Department for
Business, Energy
& Industrial Strategy

THE UNITED KINGDOM'S EIGHTH NATIONAL REPORT ON COMPLIANCE WITH THE CONVENTION ON NUCLEAR SAFETY

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Contributors to the United Kingdom's National Report

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Contents

Contributors to the United Kingdom's National Report 2
Section A – Introduction 5
Introduction 5
Overview of the Nuclear Programme 5
Overview of significant developments since the Seventh Report 6
Structure and basis of the report 6
Section B – Summary 8
Changes relating to the regulatory body 8
International Update 8
Important Safety Challenges, Ageing and Obsolescence 11
Operating Experience and Lessons Learned 12
New Build and Licensing 13
Knowledge Management 17
Feedback from the Seventh Convention of Nuclear Safety Review Meeting 18
Vienna Declaration on Nuclear Safety Response to the President's Letter 21
Achievements, Challenges and Planned Improvements 23
Areas of good practice 26
Section C – Reporting Article by Article 27
Article 6 – Existing Nuclear Installations 27
Article 7 – Legislative and Regulatory Framework 34
Article 8 – Regulatory Body 48
Article 9 – Responsibility of the Licence Holder 60
Article 10 – Priority to Safety 65
Article 11 – Financial and Human Resources 77
Article 12 – Human Factors 89
Article 13 – Quality Assurance 97
Article 14 – Assessment and Verification of Safety 106
Article 16 – Emergency Preparedness 137
Article 17 – Siting 149
Article 18 – Design and Construction 156
Article 19 – Operation 176
Tables 186
Table A1 - UK Civil Nuclear Power Reactors – Key Parameters 186
Table A2 – Summary of nuclear safety assessments 189
Table A3 – Engineering principles set out in the SAPs 195
Table A4 – Summary of incidents and INES ratings 197
Table A5 – Examples of learning from operating experience 204
Table A6 - Table of Licence Conditions 206
Annexes 208
Annex 1 - Extracts from legislation relevant to the Convention 208

Annex 2 - The Environmental Regulatory Bodies 210
Annex 3 - SFAIRP, ALARP and ALARA 217
Glossary and Abbreviations 219
References 223

Section A – Introduction

Introduction

A1 This is the eighth report explaining how the UK complies with its obligations under the Articles of the Convention on Nuclear Safety – hereinafter referred to as the 'Convention' (Ref. 1). Since the Convention came into force in 1996, the UK has participated in all reporting cycles to date meeting its obligations under the Convention.

A2 This report focuses on the UK's operational civil nuclear power stations. The nuclear industry in the UK continues to evolve, with plans to develop a new generation of nuclear power stations as part of the Government's energy policy in England and Wales. This report discusses new build design and licensing activities and demonstrates the application of modern safety standards and processes to those projects.

A3 The Office for Nuclear Regulation (ONR) is the UK national regulator for nuclear safety and security at UK nuclear power plants. This report focuses on the UK's civil nuclear power stations, consisting of a fleet of 14 advanced gas cooled reactors (AGRs) and a single Pressurised Water Reactor (PWR), for which Electricité de France Energy Nuclear Generation Ltd (EDF Energy NGL) is the sole licensee. Facilities used for national defence purposes are excluded. The report also discusses the new reactor build at Hinkley Point C for which Nuclear New Build Generation Company (HPC) Ltd (NNB GenCo) is the licensee.

Overview of the Nuclear Programme

A4 The UK is made up of Great Britain (GB) (England, Scotland and Wales) and Northern Ireland.

A5 The UK nuclear industry consists of a diverse range of nuclear facilities widely geographically spread in England, Scotland and Wales, which includes: operational and decommissioning power stations; research facilities; fuel manufacturing; spent fuel storage and reprocessing; and radioactive waste processing, storage and disposal facilities. There are no nuclear facilities in Northern Ireland. An overview of relevant facilities is provided in the ONR Guide to Nuclear Regulation (Ref. 2).

A6 The safety of the UK's non-power generating facilities is covered in the UK's report to the Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management (the Joint Convention), the latest of which was submitted in October 2017 (Ref. 3). The Joint Convention covers the management of the radioactive wastes and spent fuels that are generated at the UK's nuclear power stations.

A7 The first generation of nuclear power plants in the UK consisted of 26 Magnox reactors on 11 sites throughout the UK. These ceased operation through the period 1989-2015. The reactors have been defuelled, with the exception of the two reactors at Wylfa and two reactors at Calder Hall. These are due to complete defuelling in 2019. Whilst strictly these four reactors fall within the scope of the Convention, the defuelling and decommissioning of all 26 reactors are subject to common arrangements. The UK has included these within the scope of its latest report to the Joint Convention (Ref. 3) and not explicitly addressed them in this report. The four reactors are subject to the same regulatory regime as the operating reactors and hence sections of this report describing the regulatory regime do apply to them. This approach is consistent with the previous report to the Convention.

A8 The nuclear industry in the UK continues to evolve and successive UK Governments have committed to nuclear as a part of the energy mix. This report discusses new build design and licensing activities where appropriate to demonstrate the application of modern safety standards and processes.

A9 In conclusion, the UK maintains high standards of operational nuclear safety and environmental protection within a robust regulatory framework. The UK approach has a culture of learning and drive for continuous improvement. The UK's Eighth National Report demonstrates full compliance with the obligations of the Convention on Nuclear Safety.

Overview of significant developments since the Seventh Report

A10 Changes within ONR include the appointment of a new Chief Nuclear Inspector and Chair of the ONR Board. ONR also established a single leadership team, bringing together the former Executive and Regulatory Management Teams, to provide strategic leadership as a unified group.

A11 Following the UK decision to withdraw from Euratom, ONR has established a domestic safeguards regime to ensure that the UK continues to meet its international safeguards obligations. This new regime will be in place when Euratom safeguards arrangements no longer apply to and in the UK.

A12 Since the last report, the UK fleet of reactors has continued to face and address the challenges posed by ageing and obsolescence. Various examples of these are included in this report.

A13 For the new nuclear power station under construction at Hinkley Point C, laying of the unit 1 nuclear island concrete completed on 28 June 2019, meaning construction above ground has now commenced. The Generic Design Assessment (GDA) by ONR and the Environment Agency is ongoing for the Chinese HPR1000. The UK continues to explore the potential benefits of advanced nuclear technologies.

Structure and basis of the report

A14 The structure of the report follows the guidance issued by the Convention (Ref. 4). 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.

A15 The purpose of the report is to demonstrate compliance with the obligations in the Articles of the Convention. This is the UK's eighth report and its means of compliance with the Convention has not changed significantly in many areas since the seventh report and in some cases the first report.

A16 Where the means of compliance has changed including the introduction of new regulations, it is highlighted in the same way as this paragraph.

A17 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 changed significantly.

A18 Cross referencing has been used throughout the report to help the reader to navigate the relevant parts of the report. Links are highlighted in blue like this. Links have also been included for all references. Where text directly supports the Vienna Declaration on Nuclear Safety, this is highlighted by referring to the **VDNS principle** in **bold** text. Bold text is als he UK has been a member of the Convention since the first review meeting and has therefore been through the review process seven times. In addition, the UK regulatory system continues to be regularly peer reviewed through the International Atomic Energy Agency (IAEA)'s International Regulatory Review Service. o used to indicate where text directly supports **challenges**, **major common issues, suggestions** and **good practices** identified during the seventh convention.

A19 T Elements of the regulatory system have therefore been subject to extensive review several times. Consequently, in this report, the UK has illustrated the operation of the regulatory system by reference to worked examples of regulation in practice. This is largely achieved by including examples in the text.

A20 Where examples are used to illustrate the practical application of nuclear safety in the design, build and operation of nuclear reactors, they are highlighted in the same way as this paragraph.

A21 In preparing this report, the UK has used information available up to 31 March 2019. The UK presentation to the eighth Convention Review Meeting in Vienna April 2020 will be based on this report, augmented with information on any relevant developments that may occur in the interim period.

Section B – Summary

B1 In accordance with the guidelines for national reports, this section highlights the main developments in the UK since the last report. It only provides very brief descriptions but points directly to the parts of the report where the developments are described in more detail.

Changes relating to the regulatory body

B2 The Office for Nuclear Regulation (ONR) is the regulatory body for nuclear safety and was formed in 2014 by The Energy Act 2013. Key developments in ONR since the last report include:

- Changes to the Board and leadership teams. See paragraph A10.
- Introduction of an integrated audit and assurance framework. See paragraph 8.52.
- Further integration of security and safety, including publishing Security Assessment Principles (SyAPs) (Ref. 5). See paragraph 7.61.
- Initiation of a project to improve regulatory memory, knowledge management, capability and consistency in regulatory decision making. See paragraph 8.38.

International Update

Integrated Regulatory Review Service (IRRS) Mission to the UK in October 2019

B3 The UK has hosted three partial-scope IRRS missions in 2006, 2009 and 2013, which focused predominantly on the UK's regulatory infrastructure for nuclear safety. Following these, an IAEA expert mission took place in 2014 to review progress against mission findings. Following the 2014 expert mission, five findings remained open.

B4 In March 2018, the UK Government, through the Department for Business, Energy and Industrial Strategy (BEIS), invited the IAEA to conduct a full-scope IRRS peer review mission to the UK in October 2019.

B5 This is directly related to the major common issue on **international peer reviews** identified during the Seventh Convention.

IAEA Workshop in Astana, Kazakhstan

B6 ONR recently contributed to an IAEA-led workshop in Astana, Kazakhstan which focussed on supporting the development of the regulator in countries looking to implement nuclear power programmes. The UK was an invited speaker at the workshop, alongside a regulatory representative from Turkey and the IAEA host.

B7 The workshop outlined ONR's independence and mechanisms for ensuring sound decision making, and to ONR's regulation of civil nuclear power stations and new build. The most substantive area of discussion was in the UK's non-prescriptive legal and regulatory regime. The IAEA host noted significant advantages in the UK's approach, but also noted the need for extensive regulatory expertise and guidance to ensure consistency.

OSART and WANO missions, last three and coming three years

B8 As operator and licence holder for the UK's operational nuclear power stations, 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 two IAEA Operational Safety Review Team (OSART) missions. Many of the criteria under review by WANO and OSART include aspects of plant operations that directly relates to safety. More information on past and planned missions can be found in paragraph 10.30. This is directly related to the major common issue on **international peer reviews** from the Seventh Convention.

Multinational Design Evaluation Programme (MDEP)

B9 ONR participates in the MDEP which works to harmonise future standards and shares the results of assessments carried out by the national nuclear regulators.

B10 Over the past year, MDEP design specific working groups have increased their focus on reactor commissioning activities as new European Pressurised Reactor (EPR), Advanced Power Reactor (APR)1400, and (AP)1000 plants are preparing for commercial operations worldwide. The EPR and AP1000 Working Groups have been particularly active in this area, as together they cover 12 new reactor constructions worldwide. The past 18 months marked a significant milestone for the MDEP initiative as it provided a unique opportunity for regulators involved to demonstrate the efficiency of using common positions to collaborate effectively and share information on First Plant Only Test (FPOT) results conducted in the EPR and AP1000 plants in China. The EPR Commissioning Activities Technical Experts sub-group continued to share overall commissioning progress with the three lead EPR plants, along with the more significant lessons learned and regulatory processes and activities. The sharing of lessons learned in this arena has enhanced the effectiveness of individual regulators including ONR.

B11 In addition, through its role in the Vendor Inspection Co-operation Working Group (VICWG) MDEP has helped enhance international cooperation on areas of emerging risk in supply chain management and vendor activities, specifically with regards to Counterfeit, Fraudulent and Suspect Items (CFSIs). The ongoing cooperation has enabled participating regulators, including ONR, to consider the adequacy of their activities aimed at mitigating the risks of CFSIs entering licensee facilities through vendors. The VICWG meetings have proven to be an effective forum for the discussion of inspection issues and for the sharing of inspection resources. The UK has found the communication channels established between the members, the mutual understanding of regulatory frameworks and individual country perspectives are key to the effective functioning of the VICWG.

