rate conditions. RPVH entrants were in impervious suits to protect them from wet contamination from the cutting process and wore powered respirator protective hoods inside the tent and under the RPVH. Potential doses to the lens of the eye were a particular concern during the ALARA planning phase, because of the vertical dose rate contour under the RPVH. The legal dose limit to the lens of the eye in the UK is 20 mSv/year, the same as the whole-body dose limit.

15.29. The thermal sleeve replacement project was completed with a collective dose exposure of 135 person mSv, around 80 % of the ALARA plan estimate. The maximum individual dose to an operative was 5.9 mSv, under the ALARA plan dose constraint, and the maximum individual eye dose as measured by dedicated dosimeters was just over 12 mSv. The project exhibited good radiological controls, with the remote monitoring system being pivotal to effective dose management. CCTV cameras were deployed under the RPVH and in the tented area, along with teledosimetry repeater aerials and radio communications systems. These enabled the RP and contract teams to tightly control the doses during the 650 “jumps”, which typically lasted for less than 2 minutes each. Easily deployable inspection cameras and long-handled tools kept operatives in the lower dose rate areas under the RPVH. Purpose made metal light-weight containers helped reduce doses when moving the old thermal sleeves to the designated waste storage area. Importantly, there was extremely good communication and co-operation between the site radiation protection team and the thermal sleeve project team in the planning phase, which was around 2 months, and during the delivery phase of the project.

Public doses

15.30. For the assessment of compliance with dose limits relating to members of the public, the licensee is required to derive realistic estimates of the average effective dose (and where relevant, equivalent dose) to the appropriate representative person for the expected pathways of exposure.

15.31. Arrangements to control exposures to the public from a nuclear licensed site are partly regulated through IRR17 where the licensee must take all necessary steps to restrict exposures to other persons (other than employees) SFAIRP. In addition, arrangements to minimise doses to members of the public from discharges are regulated through discharge authorisations and permits under the Environmental Authorisations (Scotland) Regulations 2018 (EASR18) (Ref. 15.5) and the Environmental Permitting (England and Wales) Regulations 2016 (EPR16) (Ref. 15.6) respectively.

Control of exposure

Qualified experts

15.32. In the UK, the qualified expert in relation to occupational radiation protection is the Radiation Protection Adviser (RPA). At nuclear installations, the licensee is required under IRR17 to appoint and consult an RPA to provide expert advice on compliance with those regulations. HSE has published a statement (Ref. 15.7), setting out criteria for core competences of individuals and bodies to meet in order to obtain a RPA recognition in the form of a Certificate of Core Competence from an HSE-recognised RPA Assessing Body. The purpose of the recognition procedure described in this Statement is to give employers confidence that any person or body recognised as an RPA has essential competence in giving advice on compliance with IRR17 and the applicability of REPPIR19.

15.33. The qualified expert in relation to radioactive waste management and environmental radiation protection is the Radioactive Waste Adviser (RWA). Anyone who has a relevant permit or registration under EASR18 or EPR16 to manage radioactive waste needs to appoint a RWA. The RWA scheme was developed jointly by the Environment Agency, SEPA and the Northern Ireland Environment Agency (NIEA) with extensive stakeholder engagement. The environment agencies including NRW have published a statement (Ref. 15.8) on RWAs.

Controlled areas

15.34. In the UK, a controlled area is an area in which specific protection measures and safety provisions are, or could be, required for controlling normal exposures or preventing the spread of contamination during normal working conditions, and preventing or limiting the extent of potential exposures. A supervised area is an area, other than a controlled area, in which occupational exposure conditions are kept under review, even though specific protection measures and safety provisions are not normally needed.

15.35. Designation of controlled or supervised areas is required by IRR17 Regulation 17. The main purpose of designating controlled areas is to help ensure that routine and potential exposures are effectively prevented or restricted. This is achieved by controlling who can enter or work in such areas, and under what conditions. Normally, controlled areas will be designated because the employer has recognised the need for people entering the area to follow special procedures to restrict exposure to ionising radiations. Regulations 19 and 20 specify requirements for designated areas to ensure that there are appropriate arrangements for control and monitoring of radioactive contamination, including contamination of workers.

15.36. Evidence from UK installations suggests that the spread of contamination beyond the boundaries of controlled areas is uncommon. This is generally achieved by applying strict controls to such activities as changing of clothing and personal monitoring at various stages within the controlled area, rather than just at the boundary between controlled and other areas. At times during the COVID-19 pandemic, licensees have made changes to monitoring arrangements to reduce the risk of person-to-person transmission, for example by taking steps to reduce peak occupancy in high traffic areas around exit monitors. These revised arrangements have been inspected as part of ONR’s routine inspection programme.

Local rules and procedures

15.37. IRR17 Regulation 18 requires licensees to prepare written local rules to identify key working instructions intended to restrict any exposures in designated controlled or supervised areas. The local rules for a controlled area usually include arrangements for access restriction; dose levels; contingency arrangements; identification and description of the areas covered; and confirmation of the appointed Radiation Protection Supervisor (RPS). The guidance to IRR17 (Ref. 17.2) contains advice on the essential and optional contents for local rules. The RPS has a major role in helping to ensure that the work carried out is done so in compliance with the arrangements licensees have put in place to comply with IRR17 particularly, in supervising the arrangements set out in the local rules. The RPS does not need to have the same depth of knowledge of IRR17 as a RPA but must be suitably trained and should be appointed in writing.

Protective equipment

15.38. IRR17 Regulations 10 and 11 require licensees to ensure that any personal protective equipment provided pursuant to Regulation 9 is appropriate and that it is subject to routine examination and maintenance. Licensees are also required, under Regulation 15, to ensure that appropriate information, instruction, and training are provided to workers who use personal protective equipment. To meet the personal protective equipment requirements in IRR17, licensees have developed their own arrangements to ensure compliance. ONR checks that the requirements are met as part of its inspection programme. HSE has published guidance on the use and maintenance of respiratory equipment (Ref. 15.9).

Environmental discharges and monitoring

15.39. Nuclear installations require authorisations to dispose of radioactive waste, whether by discharge directly to the environment, or by burial, incineration, or transfer of waste off-site. Authorisations:

- Specify the disposal routes to be used and place limits and conditions on disposal;
- Place a requirement to minimise:
- Waste generation;
- The quantity of radioactivity discharged to the environment; and
- The radiological effects on the environment and on members of the public to ensure that impacts are reduced to ALARA.
- Require sampling and analysis to determine compliance with authorisation conditions, reporting of the quantities of radioactive waste disposed and of non-compliance with limits;
- May specify improvements in waste management arrangements; and
- Require operators to use best practicable means (BPM) in Scotland or best available techniques (BAT) in England and Wales to minimise discharges to reduce impacts to ALARA.

15.40. IRR17 Regulation 31 requires incidents, like the release (unless in accordance with a discharge authorisation or permit) or spillage of radioactive substances in excess of certain quantities, to be investigated. LC 34 (leakage and escape of radioactive material and radioactive waste) requires radioactive material or radioactive waste on a nuclear licensed site to be adequately controlled or contained, and that any leak or escape of such material to be notified, recorded, investigated, and reported in accordance with LC7 (incidents on the site) arrangements.

15.41. EPR16 includes the concept of BAT. This is broadly equivalent to the application of BPM and the best practical environmental option (BPEO) (as described below), with essentially the same assessment and determination processes and which deliver the equivalent level of environmental protection. Further references to BPM in this document should be interpreted as:

- BPM applied to authorisations granted under Radioactive Substances Act 1993 (RSA93) (Ref. 15.10) and EASR 18 in Scotland; and
- BAT applied to permits granted under EPR16 in England and Wales.

15.42. The limits on radioactive discharges are set based on the ‘justified needs’ of the licensees. The licensees make a case that the proposed limits are necessary to allow safe and continued operation of the plant. Licensees are required to use all BPM in terms of reasonably practicable measures to minimise the production and disposal of radioactive waste to achieve a high standard of protection for the public and the environment. This includes a systematic and consultative decision-making process that emphasises the protection and conservation of the environment across land, air and water. The process establishes, for a given set of objectives, the option that provides the most benefit (or least damage) to the environment as a whole, at acceptable cost in both the long and short term. This option is called the best practicable environmental option. The environment agencies have published guidance for their assessment of BPEO studies at nuclear sites (Ref. 15.11).

15.43. The Environment Agency has also published 'Radioactive Substances Regulation (RSR) – Objectives and Principles' (Ref. 15.12). In setting limits, the environment agencies use monitoring and discharge and plant performance data with suitable modelling. This is to ensure that the radiation exposure to the public as a consequence of the discharges would be less than the dose constraints and limits in the UK. These dose constraints ensure that cumulative dose contributions from a nuclear installation or group of installations, along with potential doses from other sources, from all exposure pathways remain below the public dose limit of 1 mSv/year. Currently these are a:

- Source constraint of 0.3 mSv/year for an individual nuclear installation which can be optimised as an integral whole in terms of radioactive waste disposals;
- Site constraint of 0.5 mSv/year for a site comprising more than one source, for example, where 2 or more nuclear installations are located together; and
- Dose limit of 1.0 mSv/year from all sources of man-made radioactivity including the effects of past discharges but excluding medical exposure.

15.44. Gaseous and liquid discharges from each of the power stations are regulated by the environment agencies. In 2017, gaseous and liquid discharges were below regulated limits for each of the power stations (Ref. 15.13 and Annex 2 – The Environmental Regulatory Bodies). Highlights from operating sites are shown in figure 15.2 for 2020. A summary of total doses received from NPPs between 2009 and 2020 can be found in figure 15.3.

Figure 15.2: Total Dose at Operating Nuclear Power Plants for 2020

Highlights

- 'total doses' for the representative person were less than 3% of the dose limit for all sites assessed

Operating sites

Dungeness, Kent:

- 'total dose' for the representative person was 0.012mSv and decreased in 2020
- liquid discharges of 'other radionuclides' from Dungeness A, and sulphur-35 from Dungeness B decreased in 2020

Hartlepool, County Durham:

- ‘total dose’ for the representative person was 0.017mSv and increased in 2020
- gaseous discharges of carbon-14 decreased, and liquid discharges of sulphur-35 decreased, in 2020

Heysham, Lancashire:

- ‘total dose’ for the representative person was 0.010mSv and decreased in 2020
- liquid discharges of sulphur-35 increased from Heysham 2 in 2020

Hinkley Point, Somerset:

- ‘total dose’ for the representative person was 0.023mSv and increased in 2020
- gaseous discharges of carbon-14 and sulphur-35 decreased from Hinkley Point B in 2020
- liquid discharges of tritium and suplhur-35 decreased from Hinkley Point B in 2020

Hunterston, North Ayrshire:

- ‘total dose’ for the representative person was 0.005mSv and increased in 2020
- liquid discharges of tritium from Hunterston B increased in 2020

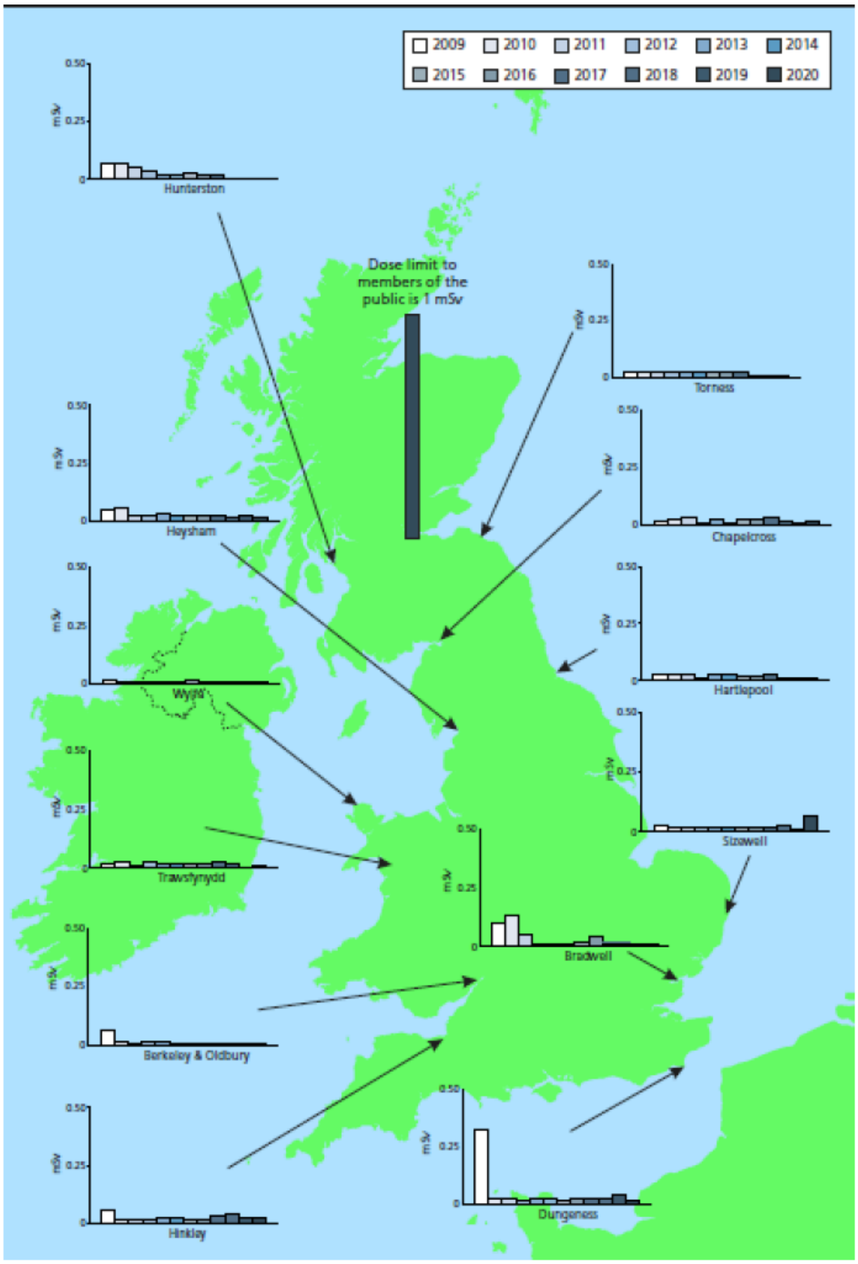
Sizewell, Suffolk:

- ‘total dose’ for the representative person was 0.017mSv and increased in 2020
- gaseous discharges of carbon-14 increased from Sizewell B in 2020

Torness, East Lothian:

- ‘total dose’ for the representative person was 0.006mSv and increased in 2020
- liquid discharges of tritium and suplhur-35 decreased in 2020

Figure 15.3: Total Dose at Nuclear Power Plants, 2009–2020



Accessible version of Figure 15.3

A map of the UK showing the total doses received from Nuclear Power Plants between 2009 and 2020.

COVID-19 impacts in 2020

15.45. On the 16 March 2020, the UK Government issued its ‘social distancing’ advice, where staff were to work at home where possible. This was subsequently amended to ‘must stay at home’ later in March 2020. In response to this, site operators and regulators reviewed and ceased non-essential work.

15.46. Although the government restrictions had effects on the nuclear power supply industry, they had relatively less effects in relation to occupational radiological protection due to special travel authorisations given to electricity supply industry employees that enabled continuation of most work. Dose profiles in the industry were therefore relatively unchanged compared to previous years. However, there were some areas of regulatory IRR17 compliance that were difficult for the nuclear and wider radiological industry to achieve. These revolved around the need for employees to be present in the workplace at specific times to undertake periodic tasks, including calibration of radiation monitoring equipment, or undertake annual medical radiation reviews in person with their doctor. ONR, in partnership with HSE (who regulate IRR17 in the non-nuclear industries), successfully published a Regulatory Position Statement (Ref. 15.14) describing, for the period of the Statement only, how compliance may temporarily continue to be achieved.

15.47. The proposed public habits surveys around major sites in England and Scotland were postponed (no habits surveys in Wales were planned for 2020).

15.48. During the first pandemic lockdown period (March 2020 to July 2020) discharge monitoring was suspended with agreement from the Environment Agency in accordance with published COVID-19 regulatory positions statements. Assessments of discharges were made once the sites returned to operations and all discharge reporting was completed by September 2020.

15.49. Environment Agency site compliance inspections for England and Wales were undertaken virtually with only a handful of physical inspections carried out where they were deemed essential. All other permit requirements and regulatory expectations remained in effect. Regulators maintained communication with all nuclear sites for the duration of the lockdown period.

15.50. To support the nuclear industry in Scotland, SEPA published the “Management of radioactive substances at nuclear sites regulatory position” (Ref. 15.15), setting out its expectations.

15.51. All Scottish site operators reviewed and ceased non-essential activities and where it was appropriate to do so, some operated under the terms of the nuclear site position statement for short periods. Where this was the case, operators were required to provide SEPA with weekly updates on compliance issues, to maintain records and to return to compliance with conditions of authorisation as quickly as possible when the pandemic restrictions allowed. Typically, use of the regulatory position statement was to defer aspects of the environmental monitoring programmes and some discharge sampling activities. SEPA engaged with all sites remotely during this period and was able to carry out several remote compliance inspections.

15.52. The COVID-19 pandemic affected many aspects of SEPA's environmental radioactivity monitoring programme, including the postponement of site-based radiological habits surveys, which assess the occupancy in specific areas around nuclear licensed sites and consumption rates of foods gathered in the area. In response to anecdotal evidence that occupancy and consumption habits were changing across Scotland due to people spending more time at home and food availability changing due to local restrictions, SEPA undertook a postal and online survey to determine if urgent changes were required to the environmental monitoring programme. The main conclusions from the report were that SEPA's monitoring programme remains fit for purpose, but small increases to outdoor occupancy rates had been observed that were likely to continue post-lockdown. Additionally, many people surveyed were keen to increase their self-sufficiency in food grown at home.

15.53. The 2020 monitoring programmes were affected by the restrictions and measures associated with the COVID-19 pandemic. Many samples could not be collected (for example, milk samples due to some farm closures in Wales and Northern Ireland) or were delayed, nor could samples be analysed as laboratories were closed. In some cases, this has affected dose assessments, necessitating the substitution of 2019 monitoring data into assessments where required.

Regulatory review and control of radiation exposure

15.54. ONR seeks to ensure that licensees have adequate arrangements in place to restrict exposures to ionising radiations SFAIRP in several ways. To take a view at a particular site, ONR undertakes assessments of safety cases against the SAPs and carries out inspections on site, including compliance against IRR17. To take a view on occupational exposure across the industry, ONR undertakes reviews across all GB nuclear sites. These are carried out in accordance with ONR guidance on IRR17 inspections (Ref. 15.16). This guidance is due for review during 2022 and the review will take account of Recommendation 14 of the 2019 IAEA Integrated Regulatory Review Service (IRRS) Mission to the UK. A further recommendation from the IRRS mission was for relevant regulators, including ONR, to establish and maintain a register of radiation generators. ONR continues to work with HSE and other regulators on the UK response to this recommendation.

15.55. To regulate doses to the public, ONR requests information on exposures (via all exposure pathways) from licensees on an annual basis. Using a sampling approach, ONR undertakes assessment of licensees' arrangements and arranges verification of off-site direct gamma and neutron dose rates through monitoring radiation levels by an independent technical support contractor.

15.56. In addition to the requirements placed on operators to monitor environmental radioactivity around their sites, the environment agencies undertake their own independent monitoring programmes, to verify doses received via other pathways. Radioactivity in surface and ground water, radiation dose rates on beaches and public occupancy areas, radioactivity in sediments, environmental material, etc. are monitored. Monitoring results are published annually. The Food Standards Agency (FSA) (Ref. 15.17) is an independent government body set up to protect the public and consumer interests in relation to food. The environment agencies and the FSA publish a joint report annually on Radioactivity in Food and the Environment (RIFE) in the UK, which also includes estimated doses to the public. The most recent RIFE report was published in 2021, which contains 2020 monitoring data (Ref. 15.13). Monitoring over recent years has confirmed that, in terms of radioactive contamination, terrestrial foodstuffs and seafood produced in and around the UK are safe to eat. Exposure of consumers to artificially produced radioactivity via the food chain remains well below the UK public dose limit of 1 mSv/year. In addition, the exposures of members of the public from all pathways resulting from aerial and liquid discharges and exposure to direct radiation from nuclear licensed sites remain below the dose limit of 1 mSv/year.

Article 15 references

15.1 The United Kingdom's Eighth National Report on Compliance with the Obligations of the Convention on Nuclear Safety (https://www.iaea.org/sites/default/files/national_report_of_the_united_kingdom_for_the_8th_review_meeting.pdf), Department for Business, Energy & Industrial Strategy, August 2019.

15.2 Working with ionising radiation. Ionising radiations Regulations 2017. Approved Code of Practice and guidance (http://www.hse.gov.uk/pubns/books/l121.htm).

15.3 ONR Safety Assessment Principles 2014 Edition (Rev 1 Jan 2020) (https://www.onr.org.uk/saps/index.htm).

15.4 Health and Safety Executive Website. Radiation Home (https://www.hse.gov.uk/radiation/)

15.5 Environmental Authorisations (Scotland) Regulations 2018 (https://www.sepa.org.uk/regulations/how-we-regulate/environmental-authorisations-scotland-regulations-2018/).

15.6 The Environmental Permitting (England and Wales) Regulations 2016 (http://www.legislation.gov.uk/uksi/2016/1154/contents/made).

15.7 HSE Statement on Radiation Protection Advisors (RPAs) (https://www.hse.gov.uk/radiation/rpnews/statementrpa.htm).

15.8 Radiation Waste Advisors (https://www.sepa.org.uk/regulations/radioactive-substances/radioactive-waste-advisers/).

15.9 Respiratory Protective Equipment at Work: A Practical Guide – HSE (http://www.hse.gov.uk/pubns/priced/hsg53.pdf).

15.10 The Radioactive Substances Act 1993 (http://www.legislation.gov.uk/ukpga/1993/12/contents).

15.11 Guidance for the Environment Agencies' Assessment of Best Practicable Environmental Option Studies at Nuclear Sites (https://www.sepa.org.uk/media/103546/bpeo_guidance.pdf).

15.12 Radioactive Substances Regulation – Objectives and Principles 2021 (https://www.gov.uk/government/publications/radioactive-substances-regulation-rsr-objective-and-principles).

15.13 Radioactivity in Food and the Environment, 2020 (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1030466/Radioactivity-in-food-and-the-environment-2020.pdf). RIFE – November 2021.

15.14 COVID-19 regulatory Position Statements (https://www.gov.uk/government/collections/covid-19-regulatory-position-statements).

15.15 Management of radioactive substances at nuclear sites regulatory position (https://regulatoryapproach.sepa.org.uk/regulatory-approach/).

15.16 ONR Technical Inspection Guide NS-INSP-GD-054 – Ionising Radiations Regulations 2017 (https://www.onr.org.uk/operational/tech_insp_guides/ns-insp-gd-054.pdf).

15.17 Food Standards Agency Website (https://www.food.gov.uk/).

Article 16 – Emergency Preparedness

> Each Contacting Party shall take the appropriate steps to ensure that there are on-site and off-site emergency plans that are routinely tested for nuclear installations and cover the activities to be carried out in the event of an emergency. For any new nuclear installation, such plans shall be prepared and tested before it commences operation above a low power level agreed by the regulatory body.
>
> Each Contracting Party shall take the appropriate steps to ensure that, insofar as they are likely to be affected by a radiological emergency, its

own population and the competent authorities of the States in the vicinity of the nuclear installation are provided with appropriate information for emergency planning and response.

Contracting Parties which do not have a nuclear installation on their own territory, insofar as they are likely to be affected in the event of a radiological emergency at a nuclear installation in the vicinity, shall take the appropriate steps for the preparation and testing of emergency plans for their territory that cover the activities to be carried out in the event of such an emergency.

16.1. Since the last report, developments under this Article are as follows:

- Implementation of the updated Radiation (Emergency Preparedness and Public Information) Regulations (REPPIR) 2019; and
- Use of modular testing of emergency arrangements in response to the COVID-19 pandemic.

16.2. Otherwise, compliance with this Article of the Convention has not substantially changed since the United Kingdom's (UK) eighth NR (Ref. 16.1) (in a way that has implications for the Convention obligations).

16.3. The information in this Article is directly related to the **major common issue** on **emergency preparedness** from the Seventh Convention and **VDNS Principle 2**.

Regulatory requirements for emergency preparedness

16.4. All UK civil nuclear sites are licensed by the Office for Nuclear Regulation (ONR) under the Nuclear Installations Act 1965 (NIA65) (Ref. 16.2). The provisions of this Act enable ONR to set requirements on licensees through licence conditions (LC) (Reg. 16.3). LC11, applicable to all licensees, requires the licensee to make and implement adequate arrangements for dealing with any accident or emergency arising on the site and its effects. REPPIR 2019 (Ref. 16.4) also puts duties on operators to make and test emergency arrangements. REPPIR requires the operator to provide ONR with details of the operator's emergency plan where requested. ONR may then scrutinise it and has a broad range of regulatory powers to ensure the emergency plan meets requirements. The plan must include:

- The arrangements to set emergency procedures in motion;
- The arrangements to co-ordinate the on-site mitigatory action;
- For conditions or events which could be significant in bringing about a radiation emergency, a description of the action which should be taken to

control the conditions or events and to limit their consequences, including a description of the safety equipment and resources available;
- The arrangements for limiting the risks to persons on the premises including how warnings are to be given and the protective actions persons are expected to take on receipt of a warning;
- The arrangements for providing early warning of the incident to the responder or responders identified in the local authority's off-site emergency plan to set the off-site emergency planning in motion, the type of information which should be contained in an initial warning and the arrangements for the provision of more detailed information as it becomes available; and
- The arrangements to prioritise keeping doses within the reference levels; including what protective actions are proposed to be taken, and how far each such action extends within any detailed emergency planning zone.

16.5. In addition, REPPIR requires licensees and local authorities to co-operate in the production and implementation of their emergency arrangements. Where an off-site emergency plan is required, it must be reviewed and tested at least every 3 years and kept up to date in the event of any material changes.

16.6. The facility operator recommends to the local authority the minimum extent of the detailed emergency planning zone around the facility according to the hazard. A geographic boundary of the detailed emergency planning zone is then determined by the local authority, considering local geographic, demographic and practical implementation factors such as the avoidance of bisecting local communities, inclusion of immediately adjacent vulnerable groups and the benefits and dis-benefits of protective actions.

16.7. REPPIR also requires outline planning for very low probability but high severity events that might extend significantly over a wider area.

Main elements of the national plan

16.8. The UK's emergency response operates on the principle of subsidiarity, which emphasises the importance of local decision-making, supported, where necessary, by coordination at a higher level. Central government's Concept of Operations (ConOps) sets out the UK arrangements for responding to and recovering from emergencies, irrespective of cause or location, requiring coordinated central government action.

16.9. Where an emergency is of a scale or complexity that some degree of central government co-ordination or support becomes necessary, a designated lead government department (LGD), or where appropriate, a devolved administration department, will be made responsible for the overall management of the central government response to the incident.

16.10. The Department for Business, Energy & Industrial Strategy (BEIS) is the LGD for managing the response to a civil nuclear emergency in England, Scotland and Wales or an overseas nuclear emergency affecting UK interests. As LGD, BEIS is responsible for coordinating the national government response to a civil nuclear emergency, supporting local action and, if needed, directing the national response. BEIS is also the competent authority for international reporting to the Intentional Atomic Energy Agency (IAEA).

16.11. The UK Government has 3 pre-defined emergency levels which are used to determine the level of central government engagement and response required. These are:

- Level 1 – Significant Emergency (broadly equivalent of IAEA INES Rating 5): Requires central government involvement or support, primarily from a LGD or a devolved administration, alongside the work of the emergency services, local authorities, and other organisations. There is, however, no actual or potential requirement that would necessitate the activation of a collective central government response;
- Level 2 – Serious Emergency (broadly equivalent of IAEA INES Rating 6): Is one which has, or threatens, a wide and/or prolonged impact requiring sustained central government coordination and support from several departments and agencies, usually including the regional tier in England and where appropriate, the devolved administrations. The central government response to such an emergency would be coordinated from the Cabinet Office Briefing Rooms (COBR), under the leadership of the lead government department; and
- Level 3 – Catastrophic Emergency (broadly equivalent of IAEA INES Rating 7): Is one which has an exceptionally high and potentially widespread impact and requires immediate central government direction and support. Characteristics might include a top-down response in circumstances where the local response had been overwhelmed, or the use of emergency powers were required

16.12. The UK uses the INES for determining the scale of nuclear incidents. This scale is broadly equivalent to UK ConOps emergency levels.

16.13. In the event of an off-site nuclear emergency in England, Scotland or Wales, the central government Emergency Operation Centre (EOC) and COBR would be activated to coordinate the response and decision-making at the national level. Central government would be supported by the Scientific Advisory Group for Emergencies (SAGE). However, the lead for the response will always remain at the local level and usually under the control of a senior police officer at the Strategic Coordinating Group (SCG) in all but the most severe events.

16.14. The UK's devolved administrations have a key role in supporting a response, and BEIS would work closely with the relevant administrations.

For example, in Scotland, the Scottish Government are responsible for consequence management and recovery of the emergency within its borders and would activate the Scottish Government Resilience Room (SGoRR).

16.15. The agencies that provide a local response are located at the off-site Strategic Coordination Centre (SCC) (see figure 16.1). At this facility, the SCG's prime function is to decide on and coordinate the appropriate protective actions to be taken off-site to protect the public. The SCG ensures that the protective actions are implemented, and that authoritative information and advice is provided to the public (the facility includes media briefing centres).

16.16. Each organisation with responsibilities for dealing with the emergency is represented at the SCC. These would include the operator, police, local authority, national health authority, local water company and the fire and ambulance services. Government departments and agencies would also be represented, including BEIS (or Scottish or Welsh equivalents), the UK Health Security Agency (UKHSA – formerly Public Health England), the relevant FSA, the relevant environmental protection agency and ONR.

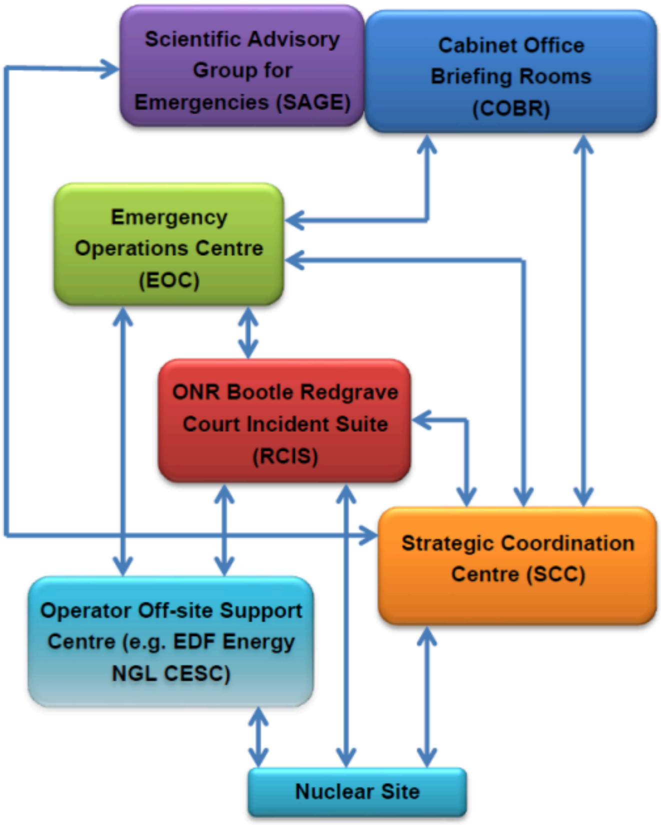
16.17. The Scientific and Technical Advice Cell (STAC), which is also located within the SCC, brings together technical experts from those agencies involved in the response. The STAC provides authoritative and independent scientific and technical radiological and health protection advice to the SCG. This will include advice on the most appropriate protective actions for different areas such as sheltering, evacuation, administration of stable iodine tablets, and any restrictions to be placed on food or water. In the early phases of an incident, prior to the formation of the STAC, the site operator will provide the SCG with advice on appropriate protective actions.