B12 In line with the MDEP Policy Group's decision to focus on design specific activities, MDEP and the Nuclear Energy Agency (NEA) have taken steps to transfer MDEP generic activities to the NEA. Last year, Digital Instrumentation and Control (DI&C) activities were successfully transferred to the NEA under the Committee on Nuclear Regulatory Activities (CNRA). A second generic issue specific working group, the Codes and Standards working group, concluded its programme of work under MDEP in June 2018 and started its new mandate under the CNRA. In both areas the aim is to broaden the scope to include operating reactors and to expand membership to include other NEA members. The UK continues to proactively participate in these initiatives and looks forward to benefitting from opportunities that the new structure will bring.

B13 MDEP is positioning itself well for meeting the challenges posed by the transition of its generic activities and the resulting reduction in scope expected with the closure of more mature designs such as the Advanced Boiling Water Reactor (ABWR). This accommodates additional memberships and the expansion of the new HPR1000 reactor design. Moving forward, MDEP will continue to build on its achievements to further improve the safety of new reactors through effective international co-operation, management and transfer of knowledge.

ENSREG Topical Peer Review on Ageing Management

B14 The information herein is directly related to the major common issue on **international peer reviews** from the Seventh Convention.

B15 The European Union's (EU) 2014 Nuclear Safety Directive (NSD) includes the requirement for the Member States to undertake a Topical Peer Review (TPR) every six years from 2017. The UK is participating in the first review which is being run under the auspices of the European Nuclear Safety Regulators Group (ENSREG) on the topic of ageing management. All of the information and reports associated with the TPR can be found on a website dedicated to the TPR at Ref. 6.

B16 ENSREG produced Terms of Reference for the TPR (Ref. 7), which envisaged three main phases:

- National Assessment Reports (NAR) produced against a common technical specification (Ref. 8). All reports were published in December 2017.
- Peer review of the NARs in two stages:
  - Written comments and responses; and
  - A peer review workshop.
- The peer review workshop was held in May 2018 and the report of the workshop is at Ref. 9 with country specific findings compiled in Ref. 10.
- Follow up phase including the preparation and monitoring of national improvement plans. ENSREG is currently considering how the improvement plans should be produced.

B17 The scope of the 2017 TPR covered power reactors and research reactors with a thermal power of greater than 1MW. The UK has no research reactors of this size, hence the scope was limited to the power reactors operated by EDF Energy NGL and the reactor under construction at Hinkley Point C by NNB GenCo.

B18 The structure and content of the UK NAR (Ref. 11) was written in accordance with the technical specification for the TPR project. This required each country to describe and assess its overall Ageing Management Programme (AMP) followed by the AMPs for several example structures, systems and components (SSC).

B19 The UK NAR demonstrated that the UK's operating reactors and the reactor under construction had adequate ageing management programmes appropriate to the stages that they were at in their lifecycles. Both licensees demonstrated that they recognised international standards and guidance including IAEA safety standards. A number of secondary but beneficial improvements were identified by both licensees and programmes for improvement were developed and agreed with ONR. The main conclusion in the UK NAR was that whilst the licensees had adequate processes in place to manage ageing, it was not considered in an integrated manner. Improvements have been put in place to ensure that it reflected the consideration of ageing in an integrated manner.

B20 The TPR found two good practices for UK, which exceed requirements to meet the appropriate international standards:

- In order 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.
- Shielding in the core of PWRs with relatively high fluence is implemented, to preventively reduce neutron flux on the Reactor Pressure Vessel (RPV) wall.

B21 Work being done on the details of the five areas of improvement are underway alongside extra work to identify further improvements through comparison of best practices, which can be found in the TPR (Ref. 9).

B22 In conclusion, both the UK NAR and the subsequent peer review concluded that the UK ageing management arrangements were adequate and suggested beneficial improvements to its ageing management processes.

Important Safety Challenges, Ageing and Obsolescence

B23 The UK is managing a fleet of reactors which are ageing through physical mechanisms and for some, component obsolescence is becoming an issue. Throughout the last reporting period there were a number of 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 1** from the Seventh Convention.

Graphite at Hunterston B

B24 In March 2018, ONR was informed that additional cracks had been found by EDF Energy NGL at Hunterston Reactor 3 during planned inspections of the graphite bricks that make up the reactor core. More information can be found in paragraphs 7.83 and 14.69.

Sizewell B Steam Generator Drain leak

B25 In November 2017 at the beginning of Sizewell B's 15th refuelling outage a pin-hole leak was discovered on Steam Generator D. More information can be found from paragraphs 6.31 to 6.34.

Carbon Deposition – Oxygen Injection

B26 Advanced Gas Cooled Reactors are prone to developing carbon deposits on their heat transfer surfaces. A proposal for using oxygen injection in Reactor 2 at Heysham 1 power station for removal of carbon deposition on fuel cladding surfaces is at an advanced stage, more information can be found in paragraphs 6.18 to 6.20.

Dungeness B Boiler modifications

B27 As Dungeness B ages it is anticipated that the threat of boiler tube leaks will increase both in terms of frequency and magnitude. EDF Energy NGL has decided to install automatic systems to enhance protection in these faults. More information can be found in paragraphs 6.16 to 6.17.

Dungeness B corrosion

B28 In response to the potential threat to systems, structures and components by corrosion under insulation (CUI) and associated plant failures, ONR initiated and specified an intervention at Dungeness B to assess the adequacy of EDF Energy NGL arrangements to manage the integrity of its concealed pipework. More information on this can be found in paragraphs 14.74 to 14.80.

Dungeness B Main Steam Line Stress Corrosion Cracking

B29 During the 2018 R22 Statutory Outage at Dungeness B Boiler 27, main steam pipework was subject to planned in service inspection. A camera inspection identified surface breaking cracking at two locations in the bore where such defects were potentially not tolerable on main steam pipework. More information on this issue can be found in paragraphs 14.82 to 14.86.

Graphite Fuel Sleeves

B30 EDF Energy NGL monitors the security of supply for AGR fuel components routinely. It became clear that the manufacture of the graphite sleeves that surround AGR fuel elements was at risk because one of the facilities involved was under threat of closure. More information on this issue can be found in paragraphs 13.23 to 13.25.

Neutron Flux Detectors

B31 Reactor protection systems at AGR stations take input from in-core neutron flux detectors specially designed to withstand the high pressures and temperatures. The procurement of detectors since station commissioning has been inconsistent with the effect that a robust supply chain no longer existed. For more information please see paragraphs 14.103 to 14.108.

Fuel tiebar obsolescence

B32 In 2003, British Energy (bought by EDF Energy NGL in 2008) learned that the supplier of tiebar material intended to close down their manual hot rolling mill, which was part of the approved tiebar manufacturing route. More information on the resolution of this issue can be found in paragraphs 14.89 to 14.95.

Operating Experience and Lessons Learned

B33 Significant operating experience and lessons learned since the last operating period can be found in Table A4 and Table A5. Some additional OPEX is also discussed below.

Fall from height at Hinkley Point B

B34 On 13 April 2017, EDF Energy NGL formally notified the ONR of a fall from height event involving an individual (Doosan Babcock Contractor) at the Hinkley Point B Nuclear Power Station (HPB). For more information please see paragraphs 7.1 to 7.109.

Grenfell Tower Fire

B35 Grenfell Tower was a residential 24 storey tower block in North Kensington, London which was constructed in 1974 and had undergone renovation in 2016. On 14 June 2017, a fire broke out in the tower and was attended by 250 fire fighters and 70 fire engines. The tower continued to burn for around 60 hours. 72 people were killed. The fire is believed to have started accidentally in a fridge freezer on the fourth floor of the tower and spread via the building's cladding installed as part of the renovation in 2016.

B36 Following the fire, ONR issued letters on 23 June 2017 to all sixteen nuclear site licensees in the UK to seek assurances that cladding on buildings and installations on nuclear sites had been assessed for nuclear fire safety and fire safety risks, and that appropriate risk control measures/systems were in place.

B37 ONR required the licensees to:

- Identify use of combustible cladding panels and/or combustible linings;
- Ensure adequate safety cases and suitable and sufficient risk assessments in place; and
- Provide a scope of work for any remedial work identified.

B38 Responses were received from all sixteen licensees and considered and assessed by specialists within ONR. There were no nuclear or fire safety issues identified that required immediate regulatory action. Twelve licensees were undertaking further programmes of work where necessary to ensure ALARP principles were met. For four licensees, further information/clarification was sought to ensure ONR received the assurances required. This was received by the end of September 2017. More information on the ALARP principle can be found in Annex 3 - SFAIRP, ALARP and ALARA.

B39 To reinforce the letter and regulatory requirements in response to the Grenfell fire, ONR also presented to the Nuclear Industry Fire Safety Co-ordinators Committee[1] in October 2017 to remind the nuclear industry of the regulatory focus on this issue and the risk management requirements of the industry. This included reiterating the requirement to consider the issues for proposed new power stations as part of the Generic Design Assessment (GDA) process.

New Build and Licensing

Update on Hinkley Point C (HPC)

B40 Under its arrangements for compliance with Licence Condition 19 (construction or installation of new plant), NNB GenCo divided the HPC project into stages separated by hold points (HPs). These represent key project milestones where there is a step change in the risk of poorly conceived or executed construction or commissioning impacting upon nuclear safety. ONR specified that the licensee required its permission to proceed beyond two of the early construction hold points:

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

B41 Since the last Convention report, ONR has given permission to allow the licensee to proceed past both hold-points (see Figure 1 and 2).

[1] The NIFSCC was set up in 1957 following the Windscale fire. All licensees and a number of fire engineering companies are represented. The Committee meets every 6 months.

Figure 1 and 2 – Construction at Hinkley Point C

B42 Since granting permission for the start of nuclear island construction, ONR has turned its focus to the update of their Intervention Strategy, Delivery Plan and associated governance. This will cover the period nominally to the end of the project, but with a key focus on the period to the next permissioning point. Lessons learned workshops were held internally within ONR and jointly with NNB GenCo and EA to inform this process. There is now a structure in place for the regulation of the next stage of the project.

Update on NuGeneration Ltd (Moorside)

B43 In early 2017 NuGeneration Ltd (‘NuGen’) was continuing to progress its plans to submit a nuclear site licence application to construct and operate three Westinghouse AP1000® PWRs at Moorside in Cumbria. During 2018, Toshiba’s proposed sale of NuGen to Korea Electric Power Corporation Company (KEPCO) reached an advanced stage, with engagement between the UK and South Korean Government officials. However, this sale was ultimately unsuccessful.

B44 On 88 November 2018, Toshiba announced its intention to withdraw from the nuclear power plant construction project in the UK, and to take steps to wind up its NuGen business. The Moorside site in West Cumbria is owned by the Nuclear Decommissioning Authority (NDA) and the land reverted to the NDA by March 2019. It remains listed as a potentially suitable site for nuclear new build under the current National Policy Statement (EN-6) and is currently being considered for inclusion in a new National Policy Statement for nuclear power stations with gigawatt-scale reactors at sites capable of deployment between 2026 and 2035. The NDA will consider a range of options for its future.

Wylfa Newydd (Hitachi-GE UK ABWR)

B45 Horizon Nuclear Power (HNP) intended to construct and operate two Hitachi-GE Advanced Boiling Water Reactors (UK ABWR®) at the Wylfa Newydd site on the island of Anglesey in North Wales. ONR’s GDA of the UK ABWR® design was completed in November 2018 and a Design Acceptance Certificate was issued soon after.

B46 HNP submitted a formal application in March 2017 to ONR for a nuclear site licence for the construction and operation of two ABWRs at Wylfa. As part of the licensing process ONR assessed Horizon’s proposals for its organisational design and other relevant factors together with a number of technical issues relating to the siting of the reactor. ONR’s assessment had yet to be formally concluded and was subject to the outcome of other considerations by UK Government.

B47 On 17th January, Horizon informed the UK Government of the decision taken at the Hitachi Board meeting in Japan not to continue with the current programme of activities. In view of this Hitachi announced that Horizon Nuclear Power intended to suspend its UK nuclear development programme. ONR has ceased work on licensing the site.

B48 In a statement to Parliament on 17 January 2019, the Secretary of State outlined that the Government had been willing to consider taking a one-third equity stake in the project (alongside investment from Hitachi and Government of Japan agencies and other strategic partners); to consider providing all of the required debt financing to complete construction; and to consider providing a ‘contract-for-difference’ to the project with a strike price expected to be no more than £75 per megawatt-hour. Despite this package of potential support, Hitachi made the decision to suspend the project for commercial reasons.

UK HPR1000 GDA

B49 In January 2017 the UK Government formally asked ONR and the Environment Agency (EA) to begin the GDA of the UK HPR1000. The UK HPR1000 is a reactor design proposed for deployment at Bradwell-on-Sea, Essex. General Nuclear System Ltd (GNS) is a UK-registered company established to implement the GDA on the UK HPR1000 reactor on behalf of three joint requesting parties: China General Nuclear Power Corporation (CGN), EDF and General Nuclear International (GNI). GNI is a UK subsidiary of CGN.

B50 Step 2 of the UK HPR1000 GDA commenced in November 2017 and was completed in November 2018. Step 2 of GDA was the commencement of technical assessment and focused on understanding and assessing the fundamental safety and security claims, and the acceptability of the UK HPR1000 within the UK regulatory regime. Safety and security claims, or assertions, are those statements that describe the design and explain why the facility is safe and secure; the UK HPR1000 safety and security claims were presented within the Preliminary Safety Report (published in GNS’ GDA website Ref. 12) and its supporting references.

B51 Step 3 of GDA commenced on 15 November 2018. It is scheduled to last 13 months. The Safety, Security and Environment Reports for UK HPR1000 are published on the requesting parties’ GDA website (Ref. 13). In Step 3 ONR has increased its regulatory scrutiny and is undertaking a more detailed assessment of the design focusing on the methods and approaches used by the UK HPR1000 GDA RP to meet the safety and security claims.

B52 More information on the GDA process can be found on the ONR website (Ref. 14).

The Bradwell B Nuclear Power Plant Project: Pre-Licence Application Engagement

B53 Bradwell Power Generation Company Ltd (BRB) is a joint venture between General Nuclear International (GNI) and EDF Energy created to deliver the Bradwell B Nuclear Power Plant project, based on deployment of the UK HPR1000 reactor technology. The project at early stages and details such as the proposed timeline and the number of units to be deployed have not yet been made public by BRB. Current work is mostly focused on site investigations.

B54 The ONR HPR1000 team is engaging with BRB to ensure that regulatory expectations are understood, particularly in relation to:

- Demonstration of site suitability; and
- Organisational development of BRB to become a prospective capable licensee.

Advanced Nuclear Technologies (ANTs)

B55 The UK Government’s Nuclear Sector Deal (Ref. 15), sets out a new framework to support development and deployment of small modular reactors (SMRs) and the innovative technologies that support them. This aims to support the nuclear industry to bring forward technically and commercially viable propositions that would lead to deployment of investible and cost competitive new reactors. This builds on the Government’s commitment of up to £56 million to support the development of advanced nuclear technologies (ANTs).

B56 ANTs encompass a wide range of innovative nuclear reactor technologies, including SMRs and Advanced Modular Reactors (AMRs). AMRs cover a wide range of potential nuclear reactor technologies within the scope of the Generation IV Forum (GIF) technology roadmap. They involve molten metal or salt, high temperature gas or water as coolants, and are very different to the reactors ONR regulates currently.

B57 The UK Government has committed up to £12 million to upskill nuclear regulators so that they can consider regulatory issues associated with both SMRs and AMRs in advance of any future licensing decisions. In addition, the regulators have reviewed and modernised the GDA process to consider lessons learnt and to introduce greater flexibility for SMR and

AMR developers. In December 2018 the Government opened up registration for expressions of interest for the regulators' GDA process for SMRs and AMRs.

B58 To meet the goals set by the Department for Business, Energy and Industrial Strategy, ONR developed a programme of work between 2017 and 2020, with the following objectives:

- Develop ONR capability and capacity to regulate ANTs;
- Review ONR's guidance and processes to ensure that they are fit for regulating ANTs;
- Provide advice to BEIS' AMR feasibility and development programme;
- Increase engagement with international regulators; and
- Engage with the ANT industry.

Development of ONR's capability and technical expertise in ANTs

B59 ONR has started the process of ANT capability growth and is establishing the foundations for future development are being established. ONR has identified skill gaps on ANTs and has developed a training strategy and a training plan which it is being implemented.

B60 To address ONR's training needs, inspectors have undertaken in-house familiarisation with the different design types, attended external courses, attended key conferences and participated in international fora. ONR has also deployed internal AMR training.

Review of ONR's processes and guidance to ensure they are fit for regulating ANTs

B61 ONR has undertaken focused reviews of its guidance (Safety Assessment Principles (SAPs), Security Assessment Principles (SyAPs) and Technical Assessment Guides (TAGs)) to check its adequacy and sufficiency for regulating ANTs. The overall conclusion is that the SAPs, SyAPs and TAGs are suitable to regulate these types of reactors, but the guidance needs to be expanded - for example, on passive safety and consideration of relevant good practice for advanced reactors. Plans are being put in place to address these recommendations.

B62 The GDA process has been modernised to take account of learning from previous assessments and introduce greater flexibility into the process.

B63 ONR is also planning to undertake a focused review of its current guidance on licensing nuclear installations (Ref. 16) to ensure that it takes into account that there many differences in the licensing of ANTs.

Knowledge Management

B64 The UK continues to recognise knowledge management is an important issue. Progress on this is discussed below and is related to the response to the common issue from the seventh review meeting on **knowledge management**.

Knowledge Management within ONR

B65 To further improve knowledge management in ONR the Well Informed Regulatory Decisions (WIReD) project has been commissioned. More information can be found in paragraphs 8.38 to 8.43.

Knowledge Management and Retention within EDF Energy NGL

B66 Within EDF Energy NGL, there are a large number of processes which are routinely used to gather and manage knowledge. More information can be found in paragraphs 11.32 to 11.40.

Feedback from the Seventh Convention of Nuclear Safety Review Meeting

Rapporteur's Report

B67 The rapporteurs' reports from the seventh Convention review meetings identify challenges and suggestions for each Contracting Party, which it must report on at the next review meeting: These are as follows:

- A Challenge is "a difficult issue for the Contracting Party and may be a demanding undertaking (beyond the day-to-day activities); or a weakness that needs to be remediated."
- A Suggestion is "an area for improvement. It is an action needed to improve the implementation of the obligations of the CNS."

B68 At the seventh meeting, the UK was in Country Group 6 and the rapporteur's report identified three challenges and no suggestions for UK. The position on each of the challenges is in Table 1.

Challenges

B69 Three challenges were identified for the UK by Country Group 6.

Table 1 – Challenges from Seventh Convention on Nuclear Safety

Challenge	Response
Challenge 1: Regulating an ageing fleet of AGR reactors, including graphite weight loss and cracking of graphite bricks. Note: Challenge 1 is ongoing from the 6th Review Meeting and encompasses the relevant parts of challenge 2 relating to lifetime management of an ageing AGR reactor fleet.	Regulating an ageing fleet of AGR reactors is covered extensively throughout this report. For more information please see Section B – Summary, Article 6 – Existing Nuclear Installations, Article 7 – Legislative and Regulatory Framework and Article 14 – Assessment and Verification of Safety.
Challenge 2: Building capacity and capability to meet the needs related to embarking on a significant program of new NPP build activities.	This is covered under Article 8 – Regulatory Body and Article 11 – Financial and Human Resources.
Challenge 3: Providing clarity on the application of the regulatory process and decision in relation to filtered containment venting system at Sizewell B.	The EDF Energy NGL response to the Japanese earthquake and Fukushima accident included looking at installing a filtered containment venting system (FCV) to Sizewell B Power Station. In 2015, it was concluded the safety benefit of such a system was very small. An ALARP statement was produced for the ONR and the initiative stopped. As part of business-as-usual further discussions with ONR, EDF Energy NGL committed to undertake an additional review of the position in 2018. The review looked at the current risk position, the European and international approach of other

	utilities and an assessment of the risks and programme of design and installation of such a system. The 2018 review concluded the residual risk associated with containment overpressure, which could be mitigated by an FCV system, remained very small. In part this was due to the modifications installed at Sizewell following the Fukushima accident. The review therefore concluded there continued to be no shortfalls in the safety case and the ALARP conclusion reached in 2015 remained unchanged. EDF Energy NGL is now considering an option to install an FCV system in the context of the plant's future lifetime extension and a decision on this is pending. EDF Energy NGL continues its close dialogue with the ONR on this matter. More information on ALARP and SFAIRP principles can be found in Annex 3 - SFAIRP, ALARP and ALARA.

Major Common Issues Arising from Country Group Discussions

B70 During the Seventh CNS review, the Contracting Parties identified a number of major common issues from country group discussions. The President of the meeting recommended that these should be addressed in the reports for the Eighth Review meeting. The UK position or reference for each of the issues is included in the table below.

Table 2 – Major Common Issues Arising from Country Group Discussions

Common Issues	Response
Safety culture	Safety culture in the UK is discussed under Articles 10 and 12. The regulation of an ageing fleet of AGR reactors is covered extensively throughout this report. For more information please see Section B – Summary, Article 6 – Existing Nuclear Installations, Article 7 – Legislative and Regulatory Framework and Article 14 – Assessment and Verification of Safety.
International peer reviews	International peer reviews which have taken place in the last reporting period and planned international peer reviews are discussed under International Update and International peer reviews.
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 Article 8 – Regulatory Body.
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 both ONR and the licensee is discussed under Article 8 – Regulatory Body and Knowledge Management and Retention in Article 11.
Supply chain Quality assurance of SSCs. • Counterfeit Fraudulent and Suspect Items (CFSI) Anomalies in RPV components	Quality assurance is addressed under Article 13 – Quality Assurance, this includes CFSI and 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 Table 1: Challenges.
Emergency preparedness	Emergency preparedness is discussed in detail under Article 16 – Emergency Preparedness and further information is available under Article 19 – Operation.
Stakeholder consultation and communication.	Communications by both ONR 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 security informed nuclear safety 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-focussed security regulation, which aims to achieve more efficient and effective regulation of cyber security and information assurance. 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.

Suggestions

B71 The suggestions in Table 3 below were made following the country reviews of the UK report for the Seventh Convention.

Table 3 – Suggestions

Suggestion	Response
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 publication/adoption) in the report, especially those adopted since the 6th National Report.	All new regulations which have come into force since the last convention have been identified under Article 7 – Legislative and Regulatory Framework and highlighted with a blue border to aid identification.

Listing major performance indicators of NPPs in 2013-2016 in a summary table.	Major performance indicators for the EDF Energy NGL fleet have been included and can be found under Use of Safety Performance Indicators (SPIs) in the UK.
Adding annual financial budget of the national regulatory body in 2013-2016 in a summary table.	This information is now included under Article 8, under Provision of financial resources.
Listing operational events and deviations in 2013-2016 in a summary table.	Operational events and decisions can be found in Table A4 – Summary of incidents and INES ratings and Table A5 – Examples of learning from operating experience.
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.	Information regarding international review activities can be found in Section B – International Update and Article 10 – International peer reviews.

B72 The majority of this information was presented in the Seventh UK National Report. However, the UK accepted the suggestions and agreed to consider the presentation format in the Eighth National Report.

Vienna Declaration on Nuclear Safety Response to the President's Letter

B73 In response to the CNS President's letter sent to all Contracting Parties in December 2018 (Ref. 17), the UK can confirm that all aspects of the Vienna Declaration on Nuclear Safety are addressed in the Eighth Report to the Convention on Nuclear Safety in line with the requirements. 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 paragraphs 14.24 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) paragraphs 14.34 to 14.41 and 17.35 to 17.38;
  - Safety upgrades paragraphs 6.9 to 6.25;
  - Assessment of plant lifetime extensions paragraphs 6.26 to 6.28;
  - ONR Safety Assessment Principles paragraph 7.61 to 7.68; and
  - Responding to operational occurrences and accidents paragraphs 19.24 to 19.31.