16.18. The operator has an important role in regaining plant control on-site and ensuring that any radiological release is minimised and terminated, and that personnel on the site are protected. The technical information regarding plant prognosis and radiological assessments by the licensee is an important aspect in the response to an emergency. The licensee has 2 roles directly related to the off-site response, to:

- Monitor the environment on and around the site for radioactivity and radiation levels; and
- Provide advice to the off-site organisations on any protective actions that could be taken to protect the public (particularly in the early stages of an emergency). For example, sheltering, issue of stable iodine tablets, or evacuation.

16.19. In response to the declaration of an off-site nuclear emergency at a nuclear site, ONR will independently monitor and record the operator's actions to be able to provide advice to government and relevant authorities, and, if appropriate, undertake subsequent enforcement action. To achieve this, the Redgrave Court Incident Suite (RCIS) would be activated as the ONR's central information and communication hub, and 'away teams' will be dispatched as appropriate dependent on the nature and location of the emergency (See figure 16.2). The RCIS is maintained, exercised and ready to be activated at short notice, 24 hours a day and 365 days a year.

Figure 16.1: UK's Emergency Arrangements Structure



Accessible version of Figure 16.1

A diagram showing the UK's emergency arrangements structure in the event of an off-site nuclear emergency.

At a national level:

- Emergency Operation Centre (EOC)
- Cabinet Office Briefing Rooms (COBR)

Advised by the Scientific Advisory Group for Emergencies (SAGE).

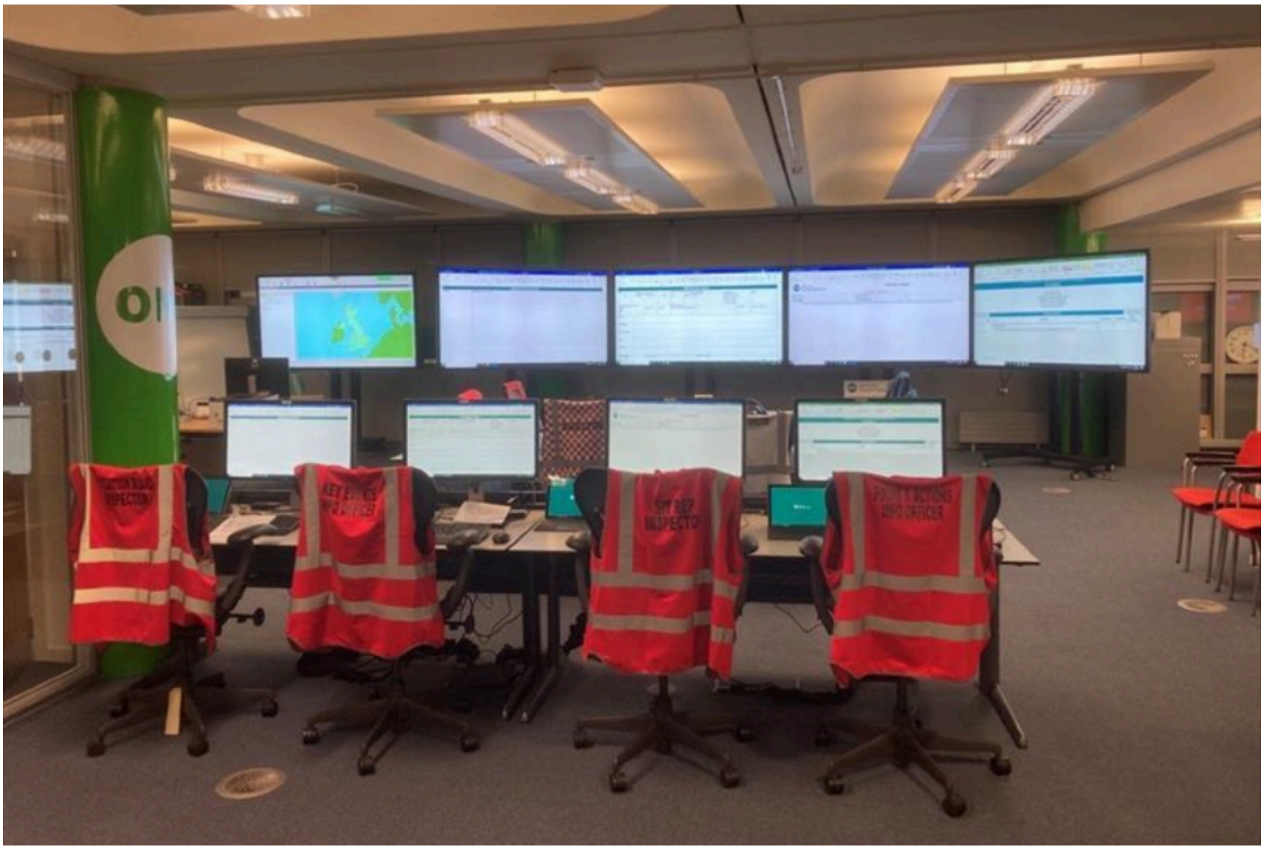
At a local level:

- Strategic Coordination Centre (SCC)
- Operator Off-site Support Centre (for example, EDF Energy NGL CESC)

- ONR Bootle Redgrave Court Incident Suite (RCIS)

All communications from the nuclear site go through the local leads to the national leads.

Figure 16.2: ONR's emergency control room, the Redgrave Court Incident Suite



Emergency plan implementation

16.20. All nuclear licensees are required to prepare, in consultation with local authorities, the emergency services and other organisations, emergency plans for any nuclear and non-nuclear emergency which may occur on the site. In parallel, local authorities prepare plans for the off-site response to a nuclear emergency for the protection of the public.

16.21. In the event of an emergency, trained station staff form a site emergency response organisation under the command of the Emergency Controller. This is based in emergency facilities located on the site. The Emergency Controller is responsible for initiating the emergency actions to be taken by EDF Energy NGL staff and for ensuring the off-site organisations which have responsibility for initiating actions to protect the public are alerted. The station is permanently staffed in such a way that a site emergency response organisation can be set up immediately. Additional key station personnel are available on call.

16.22. The on-site response is supported by the operator's Central Emergency Support Centre (CESC). It provides for the off-site support for an NPP in an emergency situation. Command, technical and health physics support teams are available at short notice during working hours and within an hour out of hours. The technical team helps to understand the situation on the site and provides advice on how to rectify the situation and on the release prognosis. The CESC will also take responsibility for the onward transmission of monitoring results and the outcome of radiological assessments to external agencies such as the SCC.

Deployable back-up equipment

16.23. EDF Energy NGL maintains a comprehensive array of deployable back-up equipment (DBUE) and a large fleet of emergency response vehicles for people and equipment transportation. Sets of DBUE have been situated at strategically selected locations in the UK. This is in line with the requirements of the **VDNS Principle 2**.

Training and exercises

16.24. EDF Energy NGL performs a regular programme of emergency exercises to test its procedures, facilities, systems and equipment. This enables everyone to practise their role in an emergency and provides an opportunity for learning/continuous improvement of the emergency plan. Emergency exercises are also the main way that EDF Energy NGL demonstrates the effectiveness of its emergency arrangements to the regulator and external agencies.

16.25. There are 3 main types of regulatory exercises, which have evolved in the UK nuclear industry: Level 1, Level 2 and Level 3. These regulatory exercises vary in the involvement of organisations locally and nationally.

- Level 1 – An exercise that involves all station staff, visitors and contractors and will take up to 6 hours to complete. This type of exercise takes place annually and demonstrates existing on-site emergency arrangements to ONR.
- Level 2 – An exercise that demonstrates how the Strategic Co-ordination Centre (SCC) and the Central Emergency Support Centre (CESC) deals with the off-site implications of an emergency. A Level 2 exercise involves the CESC, SCC, Media Briefing Centre, the emergency services, and other external organisations and will occupy at least a full working day. A desktop exercise in the site Emergency Control Centre (ECC) drives a Level 2 exercise, and these take place every 3 years.
- Level 3 – An exercise that involves all the organisations in a Level 2 exercise, but also includes full central government departmental involvement. These exercises may occur over several days and may move into the recovery phase of the emergency.

On-site exercises

16.26. Emergency response role training is an important part of these emergency exercises. It ensures each member is confident in their role and the tasks that they would be required to carry out in an emergency. Each site role has several key training modules to be completed. Each shift working team completes emergency response role training once a year as part of the training programme.

16.27. A key element in developing the emergency arrangements is through a learning culture by carrying out reviews and audits of both preparedness activities and response performance. Assessment arrangements for exercises are graded according to the scale and frequency of the exercise. For shift training exercises, assessment is completed in-house by umpires and assessors from the same station. Some training exercises are also assessed by a team of peers drawn from the fleet to observe, assess and critique the exercise performance. For the Level 1, 2 and 3 exercises EDF Energy NGL deploys an Emergency Arrangements Review Team led by the Independent Nuclear Assurance function. This allows actions to be prioritised, planned, tracked, and checked for effectiveness.

16.28. ONR oversees, makes judgements, and provides feedback on the adequacy of Level 1 exercises. As a minimum, each shift will take part in a site exercise every year when all the elements of the emergency organisation are practised. Over time the site exercises test all aspects of the approved site emergency plans, such as minimum personnel levels and common mode failure events with the potential to affect adjacent sites. The worst scenario that will be routinely exercised is based on an event that results in the loss of all on-site power and cooling to the reactors. The worst scenario exercise serves to demonstrate the severe accident management procedures for the site.

16.29. ONR oversees the exercise, the post-exercise debrief, reviews the report of the exercises, and ensures that any issues identified by the exercise are addressed. If ONR considers that aspects of the demonstration are inadequate, a repeat of all or part of the arrangements is required. Level 1 exercises undertaken since the eighth report are listed in figure 16.3. There was a reduction in the number of Level 1 exercises during 2020 due to restrictions implemented in response to the COVID-19 pandemic.

Figure 16.3: Level 1 exercises completed between January 2019 and December 2021

NPP Site	Exercise Type	Date
Heysham 2	Level 1	9 January 2019
Heysham 1	Joint Level 1 Safety and Security	23 January 2019

NPP Site	Exercise Type	Date
Torness	Level 1 Security	6 March 2019
Dungeness B	Level 1	8 May 2019
Hinkley Point B	Level 1 Security	25 July 2019
Hunterston B	Joint Level 1 Safety and Security	17 October 2019
Sizewell B	Level 1	6 November 2019
Hartlepool	Level 1	3 December 2019
Heysham 1	Joint Level 1 and 2	14 January 2020
Torness	Level 1	4 March 2020
Heysham 2	Level 1	23 February 2021
Heysham 1 and 2	Level 1 Security	21 April 2021
Dungeness B	Level 1	28 April 2021
Hunterston B	Joint Level 1 Safety and Security	19 May 2021
Torness	Level 1	28 July 2021
Hartlepool	Level 1	1 September 2021
Hinkley Point B	Level 1	16 September 2021
Sizewell B	Joint Level 1 Safety and Security	1 December 2021
Torness	Level 1 Re-demonstration	15 December 2021

Note: COVID-19 restrictions disrupted the planned 2020/2021 exercise schedules.

Off-site exercises

16.30. Level 2 exercises are delivered by the local authority and are aimed primarily at demonstrating the adequacy of the arrangements to deal with the off-site aspects of the emergency, particularly the functioning of the SCC where organisations with responsibilities within the relevant off-site emergency plan exercise their functions. Level 2 exercises are performed for each nuclear site at least once every 3 years and can be performed as a series of modular tests rather than as a single test.

16.31. Training for the SCC participants is provided by their organisations to ensure they can carry out their role effectively. The local authorities are encouraged to perform challenging exercises that address a variety of scenarios at a national level.

16.32. ONR oversees all Level 2 emergency exercises and provides feedback on the adequacy of the implementation on the off-site plan. All organisations that participate in tests of emergency arrangements co-operate to identify improvements; these are recorded within a report of each exercise that is written either by the operator (for Level 1 exercises) or the relevant local authority (for Level 2 exercises). ONR ensures that any corrective actions are implemented following the exercise through inspections or observation of subsequent exercises. Figure 16.4 lists all the Level 2 Exercises that have taken place in the UK since the UK's eighth NR.

16.33. Level 3 exercises test not only the functioning of the SCC but also the wider involvement of central government, including the exercising of the various government departments and agencies attending the EOC and COBR (for England and Wales) in London, or the SGoRR (for Scotland) in Edinburgh. Aspects of BEIS's international liaison arrangements including the process on notification of potentially affected neighbouring countries are also tested during the Level 3 exercises. Due to COVID-19 restrictions since March 2020, no Level 2 exercises have been expanded to include central and wider government testing in the form of a Level 3 exercise.

Figure 16.4: Level 2 Exercises from January 2019 to January 2022

NPP Site	Exercise Type	Date
Hartlepool	Andromeda	1 May 2019
Hunterston B	Aquila	12 June 2019
Heysham 1	Cassiopeia	14 January 2020
Hinkley Point B	Dorado	7 June 2021 and 13 October 2021
Dungeness B	Stonechat	8 September 2021

Note: COVID-19 restrictions disrupted the planned 2020/2021 exercise schedules.

16.34. The national level Lessons Learned Working Group reviews feedback from Level 2/3 exercises and collates, prioritises, and oversees the implementation of a range of improvements that are relevant across the UK. In recent years, the following actions have been taken as a result of lessons learned reviews:

- Development of a National Nuclear Emergency Response Framework to support the UK response to civil nuclear emergencies;
- A review of the process by which Scientific and Technical Advice is developed and shared; and
- Inclusion of real or realistic weather patterns in exercise scenarios where this is possible.

16.35. In addition, local authorities that have responsibility for planning for civil nuclear emergencies meet biannually to solve common issues and share best practice under the Local Authorities Nuclear Working Group.

Measures to Enhance Emergency Preparedness Programmes

16.36. [Change] The updated REPPIR regulations came into force in the UK in 2019 and ensure that:

- Arrangements are sufficiently flexible to respond to very low probability events;
- Arrangements are commensurate with the range of hazards for each facility;
- Methods for determining planning zones are consistent and transparent;
- There is co-operation between all organisations involved in emergency planning throughout the planning and testing review cycle; and
- There is continuous improvement in the production and implementation of emergency plans by requiring on-going review and implementation of learning from exercises.

16.37. [Change] In addition, the new regulations bring into use emergency reference levels, which optimise radiological protection for the public.

- An Approved Code of Practice and Guidance was published in 2019 which assists dutyholders in complying with the new regulations.

Impact of COVID-19 on the Exercise Programme

16.38. [Change] REPPIR allows for Level 2 exercises to be undertaken as a series of modular tests that demonstrate each of the elements of the off-site emergency plan separately. Many local authorities identified that elements of their off-site plan were implemented as part of the response to COVID-19 and therefore only the nuclear emergency specific response parts of the plan required testing during this exercise cycle. Where this approach was adopted, a gap analysis was produced by the local authority to identify the specific parts of the plan that required testing. ONR maintained an overview of the overall test

> programmes for each local authority to ensure all aspects of the off-site plan are adequately demonstrated over a 3-year period.

Provision of prior information to the public

16.39. REPPIR provides a legal basis for the supply of information prior to a radiation emergency to members of the public who may be affected by such an event. The local authority must provide members of the public within a detailed emergency planning zone, who would be at risk from a radiation emergency, with certain prescribed information at least every 3 years which explains what to do in the event of a radiation emergency. The local authority must also make the information available to the wider public, including those people within any outline planning zone. Every licensee also has local liaison arrangements that regularly provide links with the public in the vicinity of the site. Information in the event of a radiation emergency

16.40. REPPIR requires local authorities to prepare and keep up-to-date arrangements that ensure that members of the public affected by a nuclear emergency receive prompt and appropriate information in the event of a radiation emergency. While the agencies involved in responding to the emergency would seek to deal with any queries they received, the main channel of communication with the public outside the immediate vicinity of the affected site would be through the media.

16.41. In addition, the various information services of the local organisations involved, and of central government, together with the news media, are available to help inform the public of the facts and of the assessments being made during the nuclear emergency.

16.42. Government agencies will communicate by using an on-line real time platform to ensure that all organisations are aware of the latest developments so that standardised messages are issued to the public.

Recovery

16.43. The duration and extent of an emergency would primarily depend on the scale and nature of the radioactive release. Once the release had terminated, ground contamination would be monitored, and the police, following public health advice, would advise those who had been evacuated when they could return home. At this stage, the acute phase of the emergency condition would be officially terminated, but the return to completely normal conditions might take place over time. Following an emergency, the Recovery Working Group (RWG) is set up at the SCC to plan for, and oversee the actions taken to return to normal conditions in a safe way. The RWG works closely and in tandem with the SCG to ensure consistency of public protection in the days and weeks following an emergency.

International notifications

16.44. For an emergency at a nuclear installation in the UK, BEIS is responsible for notifying other countries and initiate requests for international assistance. Under existing early notification conventions, BEIS would inform the IAEA United System for Information Exchange in Incidents and Emergencies (USIE), and countries with which the UK has bilateral agreements and arrangements, providing information about the accident and its likely impact.

16.45. The UK uses the INES as the classification and notification system for safety significant events involving sources of radiation. BEIS has appointed ONR as the UK INES National Officer. The INES system is a commonly understood rating system that helps to facilitate communication of safety-significant information, in the case of nuclear accidents, to the technical community, media and public.

16.46. The UK takes part in internationally coordinated emergency exercises with other countries to test the emergency arrangements, should there be a nuclear emergency in another country that has the potential to affect the UK.

Response to emergencies outside the UK

16.47. BEIS is the LGD for coordinating the response to an overseas nuclear emergency and is the competent authority for international reporting to the IAEA. The UK is a signatory of the IAEA Convention on Early Notification of a Nuclear Accident and the IAEA Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency. With reference to the Convention of Early Notification, the UK has signed several international agreements covering the exchange of information in the event of a nuclear emergency. The UK is a member of IAEA's global assistance mechanism, the Response and Assistance Network (RANET) to support the provision of assistance in the event of a nuclear or radiological emergency.

16.48. The UK has national arrangements in place to respond to an overseas nuclear emergency, which will be implemented by BEIS, with support from other agencies. The UK operates a 24-7 capability of contact arrangements and duty officers to ensure that the UK can be notified of an emergency at any time. BEIS maintains its Emergency Operations Centre containing the equipment required for management of the response. BEIS has established procedures including the notification and alert of organisations within the UK with responsibilities for dealing with an overseas nuclear accident. In an event, with direct impacts on the UK, BEIS as the LGD will support COBR in delivering its response.

16.49. The UK's response is supported by the Radioactive Incident Monitoring Network, (RIMNET). RIMNET is the UK's national radiation monitoring and information management platform. RIMNET has a nationwide network of gamma dose rate monitors; this includes fixed and mobile communications. The RIMNET database also holds measurements of measured environmental concentrations in air, rainfall, water, aquatic sediments, soil, grass and foodstuffs. RIMNET supports the UK's international obligations for monitoring, early warning and information sharing in the event of a nuclear emergency overseas. A new system is being developed and will be the successor to RIMNET once implemented.

International engagement on emergency preparedness and response

16.50. The UK Government and agencies continue to take an active and collaborative role within both European and international emergency preparedness and response activities with the aims of learning, sharing and influencing best practice both within the UK and elsewhere.

16.51. UK agencies contribute to:

- The IAEA Commission on Safety Standards, including the IAEA's Radiation Safety Standards Committee (RASSC) and Emergency Planning and Response Standards Committee (EPReSC). The UK also participates in the Inter-Agency Committee on Radiological and Nuclear Emergencies (IACRNE), the Response and Assistance Network (EPR–RANET), and Modelling and Data for Radiological Impact Assessments (MODARIA). This is in line with VDNS Principle 3;
- The Heads of European Radiological protection Competent Authority (HERCA) Board of Heads and the Working Group on Radiation Emergencies;
- WENRA, the European Radiological Data Exchange Platform (EURDEP), the EU platform on preparedness for nuclear and radiological emergency response and recovery (NERIS) and the OECD NEA Working Party on Nuclear Energy Matters (WPNEM); and
- Since the end of the UK EU exit transition period on 31 December 2020, the UK is no longer part of the European Community's European Nuclear Safety Regulators Group (ENSREG), Urgent Radiological Information Exchange (ECURIE) arrangements or Article 31 Advisory Group (who advises on radiation protection issues, including Basic Safety Standards and Emergency Preparedness and Response). On 12 May 2021, the UK Government accepted the invitation for representatives of ONR to become an observer of the ENSREG (Ref. 16.5).

Article 16 reference

16.1 The United Kingdom's Eighth National Report on Compliance with the Obligations of the Convention on Nuclear Safety (https://www.iaea.org/sites/default/files/national_report_of_the_united_kingdom_for_ the_8th_review_meeting.pdf), Department for Business, Energy & Industrial Strategy, August 2019.

16.2 The Nuclear Installations Act 1965 (https://www.legislation.gov.uk/ukpga/1965/57/contents).

16.3 ONR Licence Condition Handbook (https://www.onr.org.uk/documents/licence-condition-handbook.pdf).

16.4 Radiation (Emergency Preparedness and Public Information) Regulations 2019 (https://www.legislation.gov.uk/uksi/2019/703/contents/made).

16.5 Department for Business, Energy & Industrial Strategy letter to the European Union Delegation to the United Kingdom. 12 May 2021. [ONR internal reference]

Article 17 – Siting

> Each Contracting Party shall take the appropriate steps to ensure that appropriate procedures are established and implemented:
>
> I. for evaluating all relevant site-related factors likely to affect the safety of a nuclear installation for its projected lifetime;
>
> II. for evaluating the likely safety impact of a proposed nuclear installation on individuals, society and the environment;
>
> III. for re-evaluating as necessary all relevant factors referred to in sub-paragraphs (i) and (ii) so as to ensure the continued safety acceptability of the nuclear installation;
>
> IV. for consulting Contracting Parties in the vicinity of a proposed nuclear installation, insofar as they are likely to be affected by that installation and, upon request providing the necessary information to such Contracting Parties, in order to enable them to evaluate and make their own assessment of the likely safety impact on their own territory of the nuclear installation.

17.1. Compliance with this Article of the Convention has not substantially changed since the United Kingdom's (UK) eighth National Report (NR) (Ref. 17.1) (in a way that has implications for the Convention obligations) except for those changes arising from the UK's withdrawal from the European Union (EU) and the Euratom treaty on the 31 January 2020.

17.2. Significant portions of this Article demonstrate compliance with **VDNS Principle 1**.

17.3. Proposed Nuclear Power Plants (NPPs) with a capacity of more than 50 MWe (in England) or more than 350 MWe (in Wales) are required to obtain a development consent order from the Secretary of State for the Department for Business, Energy & Industrial Strategy (BEIS), under the Planning Act 2008 (Ref. 17.2). The current National Policy Statement for Nuclear Power Generation (EN-6) (Ref. 17.3) sets out the policy framework within which applications for development consent will be decided for sites capable of deployment by the end of 2025. For other activities, such as site preparation for a new nuclear power station, or construction or alteration of buildings on an existing nuclear site, planning permission may also need to be obtained from the relevant local planning authority.

17.4. In addition, to construct and operate a nuclear power station in the UK, operators must obtain and comply with the conditions attached to a nuclear site licence as required by the Nuclear Installations Act 1965 (NIA65) and any necessary environmental authorisations as required by the Environmental Permitting (England and Wales) Regulations 2016 (EPR16 – England and Wales), Environmental Authorisations (Scotland) Regulations 2018 (EASR18 – Scotland), or Radioactive Substances Act (RSA – Northern Ireland).

17.5. In this way, site-related factors relevant to the safety of a proposed nuclear installation are considered in a staged and proportionate manner: at a strategic level during development of the National Policy Statement, as material considerations within the planning process, and in detail through the licensing and permitting regimes.

17.6. The revised overarching energy National Policy Statement (EN-1) states the need for nuclear, which could be met by gigawatt-scale, advanced nuclear or fusion technology. The government is currently working towards developing a new National Policy Statement for nuclear power stations deployable after 2025 and intends to consult on a siting strategy in due course.

Procedures for evaluating all relevant site-related factors likely to affect the safety of a nuclear installation for its projected lifetime

17.7. The safety-related factors that are considered in assessing sites cover 3 main aspects:

- The location and characteristics of the population around the site, and the physical factors affecting the dispersion of released radioactivity that might have implications for the radiological risk to people;
- External hazards that might preclude the use of the site for its intended purpose; and

- The suitability of the site for the engineering and infrastructure requirements of the facility.

17.8. The current National Policy Statement (Ref. 17.3) for new nuclear identified 8 sites in England and Wales as potentially suitable for deployment of a nuclear power station by the end of 2025 based on a strategic assessment of sites against siting criteria. The siting criteria included matters relevant to nuclear safety including flood risk, proximity to hazardous facilities and demographics. The policy framework set out in the National Policy Statement provides that new nuclear power stations may be sited in semi-urban areas, subject to detailed examination by ONR of any proposal and specifically of the demographic criteria. The demographic criteria defining semi-urban areas are set out in ONR's land use planning guidance (Ref. 17.4).

17.9. Factors relating to the radiological risk to people, external hazards and engineering and infrastructure requirements are considered within the licensee's safety case. The safety case is required to demonstrate that the risks presented to persons both on and off the site are both below the risk targets specified within ONR's Safety Assessment Principles (SAPs) (Ref. 17.5) and as low as reasonably practicable (ALARP).

17.10. To support the request for a site licence for a new site, the prospective licensee must provide a safety submission to justify, amongst other things, the suitability of the site for the nuclear installation. ONR assesses this as part of the process to determine whether to grant the site licence. As with all safety case assessments, ONR uses its SAPs for nuclear facilities and associated TAGs (Ref. 17.6) as a framework for assessing the adequacy of the licensee's application.

17.11. IAEA safety requirements for siting, as set out in 'Site Evaluation for Nuclear Installations' (NS-R-3) (Ref. 17.7) and a wide range of supporting guidance specific to nuclear power plants, are addressed within the regulatory assessment of siting and the subsequent assessment of licensees' safety case submissions. This is consistent with **VDNS Principle 3**.

17.12. SAP ST.1 requires ONR to provide development control planning advice that is aligned with the government siting policy. SAPs ST.3–ST.6 set out principles relating to how the physical location of a facility can affect its safety, including local physical aspects, site suitability, effect on other hazardous installations, and interactions between facilities on multi-facility sites.

17.13. When siting the UK's existing nuclear installations, account was taken at the time of natural and man-made hazards in the area in line with relevant good practice at the time of construction. Many external hazards, particularly earthquakes, were not considered, or considered in a way that would not meet modern standards today. The PSR process has been used extensively to capture such shortfalls on existing nuclear sites and identify practicable enhancements implemented subsequently as modifications.

17.14. The siting of future installations will consider external hazards and RGP current at that time.

17.15. ONR's SAPs set out the principles for the design of a new nuclear installation, including the need for site-specific data. SAPs EHA.1 – EHA.7 and EHA.18 – EHA.19 address the general principles of hazard analysis including identification and screening, data sources, and inputs to fault analysis. SAPs EHA.8 – EHA.17 address individual site-specific hazards. Geo-hazards (including earthquake), extreme weather (drought, high winds, and extremes of ambient temperature) and coastal flooding are examples of natural hazards that need to be considered. Manmade hazards include the possibility of an accidental aircraft crash on the site and the storage and processing of nuclear materials in the vicinity. The methods of analysis are assessed against the SAPs and subordinate ONR guidance to confirm they meet RGP or otherwise support a demonstration that site risk is ALARP.

17.16. Licensees often monitor natural phenomena at their sites; typically, this would include tide height (for coastal sites), rainfall, wind speed and seismicity. Also, licensees receive advice from government agencies responsible for weather and flood forecasting, for advice on the occurrence and location of earthquakes and for longer-term considerations, on climate change predictions.

17.17. In addition to the analysis of external hazards as initiating events that could lead to accidents, the site selection process must consider other external factors that relate to geological suitability and susceptibility to extreme weather.

17.18. ONR's SAPs ECE.4 and ECE.5 state that investigations should be carried out to determine the suitability of the natural site materials to support the foundation loadings specified for normal operation and fault conditions. The design of foundations should utilise information derived from geo-technical site investigation. The information should include ground-water conditions, contamination conditions, soil dynamic properties and any potential for liquefaction or cyclic mobility. SAP ECE.10 also specifies that the design should be such that the facility remains stable against possible changes in groundwater conditions, with consideration given to potential uncertainties due to climate change.

17.19. The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (EIA17) (Ref. 17.8) provide that development consent for a new nuclear power station cannot be granted by the Secretary of State unless an EIA has been carried out, which includes the preparation of an environmental statement. The environmental statement must include at least:

- A description of the proposed development comprising information on the site, design, size and other relevant features of the development;
- A description of the likely significant effects of the proposed development on the environment;
- A description of any features of the proposed development, or measures envisaged in order to avoid, prevent or reduce and, if possible, offset likely significant adverse effects on the environment;
- A description of the reasonable alternatives studied by the applicant, which are relevant to the proposed development and its specific characteristics, and an indication of the main reasons for the option chosen, considering the effects of the development on the environment; and
- A non-technical summary of the information listed above.

17.20. The environmental statement must also include any additional information specified in Schedule 4 to the regulations relevant to the specific characteristics of the development and to the environmental features likely to be significantly affected. The information specified in Schedule 4 includes, for example, a description of the expected significant adverse effects of the development on the environment deriving from the vulnerability of the development to risks of major accidents and/or disasters which are relevant to the project concerned.

17.21. The EIA process involves public consultation, and consultation bodies, including ONR and the relevant environment agency may make representations regarding the reliability, accuracy and/or completeness of the information provided by the applicant. The regulations also require consultation with European Economic Area states regarding developments that are likely to have significant effects on the environment in those states.

17.22. Consultation zones around nuclear installations and installations (including pipelines) that present a major accident hazard potential are maintained by ONR and HSE respectively. Arrangements within the planning process ensure that ONR and/or HSE are consulted regarding any potential developments within such consultation zones. Therefore, if planning permission was sought for a nuclear installation where the site lay within a major accident hazard consultation zone, HSE would identify and raise this matter at the planning stage. Similarly, if planning permission was sought for a major accident hazard installation within a nuclear installation consultation zone, ONR would identify and consider the external hazard potential of the proposal at the planning stage and make an appropriate representation to the relevant planning authority.