- Principle 3 (taking into account IAEA safety standards and other good practices identified in the review meetings of the CNS):
  - Quality management systems of regulatory body paragraph 8.48 to 8.50;
  - ONR Enforcement Policy Statement paragraph 10.6;
  - Management systems paragraphs 10.8, 10.23 and 13.3;
  - Leadership and management for safety paragraph 13.3;
  - Safety performance indicators paragraphs 10.19 to 10.22;
  - Safety culture paragraphs 10.16, 10.25 and 10.38 to 10.56;
  - Mapping of IAEA standards including ONR Safety Assessment Principles, EDF Energy NGL Nuclear Safety Principles and NNB GenCo Nuclear Safety Design Assessment Principles paragraphs 18.15 and 18.156;
  - Information on PSRs can be found under Safety assessment by the dutyholder: safety reviews;
  - Emergency planning and response paragraph 16.49;
  - Site evaluation for nuclear installations paragraph 17.11; and
  - INES reporting paragraph 19.48.

B74 As noted in the final bullet of the previous paragraph, the President's letter implicitly requests the Contracting Parties to address how they align with the good practices from the previous review meeting. The definition of a good practice in INFCIRC 517 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."*

B75 The expectation is therefore that only countries with similar programmes will be able to achieve the Good Practices. The UK position relative to the Good Practices is summarised in Table 4.

Table 4 – Good practices from the seventh review meeting

Good Practice	UK Position
The first topical peer review was launched in a proactive manner, even before date for transposition of the nuclear safety directive by EU Member States (Euratom).	The UK was actively involved in the planning and preparation of the topical peer review processes and defining the content. See paragraphs B14-B22.
The implementation of the Instrument for Nuclear Safety Co-operation Program for assisting non-EU countries (Euratom).	The UK contributes to the funding of the European Instrument for Nuclear Safety. As with all EU funding programmes, future UK participation will be subject to negotiation.

The Canada Nuclear Safety Commission fosters openness and transparency in its regulatory process for which it has, in particular, launched a participant funding program, which 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).	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 guidance, inspection reports and project assessment reports etc on the ONR website. • Webinars to inform the public on important topics. More information relating to ONR's openness and transparency can be found under Openness and transparency of regulatory activities.
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).	In addition to regular site stakeholder groups, attended by ONR as discussed above, Hinkley Point C holds quarterly public forums at which siting issues can be discussed.

Achievements, Challenges and Planned Improvements

B76 This section highlights the UK's achievements, challenges and improvements planned over the next reporting period.

Achievements

B77 At the time of the previous CNS report, NNBNNB GenCo had started construction of the technical galleries at Hinkley Point C. Since then, progress has been made on construction of the nuclear island. The licensee successfully provided a safety case to allow ONR to grant a permission to start construction of the concrete raft for Unit 1 (paragraphs B40 to B42).

B78 To promote integration between nuclear safety and nuclear security regulation ONR has implemented its SyAPs (paragraphs 7.61 to 7.66).

B79 Due to an ageing workforce, the ONR has introduced innovative recruitment pipelines to ensure that it can be adequately resourced in the future. This includes:

- Sponsoring talented students during study and subsequently employing them;
- The new Associate grade which allows (those with less nuclear/high hazard experience to develop and grow in ONR in a number of fields;

- The recruitment and training of those with niche skills from other industry sectors to undertake an 'equivalence role' which can lead to them becoming nuclear inspectors; and
- An apprentice scheme introduced in 2019 which entails a five-year programme resulting in a degree in nuclear engineering and science. Apprentices progress their degree whilst working with ONR and completing secondments in other parts of the nuclear industry.

B80 More information can be found in paragraph 8.31.

B81 Like most countries, the UK must deal with the challenge of obsolescence, which in some cases has required innovative approaches. Some examples of this are:

- The facility for the production of graphite sleeves for AGR fuel was under threat of closure (paragraphs 12.23 to 12.25). The licensee already had a significant stock of sleeves, but to ensure a continued supply EDG Energy NGL entered negotiations to accelerate manufacture and secure a lifetime supply of the components. Contracts to achieve this have been agreed, mitigating the original risk.
- The supplier of material for AGR fuel tiebars, another component of the fuel, took the commercial decision to close its production facility (paragraphs 14.89 to 14.95). To ensure a continuing supply of tiebars, the licensee:
  - Procured a limited supply of material using the existing route by placing an order to keep it open for a limited period.
  - Modified the production process, so that alternative suppliers could be used.
- The neutron flux detectors for the reactor protection systems at the UK AGR stations need replacement and the manufacturer of the original equipment no longer exists (paragraphs 14.103 to 14.108). To allow for replacement, the original specifications with changes to allow for modifications were used as the basis for a new design with further improvements so that a new supply route could be established. As a result of this replacement, components are now available to ensure continued reactor operation in the UK. EDF Energy NGL worked with the successor to the manufacturer to re-establish the existing supply chain and establish an alternative flux detector manufacturing facility.

B82 Prior to the first dry fuel storage (DFS) campaign at Sizewell B the pre-campaign ALARA report identified the monitoring and control of neutron exposure as a key Radiological Protection (RP) concern. 'Passive' neutron badges can have a high minimum dose threshold so the EDF Energy NGL RP team proposed using neutron EPDs to measure real-time doses and compare with the 'passive' badges. Neutron EPDs were integrated with existing plant remote monitoring system, which features high definition cameras, telecommunications headsets and remote monitoring terminals. The result was that all casks were delivered below their ALARA goals, with each cask being subsequently delivered for a lower dose. The use of neutron EPDs in the remote monitoring system made a significant contribution to dose reduction and was recognised by WANO as a unique strength. More information can be found in paragraphs 15.15 to 15.17.

B83 Two extensive repair and inspection outages requiring entry into the reactor vessel at Heysham 2 and Torness were undertaken during 2018 (paragraphs 15.24 to 15.27). Vessel entrants wear full-enclosure 'hot entry' suits to provide them with an independent air supply from outside the vessel and to keep them cool during the work. Radiation dose to vessel entrants is dominated by external gamma radiation, which is variable within the different areas within the vessel. The dose uptake to workers is monitored by the work Technical Controller in real time using teledosimetry, which allows them to make real-time decisions regarding worker dose and to communicate with the workers via radio whilst in the vessel.

Both campaigns exhibited good radiological controls with both sites coming in under the predicted collective exposure.

Challenges

B84 The AGR reactors are approaching the ends of their lives with final shutdown for the different stations scheduled between 2023 and 2030. There are a number of issues that challenge continued reactor operation, including corrosion and graphite brick cracking (see paragraphs 7.83 to 7.85 and 14.69 to 14.71). The most significant issue at the moment is graphite brick cracking, which requires the licensee to provide revised safety cases to justify continued operation which must be agreed by ONR. Both the licensee and the regulator are have devoted considerable resource to ensuring that the reactors can operate safely.

B85 When the UK formally notified the EU Commission of its intention to leave the EU, the UK also commenced the process of leaving the European Atomic Energy Community (Euratom). In anticipation of the UK's withdrawal from Euratom, the UK decided to establish a domestic State System of Accountancy for and Control of Nuclear Material (SSAC) to meet future international non-proliferation obligations. ONR has been working to establish the UK SSAC, building its capacity and capability in readiness for withdrawal from Euratom. This has entailed the recruitment and training of new safeguards staff, the development of a regulatory framework for delivery of the new regime, and the development of a Safeguards Information Management and Reporting IT System to receive from operators, process and submit nuclear material accountancy information from operators and other reports to the IAEA. The UK Government has committed £12 million to upskill the regulators so that they can consider regulatory issues associated with both small conventional reactors and ANTs in advance of any future licensing decision.

B86 ONR has launched the WIReD project, which aims to:

- Increase knowledge, productivity, connectivity and mobility of every inspector in ONR; and
- Improve interfaces and transparency of regulation for dutyholders.

B87 The 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, connectivity and mobility. 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 who are regulated. More information can be found in paragraphs 8.38 to 8.42.

B88 The outcomes ONR is seeking to achieve with WIReD are:

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

B89 A number of improvements are planned for the fleet of UK operating reactors over the next reporting period. These include but are not limited to:

- Sizewell B control and instrumentation upgrade - This will upgrade the existing process control system and distributed computer system using modern technology to ensure the systems can be managed to maintain security and reliability for the next period of station operation.

- Heysham 2 and Torness – phased reinforcement programme for the reactor protection systems: This programme will include replacement of modular systems which monitor reactor parameters such as gas temperatures and neutron flux.
- Installation of phase imbalance alarms and modification of negative phase sequence protection: 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. Protection against these faults has traditionally required the operator to recognise the situation and take action. In order to increase the confidence in this process, an additional phase imbalance alarm is being installed on the 11 kV distribution boards at all stations.
- Oxygen injection at Heysham 1: AGRs are prone to develop carbon deposits on their heat transfer surfaces. Due to low thermal conductivity, the deposition leads to higher fuel clad temperatures during reactor operation which can weaken the fuel clad. A proposal for using oxygen injection in Reactor 2 at Heysham 1 power station is at an advanced stage and expected to be deployed in 2019.
- Dungeness B boiler modifications: As the station ages it is anticipated that the potential for boiler tube failures will increase both in terms of frequency and magnitude. EDF Energy NGL has therefore decided to install automatic systems to enhance protection for water ingress faults.

B90 More information on the above improvements can be found in Article 6 – Existing Nuclear Installations.

Areas of good practice

B91 The previous section of this report identifies achievements, challenges and proposed improvements. Three of these are judged by the UK to represent good practices. They are summarised below, with a reference to the relevant paragraphs in this report:

- **Regulator recruitment**

  ONR has introduced the ONR Academy and new recruitment pipelines to deal with skills shortages including sponsoring and employing graduates, nuclear associates who have the right skills, but are short on nuclear experience and most recently degree level apprentices who will undertake their education whilst working for ONR. ONR has tailored training packages for each of these recruitment streams. Please see paragraph 8.31 for more information.
- **Obsolescence issues**

  The industry has faced a number of obsolescence issues for nuclear-specific items and has used innovative approaches to deal with them, including procuring lifetime supplies of materials and components and creating a new supply chain for obsolete neutron flux detectors. Please see paragraph B82 for a summary of these matters.
- **Preparation for Advanced Nuclear Technologies (ANTs)**

  The UK has begun to plan for the introduction and regulation of advanced nuclear technologies in the UK. ONR staff have undertaken significant internal and external training and ONR has reviewed its regulation guidance in preparation for ANTs. ONR is now in a good position to review any future designs. Please see paragraphs B55-B63 for more information.

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 shut-down 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 Seventh UK report (Ref. 18) (i.e. in a way that has implications for the Convention obligations).

Nuclear installations in the UK

6.2 There are 15 reactors operating within the UK that meet the definition in Article 2 of the Convention, consisting of 7 twin Advanced Gas-Cooled Reactors (AGR) and a single Pressurised Water Reactor (PWR), located on seven licensed sites within England and Scotland, for which EDF Energy NGL is the sole licensee. The locations of the operating reactors and their supporting engineering centres are indicated on the map shown in Figure 3 below. Also shown are the locations of the two reactors under construction at Hinkley Point C and the site at Sizewell C where a further two EPRs are planned. The operating parameters for the existing fleet are summarised in Table A1 - UK Civil Nuclear Power Reactors – Key Parameters.

EDF ENERGY NUCLEAR SITES

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

Figure 3 – Location of operating reactors, their supporting engineering centres and planned sites for EPR construction

Reactors outside the scope of the Convention

6.3 The UK's first nuclear power plants, the Magnox reactors, started operation between 1956 and 1971 and shutdown between 1989 and 2015. There were 26 Magnox reactors on 11 sites. They have all been defuelled, except for Calder Hall (on the Sellafield site in Cumbria), and Wylfa in Anglesey, which permanently ceased operation in December 2015.

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

6.4 The safety of the UK's nuclear power plants is assured through the application of a licensing and regulatory regime that places legal duties on the NPP operating company (EDF Energy NGL) as the licensee at each site. In addition, there is external review and assessment from ONR. The legislative and regulatory framework is outlined under Article 7 and the 36 licence conditions attached to each site licence are summarised in Table A6 - Table of Licence Conditions.

6.5 A safety case is fundamental to the safety of nuclear power plants. Licensees must produce a safety case which assesses and sets out the safe operating parameters for the nuclear installation. Each nuclear power plant undertakes a Periodic Safety Review (PSR) every ten years in accordance with licence condition (LC) 15. This is discussed under Article 14 – Assessment and Verification of Safety.

6.6 The nuclear site licence requires that the safety significance of any proposed modifications is categorised by the licensee. A modification cannot be implemented until the NPP operating company has produced an appropriate safety justification. In addition to PSRs, the licence requires that each operating power reactor undertake a shutdown periodically (under LC 30) for the purposes of examination, maintenance, inspection and testing. For AGRs, the operating period between shutdowns is up to a maximum of 36 months. For Sizewell B the operating period is typically 18 months because it is a different reactor design which has completely different requirement.

6.7 After these shutdowns, the licensee must apply to ONR for a legal 'Consent' to restart the reactor. This 'Consent' takes the form of a licence instrument i.e. a written permissioning document signed by a senior ONR inspector. Any 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 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.

6.8 For information on safety assessments which have been carried out since the last CNS report, refer to Table A2 – Summary of nuclear safety assessments.

Safety upgrade programmes

6.9 The UK has been undertaking periodic safety reviews of its civil nuclear power stations for many years as part of its regulatory process as required by **VDNS Principle 2**.

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

6.11 There are unique ageing and obsolescence challenges for the AGR nuclear fleet. Ongoing management of these nuclear systems is driven by extensive research and development work which is supported by internal specialist knowledge and strategic supply chain partners. This is in line with Challenge 1 from the Seventh Convention on Nuclear Safety.

6.12 For the older of the AGR power stations, the investment profile is dominated by inspections (boilers and graphite) and plant reliability work. As some of the stations move closer to the end of generation, the planned capital investment levels will reduce as the work changes to focus on maintenance. As a prudent operator, the continued reliability of plant required through the defuelling cycle is incorporated in station plans.

6.13 For the newer AGR power stations, the profile maintains current levels of investment over the medium term with specific lifetime extension work underway at Dungeness B, Heysham 2 and Torness aimed at protecting longer term plant reliability and delivering lifetime safety case improvements.

6.14 Sizewell B's PWR is EDF Energy NGL's youngest nuclear power station and work on the site is focused on early identification of and addressing obsolescence, with a specific major mid-life control and instrumentation system upgrade at an advanced stage of development.

6.15 Some examples of recent safety upgrades in the UK are illustrated below:

Dungeness B Boiler modifications

6.16 As the station ages, it is anticipated that the potential for boiler tube failures will increase both in terms of frequency and magnitude. Additionally, for AGRs, graphite weight loss in the core accentuates the effect water ingress would have on neutron moderation and hence affects the detail of an appropriate response to boiler failures if they occur. The existing safety case requires an operator response that could become more onerous as the ageing processes progress. Because of this, as part of its approach to securing an ALARP risk position for the lifetime of the station, EDF Energy NGL has decided to install automatic systems to enhance protection in water ingress faults. These will comprise of:

- An automatic boiler depressurisation system – automatic detection of a significant boiler tube failure and depressurisation of all boilers to a target pressure below reactor gas pressure;
- Boiler Over-Pressure Protection (BOPS): Automatic detection and termination of overfeed faults in post-trip and shutdown cooling; and
- Safety Relief Valve Isolation (SRVI): Remote, powered, isolation of any stuck open reactor SRV following overpressure.

6.17 The physical works requiring reactor outage are largely complete and all these new systems will be fully operational by the end of 2021.

Oxygen injection

6.18 AGRs are prone to develop carbon deposits (see Figure 4) on their heat transfer surfaces. Due to the low thermal conductivity, the deposition leads to higher fuel clad temperatures during reactor operation which can weaken the fuel clad. The reactors of Heysham 1 and Hartlepool power stations are severely affected by carbon deposition and a number of fuel pin failures were observed in the last few years. A significant population of weakened fuel clad also has the potential for worsening the radiological consequences in certain reactor faults. An oxygen injection system has been designed to remove the fuel pin deposition thereby bringing fuel closer to its design intent. Oxygen injection for the removal of fuel pin deposit has not been carried out on commercial AGRs, although it has been used to remove deposit on boiler tubes at Heysham 2 and Torness. There is also limited operating experience with other gas cooled reactors (Windscale AGR, and Magnox reactors.)

6.19 The main nuclear safety risk from the core oxygen injection is generation of a combustible gas composition. The injection system is designed to prevent gas being admitted to reactor with a high reliability out of specification.

6.20 A proposal for using oxygen injection in Reactor 2 at Heysham 1 power station is at an advanced stage and expected to be deployed in 2019. The safety case has completed the internal review process and is currently undergoing assessment by ONR. The design and manufacturing of the injection equipment is currently undergoing final qualification and testing.

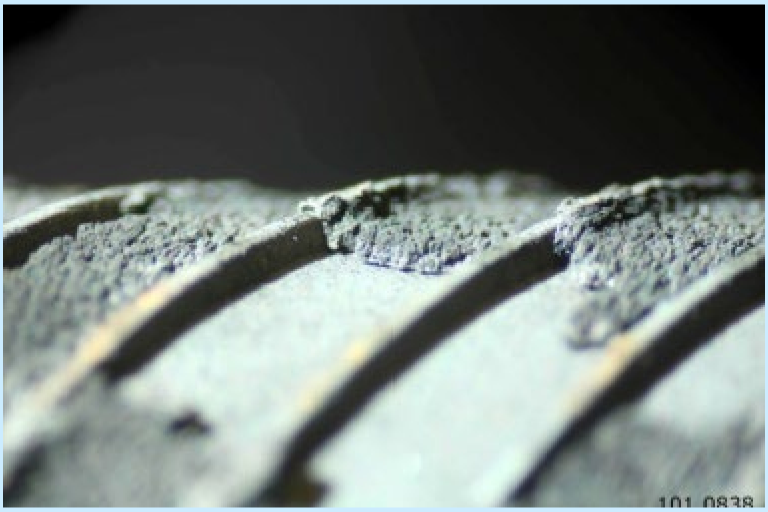


Figure 4 – Carbon Deposition on Fuel

Sizewell B control and instrumentation upgrade

6.21 At Sizewell B, a major mid-life control and instrumentation system upgrade is at an advanced stage of development. This will upgrade the existing process control system and distributed computer system using modern technology to ensure the systems can be managed to maintain security and reliability for the next period of station operation. These systems do not control any Category 1 Safety Equipment at Sizewell B. These systems also do not control plant which is essential to safety nor which is required to achieve safe shutdown following design basis faults. They do, however, provide the data processing and control functions for the majority of Safety Category 2 and 3 controls, alarms, indications and logs on the station. It is intended that existing field wiring and cabinet 'footprints' will be retained as far as possible. It is also intended that the existing system architecture be retained and the operator interface with the systems will be as close to the existing as possible. The project will include adequate training and upgrade of the simulator to retain fidelity.

Heysham 2 and Torness – phased reinforcement programme for the reactor protection systems

6.22 At Heysham 2 and Torness, the two newest AGRs, the licensee's through-life management strategy has led to the initiation of a phased reinforcement programme for the reactor protection systems. While the existing equipment continues to meet its functional safety and reliability requirement, this will become increasingly difficult to sustain because of ageing and obsolescence issues. The programme will extend over a number of years and include replacement of modular systems monitoring reactor parameters such as gas temperatures and neutron flux. The design intent is that the replacement equipment will be fit for purpose and functional equivalents for the existing equipment.

Installation of phase imbalance alarms and modification of negative phase sequence protection

6.23 Recent international and UK experience has highlighted that electrical phase imbalance faults affecting one or more phases in three 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.

6.24 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 thorough root cause investigation. Protection against these faults has traditionally made claims on the operator to recognise the situation and take action. In order to increase the confidence in this an additional phase imbalance alarm is being installed on the 11 kV distribution boards at all stations.

6.25 At the most vulnerable stations, existing Negative Phase Sequence protection on the generator will be modified. The modification will ensure that the trip function so that it disconnects the unit boards from the grid via the HV circuit breaker, and then secure electrical supplies. These will be provided by the back-up power systems as with a normal loss of grid event.

Justification for continued operation of nuclear reactors

6.26 In the UK, nuclear site licences have no time limit and 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 not possible to justify safe operations.

6.27 EDF Energy NGL is managing the UK fleet of AGRs through to their end of operating life, i.e. to the end of electrical generation, and eventual entry into decommissioning. As part of a lifetime management project, EDF Energy NGL has conducted studies aimed at optimising the remaining lifetime and generating capacity. Table 5 indicates the Plant Lifetime Extension (PLEX) currently planned for the AGR stations. In addition to these preliminary studies, further work has commenced to explore the future options and feasibility of life extension for Sizewell B operation beyond 40 years.

Table 5 – AGR planned life extensions

Site	Commenced operations	Scheduled closure	Planned life extension	Planned closure following PLEX
Hinkley Point B	1976	2016	7	2023
Hunterston B	1976	2016	7	2023
Dungeness B	1983	2018	10	2028
Heysham 1	1983	2019	5	2024
Hartlepool	1983	2019	5	2024
Heysham 2	1988	2023	7	2030
Torness	1988	2023	7	2030

6.28 ONR agreed to review the PLEX submissions to determine if, on the basis of current knowledge and experience, they provided a reasonable approach and evidence to support EDF NGL's decision to proceed with its intended PLEX campaign. For each station, ONR affirmed that the approach taken was reasonable and agreed with the overall conclusion that through life management processes should enable effective management of ageing for the proposed period of continued operation / generation. Formal agreement to continued operation, however, is subject to the licensees submitting an acceptable PSR at the appropriate time. This is in line with the requirements of **VDNS Principle 2**.

Overview of safety related issues

6.29 Since the last review, there have been a number of safety issues across the operating fleet:

- Graphite cracking at Hunterston B is outlined in paragraphs 7.83 to 7.85 and 14.69 to 14.71.
- Sizewell B Steam Generator Drain leak is noted below.
- Dungeness B corrosion is explained in paragraphs 14.74 to 14.80.
- Dungeness B Main Steam Line Stress Corrosion Cracking is detailed in paragraphs 14.82 to 14.86.

Sizewell B Steam Generator Drain Leak

6.30 In November 2017 at the beginning of Sizewell B's 15th refuelling outage a pin-hole leak was discovered on Steam Generator (SG) D.

6.31 A range of repair options were developed in parallel with conducting full forensic and 'extent of condition' inspections on all 4 SGs. Investigations concluded that the leak had been caused by primary water stress corrosion cracking (PWSCC) in the Inconel 600 seal weld on the drain line nozzle. Further inspection identified more extensive defects within the heat treated Inconel weld pad on all 4 SGs. Initial activities involved removal of the drain line assemblies and controlled machining of the associated Inconel weld pads to remove all defects.

6.32 The licensee's Structural Integrity Panel confirmed that all defects had been removed from the SG weld pads by machining, leaving an adequate depth of good Inconel material in place and no detectable damage to the ferritic forging. A workshop agreed to the deployment of an ALARP repair option to be deployed involving a welded plug. This was successfully implemented on all four steam generators. The total collective radiation dose to operators was successfully controlled well within the original estimate and the highest individual dose (incurred by one of the specialist machinists) was in line with individual doses incurred by ISI operatives on non-SG related work.

6.33 During the current cycle work is underway to review the expected lifetime of the repair to determine if a further repair may be necessary during the station lifetime.

Article 7 – Legislative and Regulatory Framework

> ***1. Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of nuclear installations.***
> ***2. 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, the following developments under this Article in the UK have taken place:

- Environmental Permitting (England and Wales) Regulations 2016 came into force;
- Transposition of UK compliance with Nuclear Safety Directives and Euratom Basic Safety Standards Directive;
- An update to the UK position on safeguards;
- Ionising Radiations Regulations 2017 have come into force;
- Radiation (Emergency Preparedness and Public Information) Regulations 2019;
- Implementation of the ONR Security Assessment Principles; and
- ONR has implemented a new Enforcement Management Model.

7.2 Compliance with this Article of the Convention has otherwise not substantially changed since the Seventh UK report (Ref. 18) (i.e. in a way that has implications for the Convention obligations).