Procedures for evaluating the likely safety impact of a proposed nuclear installation on individuals, society and the environment

17.23. The initial design of a nuclear power plant should minimise, SFAIRP, the radiation exposure to workers and the public. This should be addressed in the pre-construction safety report. ONR SAPs NT.1 and targets 1–3 set out guidelines for radiation exposure during normal operation. The safety case prepared by the licensee must convince ONR that these guidelines will be met. As the nuclear installation design develops, the safety case must become more developed and provide the necessary verification of the initial calculations. The pre-operational safety report (POSR) will consider all the commissioning tests and the validation of any initial assumptions. This will be reviewed during the plant's life in the periodic safety reviews required by LC15 (periodic review).

17.24. On multi-facility sites, the safety case must consider the whole site to establish that hazards from interactions between facilities have been considered (SAP ST.6).

17.25. SAPs targets 4, 6 and 8 set out targets for radiation exposure in design base fault sequences for people on and off the site.

17.26. SAPs target 9, and the associated paragraphs 752-758, address societal risk from severe accidents. This target is a measure of the societal concerns that would result from a major accident. It is based on an accident leading to an immediate or eventual 100 or more fatalities, likely to be mainly from very low doses to very large populations (that is, stochastic deaths). The target does not in itself cover directly all the factors related to societal concerns (such as environmental damage and clean-up costs) but is intended instead to be a surrogate to reflect these aspects (in addition, dutyholders' ALARP demonstrations must also include all applicable societal effects directly attributable to the accident). The safety case for a nuclear installation should identify accidents that result in source terms that could cause 100 or more fatalities.

17.27. SAP ST.3 states that the licensee should consider the topography and geology for the area that might affect the dispersion of the radioactivity discharged from the site, both in normal operation and released in the event of an accident. In addition, aspects of the topography of the area around the site that may affect the movement of people and goods are identified, and their effect on the safety of the plant examined. This examination determines whether the topography and road and rail systems are likely to create difficulties if it became necessary to evacuate people from the area around the plant. SAP ST.3 also expects the dispersion of radioactive releases via the atmosphere, surface water and ground water and the potential exposure pathways to be considered. 17.28 Assessment by ONR would consider:

- Fundamental Principles FP.7 (emergency preparedness and response) and AM.1 (accident management and emergency preparedness) requiring that a nuclear facility should be designed and operated to

ensure that it meets the needs of accident management and emergency preparedness;
- Siting principles ST.1 and ST.3 – ST.6 for new facilities and ST.3 (local physical aspects), ST.5 (effect of other hazardous installations) and ST.6 (multi-facility sites) during subsequent reviews;
- The operator's use of probabilistic safety analysis (PSA) (FA.10 – FA.14), severe accident analysis (FA.15, FA.16, and FA.25) and the assurance of the validity of data and models (AV.1 – AV.8); and
- Relevant TAGs (Ref. 17.6) that inform such assessment include: PSA, validation of computer codes and calculation methods and radiological analysis – fault conditions.

Planning and demographic controls

17.29. The UK Government maintains a policy relating to the control of population around nuclear sites. The current National Policy Statement for Nuclear Power Generation (EN-6 Vol II page 266, July 2011) (Ref. 17.3) states:

> " The government has a longstanding policy regarding local demographics which would limit the radiological consequences to the public in the unlikely event of an accident involving the spread of radioactive materials beyond the site boundary. This policy is a measure of prudence over and above the stringent regulatory requirements imposed on nuclear operators in order to prevent such accidents.

> " The Office for Nuclear Regulation administers the government's policy on the control of population around licensed nuclear sites. The Office for Nuclear Regulation fulfils this function throughout the entire life cycle of the installation through consultation with local authorities. This ensures that until the installation is delicensed, the basis for site licensing is preserved through constraints placed on the surrounding population by controls on future development."

17.30. The intent of this policy is expected to be maintained in the draft National Policy Statement to be published, which will be subject to public consultation.

17.31. Local planning authorities consult ONR regarding proposed developments close to nuclear sites that may lead to an increase in residential or non-residential populations, thus potentially impacting the arrangements within the off-site emergency plan, and/or pose an external hazard to the site. ONR also provides advice regarding local plans and neighbourhood plans, in which local authorities set out the policies that will inform their long-term development aims and allocate sites for residential, commercial and industrial development. These plans are produced by local planning authorities to secure their planning objectives and communities have direct power to develop a shared vision for their neighbourhood and shape the residential and commercial development and growth of their local area. ONR will respond to local and neighbourhood plan consultation requests by outlining the process ONR will follow at the planning application stage, and it is for those producing the plans to satisfy themselves that ONR will not advise against any development in the plans at the planning application stage before including such developments within their plans.

17.32. The National Planning Policy Framework (Ref. 17.9) and Planning Practice Guidance on Hazardous Substances (Ref. 17.10) (in England), Planning Policy Wales supplemented by a series of Technical Advice Notes, Welsh Government Circulars, and policy clarification letters (Ref. 17.11) (in Wales) and Scottish Planning Policy (Ref. 17.12) and Planning Circular 3/2015 Planning Controls for Hazardous Substances (in Scotland) (Ref. 17.13) provide guidance on the exercise of planning control over hazardous development and over development in the vicinity of hazardous installations (including nuclear installations).

17.33. ONR is specified as a statutory consultee for types of development within COMAH 2015 (Ref. 17.14) consultation zones around certain nuclear sites (within development management procedures covering England, Wales and Scotland) (Ref. 17.15)) and has non-statutory arrangements in place to ensure it is consulted in the case of planning applications in the vicinity of all nuclear installations where there is the potential for a radiological emergency to arise (Ref. 4).

17.34. ONR requires assurances from local authorities that proposed developments in the immediate vicinity of a nuclear installation can be accommodated within their existing (or modified) emergency preparedness arrangements to satisfy REPPIR requirements.

17.35. Local planning authorities normally follow ONR’s advice, recognising the organisation’s acknowledged expertise in assessing the risks presented by nuclear installations. When local planning authorities propose to grant planning permission against ONR advice, ONR would consider whether the decision gave rise to a serious safety concern or challenge to government policy and, where appropriate, refer the matter to the relevant Secretary of State or Scottish Minister, recommending that the application be called in for their determination.

Procedures for re-evaluating as necessary all relevant factors referred to in the above sections to ensure the continued safety acceptability of the nuclear installation

17.36. The information in this section demonstrates compliance with VDNS Principle 2.

17.37. The licensee monitors and assesses any natural phenomena that might affect safety (for example something that may change the assumptions concerning external hazards) around each nuclear site. The PSRs described under Article 14 – Assessment and Verification of Safety include requirements that the radiological risk from the nuclear installation under review will remain acceptable during the period covered by the reviews. In addition, ONR has committed to undertaking demographic reviews every 10 years around each nuclear power station site in its land use planning guidance, based upon up-to-date population data provided by a third-party supplier (Ref. 17.4).

17.38. In the event of a national or international major accident or occurrence of other extreme events, ONR would carry out a systematic review of the safety implications for UK nuclear sites, such as that done following the nuclear accident at Fukushima in 2011. ONR would request that relevant nuclear site licensees review the response of their facilities to a set of extreme situations defined within a scope determined by the nature of the event (and, where applicable, informed by international standards, agreements and specifications). This is in order to evaluate the robustness of the defence-in-depth approach, the adequacy of current accident management measures (including severe accident management strategies) and to identify the potential for safety improvements, both technical and organisational. ONR would assess the adequacy of the nuclear site licensee reviews and may make additional recommendations regarding potential safety improvements. Monitoring of the implementation of safety improvements and the completion of actions related to potential safety improvements would be included within ONR’s regulatory intervention strategies.

17.39. ONR would monitor and assess the adequacy of progress made by the UK nuclear industry until satisfied that the significant lessons learned from the event have been adequately discharged. It will, if necessary, use its regulatory powers to ensure that all reasonably practicable improvements are implemented.

Procedures for consulting Contracting Parties in the vicinity of a proposed nuclear installation

17.40. The UK Government, via the environmental regulators, considers whether planned disposal of radioactive waste could result in significant radioactive contamination from the point of view of health, of water, soil or airspace of notifiable countries (transboundary radioactive contamination). This assessment takes place before an environmental authorisation is granted. Notifiable countries are EU Member States and Norway. If there are transboundary considerations, then, as appropriate, the UK will notify these countries of the environmental authorisation application so that they may participate in the public consultation (Ref. 17.16).

17.41. The UK undertakes a broad range of information exchange to fulfil safety obligations and to promote co-operation. This includes multilateral co-operation through the IAEA, particularly on the development of safety standards and in peer review missions, for which the UK has recently supported those to Spain, Netherlands and Germany. The UK itself hosted an IRRS mission in 2019 that reviewed all aspects of the UK's radiological safety framework. The UK is a member of the Organisation for Economic Co-operation and Development (OECD) Nuclear Energy Agency (NEA) and participates in a range of the agency's safety work streams. ONR is also a member of the Multinational Design Evaluation Programme (MDEP), collaborating with other foreign national regulators looking at new reactor designs. In the European context the UK co-operates with both its fellow European nations through groups such as European Nuclear Safety Regulators Group (ENSREG), Heads of the European Radiological Protection Competent Authorities (HERCA) and WENRA.

17.42. The UK, via ONR, has entered into bilateral 'information exchange agreements' with regulators in several countries to facilitate the sharing of information – this includes both established nuclear states such as France and Canada, those with planned new reactors such as Vietnam and Poland and non-nuclear neighbouring states such as the Republic of Ireland.

17.43. The UK, through its own engagement as a member of the IAEA and as a member of the Group of Seven (G7) inter-governmental forum, encourages all states to take part in international co-operation and in particular the peer review process of the Convention – the UK is supportive of the continuing efforts of the Convention President and Secretariat to achieve greater engagement by all Contracting Parties.

Article 17 References

17.1 The United Kingdom's Eighth National Report on Compliance with the Obligations of the Convention on Nuclear Safety (https://www.iaea.org/sites/default/files/national_report_of_the_united_kingdom_for_the_8th_review_meeting.pdf), Department for Business, Energy & Industrial Strategy, August 2019.

17.2 The Planning Act 2008 (https://www.legislation.gov.uk/ukpga/2008/29/contents).

17.3 The National Policy Statement for Nuclear Power Generation (EN-6). Volume II (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/47859/2009-nps-for-nuclear-volumeI.pdf).

17.4 ONR Guide: Land Use Planning and the Siting of Nuclear Installations, July 2018 (http://www.onr.org.uk/documents/2018/ns-lup-gd-001-land-use-planning-and-the-siting-of-nuclear-installations.pdf).

17.5 ONR Safety Assessment Principles, 2014 (http://www.onr.org.uk/saps/saps2014.pdf).

17.6 ONR Safety Assessment Principles, 2014 (http://www.onr.org.uk/operational/tech_asst_guides/index.htm).

17.7 Site Evaluation for Nuclear Installation, IAEA Safety Standards, No. NS-R-3 Revision 1 (https://www.iaea.org/publications/10882/site-evaluation-for-nuclear-installations).

17.8 The Infrastructure Planning (Environmental Impact Assessment) Regulations 2017 (http://www.legislation.gov.uk/uksi/2017/572/contents/made).

17.9 Ministry of Housing, Communities and Local Government: National Planning Policy Framework, February 2019 (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/779764/NPPF_Feb_2019_web.pdf).

17.10 Planning Policy Guidance on Hazardous Substances (in England) (http://planningguidance.communities.gov.uk/blog/guidance/hazardous-substances/).

17.11 Welsh Government: Planning Policy and Guidance (https://gweddill.gov.wales/topics/planning/policy/?lang=en).

17.12 Scottish Government: Scottish Planning Policy (https://www.gov.scot/publications/scottish-planning-policy/).

17.13 Planning Circular 3/2015 Planning Controls for Hazardous Substances (in Scotland) (https://www.gov.scot/publications/circular-3-2015-planning-controls-hazardous-substances/).

17.14 Control of Major Accident Hazards Regulations 2015 (https://www.legislation.gov.uk/uksi/2015/483/contents/made).

17.15 Development Management Procedures covering England (http://www.legislation.gov.uk/uksi/2010/2184/pdfs/uksi_20102184_en.pdf), Wales (https://www.legislation.gov.uk/wsi/2012/801/made) & Scotland (http://www.gov.scot/Resource/0044/00441568.pdf).

17.16 Transboundary impacts of radioactive waste disposal: reporting and notification obligations (https://www.gov.uk/guidance/transboundary-impacts-of-radioactive-waste-disposal-reporting-and-notification-obligations-euratom-article-37).

Article 18 – Design and Construction

Each Contracting Party shall take the appropriate steps to ensure that:

I. the design and construction of a nuclear installation provides for several reliable levels and methods of protection (defence-in-depth) against the release of radioactive materials, with a view to preventing the occurrence of accidents and to mitigating their radiological consequences should they occur;

II. the technologies incorporated in the design and construction of a nuclear installation are proven by experience or qualified by testing or analysis;

III. the design of a nuclear installation allows for reliable, stable and easily manageable operation, with specific consideration of human factors and the man-machine interface.

18.1. Compliance with this Article of the Convention has not substantially changed since the United Kingdom's (UK) eighth National Report (NR) (Ref.18.1) (in a way that has implications for the Convention obligations).

18.2. Significant portions of this Article demonstrate compliance with **VDNS Principles 1 and 2**.

18.3. The UK applies the internationally endorsed principle of defence-in-depth to the design and operation of its nuclear installations and to reducing risks where reasonably practicable; these principles are firmly embedded in the Office for Nuclear Regulation's (ONR) Safety Assessment Principles (SAPs), which have been benchmarked against the International Atomic Energy Authority's (IAEA) Safety Standards. An overview of the UK's arrangements and regulatory requirements relating to the design and construction of nuclear power plant is presented below.

Mapping of IAEA standards

18.4. This information in this section demonstrates compliance with VDNS Principle 3.

ONR Safety Assessment Principles

18.5. ONR's inspectors use the SAPs (Ref. 18.2), together with supporting Technical Assessment Guides (TAGs) (Ref. 18.3), to guide their regulatory judgements and recommendations when undertaking technical assessments of existing nuclear site licensee's safety submissions and also new reactor designs considered through the GDA process.

18.6. The UK is a Member State of the International Atomic Energy Agency (IAEA) and contributes actively to the development of the IAEA's published

Safety Standards. The UK applies the IAEA Safety Standards and ensures that its own regulations, regulatory requirements, and guidance for UK nuclear facilities are consistent with them. This includes the SAPs, which were benchmarked for the 2006 issue against IAEA's Safety Standards and were updated in 2014 to reflect subsequent changes in these standards since 2006. This exercise took account of recent work by the IAEA in the development of the Design Standard on the Safety of Nuclear Power Plants (SSR 2/1) (Ref. 18.4). ONR has carried out a systematic, comprehensive review of the SAPs against each of the specific requirements of SSR 2/1. This was carried out by a multi-disciplinary team of experienced inspectors, subject to robust challenge by a review panel acting under the direction of a deputy chief nuclear inspector. As with the previous version of the SAPs, ONR considers that the 2014 SAPs are fully in line with IAEA guidance and standards. ONR acknowledges that these SAPs cannot reflect the breadth and depth of the entire suite of IAEA publications and so, as guidance is updated, ONR explicitly identifies those documents as relevant good practices within the TAGs.

EDF Energy NGL

18.7. EDF Energy NGL operates to an integrated management system that integrates safety, health, environmental, security, quality, and economic objectives to ensure that safety is not compromised. The management system draws on best practice, as defined within National and International standards, including IAEA Safety Requirements and Safety Standards. EDF Energy NGL maintains fleet-wide certification to ISO9001:2015, ISO14001:2015, OHSAS18001:2007 and ISO55001:2014.

18.8. Following IAEA OSART missions during the last reporting period, EDF Energy has undertaken a review of the applicable IAEA Safety series and standards against the EDF Energy NGL arrangements. This review has resulted in EDF Energy demonstrating compliance to the safety series standards and guides or where there is a gap having a clear justified reason to support why there is a gap.

18.9. This work was completed and documented within the company's organisational learning process together with any gaps or improvements identified in the reviews.

EDF NNB GenCo

18.10. The commitment to give priority to nuclear safety is clearly established within company policies. These policies are implemented through the integrated management system; the management system and detailed arrangements are structured to meet the IAEA Requirements contained in GSR Part 2.

18.11. In addition, any requirements including individual IAEA technical documents are contained within the Hinkley Point C Integrated Management System.

Implementation of defence-in-depth

Contracting Party's arrangements and regulatory requirements

18.12. As discussed earlier in this report (for example, Article 14 – Assessment and Verification of Safety), the SAPs and supporting TAGs, represent ONR's view of good practice; ONR expects modern facilities to satisfy their overall intent. For facilities built to earlier standards, ONR inspectors assess safety cases against the relevant SAPs when judging if a dutyholder has demonstrated that legal requirements have been met and risks have been controlled to ALARP. The extent to which the principles ought to be satisfied must also consider the age of the facility or plant.

18.13. ONR's SAPs provide numerical targets to support a judgement as to whether radiological hazards are being adequately controlled and risks reduced to ALARP. The targets quantify ONR's risk policy. More specifically, the targets are guides to inspectors to indicate where additional safety measures may need to be considered and, in the case of permissioning decisions, to help judge whether risks are tolerable. In assessing the safety of nuclear facilities, inspectors examine the safety case to judge the extent to which the targets are achieved. Some of the targets are in the form of dose levels; others are expressed as frequencies or risks. Each is set in terms of a basic safety level and a basic safety objective. It is ONR's policy that a new facility or activity should at least meet the basic safety levels, however, even if the levels are met, the risks may not be ALARP. In such cases, the designer and dutyholder must reduce the risks further. Basic safety objectives form benchmarks that reflect modern standards and expectations and mark the start of the broadly acceptable levels. Separate targets are defined for normal operations, design basis fault sequences, individual risks, accident frequencies and societal risk.

Consideration of fault and accident conditions

18.14. Nuclear facilities in the UK require safety cases which assess the risks from both normal operation and from fault and accident conditions. Fault analysis is required comprising of suitable and sufficient Design Basis Analysis (DBA), Probabilistic Safety Analysis (PSA) and Severe Accidence Analysis (SAA) (as referenced under Article 14 – Assessment and Verification of Safety) to demonstrate that the risks are ALARP. It is ONR's expectation that these 3 complementary techniques are applied to nuclear power generating facilities to demonstrate the adequacy of the design and activities being undertaken, whether this is for an existing facility or a new design.

18.15. DBA should be carried out to provide a robust demonstration of the fault tolerance of the engineering design and the effectiveness of the safety measures. Relevant good practice in the UK is that the design basis should include internal faults in the facility that have an initiating frequency down to 1×10^{-5} per annum (p.a.) and natural hazards that conservatively have a predicted frequency of down to 1×10^{-4} p.a.

18.16. Through the rigorous application of DBA, PSA and SAA techniques, it is ONR's expectation that a modern safety case will consider the full scope of operational occurrences, design basis events, low frequency fault sequences beyond the design basis and severe accident damage states. In all cases, the requirement is to demonstrate that risks have been reduced to ALARP.

18.17. The nuclear power plant operators and reactor designers proposing new plants provide comprehensive PSA evaluations of their facilities/designs, consistent with ONR's expectations. PSA assists the designers in achieving a balanced and optimised design. PSA should enable a judgement to be made of the acceptability or otherwise of the overall risks against numerical targets and should help to demonstrate that the risks are, and remain, ALARP.

18.18. The 2014 SAPs do not vary significantly regarding their requirements for the application of beyond design basis/SAA from the earlier revision. However, for the first time, an expectation was set that SAA should form part of a demonstration that potential severe accident states be 'practically eliminated'. This expectation has now been incorporated into the latest revision of ONR's Severe Accident Analysis TAG (Ref. 18.3).

Adoption of practical elimination of large and early releases [Example]

18.19. Consistent with the principle of defence-in-depth, ONR has an expectation (SAPs paragraph 610) that events and plant states beyond those considered as part of Design Basis Analysis (DBA) are managed through the provision of equipment and procedures that can control or mitigate the consequences. These scenarios, where the potential consequences may be severe, should be considered in the safety case.

18.20. ONR's DBA TAG (NS-TAST-GD-006) and Severe Accident Analysis (SAA) TAG (NS-TAST-GD-007) provide guidance to inspectors on the expectations for the analysis of severe plant states associated without and with core damage respectively. However, ONR's SAPs and SAA TAG also address the concept of practically eliminating early or large radioactive releases in the design of a nuclear facility as an additional expectation to be demonstrated for a new facility and as a benchmark to be considered SFAIRP on existing facilities in periodic safety reviews.

18.21. For nuclear power plant designers iterating on an evolving design, they may wish to invoke a specific process to identify any additional design features which are necessary to practically eliminate early or large releases. However, in the demonstration that is presented to regulators in the safety case, it is expected that a narrative drawing heavily on analysis (DBA, PSA and SAA) and engineering substantiation presented elsewhere in the safety case will be provided. The demonstration of practically eliminating early or large radioactive releases is considered a validation or check of the ultimate design, and not an extra layer of defence-in-depth or severe accident analysis technique.

18.22. Practical elimination is fully consistent with the UK requirement to reduce risks ALARP. In addition to being an example of relevant good practice that should be met, it also provides a target for what severe accident design measures should achieve and helps with arguments that providing further design features for extreme events would be grossly disproportionate.

18.23. The generic safety case for the EPR^{TM} design being built at the Hinkley Point C site did consider, deterministically, the practical elimination of large or early releases caused by high-pressure melt ejection, steam explosion and hydrogen combustion, consistent with ONR and international expectations.

18.24. The design has continued to evolve to include additional features such the Diverse Feed System (DFS) to reduce the potential for a severe accident, and measures such as the Containment Water Injection System have been added to protect the containment integrity. The safety case is being developed to take account of these.

18.25. ONR’s regulatory assessments have considered the arguments for practical elimination put forward for HPC and the supporting deterministic and probabilistic analysis which substantiates defence-in-depth claims. The view of the regulator is that the design provision and safety case demonstrations are consistent with its guidance and international expectations. The adequacy of the final design will be reviewed ahead of HPC operation, and reviewed periodically throughout its operational lifetime.

Consideration of external and internal hazards

18.26. External hazards are defined for use in plant design and DBA in terms of design bases, as described in SAPs EHA.3 and EHA.4 (Ref. 18.2). Design bases are defined by characterising the site and identifying all credible external hazards events that could affect the site (external hazards are also discussed under Article 17 – Siting). Hazards that could pose a significant risk, normally those that cannot be screened out on low frequency or low consequence grounds, are considered in the DBA and PSA analyses (SAP EHA.19). So far as plant design and assessment is concerned, external hazard design bases are simply additional ‘loads’ which the plant has to appropriately withstand. ONR inspectors test the plant design against the body of worldwide relevant good practice (including from IAEA and WENRA) and using the engineering and fault analysis SAPs generally.

18.27. Most external hazards, especially natural hazards, are significant common cause fault initiators, meaning that several (for example, seismically initiated) faults may be initiated at the same time by the same event. This can place additional burdens on post-event operator recovery actions and emergency arrangements response.

18.28. Natural hazards, for example, earthquakes, extreme weather, external flood, etc. are characterised by hazard curves describing a range of frequency/hazard severity possibilities. The design bases are defined conservatively at 1×10^{-4} p.a. Beyond Design Basis Analysis (BDBA) is also performed to consider more severe hazard events at frequencies below 1×10^{-4} p.a. to ensure the avoidance of cliff-edge effects. This is described in detail in TAG 13 – external hazards. There is substantial relevant good practice worldwide that ONR inspectors would expect licensees to have made use of in supporting claims that the plant can meet, not just the design basis, but has margin above this to account for the substantial uncertainties in all aspects of the hazard and plant analysis.

18.29. For extreme weather and flood hazards, it is usual for several hazards to affect the plant simultaneously, for example, storm weather creates an environment for high wind and high rates of precipitation at the same time. In the case of seismic events there may be possible consequential effects, for example, a tsunami. ONR inspectors look for licensees to have accounted for credible combinations of external hazards in their safety analyses (SAP EHA.6).

18.30. It is also the case that external hazards may cause internal faults (for example, plant failures) or internal hazards (for example, seismic and consequential fire, seismic and consequential internal flooding). ONR inspectors recognise that these combinations may challenge multiple safety functions and locations simultaneously. The hazards identification and characterisations process should include reasonably foreseeable combinations of hazards and consequential events (SAP EHA.1).

18.31. ONR's NS-TAST-GD-013, which provides detailed guidance to ONR inspectors on the identification and assessment of external hazards, has been substantially updated and expanded and the TAG was re-issued in October 2018. The revision process included substantial consultation with stakeholders, including other ONR specialisms, nuclear licensees, regulators from other countries and other UK regulators.

18.32. The ONR external hazards discipline has been consulted in the November 2018 update to the UK Climate Projections (UKCP18) (Ref.18.5). UKCP18 is a set of climate model projections for the UK produced by the UK Meteorological Office (Met. Office) and partners. UKCP18 updates the UKCP09 projections over UK land areas and provides updated projections of sea level rise, giving greater regional detail and providing more information on potential extremes of climate change. UKCP18 was supplemented in 2019 with local-scale projections, which are considered to better represent small-scale behaviour in the atmosphere, such as convection, than the regional projections. The use of UKCP18 is relevant good practice in determining climate change allowances for relevant natural hazards at UK licensed sites (Ref. 18.6) and has been incorporated into joint regulatory expectations, such as for flooding and coastal erosion (Ref. 18.7).

18.33. ONR's SAPs also require the identification of potential internal hazards and that hazard effects be considered in safety assessments. Internal hazards are defined as hazards which originate within the site boundary, and where the licensee has control over the initiating event in some way. The term is usually limited to apply to hazards external to the process, in the case of nuclear chemical plant, or external to the primary circuit in the case of power reactors. Internal hazards include internal flooding, fire, toxic gas release, collapses, dropped loads, impacts from vehicular transport and explosion/missiles. It is recognised that internal hazards may originate from plant failures, mal-operation of the plant, or from other hazards, including external hazards (as discussed earlier).

18.34. Detailed knowledge of the plant and site layout is required for internal hazards assessment. Hazard identification and impact assessment involves a facility and site review together with event tree analysis. Multi-facility sites would require appropriate interface arrangements to deal with the potential subsequent effects of internal hazards.

18.35. The SAPs require that the risk from internal hazards be minimised by attention to plant layout, by adopting good engineering standards and design, keeping inventories of hazardous (for example, combustible and toxic) materials to a minimum, and thereafter through good safety management practices.

18.36. More information on the regulatory expectations in relation to internal hazards can be found in ONR's Internal Hazards TAG (NS-TAST-GD-014) (Ref. 18.3).

Consideration of defence-in-depth

18.37 Defence-in-depth is seen as a fundamental element of reactor safety. It is one of ONR's key engineering principles (SAP EKP.3) (Ref. 18.2) that nuclear facilities should be designed and operated so that defence-in-depth against potentially significant faults or failures is achieved by the provision of multiple independent barriers to fault progression. It has been a requirement for all nuclear installations since the beginning of the GB reactor programme and continues to be a requirement for new build.

18.38. Defence-in-depth is generally applied in 5 levels, which should be, as far as practicable, independent from one another (SAPs, para 152) (Ref. 18.2). The methodology should ensure that if one level fails, it will be compensated for, or corrected by, the subsequent level. The aims for each level are described in detail in IAEA Safety Requirements SSR2/1 on which the levels are based. The levels are also consistent with the definitions in IAEA publication INSAG-10. The levels defined in the SAPs are identified in figure 18.1 below.

Figure 18.1: Defence-in-depth levels defined in ONR SAPs

Level	Objective	Defence/Barrier
Level 1	Prevention of abnormal operation and failures by design.	Conservative design, construction, maintenance, and operation in accordance with appropriate safety margins, engineering practices and quality levels.
Level 2	Prevention and control of abnormal operation and detection of failures.	Control, indication, alarm systems or other systems and operating procedures to prevent or minimise damage from failures.
Level 3	Control of faults within the design basis to protect against escalation to an accident.	Engineered safety features, multiple barriers and accident or fault control procedures.
Level 4	Control of severe plant conditions in which the design basis may be exceeded, including protecting against further fault escalation and mitigation of the consequences of severe accidents.	Additional measures and procedures to protect against or mitigate fault progression and for accident management.
Level 5	Mitigation of radiological consequences of significant releases of radioactive material.	Emergency control and on and offsite emergency response.

18.39. Safety cases for UK nuclear power plants need to demonstrate how the defence-in-depth principle has been applied. Even if a safety measure is not formally claimed in DBA (and therefore not part of level 3), the law requires operators and designers to do everything that is reasonably practicable to ensure that risks are reduced ALARP to maximise the effectiveness and reliability of level 1 and level 2 measures. PSA is one tool used in safety case to show the contribution of these measures to safety and to inform design, modification, and maintenance decisions on the measures.

18.40. Relevant good practice for design basis measures (level 3) as established in the SAPs is consistent with international guidance. For example:

- Challenges to structures, systems and components delivering a safety function should be addressed by incorporation of redundancy, diversity, and segregation (SAP EDR.2), including consideration of common cause failures (SAP EDR.3);
- No single random failure, assumed to occur anywhere within the systems provided to secure a safety function, should prevent the performance of that safety function (the single failure criterion, SAP EDR.4); and
- Structures, systems, and components that are important to safety should be designed, manufactured, constructed, installed, commissioned, quality assured, maintained, tested and inspected to the appropriate codes and standards (SAP ECS.3).

18.41. The requirement to physically contain radioactive material within a nuclear facility is well established. Fault sequence analysis (SAP FA.7) should be used to demonstrate, so far as is reasonably practicable, that the correct performance of the claimed passive and active safety systems ensures that:

- None of the physical barriers to prevent the escape or relocation of a significant quantity of radioactive material is breached or, if any are, then at least one barrier remains intact and without a threat to its integrity;
- There is no release of radioactivity; and
- No person receives a significant dose of radiation.

18.42. ONR’s SAP AM.1 on accident management and emergency preparedness was substantially revised in response to the Fukushima accident. Licensed nuclear sites in the UK all need to comply with the requirements of LC11 to make and implement adequate arrangements for dealing with any accident or emergency arising on the site and their subsequent effects. This includes emergency control to mitigate the radiological consequences on and off-site (level 5) if other design features have failed or been ineffective. A new operator needs to demonstrate it is developing appropriate arrangements before a site licence is granted.

Status of application of the defence-in-depth concept

Application of defence-in-depth:

18.43. Current operating reactors incorporate defence-in-depth measures to protect against a wide range of fault conditions, whether initiated by external natural and man-made hazards, internal hazards, other internal events, or consequential combinations of these.

18.44. The AGRs employ CO2 gas to take away heat from the fuel elements in the reactor core. With regards to defence-in-depth, the key features of the

AGR design include:

- Reactor Shutdown: Provided by the control rod primary shutdown system, diverse systems using nitrogen injection or tertiary systems using boron or water (details vary depending on station).
- Post-trip Cooling: If the gas circulators fail, the fuel can be cooled by natural circulation providing feed water can be supplied to one of the boilers. All AGRs have at least 2 diverse and redundant post-trip feed water systems.
- AGRs do not have a containment building around the pressure vessel. None of the design basis accidents for AGRs result in large scale fuel failure and the plant is designed to be capable of retaining the bulk of any radioactive material that might be released from the fuel. The AGRs massive concrete pressure vessel together with the large mass of graphite in the core provide hours of heat sink in case of total loss of post-trip cooling.

18.45. The UK also operates a single Westinghouse-designed 4-loop PWR, located at Sizewell B. This plant also incorporates defence-in-depth measures:

- Reactivity control is achieved by the rod cluster control assemblies, which in the event of a trip fall under gravity into the core. The emergency boration system provides a diverse means of achieving reactor shutdown.
- For intact primary circuit faults, post-trip cooling can be provided by main feed water systems, backed up by the diverse auxiliary system powered by emergency diesel generators and a turbine-driven system. For loss of coolant accident faults, the emergency core cooling system provides decay heat removal by way of high and low head safety injection pumps and pressurised accumulators. The heat sink for the post-trip cooling systems is provided by the seawater-cooled essential service water system or the air-cooled reserve ultimate heat sink, powered by the diesel generators.
- The containment building limits the release of radioactivity should a beyond design basis fault occur. Heat is removed and pressure reduced by fan coolers and reactor building spray systems.

18.46. As already discussed in this report, the UK is embarking on a new build programme utilising light water reactor technology. The expectation is that any new design demonstrably complies with current relevant good practice. Recognising the international nature of nuclear power plant development, ONR has stated that proposed new reactors should be at least as safe as modern reactors anywhere else in the world (NS-TAST-GD-005) (Ref.18.3).

Consideration of External hazards at NPPs

18.47. Consideration of external hazards within the initial designs of operating reactors varies substantially, with the earlier stations, for example, having no seismic withstand at the original design stage, and later ones having a degree of seismic withstand consistent with what was considered good practice at the time. The latest AGR stations (Heysham 2, Torness and Sizewell B) were designed in the 1980s and therefore incorporated seismic withstand (and many other modern safety features), which is reasonably consistent with current good practice.

18.48. As already discussed under Article 14 – Assessment and Verification of Safety, all the stations have undertaken substantial periodic safety reviews (PSRs) every 10 years, and these have provided a vehicle for comparison with relevant good practice in the rapidly developing area of external hazards. On the older stations especially, they have prompted significant amounts of modification work, especially to upgrade their seismic performance. This has been upgraded to a point where their safety performance is now acceptable to the regulator and consistent with regulatory safety principles, bearing in mind that these are existing (as opposed to new) stations.

18.49. Assessments of operating reactors account for a full range of natural external hazards, plus known man-made and industrial hazards, such as accidental aircraft crash. Malicious aircraft crash and security threats are also considered and there is ongoing close liaison between ONR, reactor licensees and relevant government departments, to ensure that appropriate security protection arrangements are in place.

18.50. Plant safety cases for the existing reactor fleet are developed primarily in terms of deterministically justified lines of protection to external hazards-initiated faults. Traditionally, beyond design basis analysis for external hazards-initiated faults has been undertaken in a variety of ways, including:

- Qualitatively, by identifying the degree of inherent margin in design codes and standards used to analyse plant response to hazards;
- Quantitatively in some cases by using comparison with best estimate plant analysis, or by other numerical means; and
- By inspection involving either plant walk-downs or other types of bespoke inspection.

18.51. The operating UK power reactors do not have a modern standards quantitative risk analysis of plant response to external hazards, although Sizewell B does have a modern standards seismic PSA. The safety justifications for the operating fleet are based on deterministic justifications against bounding hazards, as was the practice during their design. The 10 yearly PSRs, more frequent Safety Case Health Reviews and ongoing safety case updates have presented arguments to demonstrate that the risks are ALARP or identified remedial actions to address shortfalls.

18.52. Two objectives have been set for the external hazards beyond design basis analysis (BDBA) assessment strategy in the Hinkley Point C safety case:

- To ensure that the design basis criteria are met for external hazards just beyond the design basis (known as jBDB), accounting for possible uncertainty in the hazard definition and assessment process; to verify that a hazard with severity a small amount greater than the design basis will not lead to a step change or disproportionate increase in radiological consequences (also known as a cliff-edge effect); and
- To demonstrate for external hazards significantly beyond the design basis (known as sBDB) that the failure modes are well understood and do not contravene any assumptions considered as part of the severe accident (SA) analysis. The aim is to verify that in the event of a hazard with a frequency significantly lower than the design basis, should a severe accident occur as a result of the external hazard, a large or early release of radioactive material to the environment is very unlikely.

18.53. For Hinkley Point C, the design basis hazard magnitudes are defined as conservative estimates for the 1×10^{-4} p.a. (natural hazards), or 1×10^{-5} p.a. (external hazards of human origin) return frequencies, based on UK and international relevant good practice, using Hinkley Point C site data.

18.54. The jBDB external hazard magnitude is defined by the best estimate (50th percentile) at the 1×10^{-5} p.a. return frequency, which is intended to represent a small increase on the design basis hazard level for the purpose of preventing cliff-edge effects. Care must be taken when defining a jBDB hazard level to ensure that this does not become a new de facto design basis. The jBDB level should be used within the assessment of consequences, but modification to the design basis (or even to the design itself) would only be necessary if the analysis identified intolerable consequences; the overall assessment would be based upon the ALARP principle.

18.55. The sBDB hazard magnitude is defined by the best estimate of the 1×10^{-6} p.a. return frequency, which may vary depending on the specific hazard topic; this is a significant increase with respect to the design basis hazard return frequency.

Use of design principles

18.56. The key design principles that are discussed in this section have long been established as relevant good practice in the design of nuclear power plants built in the UK. They are essential to achieve the necessary high levels of nuclear safety expected in the UK, including under fault conditions. Given the long history of nuclear engineering in the UK, the formalisation and application of these principles has evolved over time. The latest revision of ONR's SAPs captures the current relevant good practice for these principles. They are also set out in the procedures and manuals of the nuclear power plant operators.

ONR's engineering principles

18.57. ONR's SAPs set out engineering principles (Table 3 – Examples of the Engineering Principles set out in the SAPs) that have been benchmarked against IAEA and other international guidance. ONR looks for evidence of these principles being applied in the arrangements, designs and safety cases of existing and new nuclear power plant operators so far as is reasonably practicable.

Examples of the application of design principles

18.58. The following are examples of the application of the design principles for existing AGRs and the Sizewell B PWR:

- The AGRs and Sizewell B have primary and secondary C&I protection systems to initiate key safety functions. Redundancy, separation, and segregation are widely applied within each system, and the 2 systems are independent of each other. They are fail-safe and tolerant of single failures;
- The control rods on the AGRs are fail-safe, falling under gravity if necessary. There are diverse secondary and tertiary systems for achieving reactivity control;
- The rod cluster control assemblies on Sizewell B are fail-safe, falling under gravity if necessary. The emergency boration system provides a diverse means to shutdown the reactor should there be a multiple failure of the assemblies;
- For the AGRs in the event of loss of post-trip-cooling, the high thermal inertia of the core and concrete pressure vessel means that the timescale to restore cooling is long, thereby providing increased tolerance to faults;
- For post-trip cooling the AGR boilers have segregated power supplies and feedwater systems and are capable of removing the decay heat from a tripped reactor by natural circulation of the CO_2 coolant (if pressurised);
- Sizewell B has multiple methods of cooling the reactor post shutdown in normal and fault conditions, including a high level of segregation and redundancy within the systems;
- The on-site emergency generation capacity at the AGRs (either diesels or gas turbines) available in the event of a loss of off-site power is distributed around the site; and
- The 4 essential diesel generators at Sizewell B are segregated with each unit being in its own independent cell and with the cells being in pairs in 2 separate buildings.

18.59. The designs for the proposed new reactors have been assessed by the regulator against the latest SAPs and relevant international good practice.

Implementation of beyond design basis design measures

EDF Energy NGL

18.60. As a result of a renewed consideration of modern safety case practice (and following the events at Fukushima), several areas for further safety improvements were identified and implemented by EDF Energy NGL. The aim was to improve defence-in-depth, and hence increase the robustness of sites, in the case of loss of electrical power, ultimate (and alternative) heat sinks and containment integrity. The improvements are similar for each station although some are station specific. In general terms, the key improvements include:

- Improving the robustness of reseal and re-pressurisation arrangements for the AGRs;
- Extending control C&I and lighting resilience;
- Improved training, planning and pre-engineering in order to improve mitigation measures;
- Extending transient analysis to determine the timescales for prevention of fuel and structural damage for a range of scenarios;
- Increasing mission time by increasing the capacity of water and fuel storage tanks on-site;
- Increasing the provision of off-site back-up equipment, including equipment to enable water injection for cooling, a supply of suitable inert gas for primary circuit cooling (AGRs), and electrical supplies for lighting and C&I;
- Improvements to the resilience of decay store cooling against loss of ultimate heat sink in respect of improved guidance to operators, fault recovery and understanding of credible consequences; and
- Improvements to the resilience of storage pond cooling and make-up against the loss of ultimate heat sink in respect of improved guidance to operators, replenishment of lost pond water and standalone pond cooling facilities having no dependence on any other station supplies or systems.

NNB GenCo

18.61. As part of the implementation of defence-in-depth, the potential for severe accidents is considered as part of the design of the UK EPR^{TM}. Dedicated safety functions and safety features are defined and implemented to mitigate a severe accident, along with a set of procedures requiring only a limited number of operator actions.

18.62. The aim of this approach is to collect and cool molten material from the core in a core catcher, while maintaining the integrity of the containment. The Hinkley Point C safety case claims that:

- Severe accidents which lead to large early releases due to containment failures are practically eliminated;

- The consequences of a degraded core can be mitigated to reach a Severe Accidence Safe State indefinitely, where the core melt is being cooled, the decay heat is being removed and the containment integrity is maintained.

18.63. The general safety objective of the response to the Fukushima-type event is to avoid large uncontrolled radioactive releases and long-term effects to the environment in extreme plant situations which are initiated because of extreme external hazard conditions. This is achieved by demonstrating that safety features required to prevent core melt or to mitigate the consequences of core melt can withstand the effects of such a hazard. A specific set of structures, systems, and components (SSCs) fulfil these safety features.

18.64. Design enhancements have been added to the UK EPR^{TM}, such as measures to protect the Ultimate Diesel Generators and Severe Accident batteries against flooding and the provision of an extra water supply for containment heat removal. Additional mobile equipment such as a pump to assist with containment cooling and diesel generators with identified plant connection points were added to the emergency equipment inventory. Human Factors studies were carried out to validate that operator actions could be carried out in the required timeframes and appropriate storage requirements identified.

Implementation of measures to maintain containment integrity

Advanced gas-cooled reactors

18.65. AGRs do not have a containment building around the pressure vessel. However, there are longer timescales available in the event of loss of post-trip cooling and the pressure vessel is a massive reinforced concrete structure. The concrete pressure vessel together with the large mass of graphite in the core provide hours of heat sink in case of total loss of cooling.

18.66. In the 1990s, a major research programme was carried out by the industry to gain an improved understanding of severe accident phenomena for the AGRs. The research yielded a considerable body of experimental data, model development and severe accident analyses. The work was used to support severe accident management strategies for scenarios with longer term loss of post-trip cooling, including use of water injection, filtered venting and preservation of the containment.

18.67. The primary design provision to prevent over-pressurisation of the AGR pressure vessels is the safety relief valves. In addition, there are blowdown routes used in normal operation to provide a route for lowering the vessel pressure. All discharge routes are fitted with filters, including particulate filters on the safety relief valves. These operate to limit particulate discharge in design basis faults.

Sizewell B pressurised water reactor

18.68. Sizewell B has some design features that would limit the occurrence of over-pressurisation of the containment, namely the large volume, provision of containment fan coolers and water spray system and, as a last resort, the reactor building fire suppression system could be used for additional cooling. The main operational provisions for preventing overpressure of the PWR containment in accident conditions are the reactor building spray system cooling train or initiation of the fire suppression sprays. It is also predicted that one fan cooler would be sufficient to prevent containment overpressure.

18.69. Furthermore, EDF Energy NGL is actively investigating the practicability of installing filtered containment ventilation (FCV) at Sizewell B to mitigate against containment overpressure in the event of a severe accident. It is expected to make a final decision in 2024, tied to its aspirations to extend the life of Sizewell B.

18.70. In light water reactors, generation of hydrogen may occur during severe accidents due to oxidation of Zircaloy fuel cladding, by oxidation of other metals in the corium and molten core concrete interaction. Sizewell B has active and passive hydrogen recombiners strategically placed within the containment structure.

18.71. Sizewell B has also minimised the use of fibrous material within the containment, thereby reducing the risk of clogging of filters or strainers by debris in the event of a high energy pipe break. This is further discussed in the example below for Hinkley Point C.

Hinkley Point C EPR^{TM}

18.72. Hinkley Point C has some design features that would limit the occurrence of over-pressurisation of the containment; these include the large volume, provision of the containment heat removal system, corium spreader, annulus ventilation system and catalytic hydrogen recombiners. The containment heat removal system is made up of building sprays, passive corium cooling and corium flooding systems.

18.73. An example of a design enhancement to improve the operation of severe accident safety systems is discussed below.

Containment building fibre removal programme at Hinkley Point C [Example]

18.74. The UK EPR^{TM} design has safety systems for protecting the fuel in case of high energy line break in the primary or secondary circuit. These systems draw cooling water from storage facilities that are part of a closed loop between the system, the reactor vessel and pipework and the reactor building. Recirculation is an integral part of the process, so care needs to be taken to avoid the introduction of uncontrolled quantities of debris into the reactor vessel and the fuel assemblies. The debris is produced as a result of the explosive nature of the high energy line break. The amount and type of debris is controlled through a combination of reducing potential debris sources and the use of filters or strainers upstream of sensitive components.

18.75. NNB GenCo, its responsible designer and its suppliers have been working on the design of the filters and on the minimisation of the potential debris sources, with the aim of providing a justifiable design that takes recognition of relevant good practice (RGP) in the UK. Fibrous debris has been shown capable of creating conditions that can reduce cooling water flow both in the reactor core and in filters. RGP therefore implies that fibrous debris should be considered a hazard that should be minimised as a primary design objective. The source of fibrous debris can be from thermal insulation and fire protection materials.

18.76. In a severe accident, although the core will have undergone a controlled melt-down, there is still a concern around ensuring adequate cooling of the resulting corium. Therefore, the severe accident safety systems must be capable of ensuring the supply of adequate cooling water in the face of all potential debris quantities and types.

18.77. For Hinkley Point C, a multi-legged development and assessment programme was launched covering topics such as pipework insulation systems, HVAC design, equipment qualification, filtration, and fire protection for cables. In many instances this work has had to analyse safety aspects in light of their impact on a substantially complete design. The project has had to reconsider the traditional design approach and the use of margins within the design sequence to allow a balance to be struck between pipe support loadings, non-fibrous insulation systems and HVAC loads and between cable tray loadings and cable protection systems. In addition, the project has continued to develop a filtration system commensurate with the likely debris loadings.

18.78. The development of the safety case has continued in parallel and there are several design changes being introduced to the design to support the use of non-fibrous alternatives (for example, reflective metal insulation) and fire protection systems.

Design improvements as a result of deterministic and probabilistic safety analyses

Overview of main improvements since commissioning

18.79. The most recent AGRs (Heysham 2 and Torness) were the first nuclear power plants in UK to be designed with a full system engineering approach, which included a more detailed consideration of hazards as a potential common cause, with diversity and segregation as design principles to ensure safety. The design approach also included the benefit of PSA as well as deterministic rules for safety. As a result of defence-in-depth improvements identified in the PSA, several safety features were back-fitted to the other selected reactors at the time of the first PSR. The improvements for each station were identified on a case-by-case basis, considering the design differences between the stations. The scope of changes across the AGR fleet included:

- Tertiary feed systems (high pressure and/or low-pressure backup cooling);
- Diverse guard line tripping;
- Increased segregation of gas circulators;
- Steam release trip systems;
- Seismically qualified CO2 supplies;
- Pressure vessel reseal equipment for shutdown faults; and
- Electrical overlay systems (diverse electrical supplies).

18.80. This section is in line with **VDNS Principle 2**.

Regulatory review and control activities

GDA and new reactor build:

18.81. For new build, the GDA process enables the safety, security and environmental aspects of new nuclear power station designs to be assessed before applications are made to build that design at a site. GDA ensures technical assessments are conducted before reactor construction starts. This means that regulatory questions and challenges can be addressed while the designs are still ‘on paper’. It also provides a greater opportunity to identify those improvements that will result in the best safety outcome. The GDA process has been updated in 2019 to allow for a more flexible process to suit the range of future nuclear technologies: conventional GW scale designs, SMRs and AMRs. (Ref. 18.8).

18.82. The granting of a nuclear site licence (refer to Article 7 – Legislative and Regulatory Framework and Article 14 – Assessment and Verification of Safety) is a significant step but is not itself permission to start nuclear-related construction. That requires a regulatory permission under Licence Condition 19, which is based on a substantial pre-construction safety case. This needs to demonstrate that the associated risks and hazards have been assessed, appropriate limits and conditions have been defined and adequate safety measures have been identified and put in place to operate the facility safely. Before a licence is granted, ONR needs to be satisfied that the applicant’s choice of site is suitable, that it understands the hazards and risks of the activities that it proposes to carry out, and that it has a suitable schedule of safety submissions leading through to the pre-construction safety case. At this stage, ONR also expects the licensee to consider the hazards from neighbouring facilities, including from other units for multi-reactor sites. ONR also emphasises the need to gain confidence that the applicant has the organisational capability to lead and manage safety effectively.

18.83. Subsequent design and construction changes are controlled by LCs 19 and 20. Licence Condition 19 requires the licensee to make and implement adequate arrangements to control the construction or installation of a new plant. If safety-related modifications to the design arise during the construction phase, their implementation is controlled by arrangements made under LC20.

Established sites

18.84. LC14 requires a licensee to make arrangements for the production of documentation to justify safety during all phases of a plant's lifecycle, including design and construction. A safety case is the totality of documented information and arguments developed by the licensee that substantiates the safety of the plant, activity, operation or modification in question. It provides a written demonstration that relevant standards have been met and that risks have been reduced to a level which is ALARP. The safety case must be updated regularly, and the implications of proposed facility modifications and other safety-related changes need to be examined against it and, when necessary, additional demonstrations of safety provided. In addition, LC15 requires a licensee to make arrangements for periodic reviews of safety cases. Refer to Article 14 – Assessment and Verification of Safety for further discussion on nuclear power plant safety cases.

Incorporation of proven technologies

Contracting Party's arrangements and regulatory requirements

18.85. The reliability of safety systems and the use of proven technology, link clearly to the safety role that the systems are performing. In November 2015 ONR issued its updated TAG providing guidance and expectations on the requirement to categorise safety functions and the classification of structures, systems, and components to deliver the safety function (NS-TAST-GD-094) (Ref. 18.3). The reliability claimed for any SSC should consider its novelty, experience relevant to its proposed environment, and uncertainties in operating and fault conditions, physical data and design methods (SAP ERL.1).

18.86. A graded approach should be followed, consistent with UK and international relevant good practice. The ONR SAPs recommend a 3-tier approach, firstly designating the required safety function (Category A to C) and to the classification of the SSC delivering those functions (Class 1 to Class 3). This guidance places firm expectations on the licensees regarding the expected reliability of the structures, systems and components required to deliver a safety function. This is achieved by using the structures, systems, and components' class to inform the standards and relevant good practice associated with designing, manufacturing, constructing, installing, commissioning, quality assuring, maintaining, testing and inspecting the item. It is ONR's expectation that licensees ensure that:

- The adoption of appropriate national and international nuclear specific codes and standards for Class 1 and Class 2 structures, systems, and components. For Class 3, appropriate non-nuclear specific codes and standards may be applied;
- Codes and standards are evaluated to determine if they are suitable and sufficient. Where necessary these standards and codes should be supplemented as necessary to a level commensurate with the importance of the safety function being performed;
- The amalgamation of different codes and standards for a single aspect of a safety system or safety-related system is either avoided or appropriately justified to demonstrate compatibility;
- Where there are no appropriate established codes or standards, an approach derived from existing codes or standards for similar equipment in similar applications is used (SAP ECS.4); and
- In the absence of applicable or relevant codes and standards, the results of experience, tests, analysis, or a combination thereof, is used to demonstrate that an item will perform its safety function(s) to a level commensurate with its classification (SAP ECS.5).

18.87. Regarding metal components and structures, the manufacture and installation should use proven techniques and approved procedures to minimise the occurrence of defects that might affect the integrity of components or structures (SAP EMC.14).

18.88. ONR's SAPs (Ref. 18.2) state that for the highest reliability components and structures, evidence should be provided to demonstrate that the necessary level of integrity has been achieved for the most demanding situations identified in the safety case (SAPs EMC.3 and ECE.2). This includes the use of sound design concepts and proven design features, consideration of potential in-service degradation mechanisms, use of proven materials, confirmatory testing, high standards of quality management, pre-service and in-service examination, in-service monitoring, and a process for review of experience from other facilities.

18.89. In the case of the highest reliability steel pressure vessels and pipework, a further UK regulator-specific beyond design code demonstration is required. This needs to show that the components are as defect free as possible and that they are tolerant to crack-like defects (SAP EMC.1). The approach includes the use of verified material properties and qualified non-destructive testing and is applied to the design of existing plant and in the design of new plant.

18.90. SAP EQU.1 expects that a qualification procedure should confirm that the equipment will perform its required function under the operational, environmental and accident conditions throughout its operational life. This can include type testing, experiments, or other means to indicate clearly that the proposal is safe.

18.91. SAPs EAD.3 – EAD.5 expects that arrangements should be in place for the recording and retrieval of lifetime data. This is supported by Licence Condition 28 which requires adequate arrangements for examination, inspection, maintenance and testing all plants that may affect safety. Spurious operation and unsafe failure modes are addressed in the fault analysis that is part of the safety case. Anticipated failure or expected lifetimes of components are considered as part of routine maintenance programmes.

18.92. The knowledge used at the time of writing the safety case needs to be supplemented by continued monitoring of the plant and data from commissioning, operation, periodic inspection, and testing, as well as longer-term research or experience from other facilities.

18.93. Where there is relevant operational experience to support design assumptions, this should also be included in the licensee's safety case as part of the evidence to show the safety of the plant. Under Article 19 – Operation, paragraphs 19.56 to 19.59 the focus on research and deployment from a regulatory focus is discussed and how it addresses operational feedback through nuclear safety research.

Measures taken by the licence holders to implement proven technologies

18.94. The AGRs were developed from an earlier generation of gas-cooled reactors and a prototype Advanced Gas-cooled Reactor. The AGRs themselves were typically built in sister-station pairs, with each subsequent pair attempting to learn lessons and deploy improvements identified from the preceding designs.

18.95. An important requirement for an operating facility's site licence is a requirement to perform a PSR. As part of these reviews, typically undertaken on a ten-year cycle, the operators must review their designs against modern codes and standards. Where a gap exists, they are required to consider whether it is reasonably practicable to adopt the latest codes. Over the operating lifetime of the AGRs, some significant changes have been implemented as a result of these processes. See Article 14 – Assessment and Verification of Safety for further details on PSRs.

18.96. In addition to the need to comply with applicable deterministic expectations and codes, the AGRs and Sizewell B have PSAs which establish reliability claims for structures, systems, and components. Initial assumptions for reliability need to be substantiated and then monitored throughout the operational lifetime of the equipment.

18.97. Some of the features of the AGR fleet are unique to the UK, for instance in the design of the graphite core and the boiler units internal to the pre-stressed concrete reactor vessel. The licence holder has undertaken significant research to ensure that these components and structures remain within the envelope assumed by the safety cases for these components, and that their reliability is not reduced below the values assumed in the safety case.

18.98. In the case of the Sizewell B PWR, the licensee monitors international developments to ensure that components and structures will remain within the envelope assumed in the safety case, supplemented by their own monitoring programmes. For example, irradiation ageing affecting the reactor pressure vessel is monitored by the licensee's own surveillance programme supplemented by review of worldwide knowledge in this area.

Methods for qualification of new technologies, such as digital control and instrumentation

18.99. Before any new design or feature with potentially significant safety implications is put into service, the licensee must submit a safety case to ONR that demonstrates relevant safety principles have been achieved. ONR's SAPs and associated TAGs are used by ONR inspectors to determine the suitability of design and analysis techniques.

18.100. The use of safety principles is also intended to encourage the development of new design approaches and analysis techniques where beneficial to safety, rather than a more prescriptive approach that may hold back innovation.

18.101. ONR actively encourages research into new technologies and analysis techniques. One such example is the C&I nuclear industry forum to which most UK licensees subscribe. Through this consortium, research in the C&I topic area is proposed, developed, prioritised, and managed. Research projects are undertaken by a range of leading consultancies, universities, and the licensees themselves, as appropriate. ONR inspectors provide guidance on regulatory considerations, and research outcome reports are stored in a library and made available to all consortium members. The research findings, such as an approach to qualify smart devices, are used by licensees and ONR to inform decision-making.

Regulatory review and control activities

18.102. Article 14 – Assessment and Verification of Safety, explains regulatory assessment of safety submissions and verification by ONR. Taken together, these activities describe in general terms how ONR implements oversight of the measures taken by the licensee on operational sites. ONR's SAPs are used as the basis for judging the adequacy of the safety submission, which as described previously in this section, consider aspects related to implementing technologies proven by experience and qualified by testing.

Design for reliable, stable, and manageable operation

Contracting Party's arrangements and regulatory requirements for human factors and human-machine interface

18.103. The specific arrangements by which ONR enforces, and UK licensees consider human factors and human machine interfaces is described in detail under Article 12 – Human Factors and Article 11 – Financial and Human Resources (in relation to training).

18.104. ONR expects that a robust, modern-standards human factors integration process has been followed (SAP EHF.1), so far as is reasonably practicable. For new plants, determining whether a requesting party meets this expectation is part of the formal GDA process. Underpinning this is the UK legal requirement for the safety case to demonstrate that the risk from human action and inaction has been reduced SFAIRP. Where actions important to safety are claimed, it is required that the credibility of the claim be substantiated. For example, it does not make unrealistic assumptions about human performance, there is sufficient time available, it is conducted in an environment using interfaces that support operability, and it is supported by effective administrative controls.

Implementation by the dutyholders

18.105. The operating AGR fleet was not designed in accordance with modern expectations for human factors integration. Nevertheless, human factors considerations are embedded within EDF Energy NGL's safety case and PSR processes. As such, the potential impacts on human performance from modifications (to equipment or operations) are assessed and arguments are made to demonstrate that the risks are ALARP. Furthermore, any claims made on human actions within the PSA are underpinned by appropriate human factors validation and the PSA models can be interrogated to evaluate the importance of these actions during operations.

18.106. New designs assessed for suitability for deployment within the UK have all recognised how critical the human factor is in designing for the safe generation of nuclear power. They follow the latest approaches to manage the integration of human factors into the design – for example, they use formal human factors integration tools, user centred design processes, improved systematic allocation of function analysis, and sophisticated prototyping and simulation technologies to optimise the human-technology interfaces. Evidence of this can be seen in the following design attributes, which feature in the reactor types currently being assessed:

- Increased passivity and automation to reduce the cognitive and physical burden on the operator;
- Interactive computer-based procedures;
- Automated diagnostic systems;
- Advanced core monitoring systems;

- Task-based displays, which co-locate C&I necessary to perform the task;
- User configurable displays;
- Symptom-based diagnosis to reduce the cognitive overhead of determining the correct fault recovery response; and
- Improved methods for defining alarms systems, and technologies which offer improved dynamic logical capability to reduce the logic burden on the operator.

Regulatory review and control

18.107. ONR follows a staged permissioning process (described in more detail under Article 14 – Assessment and Verification of Safety) during which it ensures that appropriate cognisance of human factors is being taken by the dutyholder. This is done by planning and conducting interventions ranging from assessing licensee design and assessment work in human factors, through to witnessing verification and validation trials, where the human-technology system performance is tested and demonstrated.

18.108. ONR also manages a research programme to ensure the latest developments in the science of human factors are well understood and reflected in its regulatory approach. The scope of this includes topics spanning impact of board performance on nuclear safety, through to research to establish relevant good practice in advanced interface design. This is discussed in more detail under Article 12 – Human Factors.

Regulatory review and control for construction

18.109. In the UK, once granted a site licence by ONR, the safety of a nuclear installation is regulated principally through the conditions attached to the nuclear site licence (see Article 7 – Legislative and Regulatory Framework and Table 6 – Licence Conditions). An inspector (or team of inspectors) is allocated to the nuclear installation site before the start of construction. This means that from the start of construction, through commissioning to normal operation, and finally decommissioning, there will always be an ONR inspector (or team of inspectors) with specific responsibilities for the regulation of the nuclear licensed site.

18.110. During the construction and commissioning phases the site inspector(s) will conduct frequent inspections and discussions with the licensee, witness key tests and check test reports. In addition, ONR inspectors often visit the site and key manufacturers' works to monitor the construction of components important to safety and witness quality assurance procedures.

18.111. There is a requirement to produce adequate documentation to justify safety of the proposed facility. This is provided in a collection of documents and other evidence that collectively form the safety case; usually termed a pre-construction safety report. Construction cannot commence without ONR's assessment of the pre-construction safety report and issue of a legal instrument. The production and control of the safety analysis is undertaken in accordance with the relevant company procedures required under other nuclear site licence conditions such as Licence Condition 14 – safety documentation.

18.112. In accordance with these arrangements the safety case evolves through the lifecycle phases of design, construction, installation, and commissioning of the new plant, with a series of staged submissions which justify safety as the project proceeds. These are called hold–points, identified to ensure that the construction or installation work is undertaken in accordance with the design specification and associated safety case. ONR may use these hold-points to exercise powers granted under the nuclear site licence to permission certain activities such as the various stages of commissioning; this is illustrated below.

Regulatory Strategy for construction of HPC [Example]

18.113. NNB GenCo is constructing 2 EPR™ reactors at Hinkley Point C. ONR's approach to regulating the ongoing construction and commissioning of HPC is based on the following strategic aims:

- Ensure HPC is adequately designed, constructed, commissioned and operated to deliver a safe and secure operational power station; + Ensure adequate development of the organisational capability that will be required to support the ramp up for installation, the transition to commissioning and subsequent commercial operations;
- Ensure NNB GenCo and other dutyholders comply with their statutory obligations and that workers and the public are protected from the current and future hazards of the site;
- Ensure an adequate and timely safety case is in place at the appropriate milestone; and
- Hold NNB GenCo and other dutyholders to account on behalf of the public in instances where they fail to comply with their legal duties.

18.114. The strategic approach is designed to secure interventions that align with the ONR Strategic Plan 2020-2025 and are consistent with the practices and behaviours set out in ONR's approach to Enabling Regulation, which requires that ONR:

- Focus on clear priorities for nuclear safety and security and communicate these to NNB GenCo and other key stakeholders;
- Be constructive in the resolution of agreed safety and security priorities;
- Be pragmatic and aim for efficient, proportionate and consistent approaches to nuclear safety and security – without compromise of intent;

- Maintain public trust by targeted, transparent, risk-informed oversight of nuclear safety and security, not shying from use of legal powers in the public interest; and
- Actively promote self-regulation of day-to-day nuclear safety and security by NNB GenCo and other dutyholders.