7.3 The information in this Article is directly related to the major common issue on **legal framework and independence of the regulatory body** from the Seventh Convention.

7.4 The Parliament of the United Kingdom of Great Britain and Northern Ireland, located in 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.

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

7.6 There are a number of 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.

7.7 Due to the continuing separation of Scottish law, many Acts do not apply to Scotland and 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, and hence any legislation must be passed by the UK Parliament. Protection of the environment is a devolved matter and hence the Scottish Government has responsibility for this area.

7.8 Wales and Northern Ireland also have devolved administrations and devolved legislatures. As with Scotland, nuclear safety is not a devolved matter for either Wales or Northern Ireland, so any legislation must be passed by the UK Parliament. Northern Ireland has no nuclear installations or facilities. Protection of the environment is, again, a devolved matter and hence the Welsh Government and Northern Ireland Executive have responsibility for this area. The Northern Ireland Executive is currently suspended. In the absence of the Executive, the Northern Ireland (Executive Formation and Exercise of Functions) Act 2018 allows senior officials in Northern Ireland Departments to take decisions on devolved responsibilities if they are satisfied that it is in the public interest to do so.

7.9 Some laws passed by the UK Parliament apply to Great Britain only. Great Britain includes England, Scotland and Wales.

7.10 Secondary legislation, for example in the form of regulations, is a type of statutory provision in the UK legislative system which can be made by a Secretary of State or minister if there is a power in primary legislation (in the case of the UK Parliament, an Act) enabling the Secretary of State or minister 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 regulators.

7.11 For as long as the UK is a member of the European Union, it must implement EU directives.[2] It does this by implementing the requirements into the UK legal framework.

Establishing and maintaining a Legislative and Regulatory Framework

7.12 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.

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

7.14 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.

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

- The Energy Act 2013 (Ref. 19);
- The Health and Safety at Work etc. Act 1974 (Ref. 20); and
- The Nuclear Installations Act 1965 (Ref. 21).

7.16 The key features of each of the statutes above are summarised below.

The Energy Act 2013

7.17 The Energy Act 2013 (TEA13) (Ref. 19) sets out the provisions which set up the(ONR) as a statutory body, establishing its purpose, its powers and functions. The ONR's purposes are those relating to regulating nuclear safety, nuclear site conventional (industrial) health and safety, civil nuclear security, nuclear safeguards and the transport of radioactive material.

7.18 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.

7.19 TEA13 establishes the ONR's ability to appoint inspectors and provides those inspectors with numerous legal powers, which are described later in this section.

[2] On 23 June 2016, the EU referendum took place and the people of the United Kingdom voted to leave the European Union. Until exit negotiations are concluded, the UK remains a full member of the European Union and all the rights and obligations of EU membership remain in force. During this period the UK will continue to negotiate, implement and apply EU legislation. The outcome of these negotiations will determine what arrangements apply in relation to EU legislation in future once the UK has left the EU.

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

Health and Safety at Work Act 1974

7.21 The Health and Safety at Work Act (HSWA74) (Ref. 20) applies to all work activities within UK and hence is much broader than nuclear safety. HSWA74 allows regulations to be made and there are many of these relating to industrial safety and radiation protection.

7.22 Under HSWA74, a general duty is placed on all employers 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 underpinned by the concept of relevant good practice. Relevant good practice 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.

7.23 TEA13 made the ONR the enforcing body for HSWA74 on licensed nuclear sites, for any adjacent construction areas and for the supply chain where structures, systems and components (SSC) are being made that may affect nuclear safety on licensed sites.

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

Nuclear Installations Act 1965

7.25 Under the Nuclear Installations Act 1965 (Ref. 21), 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 the 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’ for the purposes of TEA13, which means they are enforced by ONR under that legislation.

7.26 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.

7.27 NIA65 also allows ONR to recover all costs associated with licensing and enforcement of the licence conditions from licence holders.

Environment Act 1995 and Radioactive Substances Act 1993

7.28 Discharges from nuclear sites are regulated by environmental law. The key legislation for this is the Environment Act (EA95) and Radioactive Substances Act (RSA93).). EA95 (Ref. 22) provides the regulatory framework for environmental protection. There have been some subsequent revisions to the framework. The environmental regulators for the three countries of the UK with nuclear sites are now:

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

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

7.30 Generally, the EA, 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;
- Requirements under the Control and Management of Major Accident Hazards Regulations (COMAH) at nuclear sites.

7.31 RSA93 (Ref. 23) was originally pertinent to environmental protection across the entire UK nuclear industry, but its application has subsequently been restricted to nuclear sites in Scotland.

Environmental Permitting (England and Wales) Regulations 2016 (EPR16)

7.32 Environmental Permitting (England and Wales) Regulations 2016 (EPR10) (Ref. 24) came into force in April 2010 and replaced RSA93 in England and Wales. Environmental Permitting Regulations 2016 (EPR16) (Ref. 25) which came into force in January 2017 incorporates radioactive substances regulation with other regulated activities, such as the management of non-radioactive wastes, to provide industry, regulators and stakeholders with a single overarching permitting and compliance system. EPR16 is a consolidation of EPR10 and subsequent amendments.

7.33 EPR16 requires prior authorisation, in the form of an environmental permit, to dispose of radioactive wastes and environmental discharges. (Annex 2 - The Environmental Regulatory Bodies provides more information on the mandates of the environmental regulatory bodies).

Energy Act 2008

7.34 The Energy Act 2008 (Ref. 26) made provisions 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 introduced requirements for funded decommissioning programmes (FDP) when they apply for a new nuclear site licence. An 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 how 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.

Freedom of Information Act 2000

7.35 The Freedom of Information Act 2000 (FOI) (Ref. 27) 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 ONR to release any information it holds, unless an exemption applies. This process must be completed within 20 working days. The Environmental Information Regulations 2004 (EIR, Ref. 28) is a similar regime to that of the FOI but applies specifically to environmental information held by public authorities. The Act and EIR applies to historical documentation as well as documents generated more recently. The rights to ONR information conferred by the Act apply to everyone, anywhere in the world. The Act and the EIRs are 'reason blind' which means that information can be requested for any purpose.

Obligations under international Treaties, Conventions or agreements

Euratom - Nuclear Safety Directives

7.36 Council Directive 2014/87/Euratom (Ref. 29) amending directive 2009/71/Euratom (Ref. 30), 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.

Euratom - Basic Safety Standards Directive

7.37 Council Directive 2013/59/Euratom (Ref. 31) 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. 32, 33, 34, 35 and 36).

7.38 In response to the Directive, the UK Government has brought in a number of new regulations, including for REPPIR (Radiation (Emergency Preparedness and Public Information) Regulations 2019 (REPPIR 2019) (Ref. 37) and amended the Carriage of Dangerous Goods (Amendment) Regulations 2019 (CDG) (Ref. 38).

The CDG amendments came into force on 21 April 2019 and the REPPIR 2019 Regulations on 22 May 2019. There will be a twelve-month transition period to allow dutyholders time to come into full compliance with the new provisions of the REPPIR Regulations.

UK Position on Safeguards

7.39 When the UK formally notified the European Commission of its intention to leave the EU, the UK also commenced the process of leaving the European Atomic Energy Community (Euratom)[3]. In leaving Euratom, the UK has sought to establish a close future association with Euratom, while also putting in place all of the measures necessary to ensure that the UK continues to operate as an independent and responsible nuclear state after it leaves the European Union and withdraws from Euratom. To do this, the UK has:

- Signed new bilateral nuclear safeguards agreements, a Voluntary Offer Agreement and Additional Protocol, between the UK and the International Atomic Energy Agency, to replace the current trilateral agreements that include Euratom;
- Put in place new bilateral Nuclear Cooperation Agreements (NCAs) with third countries including Australia, Canada and the US;
- Confirmed the operability of an existing bilateral NCA between Japan and the UK; and
- Established a legislative and regulatory framework for a domestic nuclear safeguards regime, through the Nuclear Safeguards Act 2018 (Ref. 39), TEA13 and the underlying Nuclear Safeguards Regulations.

[3] Euratom, was established in the 1950s as part of the creation of the European Community. The UK became a member of both on 1 January 1973. Euratom provides the basis for the regulation of civilian nuclear activity, implements a system of safeguards to monitor the use of civil nuclear materials, controls the supply of fissile materials within EU member states, and funds leading international research.

7.40 Over the last three years, ONR has fulfilled its safeguards function of facilitating the inspection and verification activities of the international inspectorates – Euratom and the IAEA - on UK sites. These arrangements will continue after Euratom arrangements no longer apply to and in the UK.

7.41 As a result of the decision to withdraw from Euratom, the UK must establish a domestic safeguards regime to ensure that it continues to meet its international safeguards standards obligations. This new regime will need to be in place for when the UK leaves Euratom arrangements no longer apply to and in the UK.

7.42 The Nuclear Safeguards Act 2018 (Ref. 39) amends TEA13 to give ONR the necessary powers to deliver a UK State System of Accounting for and Control of Nuclear Material (SSAC) to meet this requirement. The detail of the new regime is set out in the Nuclear Safeguards (EU Exit) Regulations 2019 (Ref. 40) and the Nuclear Safeguards (Fissionable Material and Relevant International Agreements) (EU Exit) Regulations 2019 (Ref. 42).

7.43 ONR has been working to establish the UK SSAC, building its capacity and capability in readiness for EU exit. This has entailed the recruitment and training of new safeguards staff, the development of a regulatory framework for delivery of the new regime, and the development of a Safeguards Information Management and Reporting IT System to receive from operators, process and submit nuclear material accountancy information and other reports to the IAEA.

7.44 UK Government policy is that the new safeguards regime will be equivalent in effectiveness and coverage to that currently provided by Euratom. Therefore, ONR will deliver a UK SSAC that enables the UK to meet its international safeguards obligations, as set out in the UK-IAEA Voluntary Offer Agreement and Additional Protocol, and then build over time, to deliver a regime equivalent in effectiveness and coverage to that currently provided by Euratom. ONR aims to achieve this by the end of December 2020.

7.45 ONR will continue to facilitate the inspection and verification activities of the IAEA in the UK as part of the delivery of the new UK SSAC.

7.46 As the UK leaves Euratom, maintaining high standards for nuclear safety will remain a top priority. The UK has a robust and well established domestic nuclear safety regime, with nuclear safety regulated by the ONR. These arrangements will continue after the UK's exit from Euratom.

National Safety Requirements and Regulations

Secondary legislation

7.47 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. Apart from REPPIR discussed below, there are no new nuclear safety related regulations under development.

Ionising Radiations Regulations 2017

7.48 The nuclear site licensing regime is complemented by the Ionising Radiations Regulations 2017 (IRR17) (Ref. 42). These 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. 43). IRR17 implements the worker safety aspects of the European Council (EC) Directive, establishing Basic Safety Standards (2013/59/Euratom) (Ref. 31) and includes the setting of radiation dose limits for employees and members of the public for all activities involving ionising radiations. IRR17 also implements EC Directive 90/641/Euratom (Ref. 34) on the operational protection of outside workers exposed to the risk of ionising radiations during their activities in controlled areas. Outside workers are persons undertaking activities in radiation controlled areas designated by an employer other than their own. Further information on the application of IRR17 can be found under Article 15 – Radiation Protection.

7.49 Of the Ionising radiations Regulations 2017, 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.

7.50 The above three regulations together represent the UK's transposition of the 'Graded Approach' introduced in the EU Directive 2013/59/EURATOM.

7.51 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.

7.52 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.

Radiation (Emergency Preparedness and Public Information) Regulations 2019

7.53 The Radiation (Emergency Preparedness and Public Information) Regulations 2019 (REPPIR) came into force on 22 May 2019 in GB and implement the radiation emergency requirements set out in Council Directive 2013/59/Euratom (Ref. 32). The new REPPIR 2019 regulations repeal and replace REPPIR 2001 (Ref. 44), although there is a 12-month transitional period in which existing operators may comply with either set of regulations. New operators must comply with REPPIR 2019 from 22 May 2019 before they can work with ionising radiations. Implementation of the REPPIR 2019 will ensure that arrangements are sufficiently flexible to respond to very low probability events and are commensurate with the range of hazards for each facility in addition to a number of other enhancements (see paragraph 16.35).

Management of Health and Safety at Work Regulations 1999 (MHSWR99)

7.54 The Management of Health and Safety at Work Regulations 1999 (Ref. 52) are relevant as they place requirements on employers, and hence nuclear site licensees.

7.55 MHSWR99 are very wide ranging. Where its 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 HSWA, 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 works in line with regulation 4, which requires the principle of prevention to be applied and then supported by Schedule 1 which defines the principles of control.

Overview of regulations and guides issued by the regulatory body

7.57 To ensure that the regulatory interpretation of the licence conditions is consistent, the ONR has published a set of TIGs (Ref. 54), which provide guidance for ONR's inspectors on the planning, content and reporting of inspections to monitor the adequacy of nuclear site licensees' arrangements against legal requirements.

7.58 The technical principles which the ONR uses to judge safety cases are set out in its SAPs (Ref. 55). These form a framework of regulatory expectations for the use of the ONR inspectors when making technical judgments on the adequacy of licensees' safety submissions. The principles are supported by more detailed guidance in a suite of TAGs, (Ref. 56), which provide guidance to the ONR's inspectors on the interpretation and application of the ONR's SAPs when assessing the adequacy of licensees' safety cases and other safety documentation within the nuclear safety regulatory process. The SAPs incorporate the IAEA safety standards and other relevant international and national standards in accordance with **VDNS Principle 2**.

7.59 The SAPs are 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 the ONR inspectors. However, the SAPs 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.

7.60 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 Implementation of the Security Assessment Principles (SyAPs)

7.61 In order to develop consistent regulation of safety and security, ONR introduced the SyAPs in 2017. ONR uses the SyAPs (Ref. 5) 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 and the Nuclear Industries Security (Amendment) Regulations 2017 (Refs. 57 and 58).

7.62 The SyAPs provide the essential foundation for the introduction of outcome focussed 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.

7.63 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 that 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.

7.64 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 Nuclear Decommissioning Authority and the UK Department for Business, Energy and Industrial Strategy. Additional stakeholders who reviewed the SyAPs during their development include the ONR Chief Nuclear Inspectors' 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. The SyAPs and TAGs are available on ONR's website (Refs. 5 and 56).

7.65 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 a number of 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 industry's production of and ONR's assessment of SyAPs-aligned security plans for all regulated dutyholders across the civil nuclear industry. It was evident during the initial stages of implementation that the major change to outcome focussed regulation required a significant change in culture and behaviours for both ONR and industry. These changes represent some extensive challenges which will require continuous development as SyAPs continues to be embedded.

7.66 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 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 industry. ONR seeks to assess all of the UK civil nuclear industry SyAPs-aligned security plans by the end of 2020.

Nuclear site licensing

7.67 The safety of nuclear installations in Great Britain (GB) is assured by a system of regulatory control based on a licensing process by which a corporate body is granted a licence to use a defined site for specified activities.

7.68 The ONR's publication "Licensing Nuclear Installations" (Ref. 16) provides guidance on how the 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, reprocessing facilities and facilities for the storage of bulk quantities of radioactive matter which has been produced or irradiated in the course of the production or use of nuclear fuel.

7.69 No site may be used in GB for the purpose of installing or operating a nuclear reactor or prescribed nuclear installation unless a licence has been granted by ONR and is in force. The sections of NIA65 relating to the licensing and inspection of sites are "relevant statutory provisions" of TEA13, thus, these sections are subject to TEA13 arrangements for regulation and enforcement.

7.70 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 conventional 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.

7.71 A nuclear site licence is issued to a corporate body on the basis of 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.

7.72 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 the 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.

7.73 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 licence conditions. The ONR has promulgated 36 standard Licence Conditions (LCs) that together form a legal basis for requiring high standards of nuclear safety (Ref. 59). The conditions are generally non-prescriptive but set goals for all aspects of managing and assuring nuclear safety. The ONR requires that a prospective licensee provides evidence that it can comply with the licence conditions. Once a site licence has been issued, the site licensee must comply with the licence conditions. Each licensee can develop 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.

7.74 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 which may lead to the need to relicense a site include changes to the site boundary and changes to the types of prescribed activity 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.

7.75 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 radiations from anything on the site.

Sizewell C

7.76 One company is currently engaging with ONR as they prepare nuclear site licence applications for proposed new nuclear power stations. NNB GenCo Ltd intends to seek a licence to construct two EPRs at Sizewell in Suffolk. During the period leading up to nuclear site licence application, ONR continues to engage with the prospective licensee to discuss regulatory expectations. ONR focuses on providing advice and constructive challenge during the licensing process and the company’s development of the arrangements, safety submissions and capabilities that are expected of a site licence holder. ONR develops pre-application intervention strategies which set out the approach that it adopts during the pre-application period.

Regulatory inspection and assessment

7.77 The 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 these functions as appropriate to nominated inspectors.

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

7.78 Inspection is mainly undertaken on licensees' premises. It entails inspection of licensees' compliance with the Licence Conditions and their corresponding arrangements and, in particular, to ensure that operation remains within the boundaries of the safety case. Most of the routine site inspection is carried out by the ONR's site inspectors who spend about 30% of their time on site. Additionally, the ONR undertakes team inspections on particular topics. (See Article 14 – Assessment and Verification of Safety for more information).

Assessments carried out in support of permissioning activities

7.79 A safety case is the totality of documented information and arguments developed by the licensee, which substantiates the safety of the facility, activity, operation or modification. It provides a written demonstration that relevant standards have been met and that risks have been reduced so far as is reasonably practicable (SFAIRP). The ONR technical specialist assessors, who are themselves inspectors and technical experts in specific fields, will examine aspects of the safety case to establish whether the licensee has demonstrated that it understands the hazards associated with its activities and how to control them adequately.

7.80 The basis for demonstrably adequate safety is to meet the normal requirements of good practice in engineering, operation and safety management. This is a fundamental requirement for the safety cases submitted to ONR by licensees. In addition, ONR expects safety cases will include a graded application of risk assessments and probabilistic analysis to identify potential weaknesses in proposed facility designs and operations. These should show what improvements were considered and demonstrate that an adequate level of safety is not unduly reliant on a small set of particular features.

7.81 An example of an ongoing assessment relating to graphite ageing is discussed below. This supports the response to **Challenge 1** from the Seventh Convention.

- Until recently ONR used the enforcement management model (EMM) developed by the Health and Safety Executive (HSE) which was designed to enforce a broad range of legislation across all industries.

Periodic safety reviews

7.82 A nuclear site licence requires the licensee to conduct periodic safety reviews at each site. 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. The ONR assesses the outcomes of licensee's reviews. It maintains oversight of safety significant issues and ensures a proportionate response is taken by licensees to implementing improvements.

Enforcement powers

7.83 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.

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

7.85 The ONR has an Enforcement Policy Statement (EPS) (Ref. 60) that sets out the purpose of enforcement, and the principles that should be applied during enforcement activities.

In determining which enforcement measure is the most appropriate in a given situation, inspectors are guided by the ONR Enforcement Management Model (EMM) (Ref. 53).

New Enforcement Management Model

7.86 Until recently, ONR used the enforcement management model (EMM) developed by the Health and Safety Executive, (HSE) which was designed to enforce a broad range of legislation across all industries. In 2018, a new EMM was introduced by ONR, designed to be specific to nuclear installations reflecting legislation relevant to them.

7.87 The new model follows an extensive internal review by ONR along with engagement with licensees and dutyholders. It is designed to help inspectors to make decisions regarding the degree of enforcement required where dutyholder non-compliance and deficiencies are identified. The new EMM:

- Ensures consistency and simplify the enforcement decision making process.
- Provides a framework for making enforcement decisions that is more transparent and ensure that those who make decisions are accountable for them.
- Improves proportionality and targeting by considering the risk-based criteria against which decisions are made.
- Better equips inspectors to make decisions in complex cases, and allow peer review of enforcement action.
- Ensures that there is a consistent and proportionate approach to when and how ONR records enforcement decisions.

7.88 This enables ONR to more easily coordinate enforcement management information.

7.89 Key enforcement powers that are available to the ONR inspectors, as set out in TEA13 are:

- **Improvement Notice (IN)**: If) – if an inspector is of the opinion that one or more applicable legal provisions 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.

  ONR's internal processes require Superintending Inspector-level approval before an Improvement Notice is issued.

- **Prohibition Notice (PN)**: If an inspector is of the opinion that an activity is being or is likely to be carried out which risks causing serious personal injury, they can serve a PN to immediately halt an activity.

7.90 In practice, this power is rarely used by the ONR for nuclear safety purposes, as there are other suitable powers available under the licence conditions to use.

- **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.

7.91 The ONR has other regulatory powers through the standard licence conditions (LCs), and these are referred to as primary powers. There are six 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, which are legally binding. The primary powers are described below:

- **Direction:** A direction is issued by the ONR when it requires the licensee to take a particular action, such as shutting down specified operations.
- **Specification:** This power gives the ONR discretionary controls with regard to a licensee's arrangements.
- **Notification:** This power gives the 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 the ONR. Before being given consent, the licensee must satisfy the ONR that the proposed action is safe and that all procedures necessary for control are in place.
- **Approval:** This power can be used to control a licensee's arrangements. Once formally approved by the ONR, such arrangements or procedures cannot be changed without the licensee seeking a further approval from the ONR
- **Agreement:** This power allows the licensee to proceed with a particular activity or course of action when an LI from the ONR is issued.

7.92 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 incorporate further provisions referred to as derived powers. By virtue of the licensee’s arrangements, the highest category modification proposals are usually submitted to the ONR for its agreement before they can be implemented. The same control could be achieved through primary powers by the ONR specifying that consent is required. The use of derived powers does not preclude ONR making use of primary powers. Using agreement through the licensee’s arrangements, the onus is on the licensee, rather than the ONR, to identify which modifications need ONR agreement. To assure itself that these arrangements are being implemented correctly, the ONR inspections periodically check that categorisation of modifications is appropriate and that the licensee is seeking agreement when required by its arrangements.

Appeals Process – ONR

7.93 A licensee or licence applicant who is dissatisfied with a particular regulatory decision may raise concerns with the relevant ONR inspector and the 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. Should issues not be resolved after consideration by a Deputy Chief Inspector and after consideration by the Chief Nuclear Inspector, the appellant may request a 'decision review' to be undertaken by the ONR Chief Executive Officer.

7.94 Nuclear site licensees have the right of appeal to an employment tribunal in respect of Improvement and Prohibition Notices issued to them under TEA13 or HSWA74.

7.95 More generally, within UK law, a judicial review can challenge the lawfulness of any decision or action by a regulator 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

7.96 There are a range of enforcement powers available to the environmental regulators, which arise from both EPR16 (in England and Wales) and RSA93 (in Scotland and Northern Ireland), and are broadly the same across both pieces of legislation.

7.97 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 etc.

7.98 The Environment Agency has published the Enforcement and Sanctions Policy (Ref. 62) 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 enforcement powers (Ref. 63), and SEPA has published enforcement policy and enforcement guidance (Ref. 58).

7.99 Key enforcement powers that are available to the environmental regulators include:

- **Warning Letters:** A written notification that regulators believe an offence has been committed. It will be recorded and may, in the event of further non-compliance, influence subsequent choice of sanction.

- **Statutory Notices:**
    - **Enforcement / Improvement notices:** Identifying a non-compliance or likely non-compliance or significant impact or likely impact and requiring steps to be taken.
    - **Prohibition notices:** Identifying an activity with an imminent risk of pollution or harm, and directing which steps need to be taken to remove the risk, and suspending any authorisation related to the activity.
- **Formal Caution:** A formal caution is the written acceptance by an offender that he has committed an offence and may only be used where a prosecution could properly have been brought. Where a formal caution is not accepted the environmental regulator will normally prosecute for the original offence.
- **Prosecution:** The sanction of prosecution is available for all criminal offences by law. The legislation which establishes the penalty provisions gives the courts considerable scope to punish offenders and to deter others. In some cases, imprisonment and unlimited fines may be imposed.

Appeals process – Environmental regulators

7.100 Enforcement action (specifically the imposition of a sanction) can normally be appealed either through the criminal court process or as a result of 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.