Article 18 references

18.1 The United Kingdom's Eighth National Report on Compliance with the Obligations of the Convention on Nuclear Safety (https://www.iaea.org/sites/default/files/national_report_of_the_united_kingdom_for_the_8th_review_meeting.pdf), Department for Business, Energy & Industrial Strategy, August 2019.

18.2 ONR Safety Assessment Principles, 2014 (http://www.onr.org.uk/saps/saps2014.pdf).

18.3 ONR Technical Assessment Guides (http://www.onr.org.uk/operational/tech_asst_guides/index.htm).

18.4 IAEA SSR 2/1, Safety of Nuclear Power Plants: Design (https://www-pub.iaea.org/MTCD/publications/PDF/Pub1715web-46541668.pdf).

18.5 UK Climate Projections 2018 (https://www.metoffice.gov.uk/research/collaboration/ukcp).

18.6 Use of UK Climate Projections 2018, ONR, Position Statement. November 2020 (https://www.onr.org.uk/documents/2020/ukcp18-position-statement-rev-1.pdf).

18.7 Principles for Flood and Coastal Erosion Risk Management. Office for Nuclear Regulation and Environment Agency Joint Advice Note July 2017 – Version 1 (https://www.onr.org.uk/documents/2017/principles-for-flood-and-coastal-erosion-risk-management.pdf).

18.8 ONR, New Nuclear Power Plants: Generic Design Assessment Guidance to Requesting Parties (https://www.onr.org.uk/new-reactors/onr-gda-gd-006.pdf), ONR-GDA-GD-006, Revision 0, October 2019.

Article 19 – Operation

Each Contracting Party shall take the appropriate steps to ensure that:

I. the initial authorization to operate a nuclear installation is based upon an appropriate safety analysis and a commissioning programme demonstrating that the installation, as constructed, is consistent with design and safety requirements;

II. operational limits and conditions derived from the safety analysis, tests and operational experience are defined and revised as necessary for identifying safe boundaries for operation;

III. operation, maintenance, inspection and testing of a nuclear installation are conducted in accordance with approved procedures;

IV. procedures are established for responding to anticipated operational occurrences and to accidents;

V. necessary engineering and technical support in all safety-related fields is available throughout the lifetime of a nuclear installation;

VI. incidents significant to safety are reported in a timely manner by the holder of the relevant licence to the regulatory body;

VII. programmes to collect and analyse operating experience are established, the results obtained and the conclusions drawn are acted upon and that existing mechanisms are used to share important experience with international bodies and with other operating organizations and regulatory bodies;

VIII. the generation of radioactive waste resulting from the operation of a nuclear installation is kept to the minimum practicable for the process concerned, both in activity and in volume, and any necessary treatment and storage of spent fuel and waste, directly related to the operation and on the same site as that of the nuclear installation, takes into consideration conditioning and disposal.

19.1. Since the last report, developments under this Article are as follows:

- Several previously operational reactors have shut down and are preparing for defuelling;
- The COVID-19 pandemic has challenged all sites, requiring them to put in place arrangements to manage the potential interruption to the supply of goods and services. ONR issued several position statements explaining that regulatory action would be unlikely to be taken in specific cases where requirements cannot be met as a result of the pandemic; and
- The reduction in national electricity demand as a result of COVID-19, coupled with plentiful electricity generation from wind and solar power sources during the summer of 2020, posed unique grid stability problems and required Sizewell B to operate at reduced load for an extended period of time.

19.2. Otherwise compliance with this Article of the Convention has not substantially changed since the United Kingdom's (UK) eighth National Report (NR) (Ref. 19.1) (in a way that has implications for the Convention obligations).

19.3. The UK currently has 15 nuclear reactors on sites owned and operated by EDF Energy NGL. Four of the reactors – 2 each at Dungeness B and Hunterston B – shutdown in 2021 and early 2022 and will not restart, and the 2 reactors at Hinkley Point B are due to shutdown in summer 2022. Two EPR™ reactors are being constructed at Hinkley Point C. There is the potential for 2 further reactors to be built at Sizewell C, but the final investment decision for this project has not yet been taken. The main focus in this section of the report is on the operating reactors. However, the regulatory aspects are the same for all sites, so where these are described in this section, they will equally apply to Hinkley Point C and, should it be built, Sizewell C.

Initial authorisation

19.4. In the UK, once granted a site licence by the Office for Nuclear Regulation (ONR), the safety of a nuclear installation is regulated principally through the conditions attached to the nuclear site licence (see Article 7 – Legislative and Regulatory Framework and Table 6 – Licence Conditions). ONR, through its inspection and assessment activities (see Article 14 – Assessment and Verification of Safety) judges compliance with the licence conditions throughout all of the lifecycle phases.

19.5. The commissioning of a nuclear installation is regulated by ONR in accordance with the requirements of Licence Condition (LC) 21 (commissioning). This condition requires the licensee to make and implement adequate arrangements for the commissioning of any new or modified plant or processes that may affect safety.

19.6. Using powers under the licence, ONR may specify that the licensee shall not progress from one stage to the next without its formal agreement. ONR's agreement is dependent upon the licensee demonstrating its readiness to proceed to the next stage and that it has justified the safety of the structures, systems, and components it intends to construct, install, or commission during the stage. The intended approach for new reactors in the UK, is that ONR shall require the licensee to seek Consent to commence construction. Thereafter, ONR has the option to exercise powers requiring the licensee to seek its Consent to proceed between subsequent stages of construction and commissioning. The licence also gives ONR the power to direct the licensee to stop construction at any point it judges to be necessary.

19.7. Prior to commencing commissioning, ONR expects the licensee to update the pre-construction safety report (PCSR) that provided the basis for proceeding with construction, to reflect the plant as built – including modifications to the initial design, or those made during construction. This updated report, referred to as the pre-commissioning safety report, provides the basis for commencing commissioning. The commissioning programme required under LC21 is produced by the licensee to ensure that all systems important to safety are tested to demonstrate that the plant complies with the design intent and is ready for operation. A comprehensive test and commissioning programme also allows for the detection of any unintended or undesirable modes of operation that the initial design had not anticipated.

19.8. LC21 requires a suitably qualified person or persons to be appointed to control, witness, record and assess the result of the commissioning tests. Full and accurate records are kept for the commissioning programme. In addition to plant hardware, key management functions are established prior to commissioning and are tested during the commissioning process. LC23 (operating rules) requires operating limits to be derived from the safety cases, and these in turn define the safe operating envelope of the plant and provide the basis for operating rules and operating procedures. These are tested as part of the commissioning programme. Any changes to the plant or procedures found to be necessary during the commissioning process are implemented under the arrangements established under LC21.

19.9. ONR targets its inspection and assessment to ensure that the licensee’s arrangements are robust, with the objective of preventing accidents throughout the lifetime of the reactors, including all stages in the commissioning leading up to normal operation.

Hinkley Point C

19.10. Two EPR^{TM} reactors are currently under construction at Hinkley Point C. The next major safety report for HPC will be the Pre-Commissioning Safety Report (PCmSR), to be issued in 2025 to support active commissioning.

Sizewell C

19.11. An application has been submitted for a nuclear site licence to be granted for 2 EPR^{TM} reactors at Sizewell C. ONR is expected to reach a decision on the application in 2022, which will support the prospective licensee in making a final investment decision later in 2022.

Operational limits and conditions

19.12. LC23 requires the licensee to produce an adequate safety case to demonstrate the safety of a plant and to identify the conditions and limits that are necessary in the interests of safety. The safety case limits are the measurable plant parameters that define the envelope for safe operation, and the conditions (plant configurations, availability, and operator actions) necessary to keep the plant within this envelope. These limits and conditions are referred to as the operating rules.

19.13. EDF Energy NGL, through its safety cases, defines a safe operating envelope via a set of operational parameters, within which the power station is required to operate. This envelope represents a bounding condition from which fault transients can be assumed to start.

19.14. Technical specifications are used to ensure that the station is always operated within the safe operating envelope. The limiting conditions expressed in the technical specifications often contain additional margins over and above the bounding conditions that are assumed in the transient analysis. The basis of the justification for the limiting conditions is referenced within the technical specification documentation through a set of comprehensive commentaries, which explain the requirement for the limit and reference the relevant safety case documentation.

19.15. In addition, the technical specifications also address pre-fault safety system and safety-related system availability and performance. These limits and conditions represent assumptions that are made in the safety case about the availability and reliability of lines of protection for each essential safety function. Technical specifications and comprehensive safety case documentation are available to all staff via the company's document management system. Controlled paper copies are maintained in control rooms.

19.16. EDF Energy NGL has an accredited training programme based on a systematic approach to the identification and fulfilment of training requirements. This ensures that all members of staff whose duties require an understanding of the technical specifications and the underlying safety case reasons behind the contained limits and conditions, receive appropriate training.

19.17. Revisions to the technical specifications are controlled though the company's 'Maintain Design Integrity' process which includes specific authorisations for role holders and a risk-assessment based grading of the significance of changes. For the more significant changes, independent assessment by the company's internal regulator, the Nuclear Safety Committees and ONR is required.

Sizewell B part power operation [Example]

19.18. During the summer of 2020, National Grid asked EDF Energy NGL to operate Sizewell B at reduced load in order to help it manage the risk to grid stability at a time of ample solar and wind generation and reduced electricity demand (partially the result of the national COVID-19 lockdown).

19.19. Sizewell B's safety case places a limit on the time the reactor can be operated at reduced power in each fuel cycle. To operate beyond this time, EDF Energy NGL produced a safety case modification in accordance with its arrangements for LC22 (modification or experiment on existing plant) allowing for an extended period of reduced-power operation, which was achieved by operating on just one of the station's 2 turbines.

19.20. National Grid is making a number of improvements to enhance grid stability, which will allow Sizewell B (and future reactors, such as those being constructed at Hinkley Point C) to operate at full power in similar circumstances.

Control of chemical stocks

19.21. COMAH 2015 divides sites holding significant stocks of hazardous chemicals into Upper and Lower Tiers, based on limits on the quantities of specific hazardous chemicals on the site. The regulations require Lower Tier site operators (which includes many of EDF Energy NGL's nuclear licensed sites) to notify the Competent Authority (in this case, ONR and the relevant environmental regulator) of a significant increase in the quantity of dangerous substances leading to a change in inventory above the threshold for Upper Tier.

19.22. Many of the hazardous chemicals on sites are needed to maintain compliance with the limits and conditions of the reactor safety case. As the COVID-19 pandemic progressed and the supply of many of these chemicals was impacted, it was recognised that it could be desirable for sites to seek a temporary increase in their chemical inventories to mitigate the potential risk of having insufficient chemical stocks at site to ensure safe plant operations.

19.23. In 2020 the joint Competent Authority clarified that, should the challenging conditions associated with the pandemic preclude dutyholders from producing a safety report within the usual timescales – a breach of COMAH – the Competent Authority would not necessarily take enforcement action, provided that dutyholders consider other pragmatic and proportionate measures to demonstrate adequate risk management.

Procedures for operation, maintenance, inspection, and testing

19.24. LC24 (operating instructions) requires the licensee to ensure that all safety related operations are undertaken in accordance with written instructions. These instructions include the implementation of the operational limits and conditions identified in the safety analysis or safety case.

19.25. The licensee has procedures and instructions for the operation and maintenance of the reactors, which describe the process by which these essential activities are managed and executed on all reactor sites, outlining interactions and dependencies on other defined processes. The documents set out the standards and expectations that underpin the sustained delivery of safe, reliable generation based on identified best practices from WANO and INPO.

19.26. All operating, maintenance, inspection and testing procedures and associated documentation are available electronically to all power station staff. These procedures form an essential element of the overall management system at the site and within the broader arrangements within EDF Energy NGL's corporate centre. Comprehensive paper copies of the technical specifications, operating procedures and instructions are provided in the reactor control room and the emergency control centre. These are also supplemented by station operating instructions which cover all the reactor evolutions including start-up, de-loading, normal operation and fault conditions.

19.27. EDF Energy NGL's maintenance and inspection arrangements ensure that effective preventive maintenance tasks are performed in accordance with established procedures on the correct equipment at the appropriate time, to achieve high reliability and availability of the plant. The core elements of these procedures are the identification of important nuclear safety components which have a significant impact on safety, reliability and generation. These are subject to a preventive maintenance review, based upon reliability centred maintenance, to determine applicable and effective maintenance tasks.

19.28. EDF Energy NGL's arrangements ensure that all relevant staff at the power stations are fully involved in the development of procedures required for safe operation, maintenance, inspection, and testing. Through the use and implementation of all procedures, the station staff are also able to feedback any suggested improvements which will be considered as part of the regular review of all operating and maintenance procedures.

19.29. LC28 (examination, inspection, maintenance, and testing) requires licensees to make and implement arrangements for the regular and systematic examination, inspection, maintenance and testing of all plant which may affect safety. This work is set out in a maintenance schedule that details the scope and frequency of maintenance. This schedule identifies those examinations, inspections, maintenance, and tests that are required to demonstrate the continued ability of the plant to meet claims in the safety case. The intervals between maintenance schedule activities are determined by the safety case, operational experience, engineering judgement and manufacturers' recommendations. The work is carried out in accordance with procedures by suitably qualified and experienced persons, under the control and supervision of an appropriate person specifically appointed for that task, who must sign a full and accurate report on completion of the work. Any examination, inspection, maintenance, or test that indicates that the safety of the plant may be affected is reported to the licensee, who takes appropriate action. Any deferrals of the defined maintenance tasks are subject to the same rigorous process EDF Energy

NGL has defined for modifications to plant and safety cases, as required under the licence condition for maintenance. As part of its on-site activities, ONR inspectors ensure that all operations, maintenance, and inspections are carried out in compliance with the station's procedures.

19.30. During the COVID-19 pandemic, EDF Energy NGL recognised that a sufficiently severe outbreak affecting staff at one of their sites might make it impossible for examination, maintenance, inspection, or testing required by LC28 to be carried out. To mitigate this possibility, non-essential maintenance was deferred to allow for the prioritisation of maintenance schedule activities; in addition, modifications were pre-emptively prepared to defer maintenance schedule activities as a last resort. However, in the event, EDF Energy NGL was able to manage the impact of COVID-19 on all its sites such that deferral of maintenance schedule activities was not necessary.

Other requirements for examination, inspection, maintenance, and testing

19.31. In addition to LC28, there are several regulations made under the Health and Safety at Work Act 1974 (HSWA74) that, while not specific to nuclear licensed sites, make an important contribution to safety on those sites.

19.32. The Pressure Systems Safety Regulations 2000 (PSSR) place duties on the owner/user of pressure systems (including nuclear site licensees) to have them examined at suitable intervals, as identified within a Written Scheme of Examination. The aim of such examinations is to assist in minimising the risk of danger to persons from the release of stored energy or the scalding effects of steam.

19.33. The regulations allow for the postponement of such an examination, provided certain conditions are met. However, the regulations do not allow for an extension to an existing postponement, otherwise referred to as a 2nd postponement.

19.34. The Lifting Operations and Lifting Equipment Regulations 1998 (LOLER) place similar obligations on dutyholders with respect to the owners/users of lifting equipment. In addition, the Regulatory Reform (Fire Safety) Order 2005 and the Fire (Scotland) Act 2005 place obligations with respect to the management of fire risk assessments and maintenance of fire protection equipment in England/Wales and Scotland, respectively.

19.35. As a result of the restrictions to movement imposed of personnel in response to the COVID-19 pandemic, there existed the potential that relevant equipment already subject to a postponement may not have its examination completed by the revised due date as the Competent Person (for PSSR and LOLER) or other suitably qualified and experienced maintainers may have been unable to attend the licensed site. Therefore, the licensee would be in breach of the relevant legislation by operating the affected systems – which may be required for nuclear safety purposes or to support continued operation – beyond its agreed postponement date.

19.36. In such cases, ONR issued a Regulatory Position Statement (RPS) proposing that it would not automatically seek to enforce against a breach of the legislation. Using PSSR as an example, to inform any decisions ONR would consider whether the dutyholder had:

- provided adequate justification that the pressure system or equipment cannot be thoroughly examined.
- identified the safety significant operations that need to be carried out using the pressure system or equipment, such as for safety (nuclear and/or conventional) reasons;
- provided adequate justification that the identified in-service operations are necessary;
- provided adequate justification of how the risks are reduced so far as is reasonably practicable (SFAIRP) and appropriately mitigated, such as risk assessment, satisfactory maintenance records, past examination records and examination by the licensee's suitably qualified and experience person(s); and
- proposed a suitable date for return to full compliance through a thorough examination and justified why this date is as soon as reasonably practicable.

Periodic shutdown

19.37. All UK operating nuclear reactors are required to shutdown at specified intervals for inspection and testing. These periodic shutdowns required under LC30 (periodic shutdowns) occur every 18 months for Sizewell B and 3 years for the AGRs. Once shutdown, the reactor cannot be restarted without the formal consent of ONR. Prior to issuing a consent, ONR needs to be satisfied that all necessary maintenance, inspection, and testing has been completed, that the licensee has fully evaluated its findings and that the safety case remains valid. This evaluation may identify any necessary changes to the type and frequency of maintenance, inspection, and testing.

19.38. During the COVID-19 pandemic, EDF Energy NGL found it necessary to defer the shutdown under LC30 of several its reactors to ensure that the risks from the pandemic were appropriately managed. The decision to defer each periodic shutdown was supported by a safety case as required by LC22 and was subject to the agreement of ONR.

Procedures for responding to operational occurrences and accidents

19.39. The information in this Article is directly related to the major common issue on **emergency preparedness** from the Seventh Convention and **VDNS Principle 2**.

19.40. The plant protection system will ensure that, after an operational occurrence, the plant is brought back into a safe state. The safety case identifies a range of fault conditions that will generate plant alarms for operator action or automatic response. The operating instructions and emergency operating procedures, required by the licence condition for operating instructions, identify the necessary operator actions. Fault conditions are addressed by providing strategies and guidelines to help operators decide on their emergency response. The administrative process for development of emergency operating procedures is the same as the process for other operating procedures described above.

19.41. All the EDF Energy NGL reactors have procedures contained in the station operating instructions, for responding to alarms (actions on receipt of alarms) and reactor trips (known elsewhere as emergency operating procedures).

19.42. For the AGRs, if the reactor does not respond as per the operating instructions or the sequence progresses further, then the licensee must use a series of documents called Symptom-Based Emergency Response Guidelines (SBERGs), which are aimed at the prevention of an uncontrolled release. They are, therefore, concerned with shutting the reactor down and maintaining adequate post-trip cooling. If recovery actions within the guidelines are unsuccessful, or plant/core damage occurs for any other reason, further guidance is given in the AGR Severe Accident Guidelines (SAGs).

19.43. For Sizewell B, symptom-based procedures, and guidance to manage a severe accident (equivalent to severe accident management guidelines) are contained within the station operation instructions.

19.44. ONR's SAPs (Ref. 19.2) outline the expectation that licensees should analyse those fault sequences beyond the design basis that have a potential to lead to severe accidents. These analyses should determine the magnitude and radiological consequences of such an accident and demonstrate that there is not a sudden escalation of consequences just beyond the design basis. These analyses should inform preparation of accident mitigation strategies and emergency plans.

19.45. Following Fukushima, EDF Energy NGL has undertaken an extensive work programme leading to a revision of both the severe accident guidelines and symptom-based emergency response guidelines. This was informed by the development of a level 2 PSA for the AGRs. EDF Energy continues to assess its ongoing emergency arrangements based on the AGR fleet moving from generation to defuelling. 19.46. Sizewell B has completed a similar exercise resulting in updated Living Probabilistic Safety Analyses and associated operating documentation. In addition, recognising the aspiration to extend the life of Sizewell B, EDF Energy NGL is actively investigating the practicability of installing filtered containment ventilation (FCV) at Sizewell B to mitigate against potential containment overpressure in the event of a severe accident, with a commitment to make a final decision in 2024 once it has made a decision regarding life extension.

19.47. The arrangements for dealing with accidents and emergencies are set out under Article 16 – Emergency Preparedness.

Engineering and technical support

19.48. The nuclear site licence requires that the licensees have access to sufficient technical expertise for all stages of a plant's life. EDF Energy NGL's engineering and technical support is provided by its central technical organisation located within its headquarters. The role of this organisation is intended to minimise the risk to operating facilities, resolve operational problems in a timely manner and facilitate the definition of standardised methods of working and fleet approach.

19.49. Although most of the licensee's technical resource is provided by its own staff resources, amounting to several hundred staff, use is also made of additional technical contractors as appropriate. ONR considers this to be acceptable, providing that EDF Energy NGL retains sufficient expertise to be an 'intelligent customer' of such work.

19.50. Additional responsibilities of the central technical organisation include lifetime planning, equipment reliability and asset management. The department has a responsibility to develop, implement, document, and communicate asset management strategy and priorities.

19.51. EDF Energy NGL's design authority is a key element of its central technical organisation. The role of the design authority is to ensure fit for purpose design solutions to manage nuclear safety risks over the lifetimes of the power stations. Furthermore, the design authority is effectively the custodian of the relevant specialist part of the reactor's safety case to ensure that the integrity of the design and the safety case remain consistent.

19.52. Another of the central functions is that of engineering which provides technical support to the stations using the additional resource, and capabilities of its technical support alliance partners to maximise the value of work delivered by the organisation. The adoption of a fleet critical group within the central technical organisation enables EDF Energy NGL to bring focus to critical issues affecting the power stations and, by the application of increased focus and priority, return the issues to normal business as safely, quickly, and efficiently as it is possible to do so.

End-of-generation

19.53. Since the last report, 4 reactors at 2 locations – Dungeness B and Hunterston B – have shut down and will not restart. Preparation has begun for their defuelling. Another 2 reactors at Hinkley Point B are expected to cease generating in summer 2022. Four further reactors, 2 each at Heysham 1 and Hartlepool, are expected to shut down in 2024.

19.54. End-of-generation (EoG) does not significantly alter the legislative requirements placed on a reactor, until the reactors have been defuelled. The 36 licence conditions remain applicable, and the requirement for operational limits and conditions and procedures for operation, maintenance, inspection, and testing, and responding to operational occurrences and accidents remains as described above.

19.55. However, as EDF Energy NGL prepares to defuel its shutdown reactors and hand them over to the Nuclear Decommissioning Authority for eventual decommissioning, it is undergoing a significant change in its organisational structure, particularly (though not exclusively) at the corporate level, where much of the engineering and technical support for stations resides. This will allow it to manage the separate challenges of defuelling and preparing to decommission stations at the end of their life; continue to support operation of the remaining AGRs until their planned shutdown dates; and manage longer-term generation at Sizewell B (recognising the challenges and opportunities that the potential new build of PWRs at Hinkley Point C and Sizewell C will bring).

Research and development – regulatory focus

19.56. There are issues associated with operating reactors that require technical substantiation. This substantiation is obtained by research and development programmes. The licensees commission and undertake research to support the safe operation of their nuclear installations. In addition, the UK Government has given ONR the responsibility to oversee long-term generic (non-site specific) safety research. Examples of research undertaken can be found under Article 6 – Existing Nuclear Installations.

19.57. The Energy Act 2013 enables ONR to carry out or commission research in connection with its purposes and therefore supports delivery of its strategic goal of being an exemplary regulator.

19.58. Nuclear site licensees are responsible for managing the risks of their operations, and the designers and manufacturers of nuclear plant are responsible under HSWA74 for undertaking the research necessary to identify and reduce these risks. The licensees are required by the licence condition for operating rules to produce safety cases to demonstrate the safety of their operations, so they are responsible for performing any research necessary to substantiate their safety claims. ONR's research needs are different as they must support its independent regulatory decision-making. This needs to be based on objective scientific and technical understanding of the safety issues.

19.59. ONR publishes an annual research update to confirm and summarise the work completed. The evaluation and publication process will ensure ONR's research generates useful outputs and is disseminated to maximise the potential benefits.

Reporting of events significant to safety

Overview of Contracting Party's arrangements and regulatory requirements

19.60. There are legal requirements outlined in various regulations and in some of the licence conditions (most significantly LC7 (incidents on site) for dutyholders to notify ONR of significant events occurring on nuclear sites.

19.61. EDF Energy NGL has implemented reporting arrangements to meet regulatory expectations. These arrangements set out what information should be included in an initial notification to ONR and on what timescales the notification should be made, ranging from immediate notification to within a week depending on the safety-significance of the incident.

19.62. LC7 compliance arrangements made by each licensee cover a wide spectrum of events. Notifications to ONR contain preliminary information, and ONR expects the licensee to make a follow-up report within 60 days following an event notification. The licensees include the following information in follow-up reports for events:

- Confirmation of the factual details in the preliminary information;
- Conclusions from the licensee's investigation of the event including the cause of the event;
- Summary of the mitigation and corrective actions taken or to be taken;
- An outline of learning from the event with any implications for related plant; and
- Confirmed International Nuclear and Radiological Event Scale (INES) level ascribed to the incident.

Overview of established reporting criteria and reporting procedures

19.63. ONR has published guidance on notifying and reporting incidents and events in all its areas of responsibility, which now include security, safeguards, and transport in addition to nuclear safety (Ref. 19.3).

19.64. ONR's guidance identifies the category of incidents that are required to be reported including nuclear safety, radiological safety, nuclear security, and nuclear safeguards. It also requires a description of each type of incident within the relevant category, together with the timings required to complete the notifications. Illustrative examples of each type of incident are provided for clarification.

Incident follow-up and investigation by ONR

19.65. An important part of ONR's role is to investigate incidents and where appropriate, to take proportionate enforcement action. For further information on enforcement by ONR, see Article 7 – Legislative and Regulatory Framework.

19.66. Formal enforcement action, in the form of Notices issued under HSWA74 or TEA13, was taken on 2 occasions in the reporting period:

- In June 2019, it was identified that at Heysham 1 several control rod standpipe gas circulator penetration liners were overdue examination as specified in their Written Scheme of Examination. This resulted in an Improvement Notice being issued in June 2020 associated with PSSR, requiring EDF Energy NGL to complete the overdue inspections by December 2020; and
- In April 2020, during the statutory outage at Heysham 2, there were not adequate arrangements for the regular and systematic examination, inspection, maintenance and testing of the log/lin flux detectors connected to Reactor 8. This resulted in an Improvement Notice being issued associated with Licence Condition 28(1), requiring EDF Energy NGL to put in place measures to prevent recurrence by April 2021 (subsequently extended, with ONR's agreement, to July 2021).

19.67. The UK complies with the requirements of the IAEA's INES reporting arrangements. For most incidents reported to ONR (those of lesser significance and where the applicable INES level is clear), the INES level is determined by the originator of the report. In other cases, advice is sought from the UK INES national officer, who is the final arbiter in determining the INES rating for any incident. For relevant incidents the dutyholder is expected to assign a provisional INES rating, this is so that any onward international reporting commitments can be made should the rating be at Level 2 or higher on INES. International reporting is made through the IAEA online reporting database by the national officer. The use of INES is in line with **VDNS Principle 3**.

19.68. In practice, there are some incidents where further information is needed before finalising an INES rating; primarily where the use of additional factors set out in the INES user manual is applicable. Most of these incidents are at the boundary between levels 0, 1 and 2, where the verification of certain aspects can take some time and require a full root cause investigation. As a result, it is not uncommon for the INES rating to be revised after an investigation being carried out by the licensee or ONR.

Reported incidents significant to safety for the past 3 years

19.69. This report includes events that have occurred over a reporting period, from January 2019 to December 2021. Since the Seventh UK Convention Report, there have been a total of 11 incidents rated at INES Level 1 and one event at INES Level 2 on the operating reactor fleet.

19.70. The list of events and outcomes presented in Table 4 – Summary of Incidents and INES Ratings demonstrate how, through the identification, reporting, categorisation and collection of event data, safety improvements are identified and delivered via the licensee's arrangements, including, where necessary, plant modifications and/or interim arrangements.

Documentation and publication of reported events and incidents

19.71. ONR reports incidents to the public through 2 routes, both of which are available on its website. Nationally, it publishes a quarterly statement if there have been any incidents that meet specific ONR reporting criteria. Locally, ONR includes incident reports in the quarterly reports that it makes to the local site stakeholder groups of each licensed nuclear site. These groups comprise members of local government, together with the emergency services and representatives of local communities. Meetings are open to the public. Such incident reports indicate, as appropriate, the circumstances of the incident, the action taken or being taken by ONR together with any remedial actions being planned or taken by the relevant licensee. The stakeholder reports also cover ONR's wider regulation and activities on the site for the period.

19.72. Additionally, ONR publishes its annual Chief Nuclear Inspector's report on Great Britain's nuclear industry, which includes a summary of the nuclear safety and radiological safety events reported to ONR during the year. The latest of these reports covers the period April 2020 to March 2021 (Ref. 19.4).

19.73. The UK is a signatory to the 1986 IAEA Convention on Early Notification of a Nuclear Accident which requires notifying the IAEA when "…a release of radioactive materials occurs or is likely to occur and which has resulted or may result in an international trans-boundary release that could be of radiological safety significance for another state". The Department for Business, Energy & Industrial Strategy (BEIS) is the UK Competent Authority and provides contact points for issuing and receiving notification and information on any nuclear accidents arising from nuclear power plants.

Operational experience feedback

19.74. Recognising that effective organisational learning is an important element of a strong nuclear safety culture, ONR's SAPs set out regulatory expectations for nuclear licenses' operational experience feedback programmes. One of the SAPs for leadership and management for safety (SAP MS.4) (Ref. 19.2) states that:

> " Organisations should have effective processes for seeking out, analysing and acting upon lessons from a wide range of sources. A learning organisation should challenge established understanding and practice by reflecting on experiences to identify and understand the

reasons for differences between actual and intended outcomes. An absence of major accidents and incidents does not necessarily indicate that risks are being adequately controlled and should not breed complacency. Near misses should be seen as opportunities to learn and a culture of open reporting should be fostered."

19.75. The SAPs also state that information should also be actively sought from external sources, including those from beyond the nuclear sector to identify learning and improvement opportunities. Identified lessons should be embedded through a structured system for implementing corrective actions in a timely manner. The UK's regulatory regime requires the licensee to develop its own arrangements setting out how these principles will be achieved.

19.76. EDF Energy NGL's arrangements for organisational learning set out requirements for a corrective action programme to ensure that causes of non-conformances and other problems are determined, and corrective actions are taken to prevent their recurrence.

19.77. The corrective action programme establishes a process which enables anyone to identify potential deviation from the expected norm. Non-conformances collected by the programme are prioritised based on potential safety, security and environmental significance by suitably qualified and experienced personnel and used to inform the application of a graded approach to investigating the causes of the problem. A database is used to track identified corrective actions and ensure completeness of resolution. Effectiveness reviews are carried out to confirm that corrective actions have delivered the desired improvements.

19.78. Within the organisation, EDF Energy NGL routinely carries out self-assessments to evaluate the performance of work and identify areas for improvement. Self-assessments are supported by benchmarking, which seeks to identify opportunities for improvement from interactions with other EDF Energy NGL sites as well as external organisations, where good practices may be observed. The self-assessment process is also informed by the analysis of data and metrics from a variety of sources including from the corrective action programme to identify adverse trends, patterns, and incidences of re-occurrence. Corrective actions identified from the self-assessment process are monitored to ensure they are acted upon in a timely manner.

19.79. EDF Energy NGL's operational experience programme seeks to ensure that learning from other stations and from external organisations (including those outside the nuclear industry) is identified and acted upon to reduce the potential for recurring events. Sources of learning, which are typically screened and tracked by EDF Energy NGL's operational experience programme, include: the relevant IAEA databases, WANO, INPO documents, relevant learning from other UK licensees, learning from across the licensee's organisation and any other relevant material containing potential learning opportunities. Operational experience related information is screened and analysed to select and prioritise potential learning opportunities.

19.80. EDF Energy NGL has well developed mechanisms to distribute learning identified through its operational experience programmes including information shared through the WANO and other relevant organisations, which also provide international experience relevant to UK operators. EDF Energy NGL has in recent years developed an Organisational Learning Portal (OLP) which provides all company employees (and contractors) access to shared learning from events. This has provided an opportunity to quickly share lessons from across the EDF Energy NGL fleet and ensure historic information is adequately stored and easily accessible.

19.81. As part of its international operational experience feedback processes, ONR routinely liaises with EDF Energy NGL to discuss information on incidents and to identify those that may be appropriate to share more widely through international reporting mechanisms. ONR is the UK's reporting authority, including for INES and the IAEA/NEA International Reporting System (IRS) for operational experience.

19.82. A summary of OPEX can be found in Table 5 – Examples of Learning from Operational Experience.

Regulatory review of licence holder

19.83. In determining its response to incidents notified to ONR, it applies the key principles underpinning its Enforcement Policy Statement (Ref. 19.5) and related processes, which include the requirements that ONR acts proportionately and in a targeted and consistent manner. This means that the nature of ONR's response and subsequent enforcement are informed by and proportionate to the magnitude of any failure to comply with the law (including any failure to minimise risk to workers or the public so far as is reasonably practicable).

19.84. Consequently, when incidents of a minor nature occur (those that present minimal, if any, risk to workers or the public, and which represent most incidents reported to ONR), ONR's focus is to review the nature of the event and the dutyholder's response, to satisfy itself that the dutyholder has:

- Taken effective action to minimise, so far as is reasonably practicable, any risk to workers or members of the public;
- Competently and diligently investigated the event, and that appropriate learning opportunities and improvements have been identified; and
- Been proactive in delivering appropriate improvements to an appropriate timescale (to minimise the potential for a recurrence).

19.85. In cases where the actual or potential consequences are judged to be more significant, ONR may elect to investigate the incident itself to establish the magnitude of any failure to comply with relevant law. If warranted, ONR will also take appropriate enforcement action in accordance with its Enforcement Policy Statement.

19.86. It is important to note that incidents are only one consideration in relation to enforcement decisions and, indeed, ONR may carry out enforcement action where it believes that there has been a breach of law but where no incident has occurred.

19.87. Additionally, and where appropriate, ONR will use the information it obtains to:

- Notify relevant government departments if pre-agreed reporting criteria are met;
- Inform its future regulatory strategy and inspection programmes; and
- Disseminate any generic learning points to the wider industry and, where appropriate, internationally.

19.88. Finally, in the highly unlikely event of a nuclear or radiological emergency, ONR has the capacity to coordinate its national safety/security regulatory activities to provide support and advice to local government, other government agencies, and in support of national emergency plans. ONR's arrangements are described in detail under Article 16 – Emergency Preparedness.

Management of spent fuel and radioactive waste on the site

19.89. Information on radioactive discharges, and on the disposal of solid radioactive waste, is provided in the UK's seventh national report for the Joint Convention (Ref. 19.6).

19.90. LC34 (leakage and escape of radioactive material and radioactive waste) requires radioactive material or waste to be controlled and contained so that it does not leak or escape, except in compliance with discharges granted by the environmental regulators. Licensees must demonstrate that this is the case, to the satisfaction of the regulator. Any leak or escape must be notified, recorded, investigated, and reported, as required by the arrangements made under LC7. Each site has a discharge authorisation issued by the appropriate environment agency. The licensee must demonstrate how it complies with such authorisations. 19.91. LC32 (accumulation of radioactive waste) requires that, so far as is reasonably practicable, the rate of production and the total quantity of radioactive waste on the site at any one time is minimised. The quantity, type and form of the radioactive waste accumulated or stored may be subject to limitations specified by ONR. As part of its integrated intervention strategies, ONR requires EDF Energy NGL to make full use of the authorised disposal routes to reduce the volume of disposable radioactive waste stored on sites if it is judged that accumulations are excessive.

19.92. LC33 (disposal of radioactive waste) requires the disposal of radioactive waste to be in accordance with an authorisation granted under the Environmental Authorisations (Scotland) Regulations 2018 (EASR18) in Scotland and Environmental Permitting (England and Wales) Regulations 2016 (EPR16) in England and Wales. Hence, discharges of liquid and gaseous radioactive waste, and disposals of solid waste, are regulated by conditions and limitations attached to an authorisation or environmental permit granted by the appropriate regulatory body under EASR18 and EPR16. These authorisations or permits also require that operators use best practicable means (BPM) or best available techniques (BAT), respectively, to minimise the creation of radioactive waste.

19.93. The UK has a general policy of progressive and substantive reductions in radioactive discharges. In general, limits are set with minimum headroom above the level of actual discharges that would be consistent with ‘normal operation’. In July 2009, the UK, Welsh, Scottish and Northern Ireland governments jointly published a ‘UK Strategy for Radioactive Discharges’ to cover the period to 2030 (Ref. 19.7), which was reviewed in 2018. In parallel, the UK Government published statutory guidance to the Environment Agency on the implementation of the strategy. The Scottish Government published separate Guidance to SEPA in 2008. The UK’s strategy also forms its national plan for meeting its obligations under the OSPAR Convention (Ref. 19.8).

19.94. For the AGRs, irradiated fuel assemblies are transferred by the fuelling machine to a buffer store and held for a suitable period, typically a few weeks, which allows the short-lived radioactive isotopes to decay. The assembly is then transferred, by the fuelling machine, to an irradiated fuel dismantling facility, where the individual elements are separated from the assembly and transferred to a storage pond. In the pond, the elements are stored below water in boron steel skips.

19.95. After a suitable further cooling period, skips are loaded into transport flasks and dispatched off-site for further storage, as reprocessing of AGR fuel ceased in 2018. As AGR stations reach the end of their operational life, the increased focus on defuelling, and the subsequent demonstration that sites are free from nuclear fuel, means there will be a corresponding increase in shipments of fuel sent off site for storage. The AGR Operating Programme (AGROP), is specifically designed to ensure that as the number of AGRs that cease generation increases, AGR sites can continue to be defuelled efficiently, safely, and securely.

19.96. There are 3 classes of radioactive waste that are or have been produced because of operation of an AGR:

- High level waste is a by-product of past fuel reprocessing process at Sellafield. The waste is currently stored at Sellafield and will ultimately be vitrified for long term storage prior to disposal in a Geological Disposal Facility (GDF). There is no high level waste on power reactor sites in UK;
- Intermediate level waste comprises of sludges and resins used for water treatment, activated components from fuel stringer and plug unit disassembly and gas filter materials. This type of waste is stored at the power station site either in drums (in the case of liquid wastes) or in a shielded vault (in the case of solid fuel stringer and plug unit components); and
- Low Level Waste from operational power stations is principally lightly contaminated miscellaneous waste arising from maintenance and monitoring, such as plastic, paper and metal.

19.97. For the PWR at Sizewell B the reactor is refuelled roughly every 18 months, and the spent fuel is then transferred to a fuel pond and stored under water in racks. After a suitable period of cooling in the pond, the fuel will be transferred into casks and stored in the dry fuel store pending a future decision about whether to classify it as waste for disposal. The store will house spent fuel from Sizewell B until a GDF is available for the permanent disposal of spent fuel that has been classified as waste.

Article 19 references

19.1 The United Kingdom's Eighth National Report on Compliance with the Obligations of the Convention on Nuclear Safety (https://www.iaea.org/sites/default/files/national_report_of_the_united_kingdom_for_the_8th_review_meeting.pdf), Department for Business, Energy & Industrial Strategy, August 2019.

19.2 ONR Safety Assessment Principles, 2014 (http://www.onr.org.uk/saps/saps2014.pdf).

19.3 ONR guidance: Notifying and reporting incidents and events to ONR (http://www.onr.org.uk/operational/inspection/onr-opex-gd-001.pdf).

19.4 Chief Nuclear Inspector's annual report on Great Britain's nuclear industry, October 2021 (https://www.onr.org.uk/documents/2021/cni-annual-report-2021.pdf).

19.5 ONR Enforcement Policy Statement, April 2020 (http://www.onr.org.uk/documents/enforcement-policy-statement.pdf).

19.6 The UK's 7th national report on compliance with the obligations of the Joint Convention on the safety of spent fuel and radioactive waste management (https://www.gov.uk/government/publications/the-uks-7th-national-report-on-compliance-with-the-obligations-of-the-joint-convention-on-the-safety-of-spent-fuel-and-radioactive-waste-management), October 2020 - GOV.UK (www.gov.uk).

19.7 UK Strategy for Radioactive Discharges, July 2009 (https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/249884/uk_strategy_for_radioactive_discharges.pdf).

19.8 The Convention for the Protection of the Marine Environment of the North-East Atlantic (https://www.ospar.org/convention). 1992.

Tables

Table 1 – UK Civil Power Reactors' Key Parameters

Nuclear Installation	Dungeness B (1)	Hartlepool	Heysham 1 (2)	Heysham 2
Licensee	EDF Energy NGL	EDF Energy NGL	EDF Energy NGL	EDF Energy NGL
Reactor type	AGR	AGR	AGR	AGR
No. of reactors	2	2	2	2
1st Power Operation	1983	1983	1983	1988
Forecast end-of-generation date	(2021)	2024	2024	2028
Reactor Thermal Power (MWth/Reactor)	1550	1575	1575	1700
Electrical Gen. Power (MWe/Reactor)	585	640	630	670

Nuclear Installation	Dungeness B (1)	Hartlepool	Heysham 1 (2)	Heysham 2
Total exported (MWe/Reactor)	520	590	580	610
Nuclear fuel	UO2	UO2	UO2	UO2
Fuel cladding	Stainless Steel	Stainless Steel	Stainless Steel	Stainless Steel
Nuclear moderator	Graphite	Graphite	Graphite	Graphite
Reactor core: Fuel channels	408	324	324	332
Reactor core: Assemblies per channel	7	8	8	8
Reactor core: Fuel pins /assembly	36	36	36	36
Coolant	CO2	CO2	CO2	CO2
Coolant containment	Pre-stressed Concrete Pressure Vessel (PCPV)	PCPV	PCPV	PCPV
Coolant pressure (Bar)	30	42	42	42
Coolant max. temp. (^{o}C)	650	660	660	660
Steam turbine inlet pressure (Bar)	163	159	159	159
Steam turbine inlet temp. (^{o}C)	555	517	547	538

Nuclear Installation	Dungeness B (1)	Hartlepool	Heysham 1 (2)	Heysham 2
Gross electrical power (MWe)	1170	1280	1260	1340

Nuclear Installation	Hinkley Point B	Hunterston B (1)	Torness	Sizewell B
Licensee	EDF Energy NGL	EDF Energy NGL	EDF Energy NGL	EDF Energy NGL
Reactor type	AGR	AGR	AGR	PWR
No. of reactors	2	2	2	1
1st Power Operation	1976	1976	1988	1995
Forecast end-of-generation Date	Summer 2022	(2022)	2028	2035
Reactor Thermal Power (MWth/Reactor)	1320	1320	1700	3425
Electrical Gen. Power (MWe/Reactor)	525	530	645	1260
Total exported (MWe/Reactor)	475	480	595	1198
Nuclear fuel	UO2	UO2	UO2	UO2
Fuel cladding	Stainless Steel	Stainless Steel	Stainless Steel	Zr-4
Nuclear moderator	Graphite	Graphite	Graphite	Water
Reactor core: Fuel channels	308	308	332	-
Reactor core: Assemblies per	8	8	8	193

Nuclear Installation	Hinkley Point B	Hunterston B (1)	Torness	Sizewell B
channel				
Reactor core: Fuel pins /assembly	36	36	36	264
Coolant	CO_2	CO_2	CO_2	H_2O
Coolant containment	PCPV	PCPV	PCPV	Steel Pressure Vessel
Coolant pressure (Bar)	41	40	43	150
Coolant max. temp. (^oC)	583	583	660	323
Steam turbine inlet pressure (Bar)	126	126	159	67
Steam turbine inlet temp. (^oC)	435	435	538	283
Gross electrical power (MWe)	1050	1060	1290	1260

Note:
(1) Station no longer generating. Awaiting defuel.
(2) Heysham 1 is currently limited to operating at 84 % power (only 7 out of 8 boilers are in service).

Nuclear Installation	Hinkley Point C (Under Construction)
Licensee	NNB GenCo (HPC)
Reactor type	PWR
No. of reactors	2
Forecast Commercial Power Operation Date (Unit 1/Unit 2)	2027/2028

Nuclear Installation	Hinkley Point C (Under Construction)
Reactor Thermal Power (MWth/Reactor)	4500
Electrical Gen. Power (MWe/Reactor)	1780
Total exported (MWe/Reactor)	1650
Nuclear fuel	UO2
Fuel cladding	Zirconium alloy
Nuclear moderator	Water
Reactor core: Fuel Assemblies	241
Reactor core: Fuel pins /assembly	265
Coolant	Water
Coolant containment	Steel Pressure Vessel
Coolant pressure (Bar)	155
Coolant maximum temperature (^{o}C)	312
Steam turbine inlet pressure (Bar)	76
Steam turbine inlet temp. (^{o}C)	291
Gross electrical power (MWe)	3560

Table 2 – Summary of Nuclear Safety Assessments

Name of Assessment/ Consent	Outcome	Description	Dat
Hinkley Point B – Consent under Licence Condition 30(3) to start-up	Consent	Following assessment and inspection ONR issued Consent to restart Hinkley Point B Reactor 3 following the 2019 shutdown	May

Name of Assessment/ Consent	Outcome	Description	Dat
Hinkley Point B Reactor 3 following the 2019 Periodic Shutdown		www.onr.org.uk/pars/2019/hinkley-point-b-18-032.pdf	
Hunterston B – Return to service of Reactor 4 following core inspections	Agreement	Following assessment ONR Agreed to the implementation of this modification www.onr.org.uk/pars/2019/hunterston-b-19-004.pdf	Aug 201
Heysham 1 – Injection of Oxygen into Heysham 1 Reactor 2 for Removal of Fuel Carbon Deposit	Agreement	Following assessment ONR Agreed to the implementation of this modification www.onr.org.uk/pars/2019/heysham-1-18-030.pdf	Oct 201
Hartlepool Reactor 2 – Consent to restart reactor following periodic shutdown	Consent	Following assessment and inspection ONR issued a Consent to restart Hartlepool Reactor 2 following periodic shutdown. www.onr.org.uk/pars/2019/hartlepool-19-008.pdf	Nov 201
Heysham 2 – ONR Agreement for Extension of Operating Period for Heysham 2 Reactor 8	Agreement	Following assessment, ONR Agreed to the extension to the Reactor 8 operating period. www.onr.org.uk/pars/2019/heysham-2-19-011.pdf	Nov 201
Hinkley Point B – Justification for an increase in the operational allowance for	Agreement	Following assessment, ONR agreed Hinkley Point B Reactor 3 and 4 could continue to operate up to pre-determined core burn up.	Dec 201

Name of Assessment/ Consent	Outcome	Description	Dat
the graphite cores		www.onr.org.uk/pars/2019/hinkley-point-b-19-010.pdf	
Heysham 2 and Torness – Periodic Safety Review 2019-2020	N/A	ONR considered that the licensee's arrangements for periodic review had been adequately followed. www.onr.org.uk/pars/2020/heysham-2-torness-19-012.pdf	Jan 202
Dungeness B – Justification for Increasing the Fuel Storage Pond Decay Heat Limit	Agreement	Following assessment, ONR Agreed to the implementation of the Dungeness B fuel storage pond decay heat limit increase. www.onr.org.uk/pars/2020/dungeness-b-19-015.pdf	Apr
Heysham 2 – Consent to start up Heysham 2 Reactor 8 following Periodic Shutdown	Consent	Following assessment and inspection, ONR granted Consent to start-up Heysham 2 Reactor 8, following its 2020 periodic shutdown. www.onr.org.uk/pars/2020/heysham-2-19-017.pdf	Apr
Sizewell B – Approval of Emergency Plan	Approval	Following assessment, ONR Approved the emergency plan. www.onr.org.uk/pars/2020/sizewell-b-20-017.pdf	Apr
Dungeness B – Approval of Emergency Plan	Approval	Following assessment, ONR Approved the emergency plan. www.onr.org.uk/pars/2021/dungeness-b-20-014.pdf	May

Name of Assessment/ Consent	Outcome	Description	Dat
Heysham 1 – Agreement for Extension of Operating Period for Heysham 1 Reactor 1	Agreement	Following assessment, ONR's agreed to the extension of the operating period. www.onr.org.uk/pars/2020/heysham-1-20-003.pdf	Jun
Heysham 1 – Agreement for Extension of Operating Period for Heysham 1 Reactor 1	Agreement	Following assessment, ONR Agreed to the requested extension to the operating period. www.onr.org.uk/pars/2020/heysham-1-20-003.pdf	Jun
Torness 1 – Agreement to defer the Torness reactor 1 statutory outage	Agreement	Following assessment, ONR Agreed to the requested extension to the operating period. www.onr.org.uk/pars/2020/torness-20-006.pdf	July
Torness 1 – Agreement to the extension of the current operating period	Agreement	Following assessment, ONR Agreed to the proposed extension of the Reactor 1 operating period. www.onr.org.uk/pars/2020/torness-20-006.pdf	July
Hunterston B – An Operational Safety Case for Hunterston B R3 to a Core Burn-up of 16.425 TWd Following the 2018 Graphite Core Inspection Outage.	Agreement	Following assessment, ONR Agreed to the implementation of the safety case. www.onr.org.uk/pars/2020/hunterston-b-20-004.pdf	Aug 202

Name of Assessment/ Consent	Outcome	Description	Dat
Hunterston B – Consent under Licence Condition 30(3) to start-up Hunterston B Reactor 3 following the 2019 Periodic Shutdown	Consent	Following assessment and inspection ONR issued a Consent to restart Hunterston B Reactor 3 following the 2019 periodic shutdown. www.onr.org.uk/pars/2020/hunterston-b-18-031.pdf	Auç 202
Heysham 1 and 2 and Hinkley Point B – Approval of EDF Energy Nuclear Generation Limited Emergency Arrangements	Approval	ONR Approved the Heysham 1 and Hinkley Point B licensed sites emergency plans. www.onr.org.uk/pars/2020/heysham-hinkley-point-b-20-001.pdf	Auç 202
Hunterston B – Justification for Return to Service of Hunterston B R4	Agreement	Following assessment, ONR Agreed to the implementation of the safety case. www.onr.org.uk/pars/2020/hunterston-b-20-012.pdf	Sep 202
Torness – Approval of Emergency Arrangements	Approval	Following assessment, ONR Approved the emergency arrangements. www.onr.org.uk/pars/2020/torness-20-016.pdf	Oct 202
Hunterston B – ONR Agreement for Extension of Operating Period for Hunterston B Reactor 4	Agreement	Following assessment, ONR Agreed to the extension of Hunterston B Reactor 4 operating period www.onr.org.uk/pars/2020/hunterston-b-20-015.pdf	Nov 202

Name of Assessment/ Consent	Outcome	Description	Dat
Dungeness B – Agreement to the extension of Dungeness B's operating period under LC30(2).	Agreement	Following assessment, ONR Agreed to the extension to the R21 operating period. www.onr.org.uk/pars/2020/dungeness-b-20-010.pdf	Dec 202
Heysham 1 – Consent to Start-Up Reactor 1 Following Periodic Shutdown	Consent	Following assessment, ONR issued a Consent to the start-up of Heysham 1 Reactor 1 following its 2020 periodic shutdown. www.onr.org.uk/pars/2020/heysham-1-20-020.pdf	Dec 202
Hartlepool & Heysham 1 – Agreement to the Graphite Weight Loss Structural Integrity Assessment Limit	Agreement	Following assessment, ONR Agreed to the update of the weight loss assessment limit. www.onr.org.uk/pars/2021/hartlepool-heysham-20-023.pdf	Feb 202
Sizewell B – Approval of Emergency Plan	Approval	Following assessment, ONR Approved the emergency plan www.onr.org.uk/pars/2021/sizewell-b-20-027.pdf	Feb 202
Hartlepool – Agreement to the extension of the current operating period for Reactor 1.	Agreement	Following assessment, ONR Agreed to the extension of the R1 operating period. www.onr.org.uk/pars/2021/hartlepool-20-025.pdf	Mar 202
Hinkley Point B – Post Keyway Root Cracking Safety Case	Agreement	Following assessment, ONR Agreed to the Hinkley Point B Reactor 3 and 4 post keyway root cracking safety case.	Mar 202

Name of Assessment/ Consent	Outcome	Description	Dat
		www.onr.org.uk/pars/2021/hinkley-point-b-20-026.pdf	
Hunterston B – Approval of Emergency Plan	Approval	Following assessment, ONR Approved the emergency plan www.onr.org.uk/pars/2021/hunterston-b-20-030.pdf	Mar 202
Hunterston B – Agreement to the Extension of the Operating Period for Hunterston B Reactor 4	Agreement	Following assessment, ONR Agreed to the extension of Hunterston B Reactor 4 operating period. www.onr.org.uk/pars/2021/hunterston-b-20-028.pdf	Mar 202
Hartlepool – Emergency Arrangements Approval	Approval	Following assessment, ONR Approved the emergency arrangements www.onr.org.uk/pars/2021/hartlepool-20-019.pdf	Apr
Hunterston B – Post Keyway Root Cracking Safety Case.	Agreement	Following assessment, ONR Agreed to the proposed modification. www.onr.org.uk/pars/2021/hunterston-b-20-031.pdf	Apr
Torness reactor 1 – Consent for start-up after periodic shutdown	Consent	Following assessment, ONR issued a Consent to allow the start-up of Torness Reactor 1 following its 2021 periodic shutdown. www.onr.org.uk/pars/2021/torness-20-029.pdf	Apr
Hinkley Point B – LC30 (2) agreement to extend the	Agreement	Following assessment, ONR Agreed to the extension of the operating period.	May

Name of Assessment/ Consent	Outcome	Description	Dat
operation period		www.onr.org.uk/pars/2021/hinkley-point-b-21-002.pdf	
Sizewell B – Consent under Licence Condition 30(3) to start-up the reactor following periodic shutdown	Consent	Following assessment and inspection ONR issued Consent to restart Sizewell B following periodic shutdown www.onr.org.uk/pars/2021/sizewell-b-21-006.pdf	Aug 202
Sizewell B – Refuelling Outage 17 (RO17) Consent to Start Up	Consent	Following assessment and inspection, ONR granted Consent to start-up the reactor. www.onr.org.uk/pars/2021/sizewell-b-21-006.pdf	Aug 202
Heysham 2 – Agreement to the extension of the operating period for Reactor 2	Agreement	Following assessment ONR Agreed to the extended operating period of Heysham 1 Reactor 2. www.onr.org.uk/pars/2021/heysham-1-21-005.pdf	Aug 202
Sizewell B – Consent to Start-Up the Reactor Under Licence Condition 30(3)	Consent	Following assessment and inspection ONR granted Consent to start-up the reactor www.onr.org.uk/pars/2021/sizewell-b-21-006.pdf	Aug 202
Heysham 2 – Consent to Start-Up Heysham 2 Reactor 7 Following Periodic Shutdown	Consent	Following assessment and ONR granted Consent to start-up of Heysham 2 Reactor 7 following its 2021 periodic shutdown. www.onr.org.uk/pars/2021/heysham-2-21-007.pdf	Sep 202

Name of Assessment/ Consent	Outcome	Description	Dat
Hinkley Point C – Agreement under LC 19(1) to commence bulk Mechanical, Electrical and HVAC installation in Unit 1 nuclear island	Agreement	Following assessment ONR Agreed to the installation. www.onr.org.uk/pars/2021/hinkley-point-c-21-002.pdf	Nov 202
Torness – Agreement to the Extension of the Operating Period for Reactor 2	Agreement	Following assessment, ONR Agreed to the extended operating period of Torness Reactor 2. www.onr.org.uk/pars/2021/torness-21-010.pdf	Nov 202
Hartlepool – Consent to restart Reactor 1 following the 2021 periodic shutdown	Consent	Following assessment and inspection, ONR Consented to start-up Hartlepool Reactor 1. www.onr.org.uk/pars/2021/hartlepool-21-012.pdf	Dec 202
Dungeness B – Approval of Amended Nuclear Licensed Site Emergency Plan	Approval	Following assessment, ONR Approved the emergency plan. www.onr.org.uk/pars/2021/dungeness-b-21-014.pdf	Dec 202
Hunterston B and Hinkley Point B – Declassification of the reactor pressure boundary and associated systems for the	Agreement	Based on the evidence sampled, ONR Agreed to the declassification of the reactor pressure boundary and associated systems. www.onr.org.uk/pars/2021/hpb-hnb-21-011.pdf	Feb 202

Name of Assessment/ Consent	Outcome	Description	Dat
post generation phase.			
Agreements to HPB and HNB, NS/SC 7781 – Defuelling Essential Shutdown Reactor Safety Case and to NP/SC 7786 - Defuelling Fuel Handling Essential Safety Case	Agreement	www.onr.org.uk/pars/2022/hinkley-hunterston-21-009.pdf	Mar 202
Hinkley Point C – Agreement under Licence Condition 20 of Schedule 2 of Nuclear Site Licence No. 97A: Reflective Metal Insulation Replacements and Fibre Removal from the Reactor Building	Agreement	Following assessment ONR Agreed to the removal. www.onr.org.uk/pars/2022/hinkley-point-c-22-002.pdf	Apr
Hinkley Point C – Agreement under Licence Condition 19(1) to receive the first Nuclear Steam Supply System component to	Agreement	Following assessment ONR Agreed to the receipt. www.onr.org.uk/pars/2022/hinkley-point-c-21-003.pdf	Jun

Note: More information is available on the ONR website: ONR Project Assessment Reports (PARs) (https://www.onr.org.uk/pars/index.htm).

Table 3 – Example Engineering Principles from the SAPs

Principle	Details
Inherent safety (EKP.1)	The underpinning safety aim for any nuclear facility should be an inherently safe design, consistent with the operational purposes of the facility.
Fault tolerance (EKP.2)	The sensitivity of the facility to potential faults should be minimised.
Defence-in-depth (EKP.3)	Nuclear facilities should be designed and operated so that defence-in-depth against potentially significant faults or failures is achieved by the provision of multiple independent barriers to fault progression.
Safety measures (EKP.5)	Safety should be secured by characteristics as near as possible to the top of the list below: (a) Passive safety measures that do not rely on control systems, active safety systems or human intervention. (b) Automatically initiated active engineered safety measures. (c) Active engineered safety measures that need to be manually brought into service in response to a fault or accident. (d) Administrative safety measures. (e) Mitigation safety measures (for example, filtration or scrubbing).
Safety classification of structures, systems, and components (ECS.2)	Structures, systems, and components that must deliver safety functions should be identified and classified based on those functions and their significance to safety.
Failure to safety (EDR.1)	Due account should be taken of the need for structures, systems, and components to be designed to be inherently safe, or to fail in a safe manner, and potential failure modes should be identified, using a formal analysis where appropriate.

Principle	Details
Redundancy, diversity, and segregation (EDR.2)	Redundancy, diversity, and segregation should be incorporated as appropriate within the designs of structures, systems, and components.
Common cause failure (EDR.3)	Common cause failure should be addressed explicitly where a structure, system or component employs redundant or diverse components, measurements, or actions to provide high reliability.
Single failure criterion (EDR.4)	During any normally permissible state of plant availability, no single random failure, assumed to occur anywhere within the systems provided to secure a safety function, should prevent the performance of that safety function.
Engineered safety measures (ERL.3)	Where reliable and rapid protective action is required, automatically initiated, engineered safety measures should be provided.
Automatic initiation (ESS.8)	For all fast-acting faults (typically less than 30 minutes) safety systems should be initiated automatically and no human intervention should then be necessary to deliver the safety function(s).
Allocation of safety actions (EHF.2)	When designing systems, dependence on human action to maintain and recover a stable, safe state should be minimised. The allocation of safety actions between humans and engineered structures, systems or components should be substantiated.

Table 4 – Summary of Incidents and associated INES Ratings

Hunterston B

Significant Events Reported to ONR: INES Rating 1 – Anomaly

Date	Event Description	Dutyholder Response	ONR Action
18/07/2019	During July 2019 the station had an unplanned LCO event when a 110V GIS Supply was found to be faulty to West CO_2 Plant Instrument Panel Changeover Switch. Following investigation, it was revealed a GIS supply fuse had failed. The consequence of this was an unplanned entry into a 36-hour LCO.	The decision was taken by the Shift Manager to put the East Plant in service to allow exit from LCO and progress supply fault investigation. WR raised.	ONR discussed this event with station management and engineering staff and was satisfied the station had acted appropriately.
23/11/2019	In preparation for start-up of Reactor 1, the night shift was required to complete manual function testing of auto and coarse control rods as per SOI (Station Operating Instruction). Some of the coarse rods did not raise correctly when it was attempted to do so by operators. This fault was later traced to a dirty contact. During the following day shift, operators investigated the issue with the failed coarse control rod lifts. Visual inspection of relays was completed, and a request made to CCR to re-attempt the tests to rule out relays being in the wrong state. This was successful but operators noticed that automatic non-safety rods had been inserted	The automatic safety rods were withdrawn to restore compliance before any further plant testing was completed.	ONR followed up this issue during pre-planned site intervention.

Date	Event Description	Dutyholder Response	ONR Action
	several hours before the initial testing. This was against the SOI, however significant negative reactivity remained.		
03/10/2021	Following West CO2 plant high pressure (HP) heater fault, a controlled reactor shutdown was enacted within the 4-hour period. With the reactor shutdown there is a 24-hour action condition to restore HP supplies. Unfortunately, the HP heater could not be repaired under these timescales, so a risk assessment was produced by the dutyholder. This risk assessment identified that although the HP supplies and full tech spec required plant cannot be restored there is protection against safety case faults that require CO2 via use of the claimed low pressure CO2 route direct to the vaporisers.	Although Tech Spec compliance was maintained, full Tech Spec plant requirements were found not to be able to be met when the dutyholder planned to exit the action condition. An event recovery was entered by the station to restore HP CO2 supplies in a timely manner.	ONR followed up this issue during pre-planned site intervention.

Hinkley Point B

Significant Events Reported to ONR: INES Rating 1 – Anomaly

Date	Event Description	Dutyholder Response	ONR Action
19/05/2021	Water was found to be present in the main reactor pressure vessel relief valve escape pipework across both reactors. Following analysis, it was discovered that the presence of water has the potential to challenge the integrity of the escape pipework bellows in the event of a major pressure transient, leading to bellows failure and hot gas release into the circulator hall. This scenario had not been explicitly considered in the safety case. All relief valve lines were inspected, and any standing water drained to remove the risk. An IJCO has been produced to close the safety case gap. There was no actual event or release.	The safety concern has been discussed with design authority SQEP and the Safety Case Anomaly Process has been initiated and an interim Justification for Continued Operation (iJCO) is in progress. Event recovery has been initiated supported by CTO, to progress confirming if water is present, and if so, removing it from the system. This is only affecting Reactor 3 as Reactor 4 SRV escape pipework has recently been inspected and drained.	ONR followed up this issue during pre-planned site intervention.

Hartlepool

Significant Events Reported to ONR: INES Rating 1 – Anomaly

Date	Event Description	Dutyholder Response	ONR Action
04/10/2021	In October 2021 the station entered an Immediate Action limited condition of operation (LCO) as 3 CO_2 vaporisers were unavailable. Vaporiser 3 was isolated and 4 and 5 tripped, resulting in A and B CO_2 export mains and therefore CO_2 supply unavailability.	The station entered Operational Alert to manage plant operations and Vaporiser return to service activities. Vaporisers 4 and 5 plant setup and testing was completed, and Vaporisers 4 and 5 were declared available, the action condition was exited, and the Operational Alert was stood down 6 October 2021. An ACIN has been initiated into the event.	ONR followed up this issue during pre-planned site intervention.

Dungeness B

Significant Events Reported to ONR: INES Rating 1 – Anomaly

Date	Event Description	Dutyholder Response	ONR Action
07/04/2019	During April 2019, localised corrosion and some pitting was identified on some nitrogen injection pipework in a trench. A decision was made to perform 100 % inspection of the rest of the nitrogen line in that trench. Most	The licensee decided to perform further inspection of other pipework, including the expansion loop, to ensure there are no other areas of concern. Insulation materials were assessed and	ONR followed up this issue and provided regulatory advice to the dutyholder. In addition, ONR has an extant intervention programme in

Date	Event Description	Dutyholder Response	ONR Action
	of the pipework was found to be in good condition, however there is a section adjacent to an expansion loop that was known to have suffered degradation in the past (trefoils were in place over the adjacent trenches) and where the pitting was discovered. When assessing this area an audible hiss was heard coming from the pipework. Once it was confirmed to be the nitrogen line, the work party was immediately withdrawn due to the known contamination of this line and the potential for the release of reactor gas (CO2). All staff involved were provided with reassurance monitoring to ensure they were not personally contaminated.	monitored for potential contamination and an Apparent Cause Investigation was undertaken.	response to the overall significant corrosion issues at the Dungeness B site.
15/08/2019	In July 2019, following a plant walkdown of the auxiliary cooling water (ACW) system, it was noted that the supporting requirements to	The licensee’s central technical organisation (CTO) was contacted to provide advice on the ability of the ACW to meet its seismic claims and	ONR followed up this issue during pre-planned site interventions. A regulatory issue was raised to follow the

Date	Event Description	Dutyholder Response	ONR Action
	support the ACW system seismic claim were not clear. As the requirements were not clearly defined, licensee engineering staff were not able to monitor potential degradation of nuclear safety claimed equipment.	this was communicated to the relevant personnel. A list of remedial work requiring completion was compiled by the licensee to enable the system to be reclaimed and de-isolated. An investigation was completed by the licensee and a long-term solution was identified whereby the entire ACW system would be walked down by a seismic SQEP staff member to make recommendations for alterations to the supporting arrangements to improve system reliability due to seismic faults.	station's progress in addressing the shortfalls identified in its own investigation report which includes the extent of condition findings for other systems which have seismic claims.

Heysham 1

Significant Events Reported to ONR: INES Rating 2 – Incident

Date	Event Description	Dutyholder Response	ONR Action
22/07/2021	During July 2021, following failure of a National Grid transformer located offsite, Heysham 1 experienced loss of the	EDF declared a site incident and utilised emergency arrangements to manage the post	ONR has conducted a formal investigation into the circumstances

Date	Event Description	Dutyholder Response	ONR Action
	400kV power supplies to Reactor 2 and after about 10 s to Reactor 1. Both reactors were operating at nominal full power before the grid power loss and tripped automatically. Post trip cooling was successfully established by automatic start of one Emergency Boiler Feed Pumps (EBFP) which has sufficient capacity to cool both reactors post trip. Two out of the 4 station's EBFPs failed to start automatically on demand, and one was in planned maintenance. However, the Technical Specification requires the operation of at least 2 EBFPs during post trip cooling. About 45 min after the loss of grid the 2 failed EBFPs were started manually. If all 4 EBFPs were lost, the next line of defence to remove heat would be through initiation of High Pressure Back Up Cooling (HPBUC). This is an independent system of diesel engine powered pumps	trip response. An internal investigation has been carried out to identify the causes of the incident.	surrounding the incident, which did not reveal any significant shortfalls in compliance.

Date	Event Description	Dutyholder Response	ONR Action
	which remained available throughout. No one was injured in the incident and there were no radiological consequences.		

Heysham 2

Significant Events Reported to ONR: INES Rating 1 – Anomaly

Date	Event Description	Dutyholder Response	ONR Action
16/04/2020	Shortly after taking Reactor 8 critical as part of the return to service after a statutory outage, 3 out of 4 “log/lin” flux protection channels were found to be configured incorrectly. All the control rods were subsequently re-instated to put the reactor in a safe shutdown state. As part of normal operating procedures, once the reactor is taken critical, a check of the 4 “log/lin” flux detector protection channels is carried out at ~30kW reactor power. The check identified that channels were not operating correctly. The reactor was taken subcritical by reinserting all the control rods.	Subsequent investigations revealed the detector output and test cables had not been configured correctly after testing (reactor at engineering run conditions with the reactor protection reset) the previous week. During the event the diverse shutdown amplifier Flux Protection and low power Pulse Protection always remained available. Reactor start-up has been placed on hold. An Event Recovery organisation has been established with off-site	ONR followed up this issue during pre-planned site intervention.

Date	Event Description	Dutyholder Response	ONR Action
		independent input to investigate how this happened, to confirm there are no unrevealed extent of condition issues on Unit 7 and to provide wider assurance of the integrity of the reactor protection systems on Unit 8.	
15/03/2021	It was identified that the Reactor Make-up Shields' (MUSs') spherical pressure vessel split housing was not assessed in the original design for the bounding fault condition of a seal failure causing the void between the vessel and housing to become pressurised. The preload in the split housing fasteners may not be sufficient to prevent elastic gapping of the joint, resulting in a potential leakage flow above tolerable level (but not joint failure). Furthermore, the lower split housing itself has not been assessed to the design code for this fault case, so there was no substantiation of the housing's capability to withstand it.	Fuelling machine operations at pressurised reactors (including off-load refuelling - OPR, low power refuelling - LPR, and non-fuel handling - including control rod assembly and flux-measuring assembly exchanges) have been embargoed.	ONR followed up this issue during pre-planned site intervention.

Torness

Significant Events Reported to ONR: INES Rating 1 – Anomaly

Date	Event Description	Dutyholder Response	ONR Action
15/03/2021	It was identified that the Reactor Make-up Shields' (MUSs') spherical pressure vessel split housing was not assessed in the original design for the bounding fault condition of a seal failure causing the void between the vessel and housing to become pressurised. The preload in the split housing fasteners may not be sufficient to prevent elastic gapping of the joint, resulting in a potential leakage flow above tolerable level (but not joint failure). Furthermore, the lower split housing itself has not been assessed to the design code for this fault case, so there was no substantiation of the housing's capability to withstand it.	Fuelling machine operations at pressurised reactors (including off-load refuelling - OPR, low power refuelling - LPR, and non-fuel handling - including control rod assembly and flux-measuring assembly exchanges) have been embargoed.	ONR followed up this issue during pre-planned site intervention.

Sizewell B

Significant Events Reported to ONR: INES Rating 1 – Anomaly

Date	Event Description	Dutyholder Response	ONR Action
24/04/2021	During inspection of the Reactor Upper Internals, prior to their planned removal as part of a refuelling outage, an anomaly was identified. A cylindrical component	Event recovery has been entered, and an Operational Decision-making meeting has been held to	ONR followed up this issue during pre-planned site intervention.

Date	Event Description	Dutyholder Response	ONR Action
	called a ‘Thermal Sleeve’ has become detached from the reactor pressure vessel (RPV) Head and had remained in place on a control rod drive shaft on the Upper Internals. The ‘Thermal Sleeve’ is designed to be an integral part of the RPV head.	assess the condition and its impact on removal of the Upper Internals. The dutyholder completed this assessment and found that repairs were needed on other sleeves. This is now being performed to ensure long term life of the plant.	

Note:
(1) More information on the events reported above, and other international events can be found on the IAEA Nucleus Portal: Sign In - NUCLEUS - IAEA.
(2) All intervention records can be found on the ONR Website: https://www.onr.org.uk/intervention-records/index.htm.

Table 5 – Examples of Learning from Operating Experience

Event Description	Main Action Taken
In October 2019, during a Vendor Bid Exception, EDF Energy became aware of a potential safety issue with a rotary actuator where cracks could develop around the end cap potentially resulting in the forceful ejection of the end cap.	EDF implemented a full quarantine of all stocked items, as well as performed installation of bracing on any installed actuators to prevent any ejection of the end cap.
During a start-up of a reactor, the 50 % boiler feed pump speed control became unstable, this was due to incorrect	The management regime for the 50 % boiler feed pump has been improved, detailing the

Event Description	Main Action Taken
operation of the electrolyte control system and the electrodes sticking on a rubber gasket.	relationship between electrolyte concentration and resistance. The system was altered to remove the need for a rubber gasket, thus removing the cause of the sticking electrode.
During normal operation, the Bled Steam Governor Valve on the Main Boiler Feed Pump turbine at Heysham 2 indicated it had tripped shut due to a board failure within the controller. In fact, the valve was still open as a valve position indication error had occurred. The normal process to maintain the boiler feed resulted in the Governor opening the live steam valve to compensate from the loss of steam flow from the Bled Steam valve. The result for both valves still providing flow was an overspeed which resulted in a reactor trip.	The failure mode has been assessed and a separate video indication has been provided to the control room, so they can physically see the valve position. A review of other Turbine Governor system circuit boards was carried out to ensure that system configuration control of both hardware and firmware is reflected against the components.
During planned switching of a 3.3kV Unit Auxiliary Board one of the contactors failed to connect and power to the board was lost. The loss of power resulted in 3 control rods drifting into the core as part of the failsafe system (control rods go into the core under gravity). The activity was being carried out as a Risk of Trip Activity (ROTA); however, the assessment of risk did not go to individual component level, so the contactor was not identified as a Single Point Vulnerability (SPV).	The risk of trip assessment has been amended to capture more detail to assess component risk. All auto switch-over components have been assessed to identify if they are Single Point Vulnerabilities (SPV). Improved maintenance strategy has been deployed for SPV’s based on the investigation into contactor 152.
Whilst running at nominal full load 2 Power, 2 Safety Regulating Groups of control rods (SRG1 and SRG2) tripped to	A full plant walkdown of similar systems was undertaken to identify the extent of condition.

Event Description	Main Action Taken
manual control because of the loss of the 50V dc control supply from the ‘A’ Power supply. Changing over to the ‘B’ supply was initiated as per approved station procedure but this supply was also found to have failed. The investigation of the power supply units showed that the fuses within the supply units were too low (10A fuse) when a 20A fuse was required. This was likely an error introduced during commissioning. This problem was not discovered while both power supplies were operating as they were sharing the load therefore not exceeding the fuse rating. The load sharing is not equal as it depends on the independent supply voltage to each unit. They have therefore cycled in terms of load resulting in increased thermal fatigue. It was recognised that failure of 1 unit would result in full load being transferred to the second unit, which would have caused the same failure.	The Power supply units of this type have been identified as Single Point Vulnerabilities and maintenance strategies update. All effected systems were rectified using the correctly rated fuses. Improved alarms were deployed to monitor individual supplies, rather than the system supply.
Whilst carrying out maintenance of a fan unit which cools the Main Turbine Governor valve control modules, the fan unit was incorrectly wired. The incorrect wiring resulted in the transmission of electrical noise to the micro governor modules, this caused a voltage spike which resulted in the modules going into a failsafe state. This resulted in an automatic trip of the reactor. The investigation found that there were 2 different types of fan units, and these had different contacts which required different wiring actions. The lighting for the area made visibility in the panel more difficult.	The fan units have been changed so that all unit have the same wiring connector blocks. The potential for failure of the fan unit being a Single Point Vulnerability has been added to the station procedures. The fan units are now being replaced with more modern units to reduce the need for maintenance and increase the reliability of the fan units.

Event Description	Main Action Taken
The Chloride Ingress Protection System is designed to ensure sea water does not enter the boilers. The system is designed with a 2 out of 4 protection scheme. The loss or maintenance of a single channel would leave the system operating with 3 out of 4 protection channels operating. In July 2019 a spurious trip of a chloride ingress protection system channel 4 coupled with an unrevealed fault on a relay in channel 2 resulted in a 2 out of 4 failure and the closure of the condensate feed valves. This is an automatic action to prevent seawater entering the boilers. With falling deaerator levels, the unit was manually tripped.	The Chloride Ingress Protection relays have been replaced and improved maintenance routines and operational checks put in place. The ageing and obsolescence programme has implemented a system upgrade programme to replace the old obsolete systems with modern equivalents. A fleet wide review has been undertaken to identify is a partially failed relay can cause the problem on other sites. Different system designs have identified that this would not be a risk.
An oil leak from a turbine bearing jacking oil pipe resulted in the need to deload the unit. The oil is supplied via small bore pipework. The risk of failure of this type of pipework as a result of vibration and associated high cycle fatigue had not been identified.	The fleet has carried out an inspection of all similar pipework to identify similar degraded pipework conditions. The maintenance and inspection requirements for this type of pipework and pipework supports has been updated. Additional isolation valves have been installed to enable defects to be rectified without the need to deload and place the plant through a transient.
During high winds a large section of steel cladding detached from the underside of a roof section. The cladding fell approximately 40 metres. The area was unpopulated at the time. The cladding securing fixings were found	A programme of inspections was created to systematically inspect cladding fixings to identify and similarly degraded plant. The fixings and supporting

Event Description	Main Action Taken
to have suffered galvanic corrosion. The separating washers, which were used in the original fixing, were found to have perished resulting in the bimetallic corrosion.	metalwork were rectified with the introduction of appropriate fixings to prevent further corrosion.

Table 6 – Licence Conditions

LC	Title	Description
LC1	Interpretation	Defines the expressions used in the Licence Conditions
LC2	Marking of the site boundary	The licensee shall make and implement adequate arrangements to prevent unauthorised persons from entering the site or, if so directed by ONR, from entering such part or parts thereof as ONR may specify.
LC3	Control of property transactions	The licensee shall make and implement adequate arrangements to control all property transactions affecting the site or any part of the site to ensure that the licensee remains in overall control of the site. The arrangements shall include provision for the classification of property transactions according to their safety significance and their impact on the licensee's control of the site.
LC4	Restrictions on nuclear matter on the site	The licensee shall ensure that no nuclear matter is brought onto the site except in accordance with adequate arrangements made by the licensee for this purpose. The licensee shall ensure that no nuclear matter is stored on the site except in accordance with adequate arrangements made by the licensee for this purpose.
LC5	Consignment of nuclear matter	The licensee shall not consign nuclear matter (other than excepted matter and radioactive waste) to any place in the United

LC	Title	Description
		Kingdom other than a relevant site except with the consent of ONR.
LC6	Documents, records, authorities, and certificates	The licensee shall make adequate records to demonstrate compliance with any of the conditions attached to this license.
LC7	Incidents on the site	The licensee shall make and implement adequate arrangements for the notification, recording, investigation and reporting of such incidents occurring on the site.
LC8	Warning notices	The licensee shall ensure that suitable and sufficient notices are kept on site for the purposes of informing persons thereon of each of the following matters, that is to say; warning signals, the location of emergency exits, and the measures to be taken by such persons in the event of an emergency.
LC9	Instructions to persons on the site	The licensee shall ensure that every person authorised to be on the site receives adequate instructions as regards to risks and hazards associated with the plant and its operation, the precautions to be observed, and the action to be taken in the event of an accident or emergency on site.
LC10	Training	The licensee shall make and implement adequate arrangements for suitable training for all those on site who have responsibility for any operations which may affect safety.
LC11	Emergency arrangements	The licensee shall make and implement adequate arrangements for dealing with any accident or emergency arising on the site and their effects.
LC12	Duly authorised and other suitably qualified and experienced persons	The licensee shall make and implement adequate arrangements to ensure that only suitably qualified and experienced persons perform any duties which may affect the safety of operations on the site, or any other duties assigned by or under these conditions or any arrangements required under these conditions.

LC	Title	Description
		The aforesaid arrangements shall also provide for the appointment, in appropriate cases, of duly authorised persons to control and supervise operations that may affect plant safety.
LC13	Nuclear safety committee	The licensee shall establish a nuclear safety committee or committees to which it shall refer for consideration and advice the following: all matters required by or under these conditions to be referred to a nuclear safety committee; such arrangements or documents required by these conditions as ONR may specify; any matters on the site affecting safety or off the site which ONR may specify; any other matters that the licensee considers should be referred to the nuclear safety committee.
LC14	Safety documentation	The licensee shall make and implement adequate arrangements for the production and assessment of safety cases consisting of documentation to justify safety during the design, construction, manufacture, commissioning, operation, and decommissioning phases of the installation.
LC15	Periodic review	The licensee shall make and implement adequate arrangements for the periodic and systematic review and reassessment of safety cases.
LC16	Site plans, designs and specifications	The licensee shall submit to ONR an adequate plan of the site showing the location of the boundary of the licensed site and every building or plant on the site which might affect safety.
LC17	Management systems	The licensee shall establish and implement management systems which give due priority to safety.
LC18	Radiological protection	The licensee shall make and implement adequate arrangements for the assessment of the average effective dose to such class or classes of persons specified in the aforesaid arrangements and the licensee

LC	Title	Description
		shall notify ONR if the average effective dose to such class or classes of persons exceeds such level as ONR may specify.
LC19	Construction or installation of new plant	Where the licensee proposes to construct or install any new plant which may affect the safety the licensee shall make and implement adequate arrangements to control the construction or installation.
LC20	Modification to design of plant under construction	The licensee shall ensure that no modification of the design which may affect safety is made to any plant during the period of construction except in accordance with adequate arrangements made and implemented by the licensee for that purpose.
LC21	Commissioning	The licensee shall make and implement adequate arrangements for the commissioning of any plant or process which may affect safety.
LC22	Modification or experiment on existing plant	The licensee shall make and implement adequate arrangements to control any modification or experiment carried out on any part of the existing plant or processes which may affect safety.
LC23	Operating rules	The licensee shall, in respect of any operation that may affect safety, produce an adequate safety case to demonstrate the safety of that operation and to identify the conditions and limits necessary in the interests of safety. Such conditions and limits shall hereinafter be referred to as operating rules.
LC24	Operating instructions	The licensee shall ensure that all operations which may affect safety are carried out in accordance with written instructions hereinafter referred to as operating instructions.
LC25	Operational records	The licensee shall ensure that adequate records are made of the operation, inspection and maintenance of any plant

LC	Title	Description
		which may affect safety. The aforesaid records shall include records of the amount and location of all radioactive material, including nuclear fuel and radioactive waste, used, processed, stored, or accumulated upon the site at any time.
LC26	Control and supervision of operations	The licensee shall ensure that no operations are carried out which may affect safety except under the control and supervision of suitably qualified and experienced persons appointed for that purpose by the licensee.
LC27	Safety mechanisms, devices, and circuits	The licensee shall ensure that a plant is not operated, inspected, maintained, or tested unless suitable and sufficient safety mechanisms, devices and circuits are properly connected and in good working order.
LC28	Examination, inspection, maintenance, and testing	The licensee shall make and implement adequate arrangements for the regular and systematic examination, inspection, maintenance and testing of all plant which may affect safety.
LC29	Duty to carry out tests, inspections, and examinations	The licensee shall carry out such tests, inspections, and examinations in connection with any plant as ONR may, after consultation with the licensee, specify.
LC30	Periodic shutdown	Where necessary for the purpose of enabling any examination, inspection, maintenance or testing of any plant or process to take place, the licensee shall ensure that any such plant or process shall be shut down in accordance with the requirements of its plant maintenance schedule referred to in Condition 28.
LC31	Shutdown of specified operations	The licensee shall, if so directed by ONR, shutdown any plant, operation, or process on the site within such a period as ONR may specify.

LC	Title	Description
LC32	Accumulation of radioactive waste	The licensee shall make and implement adequate arrangements for minimising SFAIRP the rate of production and total quantity of radioactive waste accumulated on the site at any time and for recording the waste so accumulated.
LC33	Disposal of radioactive waste	The licensee shall, if so directed by ONR, ensure that radioactive waste accumulated or stored on the site is disposed of as ONR may specify and in accordance with an environmental permit granted under the Environmental Permitting (England and Wales) Regulations 2010, or the Radioactive Substances Act 1993 (for licensed sites in Scotland).
LC34	Leakage and escape of radioactive material and radioactive waste	The licensee shall ensure, SFAIRP, that radioactive material and radioactive waste on site is always adequately controlled and contained, so that it cannot leak or otherwise escape from such control or containment. The licensee shall ensure, SFAIRP, that no such leak or escape of radioactive material or radioactive waste shall occur without being detected, and that such leak or escape is then notified, recorded, investigated, and reported in accordance with arrangements made under Condition 7.
LC35	Decommissioning	The licensee shall make and implement adequate arrangements for the decommissioning of any plant or process which may affect safety.
LC36	Organisational capability	The licensee shall provide and maintain adequate financial and human resources to ensure the safe operation of the licensed site. The licensee shall make and implement adequate arrangements to control any change to its organisational structure or resources which may affect safety.

Annexes

Annex 1 – Extracts from Legislation Relevant to the Convention

Extracts from the Nuclear Installations Act 65 (NIA65) relevant to the convention

NIA65 Section 1 – Restriction of certain nuclear installations to licensed sites

(1) No person may use a site for the purpose of installing or operating—

(a) any nuclear reactor (other than a nuclear reactor comprised in a means of transport, whether by land, water or air), or

(b) any other installation of a prescribed kind, unless a licence to do so has been granted in respect of the site by the appropriate national authority and is in force.

(2) Such a licence is referred to in this Act as a “nuclear site licence”.

(3) The only kinds of installation that may be prescribed under subsection (1)(b) are installations (other than nuclear reactors) designed or adapted for —

(a) producing or using atomic energy,

(b) any process which—

(i) is preparatory or ancillary to producing or using atomic energy, and

(ii) involves, or is capable of causing, the emission of ionising radiations, or

(c) storing, processing or disposing of—

(i) nuclear fuel, or

(ii) bulk quantities of other radioactive matter which has been produced or irradiated in the course of the production or use of nuclear fuel.

(4) Regulations under subsection (1)(b) may make provision for exempting an installation from subsection (1).

(5) Regulations made by virtue of subsection (4)—

(a) may provide for any exemption to be conditional;

(b) may not result in an installation being exempt from subsection (1) unless the Secretary of State is satisfied that it is not a relevant installation (or, in the case of a conditional exemption, would not be a relevant installation if the prescribed conditions were satisfied).

(6) Before exercising any function under subsection (1)(b), (4) or (5) in or as regards Scotland, the Secretary of State must consult the Scottish Ministers.

(7) Any person who contravenes subsection (1) is guilty of an offence.

(8) A person convicted of an offence under subsection (7) in England and Wales or Scotland is liable—

(a) on conviction on indictment to imprisonment for a term not exceeding 2 years, or a fine, or both;

(b) on summary conviction to imprisonment for a term not exceeding 12 months, or a fine (in England and Wales) or a fine not exceeding £20,000 (in Scotland), or both.

(9) A person convicted of an offence under subsection (7) in Northern Ireland is liable—

(a) on conviction on indictment to imprisonment for a term not exceeding 5 years, or a fine, or both;

(b) on summary conviction to imprisonment for a term not exceeding 3 months, or a fine not exceeding the prescribed sum, or both.

(10) In relation to an offence committed before the commencement of [paragraph 24(2) of Schedule 22 to the Sentencing Act 2020] (general limit on magistrates' court's power to imprison), the reference to 12 months in subsection (8)(b), as it has effect in England and Wales, is to be read as a reference to 6 months.

(11) Subsection (1) is subject to section 47 of the Energy Act 2008 (prohibition in England and Wales and Northern Ireland on use of site in absence of approved funded decommissioning programme).

NIA65 Section 7 – Duty of licensee of licensed site

Subject to subsection (4), where a nuclear site licence has been granted in respect of a site, the licensee has the duties set out in subsections (1A), (1C) and (1E).

(1A) It is the duty of the licensee to secure that no occurrence involving nuclear matter falling within subsection (1B) causes—

(a) injury to any person,

(b) damage to any property of any person other than the licensee, or

(c) significant impairment of the environment, being injury, damage or impairment that arises out of or results from the radioactive properties, or a combination of those and any toxic, explosive or other hazardous properties, of that nuclear matter.

(1B) The occurrences referred to in subsection (1A) are—

(a) any occurrence on the licensed site involving nuclear matter during the period of the licensee's responsibility;

(b) any occurrence elsewhere than on the licensed site involving nuclear matter that is not excepted matter and which, at the time of the occurrence, satisfies the requirement mentioned in section 7A(1).

(1C) It is the duty of the licensee to secure that no occurrence involving the emission of ionising radiations falling within subsection (1D) causes–

(a) injury to any person,

(b) damage to any property of any person other than the licensee, or

(c) significant impairment of the environment, being injury, damage or impairment that arises out of or results from the radioactive properties, or a combination of those and any toxic, explosive or other hazardous properties, of the source of the emissions.

(1D) The occurrences referred to in subsection (1C) are—

(a) an emission of ionising radiations during the period of the licensee's responsibility from anything caused or suffered by the licensee to be on the site which is not nuclear matter;

(b) a discharge on or from the site of waste, being waste (of any form) that emits ionising radiations but is not nuclear matter, during the period of the licensee's responsibility.

(1E) It is the duty of the licensee to secure that no event happens that creates a grave and imminent threat of a breach of the duty under subsection (1A) or (1C)

Extracts from the Health and Safety at Work etc. Act 74 (HSWA74) relevant to the Convention

Section 2 General duties on employers to their employees

(1) It shall be the duty of every employer to ensure, so far as is reasonably practicable, the health, safety and welfare at work of all his employees.

(2) Without prejudice to the generality of an employer's duty under the preceding subsection, the matters to which that duty extends include in particular–

(a) the provision and maintenance of plant and systems of work that are, so far as is reasonably practicable, safe and without risks to health;

(b) arrangements for ensuring, so far as is reasonably practicable, safety and absence of risks to health in connection with the use, handling, storage and transport of articles and substances;

(c) the provision of such information, instruction, training and supervision as is necessary to ensure, so far as is reasonably practicable, the health and safety at work of his employees;

(d) as far as is reasonably practicable as regards any place of work under the employer's control, the maintenance of it in a condition that is safe and without risks to health and the provision and maintenance of means of access to and egress from it that are safe and without such risks;

(e) the provision and maintenance of a working environment for his employees that is, so far as is reasonably practicable, safe, without risks to health, and adequate as regards facilities and arrangements for their welfare at work.

Section 3 places the following duties on employers and the self-employed to persons other than their employees

(1) It shall be the duty of every employer to conduct his undertaking in such a way as to ensure, so far as is reasonably practicable, that persons not in his employment who may be affected thereby are not thereby exposed to risks to their health or safety.

(2) It shall be the duty of every self-employed person to conduct his undertaking in such a way as to ensure, so far as is reasonably practicable, that he and other persons (not being his employees) who may be affected thereby are not thereby exposed to risks to their health or safety.

(3) In such cases as may be prescribed, it shall be the duty of every employer and every self-employed person, in the prescribed circumstances and in the prescribed manner, to give to persons (not being his employees) who may be affected by the way in which he conducts his undertaking the prescribed information about such aspects of the way in which he conducts his undertaking as might affect their health or safety.

Extracts from the Environmental Permitting (England and Wales) Regulations 2016 relevant to the Convention

Schedule 23, Part 4, Section 1 – Optimisation and dose limits

In respect of a radioactive substances activity that relates to radioactive waste, the regulator must exercise its relevant functions to ensure that—

(a) all exposures to ionising radiation of any member of the public and of the population as a whole resulting from the disposal of radioactive waste are kept as low as reasonably achievable, taking into account economic and social factors, and

(b) the sum of the doses resulting from the exposure of any member of the public to ionising radiation does not exceed the dose limits set out in Article 13 of the Basic Safety Standards Directive subject to the exclusions set out in Article 6(4) of that Directive.

Annex 2 – The Environmental Regulatory Bodies

A2.1. This Annex provides further information to that supplied under Article 8 on the regulators that enforce environmental regulation in the UK.

Environment Agency

Mandate and Duties

A2.2. The Environment Agency was created by the Environment Act 1995 (EA95) with the aim of providing a more integrated approach to protecting and improving the environment of England as a whole – land, air and water. It is an executive 'non-departmental public body', sponsored largely by the Department for Environment, Food and Rural Affairs (DEFRA). Within England the Environment Agency is responsible for regulating major industry (including the nuclear industry) and waste, treatment of contaminated land, water quality and resources, fisheries, inland river, estuary and harbour navigations, and conservation and ecology. The Environment Agency is also responsible for managing the risk of flooding from main rivers, reservoirs, estuaries and the sea. The Environment Act sets out the principal aim of the Environment Agency "in discharging its functions so to protect or enhance the environment, taken as a whole, as to make the contribution towards attaining the objective of sustainable development".

A2.3. The Environment Agency applies the regulatory framework set by government. It works with businesses to make sure they operate in a way that avoids harming people or the environment, without imposing unnecessary administrative burdens on them.

Structure

A2.4. The Environment Agency has a board of up to 15 members, including the Chairman and Chief Executive, who are accountable to government ministers for the Environment Agency's organisation and performance. All are appointed by the Secretary of State for Environment, Food and Rural Affairs. The Board delegates the Environment Agency's day-to-day management to its Chief Executive and staff.

A2.5. The Environment Agency's regulation of the nuclear sector is delivered through its 2 specialist groups (North and South). These groups carry out the regulation of radioactive waste disposals, including discharges of liquid and gaseous wastes on and off nuclear licensed sites, and support the wider Environment Agency radioactive substances regulation of radioactive waste management on other sites.

A2.6. Since 1 April 2013 these groups have provided supported to Natural Resources Wales regulation of nuclear sites in Wales. The Environment Agency's nuclear groups also support and ensure co-ordination of the non-radioactive aspects of Environment Agency regulation of activities at nuclear sites (for example, permitting of chemical and combustion processes, and Control of Major Accident Hazards (COMAH, where the Environment Agency is joint Competent Authority with ONR on licensed sites in England)). Within these groups are several assessment teams which provide national support on solid waste disposal, generic designs of potential new nuclear reactors, radiation incident management and independent checking, monitoring and assessment of discharges to the environment. The Environment Agency and the Food Standards Agency (FSA) liaise closely to ensure that their environmental monitoring is appropriate. Annual results from the environmental monitoring programme in the UK are published jointly by the environment agencies, the FSA and the Environment and Heritage Service for Northern Ireland in a report entitled ‘Radioactivity in Food and the Environment’ (RIFE). The latest assessment of radioactivity in food and the environment and the public’s exposure to radiation reports on the results of sampling and analysis carried out for 2020 (Ref. A2.1).

A2.7. Both groups are supported by the Radioactive Substances Regulation Group which works from the Environment Agency’s national office, linking nuclear regulation to the development and implementation of national strategies (for example, nuclear decommissioning and clean-up) and providing advice to UK Government’s policy development work, working internationally in support of a range of UK commitments and obligations (including participation in the OECD’s Nuclear Energy Agency (NEA) and International Atomic Energy Agency (IAEA) programmes). The national team also supports the wider Environment Agency regulation of non-nuclear use of radioactive substances (including support to the collection of disused radioactive sources and responsibility for security regulation of high activity sealed sources).

Financial Resources

A2.8. The Environment Agency’s annual gross expenditure for 2020 to 2021 was £1.6 billion, over half of which is spent on flood and coastal risk management. Income is derived chiefly from 3 sources:

- income raised from charging for regulation;
- flood defence levies; and
- government grants, which help to finance amongst other things, pollution prevention and control activities

A2.9. Section 41 of EA95 provides the Environment Agency with the power to impose financial charges for regulatory activities in order to recover the expenses incurred through regulation. Such expenses include those incurred in respect of a programme of waste and environmental monitoring carried out by the Environment Agency. The Environment Agency uses a work-recording system to identify the effort and expenses of its staff attributable to each licensee.

A2.10. The Environment Agency charges operators for its nuclear regulatory activities on the basis of a daily rate for inspectors. This rate is reviewed annually. The Environment Agency also recharges operators for the monitoring it carries out. Annual charges for nuclear and non-nuclear regulatory work and monitoring activities in the financial year 2020/21 were approximately £21m.

Human Resources

A2.11. The Environment Agency has a total of over 10,000 staff, although only a small proportion of these are involved in nuclear regulation. The nuclear regulatory groups have a total of around 70 technical staff, with additional administrative support.

Inspectors' Qualifications:

A2.12. Nuclear regulatory staff recruited by the Environment Agency are required to have a good honours degree in science or engineering, and several years' experience in a technical or management role in the nuclear industry.

Inspectors' Training:

A2.13. The Environment Agency has established standards of competency for its staff involved with the regulation of radioactive substances. Competence standards for nuclear regulation are separately identified within the overall framework.

A2.14. The standards are used as a benchmark for all staff, but the need to undergo a structured programme depends on the individual's experience. For more experienced staff, the standards are used informally to better target professional development. For new inspectors, attainment of the competency standards is mandatory and these are used in a formal manner.

A2.15. Developing the competences of staff is achieved by combination of structured training (for example on legal requirements) and developmental experience (for example onsite inspection or issuing Enforcement Notices). The system adopted by the Environment Agency allows for competences to be demonstrated and the standards achieved to be recorded. More experienced staff act as mentors for new staff going through the competences programme.

Scottish Environment Protection Agency (SEPA)

Mandate and Duties

A2.16. The Scottish Environment Protection Agency (SEPA) was established by the Environment Act 1995 and is Scotland's principal environmental regulator. SEPA is responsible for regulating a wide range of activities including waste, water, contaminated land and industrial emissions as well as radioactive substances activities relating to public exposures in Scotland.

A2.17. SEPA's statutory purpose is set out in the Regulatory Reform (Scotland) Act 2014 which requires it to carry out its functions for the purpose of protecting and improving the environment, including managing natural resources in a sustainable way. In carrying out these functions, SEPA must contribute to improving the health and well-being of people in Scotland and achieving sustainable economic growth insofar as this is not inconsistent with its regulatory functions.

A2.18. SEPA independently regulates the management of radioactive waste at nuclear and non-nuclear facilities and the management of radioactive material, including radioactive source security, at non-nuclear facilities in Scotland. Radioactive substances are regulated under the Environmental Authorisations (Scotland) Regulations 2018 (EASR18).

A2.19. SEPA works with Food Standards Scotland (FSS) on a joint environmental monitoring programme that measures levels of radioactivity in food and the environment in Scotland. The results of environmental monitoring are used to assess public exposures from the consumption of food and doses arising from radioactive waste disposals.

Organisational Structure

A2.20. SEPA is constituted by a Board that is appointed by, and responsible to, the Scottish Ministers. The Board has responsibility for ensuring that SEPA fulfils the aims and objectives set by Scottish Ministers and membership of the Board includes a Chief Executive to whom is delegated the day-to-day management of SEPA.

A2.21. SEPA's Radioactive Substances Unit is a specialist team of around 25 people who devote their whole time to specialising in all aspects of radioactive substances. This incorporates nuclear and non-nuclear regulation, radioactive substances policy and science functions.

Financial and Human Resources

A2.22. SEPA has legal powers that allow it to recover costs for the regulation of operators. It also receives finance from the Scottish Government in the form of grant-in-aid for work that is not cost recoverable and from other sources such as a financial agreement with the NDA.

A2.23. In the financial year 2019/20, SEPA's total income was £83.3m, of which £37.3m was grant-in-aid from the Scottish Government.

A2.24. SEPA has approximately 1300 staff working together to protect and improve the Scottish environment by using a combination of legislation and good practice measures.

A2.25. SEPA has established a capability assessment matrix for staff in the Radioactive Substances Unit that is based on IAEA good practice, the requirements of 'National Occupational Standards for Nuclear Regulators' and the core syllabus for radioactive waste advisers. The capability assessment matrix defines the range of competences and skills that staff in the Radioactive Substances Unit are expected to have to deliver their role effectively and competently.

A2.26. All radioactive substances specialists have academic qualifications and experience relevant to their function on entry into SEPA and will receive any additional training needed for them to carry out their function. Additional training needs are identified based on the capability assessment matrix.

A2.27. The performance and development of staff is kept under continuous review and is formally reviewed through annual personal development reviews.

Natural Resources Wales

Mandate and Duties

A2.28. From April 2013, Natural Resources Wales (NRW) became responsible for the enforcement of environmental protection in Wales. NRW took over the Environment Agency's responsibilities in Wales for regulating radioactive substances, including the disposal of radioactive waste from nuclear licensed sites and non-nuclear premises that use radioactive substances.

A2.29. NRW is the largest Welsh Government Sponsored Body, largely taking over the functions of the Countryside Council for Wales, Forestry Commission Wales and the Environment Agency in Wales, as well as certain Welsh Government functions (such as Marine Licensing).

A2.30. NRW are responsible for delivering compliance, permitting, and enforcement for conventional environmental permits at licensed sites and permitting and enforcement for nuclear regulation matters. Nuclear compliance activities in Wales continue to be delivered by the Environment Agency on behalf of NRW and will do for the foreseeable future.

A2.31. Using its statutory functions, NRW issues various permits, licences, consents and registrations, ranging from major industrial operations, such as a licence to operate large combustion plant, down to domestic matters such as septic tank licensing.

A2.32. NRW's statutory functions include administering the Environmental Permitting Regulations 2016 (EPR16) in Wales. The provisions of EPR16 fall within the competence of the devolved administrations in the UK, including the Welsh Government.

A2.33. Through a standing Service Level Agreement (SLA) the Environment Agency delivers nuclear compliance activities on behalf of NRW. This covers day to day regulation of the nuclear permit, detailed technical site audits and inspections applying a high level of scrutiny to the nuclear site operations. Each site has a nominated Environment Agency Nuclear Site Inspector who acts as an agent for NRW, maintaining an NRW warrant to do so. They make recommendations but NRW retain the final decision-making capacity for all aspects of site regulation.

A2.34. As part of the SLA, The Environment Agency undertakes radiological monitoring of the environment in Wales on behalf of NRW in addition to the conventional environmental monitoring that NRW conducts. The results of the radiological environmental monitoring programme is published annually in the RIFE jointly produced by the environment agencies and the FSA.

Structure

A2.35. Members of NRW's board are collectively responsible to the Welsh Government for ensuring that the environment and natural resources of Wales are: sustainably maintained, sustainably enhanced and sustainably used. They are responsible for developing and approving the long-term strategy for NRW in order to meet its responsibilities and duties under the Natural Resources Body for Wales (functions) Order 2013.

A2.36. The Board of NRW consists of a Chair and not fewer than 5 and no more than 11 other members appointed by the Welsh Ministers, the Chief Executive and not fewer than 2 and no more than 4 other members appointed by the body.

A2.37. Day to day running of the organisation is delegated to the Executive team.

A2.38. The delivery of nuclear and non-nuclear radioactive substances policy, strategy and regulation is delivered by several functions within the organisation including engagement with UK and Welsh government, regulatory partners, operators and stakeholders.

Financial Resources

A2.39 NRW's comprehensive expenditure for 2020/2021 was £225m.

A2.40 NRW's income is derived chiefly from 3 sources:

- Government grant-in-aid, which helps to finance, amongst other things, flood and coastal risk management;
- Income raised from charging for regulation; and
- Commercial activities, such as income from timber.

A2.41. Through the SLA, NRW pay the Environment Agency a fee to undertake regulatory activity within Wales.

Human Resources

A2.42. NRW has approximately 2000 staff following an internal restructuring programme. In terms of nuclear regulation, there are 3 policy advisors in the Radioactivity and Industry Policy (RIP) team working on nuclear policy, strategy and regulation, including aspects related to advanced nuclear technologies and nuclear new build (Generic Design Assessment (GDA)), environmental permitting and decommissioning of the existing nuclear sites in Wales, and environmental permitting and regulation for non-nuclear sites subject to non-nuclear radioactive substances regulation. NRW belong to several nuclear policy and strategy regulatory working groups, working closely with partner regulators (specifically ONR, Environment Agency and SEPA) as well as government departments, nuclear operators, designers and developers.

A2.43. Within the Operational functions, a specialist nuclear compliance officer works towards compliance activities at the 2 existing nuclear licensed sites in Wales (Trawsfynydd and Wylfa), and 7 specialist non-nuclear compliance officers work within 4 area teams (North, South East, South Central and South West Wales) delivering compliance of non-nuclear radioactive substances regulation. In addition, several specialists from other operational teams work closely with Environment Agency staff delivering the compliance activity for NRW at the nuclear sites within their area. This includes matters such as conventional waste issues, non-radiological discharges, conservation, habitats, planning and flooding issues.

Inspectors' Qualifications and Training:

A2.44. NRW do not directly employ nuclear site inspectors but rather contract the services of the Environment Agency to deliver the day-to-day compliance activity of the nuclear environmental permits for the 2 nuclear licensed sites alongside the NRW specialist nuclear compliance officer.

Openness and transparency of regulatory activities

A2.45. The environmental regulators and the Food Standards Agency (FSA) publish a joint report annually on Radioactivity in Food and the Environment (RIFE) in the UK, which also includes estimated doses to the public. The Environment Agency also publishes an annual report “Regulating for people, the environment and growth” that reports on its regulation work and the environmental performance of regulated businesses in England.

A2.46. The environmental regulators also have well-established mechanisms for communicating and engaging with the public and interested groups including attendance at quarterly Site Stakeholder Groups and Local Liaison Committees. Non-routine site matters (e.g. enforcement letters, incidents) are reported at these meetings. The Environment Agency also has an extensive programme of engagement meetings with non-governmental organisations (NGO) and communities around high public interest nuclear sites. These are both face-to-face and online. Public and stakeholder enquiries are also responded to through the Customer Contact Centre and via email. Regular eBulletins about nuclear regulation are issued to stakeholder lists – both national and local to sites.

A2.47. The environmental regulators attend events and conferences organised by others to engage with the public and stakeholders and promote understanding of their work. This includes science fairs for children, STEM events, parliamentary receptions, industry conferences and international events.

A2.48. The environmental regulators work with broadcast, print and digital media outlets, using a variety of channels to promote their work, responding in an open and prompt manner wherever possible. They publish news stories and blogs where appropriate to promote publications, announcements and consultations. They publish information and guidance about regulation of nuclear sites and radioactive substances on their websites and use social media channels to engage with stakeholders. All the environmental regulators have press offices that are accessible 24 hours – during working hours for 'routine' enquiries and out of hours for urgent issues and emergencies.

A2.49. The environmental regulators also communicate with government and the devolved administrations through working and senior level contacts within Defra, BEIS, Scottish Government, Welsh Government, and with the Ministry of Defence (MoD).

A2.50. The environmental regulators want their decisions to be better informed through good engagement. They want to understand peoples' comments and views. Where relevant they can use these to help inform determination of permit applications and new guidance. The environmental regulators must consult the public and relevant organisations on new bespoke permit applications for all radioactive substances activities, other than those involving sealed radioactive sources. When the environmental regulators make a permit decision, they use information on the potential environmental and human health impacts of the activity. Public consultation lets people and organisations take part in their decision making. Anyone can comment on issues that could affect them or where they have particular knowledge. The environmental regulators take all relevant comments into account so they can make better decisions.

A2.51. The environmental regulators also consult the public and relevant organisations on any other application if they consider it appropriate, for example applications of high public interest (HPI). They may carry out additional consultation if:

- any significant changes are made to an application, for example a change to the proposed activity or operator
- they receive new information about the application

- High public interest applications (this is decided on a case-by-case basis).

A2.52. To reach their decision, the environmental regulators consider all the relevant information, including:

- whether the interest relates to issues regulated under an environmental permit
- the breadth and scale of interest – for example, the number of different sources such as individuals, interest groups, businesses, local councillors, media and whether there is ongoing engagement from the local MP
- whether the interest is, or is likely to be, sustained for a period of time

A2.53. When the Environment Agency consults on a permitting application, it's published on both GOV.UK and its dedicated consultation website ('citizen space'). This explains:

- what the application is about;
- where you can view the application documents;
- how you can comment; and
- when you need to comment by.

A2.54. The Environment Agency also publishes its consultation plan for HPI sites on its website in advance of consultation and seeks feedback on its approach. Its consultation plan includes advertising, press releases, targeted articles in stakeholder publications, social media, a dedicated consultation website, public events – both online and in person, and publishing information in plain English for the public.

A2.55. Public and stakeholder engagement is integral to the Environment Agency's nuclear regulation. It regularly seeks feedback from stakeholders and conducts market research and public dialogue to understand their views. It has used public engagement projects such as Sciencewise to understand more about how to build greater trust between the regulators and the public."

Annex 2 References

A2.1 Radioactivity in Food and the Environment (RIFE) report 2020 (https://www.food.gov.uk/research/radioactivity-in-food-and-the-environment/radioactivity-in-food-and-the-environment-rife-report-2020).

Annex 3 – SFAIRP, ALARP and ALARA

A3.1. The SAPs are consistent with 'Reducing Risks, Protecting People: HSE's Decision- Making Process' (R2P2) (Ref. A3.1), which provides an overall framework for decision-making to aid consistency and coherence across the full range of risks falling within the scope of HSWA74. This extended the framework in The Tolerability of Risks from Nuclear Power Stations (TOR) (Ref. A3.2). In R2P2, 'hazard' is defined as the potential for an intrinsic property or disposition of something to cause a detriment, and 'risk' is the chance that someone or something is adversely affected by the hazard. In these SAPs, anything that is capable of causing harm is termed a 'hazard'. The relative importance of hazard and risk in determining the acceptability of control measures will vary according to the circumstances. In some cases, particularly where the hazard is particularly high, or knowledge of the risk is very uncertain, ONR may choose to concentrate primarily on the hazard.

A3.2. R2P2 describes risks that are unacceptably high and the associated activities would be ruled out unless there are exceptional reasons, and also the risks that are so low that they may be considered broadly acceptable and so no further regulatory pressure to reduce risks further need be applied. However, the legal duty to reduce risk so far as is reasonably practicable (SFAIRP) applies at all levels of risk and also extends below the broadly acceptable level. The overall risk levels set out in R2P2 and TOR have been translated into specific numerical targets within the SAPs. The derivation and basis for the SAPs numerical targets are described in Annex 2 of the SAPs.

A3.3. Though R2P2, TOR and the SAPs set out indicative numerical risk levels, meeting relevant good practice in engineering and operational safety management is of prime importance. In general, ONR has found that meeting relevant good practice in engineering, operation and safety management leads to risks that are reduced SFAIRP and numerical risk levels that are at least tolerable, and in many cases broadly acceptable.

A3.4. HSE and ONR guidance generally uses the term 'as low as reasonably practicable' (ALARP) as a convenient means to express the legal duty to reduce risks SFAIRP. For assessment purposes the terms ALARP and SFAIRP are interchangeable and require the same tests to be applied. ALARP is also equivalent to the phrase 'as low as reasonably achievable' (ALARA) used in relation to ionising radiations exposure by other bodies nationally and internationally.

A3.5. The SAPs assist inspectors in the judgement of whether, in their opinion, the designers or dutyholder's safety case has satisfactorily demonstrated that the requirements of the law have been met. The guidance associated with each principle gives further interpretation on their application.

A3.6. The starting point for demonstrating that risks are ALARP and safety is adequate is that the normal requirements of good practice in engineering, operation and safety management are met. This is a fundamental expectation for safety cases. The demonstration should also set out how risk assessments have been used to identify any weaknesses in the proposed facility design and operation, identify where improvements were considered and show that safety is not unduly reliant on a small set of particular safety features. The development of standards defining relevant good practice often includes ALARP considerations, so in many cases meeting these standards will be sufficient to demonstrate that legal requirements have been satisfied. In other cases, for example where standards and relevant good practice are less evident or not fully applicable, or the demonstration of safety is complex, the onus is on the dutyholder to implement measures to the point where it can demonstrate that the costs of any further measures would be grossly disproportionate to the reduction in risks achieved by their adoption.

A3.7. The principles are used in helping to judge whether reducing risks to ALARP is achieved and that is why they are written using 'should' or similar language. Priority should be given to achieving an overall balance of safety rather than satisfying each principle, or making an ALARP judgement against each principle. The principles themselves should be met so far as is reasonably practicable. This has not been stated in each case to avoid excessive repetition. ONR's inspectors need to apply judgement on the adequacy of safety in accordance with HSE guidance on ALARP.

A3.8. In many instances it will be possible for dutyholders to demonstrate that the magnitude of the radiological hazard will result in doses that will be so low (for example in relation to legal limits) that detailed consideration of off-site effects and/or worker risks is unnecessary.

A3.9. The application of the ALARP process should be carried out comprehensively and consider all applicable principles, with all relevant risks considered as a combined set. When judging whether risks have been reduced ALARP, it may be necessary to take account of conventional risks in addition to nuclear risks and justify that an appropriate balance has been achieved.

Annex 3 References

A3.1 Reducing Risks, Protecting People: HSE's Decision-Making Process (http://www.hse.gov.uk/risk/theory/r2p2.pdf).

A3.2 The Tolerability of Risks from Nuclear Power Stations (http://www.onr.org.uk/documents/tolerability.pdf).

Abbreviations and acronyms

A

ACoP: Approved Code of Practice

ACW: Auxiliary Cooling Water

AF: Assessment Finding

AGR: Advanced Gas-cooled Reactor

AGROP: AGR Operating Programme

ALARA: As Low As is Reasonably Achievable

ALARP: As Low As is Reasonably Practicable

AMR: Advanced Modular Reactor

ANT: Advanced Nuclear Technology

ASME: American Society for Mechanical Engineers

B

BDBA: Beyond Design Basis Analysis

BEIS: Department for Business, Energy & Industrial Strategy

BAT: Best Available Technology

BPEO: Best Practicable Environmental Option

BPM: Best Practicable Means

BRB GenCo: Bradwell Power Generation Company Limited

BSL: Basic Safety Limit

BSO: Basic Safety Objective

BSSD: Basic Safety Standards Directive

C

CE: Chief Executive **CBSIS**: Computer Based Systems Important to Safety

CESC: Central Emergency Support Centre

CGN: China General Nuclear Power Corporation

CIEHF: Chartered Institute of Ergonomics and Human Factors

COBR: Cabinet Office Briefing Rooms

COMAH: The Control of Major Accident Hazard Regulations 2015

ConOps: Concept of Operations

COS: Commissioned Operational Service

CO2: Carbon Dioxide

CNI: Chief Nuclear Inspector

CSFI: Counterfeit, Fraudulent and Suspect Items

CSJ: Construction Safety Justification

CS&IA: Cyber Security and Information Security

CTO: Central Technical Office

CTP: Coronavirus Transformation Programme

C&I: Control and Instrumentation (alternative I&C)

D

DAC: Design Acceptance Confirmation

DAP: Duly Authorised Person

DBA: Design Basis Analysis

DBUE: Deployable Back-up Equipment

DCE: Deputy Chief Executive

DCNI: Deputy Chief Nuclear Inspector

DEFRA: Department for Environment, Food and Rural Affairs

DFS: Diverse Feed System

DWP: Department for Work and Pensions

DWMP: Decommissioning and Waste Management Plan

E

EASR18: Environmental Authorisations (Scotland) Regulations 2018

EA95: Environment Act 1995

EBFP: Emergency Boiler Feed Pump

EC: European Council

ECC: Emergency Control Centre

ECURIE: Urgent Radiological Information Exchange

EDF Energy NGL: Électricité de France Energy Nuclear Generation Ltd

EDF SA: Électricité de France SA

EDM: Electro-Discharge Machine

EDR: Executive Director of Regulation

EDRMS: Electronic Document and Records Management System

EIA17: Infrastructure Planning (Environmental Impact Assessment) Regulations 2017

EIMT: Examination, Inspection, Maintenance, and Testing

EIR: Environmental Information Regulations 2004

EMM: Enforcement Management Model

ENSREG: European Nuclear Safety Regulators Group

EOC: Emergency Operation Centre

EoG: End-of-generation

EPD: Electronic Personal Dosimeters

EPR: European/Evolutionary Power Reactor

EPReSC: Emergency Planning and Response Standards Committee

EPRI: Electric Power Research Institute

EPR–RANET: Response and Assistance Network

EPRWG: EPR^{TM} Working Group

EPR16: Environmental Permitting (England and Wales) Regulations 2016

EPS: Enforcement Policy Statement

EU: European Union

Euratom: European Atomic Energy Community

EURDEP: European Radiological Data Exchange Platform

F

FAP: Funding Arrangements Plan

FA3: Flamanville 3

FDP: Funded Decommissioning Programme

FID: Final Investment Decision

FFV: Fuel Free Verification

FMP: Fixed Monetary Penalties

FNSC: First Nuclear Safety Concrete

FOI: Freedom of Information

FSA: Food Standards Agency

FSS: Food Standards Scotland

F&PS: Fault and Protection Schedule

G

GB: Great Britain (England, Scotland and Wales)

GDA: Generic Design Assessment

GDF: Geological Disposal Facility

GNI: General Nuclear International

GNSL: General Nuclear System Limited

G7: Group of Seven

H

HASS: High Activity Sealed Sources

HAW: Higher Activity radioactive Waste

HERCA: Heads of the European Radiological Protection Competent Authority

HFMP: Human Factors Management Plan

HLW: High-Level Waste

HP: High Pressure

HPBUC: High Pressure Back Up Cooling

HPC: Hinkley Point C

HPI: High public Interest

HSE: Health and Safety Executive

HSWA74: Health and Safety at Work Act 1974

HUET: Human Performance Evaluation Tool

HVAC: Heating Ventilating and Air Conditioning

I

IAEA: International Atomic Energy Agency

IACRNE: Inter-Agency Committee on Radiological and Nuclear Emergencies

IAP: Independent Advisory Panel

ICRP: International Commission on Radiological Protection

IIS: Integrated Intervention Strategy

iJCO: interim Justification for Continued Operation

ILW: Intermediate-Level Waste

IMT: Incident Management Team

IN: Improvement notice

INA: Independent Nuclear Assurance

INPO: Institute of Nuclear Power Operations

IRRS: Integrated Regulatory Review Service

IRR: Ionising Radiations Regulations

IRR17: Ionising Radiations Regulations 2017

IRR99: Ionising Radiations Regulations 1999

ISO: International Standards Organisation

ISS: Integrated Intervention Strategy

ITA: Independent Technical Assessment

IMS: Integrated Management System

IMT: Incident Management Team

IN: Improvement Notice

INA: Independent Nuclear Assurance

INES: International Nuclear and Radiological Event Scale

INPO: Institute of Nuclear Power Operations

IRS: International Reporting System

ITA: Independent Technical Assessment

I&C: Instrumentation and Control (alternative C&I)

J

JIT: Just-In-Time

L

LC: Licence Condition

LCO: Limits and Conditions for Operation

LGD: Lead Government Department

LI: Licence Instrument

LoC: Letter of Compliance

LLW: Low Level Waste

LMfS: Leadership and Management for Safety

LOLER: Lifting Operations and Lifting Equipment Regulations 1998

LRQA: Lloyd's Register Quality Assurance

LTQR: Lifetime Quality Records

M

MDEP: Multinational Design Evaluation Programme

MHSWR99: Management of Health and Safety at Work Regulations 1999

MoD: Ministry of Defence

MODARIA: Modelling and Data for Radiological Impact Assessments

MoU: Memoranda of Understanding

MUSs: Make-up Shields

N

NAR: National Assessment Reports

NCA: Nuclear Co-operation Agreements

NDA: Nuclear Decommissioning Authority

NEA: Nuclear Energy Agency

NERIS: nuclear and radiological emergency response and recovery

NES: Nuclear Energy Series

NGO: Non-Governmental Organisation

NIA: Nuclear Industry Association

NIA65: Nuclear Installations Act 1965

NIC: Nuclear Island Concrete

NISR: Nuclear Industries Security Regulations 2003

NLF: Nuclear Liabilities Fund

NNB GenCo: Électricité de France Energy Nuclear New Build

NNL: National Nuclear Laboratory

NPP: Nuclear Power Plant

NR: National Report

NRW: Natural Resources Wales

NSA: Nuclear Skills Alliance

NSC: Nuclear Safety Committee

NSD: Nuclear Safety Directives

NSSG: Nuclear Skills Strategy Group

NWA: Nuclear Workforce Assessment

NWoW: New Ways of Working

O

OECD: Organisation for Economic Co-operation and Development

OEI: Organisational Effective Indicator

OEM: Original Equipment Manufacturer

OET: ONR Executive Team

OLP: Organisational Learning Portal

ONR: Office for Nuclear Regulation

OPEX: Operational Experience

OSART: IAEA Operational Safety Review Team

P

p.a.: Per Annum (per year)

PAR: Project Assessment Report

PCmSR: Pre-Commissioning Safety Report

PCPV: Pre-stressed Concrete Pressure Vessel

PCSR: Pre-Construction Safety Report

PIR: Post Implementation Review

PN: Prohibition Notice

POSR: Pre-Operational Safety Report

PWR: Pressurised Water Reactor

PSA: Probabilistic Safety Analysis

PCPV: Pre-stressed Concrete Pressure Vessel

PSD: Primary Shutdown System

PSHA: Probabilistic Seismic Hazard Assessment

PSR: Periodic Safety Review

PSRG: Project Safety Review Group

PSSR: Pressure Systems Safety Regulations 2000

PTP: Post and Training Profile

PWSCC: Primary Water Stress Corrosion Cracking

R

RA: Regulatory Assurance

RAB: Regulated Asset Base

RAG: Red/Amber/Green

RANET: Response and Assistance Network

RASSC: IAEA's Radiation Safety Standards Committee

RC: Reference Configurations

RCF: Regulatory Competence Framework

RCIS: Redgrave Court Incident Suite

RD: Regulatory Directorate

REPPIR: Radiation Emergency Preparedness and Public Information Regulations 2019

RGP: Relevant Good Practice

RIFE: Radioactivity in Food and the Environment

RIMNET: Radioactive Incident Monitoring Network

RIP: Radioactivity and Industry Policy

RLT: Regulatory Leadership Team

RM: Review Meeting

RO: Refuelling Outage

ROM: Regulatory Oversight Manager

ROS: Routine Operational Service

ROTA: Risk of Trip Activity

RP: Requesting Party

RPA: Radiation Protection Advisor

RPS: Radiation Protection Supervisor

RPS: Regulatory Position Statement

RPV: Reactor Pressure Vessel

RPVH: Reactor Pressure Vessel Head

RSR: Radioactive Substances Regulation

RSA93: Radioactive Substances Act 1993

RTS: Return-to-Service

RWA: Radioactive Waste Adviser

RWG: Recovery Working Group

RWM: Radioactive Waste Management

R2P2: Reducing Risk Protecting People

S

SA: Severe Accident

SAA: Severe Accident Analysis

SAG: Severe Accident Guidelines

SAGE: Scientific Advice Group for Emergencies

SAP: Safety Assessment Principle

SAT: Systematic Approach to Training

SBI: System Based Inspections

SBERGs: Symptom-Based Emergency Response Guidelines

SCC: Stress Corrosion Cracking

SCG: Strategic Coordinating Group

SCQWG: Supply Chain Quality Working Group

SDF: Safety Director's Forum

SEPA: Scottish Environment Protection Agency

SFAIRP: So Far As Is Reasonably Practicable

SG: Steam Generator

SGoRR: Scottish Government Resilience Room

SIMRS: Safeguards Information Management and Reporting IT System

SLA: Service Level Agreement

SLT: Senior Leadership Team

SMP: Safety Management Prospectus

SMR: Small Modular Reactor

SoDA: Statement of Design Acceptability

SOI: Station Operating Instruction

SPI: Safety Performance Indicator

SPV: Single Point Vulnerability

SQEP: Suitable Qualified and Experienced Personnel

SRG: Safety Related Group (of control rods)

SSAC: UK's State System of Accounting for and Control of Nuclear Material

SSC: Structures, Systems and Components

SSD: Secondary Shutdown System

STAC: Scientific and Technical Advice Cell

SyAPs: Security Assessment Principle

SZC: Sizewell C

T

TAG: Technical Assessment Guide

TCO: Technical Client Organisation

TEA13: The Energy Act 2013

TIG: Technical Inspection Guide

TOR: Tolerability of Risk

TPR: Topical Peer Review

TSC: Technical Support Contractors

TSD: Tertiary Shutdown System

TSO: Technical Services Organisation

U

UK: United Kingdom

UKCP: UK Climate Projections

UKHSA: United Kingdom Health Security Agency

USIE: IAEA United System for Information Exchange in Incidents and Emergencies

V

VDNS: Vienna Declaration on Nuclear Safety

VICWG: Vendor Inspection Co-operation Working Group

VMP: Variable Monetary Penalties

VOA: Voluntary Offer Agreement

W

WANO: World Association of Nuclear Operators

WENRA: Western European Nuclear Regulators Association

WIReD: Well Informed Regulatory Decisions

WNA: World Nuclear Association

WPNEM: NEA Working Party on Nuclear Energy Matters