Experience with legal actions and enforcement measures

7.101 Other examples of enforcement action can be found under Article 14 – Assessment and Verification of Safety

Article 8 – Regulatory Body

1. 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.
2. 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:

- ONR have established the WIReD project to improve knowledge management;
- ONR has established an integrated audit and assurance framework; and
- ONR has introduced webinars to improve public understanding on key nuclear topics.

8.2 Compliance with this Article of the Convention has not otherwise substantially changed since the Seventh UK report (Ref. 18) (i.e. in a way that has implications for the Convention obligations).

8.3 The information in this Article is directly related to the major common issue on **legal framework and independence of the regulatory body** from the Seventh Convention.

Establishment of the regulatory body

Legal foundation and statute of the regulatory body

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

ONR's mandate, mission and tasks

8.5 ONR regulates safety at 37 licensed nuclear sites in the 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, and works with the IAEA and Euratom to ensure that safeguards obligations for the UK are met (see paragraphs 7.39 to 7.48 for information about how safeguards arrangements will change when Euratom arrangements no longer apply to the UK). ONR co-operates with international bodies on safety and security issues of common concern, including associated research. As an independent regulator, formed to act in the interest of the public, ONR aims to take an enabling stance to government policy on nuclear growth and will adopt a balanced approach to the regulation of the nuclear industry. The priority remains regulating the safety and security of nuclear facilities.

8.6 ONR's role, captured in the mission statement, is to *"provide efficient and effective regulation of the nuclear industry, holding it to account on behalf of the public".* ONR has published its strategy and plans on its website (Ref. 59).

8.7 The vision for ONR over the lifetime of the current strategy is to *"be an exemplary regulator that inspires respect, trust and confidence."*

8.8 ONR delivers its strategy through core functions of licensing, inspection and enforcement, review and assessment and setting safety standards. 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 the licensed sites and acts in conformance with its Enforcement Policy Statement (EPS) (Ref. 60); this is to be implemented in accordance with the UK's Regulators' Code (Ref. 66) and the regulatory principles required under the Legislative and

Regulatory Reform Act 2006 (Ref. 67). The EPS explains how ONR will act with respect to regulating dutyholders.

8.9 The ONR delivers its statutory obligations, in a manner consistent with international obligations, through six core functions, which are reflected in ONR's Summary Regulatory Plan 2018/19 (see Appendix B). These are summarised as follows:

- Inspect and evaluate the safety and security culture and performance of dutyholders, ensuring risks are well controlled.
- Enforce the law in accordance with the ONR EPS.
- Deliver a permissioning regime, ensuring that dutyholder activities of principal significance to nuclear safety and security achieve UK legal standards.
- Maintain and improve the regulatory framework, maintain ONR's management systems and sustain its regulatory capability.
- Engage, inform, advise and consult with dutyholders, international bodies and other stakeholders.
- Influence licensees to develop through-life strategies, achieving sustained delivery of good practice in health, safety and security.

Enabling Regulation

8.10 ONR's compliance with the principles of the UK Government's Regulators' Code is demonstrated through a regulatory philosophy that is to work in an enabling way with dutyholders, whilst enforcing compliance with the law and regulatory requirements.

8.11 This is a constructive approach with dutyholders and other relevant stakeholders that seeks effective delivery against clear and prioritised safety (including nuclear safety, transport, conventional health and safety) and security outcomes. The key principles of the approach are:

- **Constructive approach**: Requiring regulators, dutyholders as well as other stakeholders (for example, BEIS and the 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 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 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.
- **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.
- **Avoid passive acceptance and seek fit-for-purpose solutions**: Not prescribing to dutyholders what to do but challenge their proposals if considered disproportionate and avoiding 'goldplating'.

8.12 This approach continues to prove very successful producing some significant improvements to longstanding issues at the UK's reprocessing complex at Sellafield and accelerating hazard and risk reduction. This was achieved by working with key stakeholders to identify and remove barriers to delivery and to drive continuous improvement. This has resulted in tangible risk reduction in key legacy facilities and the alignment of key stakeholders, to the benefit of nuclear safety.

8.13 ONR's GDA process is another example of working in an enabling way. The traditional approach to licencing of new reactor sites involved a significant amount of regulatory assessment of the safety of the design following the investment decision and in parallel with reactor construction. This has the obvious risk of delays and cost increases if design changes driven by regulatory concerns are required during the construction phase. By assessing reactor designs proposed for the UK on a generic basis, in advance of any site-specific proposals, ONR gives clarity on regulatory requirements and their financial impact, thereby optimising the safety of the design and reducing commercial risk.

Organisational structure of ONR

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

8.15 ONR's inspectors / staff are assigned to specialisms, from which they are allocated to ONR's divisions. The current ONR regulatory structure is outlined below. In addition, there are enabling programmes for corporate services and other assurance and support functions.

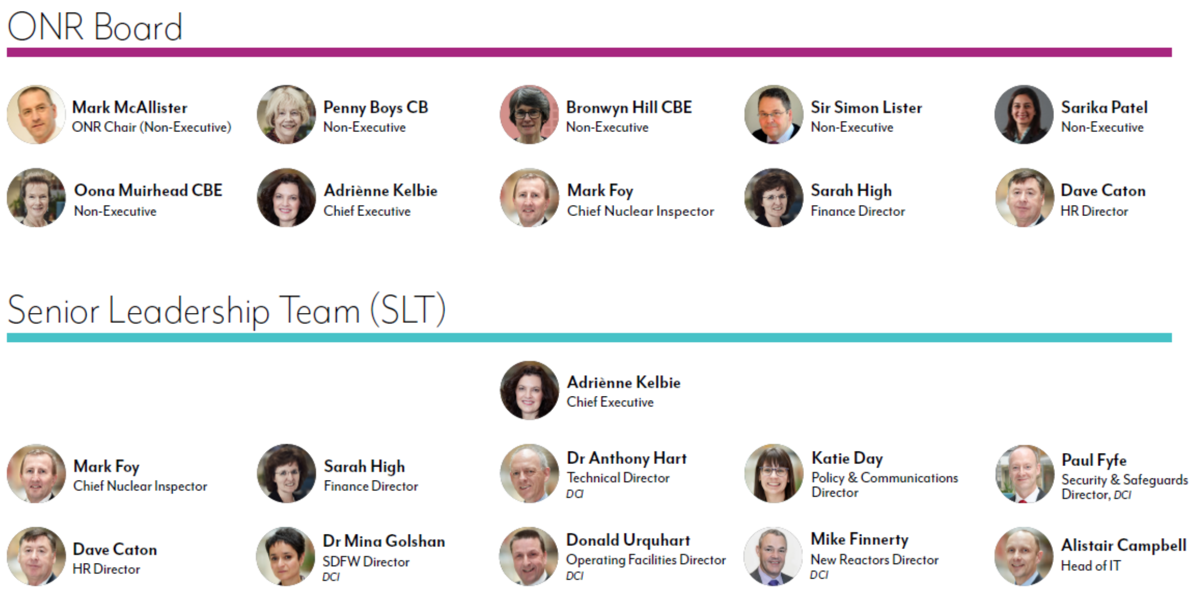


Figure 6 – ONR Board and Senior Leadership Team

8.16 ONR was established, under the Energy Act 2013 (Ref. 19). The ONR Board is made up of non-executive and executive members, 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.

8.17 ONR's regulatory structure has continued to ensure that its functions retain a strong focus on the industry sectors that it regulates and reinforces effective key stakeholder interfaces. There are now five divisions within the Regulatory Directorate reporting to the Chief Nuclear Inspector as the authoritative regulatory head, which are shown in Figure 7. Those relevant to the convention are outlined below:

- The Operating Facilities Division regulates the safety of operating nuclear power stations 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 power station and undertakes the systematic 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 support the development of Advanced Nuclear Technologies.
- The Technical Division was created in 2017 and ensures that ONR is competently resourced to effectively regulate the health, safety and security of 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.

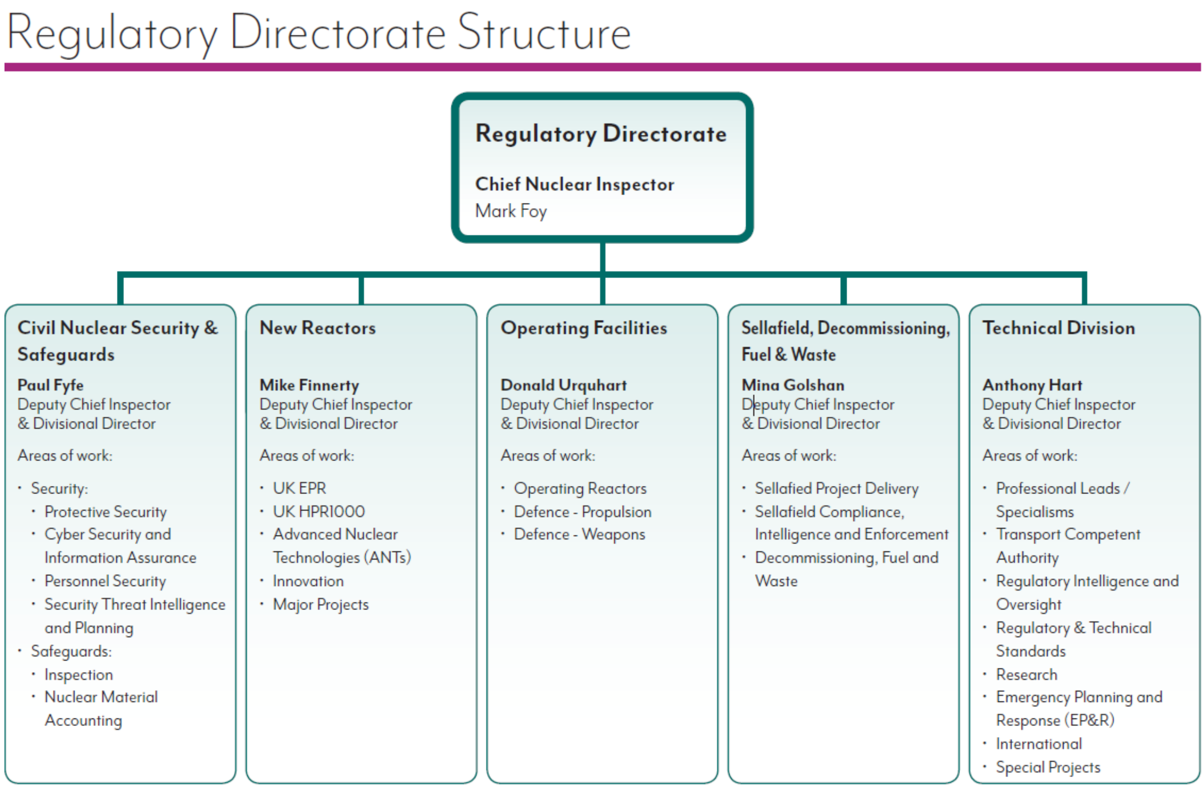


Figure 7 – ONR Regulatory Structure

Provision of adequate human resources

8.18 The information herein is directly related to the major common issue on legal **financial and human resources** from the Seventh Convention.

8.19 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 June 2019, ONR's technical cadre totals approximately 411 technical staff and 218 other support staff.

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

8.21 ONR's external recruitment campaigns continue to bring in specialist skills in an increasingly competitive market. ONR's Cheltenham office in the south-west of England continues to attract new recruits with 88 of its staff based there and a further 52 staff at a new office in London. These satellite locations have significantly enhanced ONR’s recruitment pool.

8.22 ONR has successfully recruited 215 regulatory specialists since 1 April 2014, which has included some of its ‘hotspot’ areas such as Human Factors, Electrical Engineering and Structural Integrity. Although there have been recent successes in recruitment, maintaining staff levels and absorption and assimilation of new recruits will remain a challenge. To assist with this, and to account for the additional ONR resource for the UK nuclear new build pipeline, and business as usual activity ONR has developed a resource plan which provides detailed resource requirements over the coming years. This planning ensures 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 abroad. This provides opportunities to share best practice and provides insight into the regulatory regime. This directly relates to **Challenge 2** from the Seventh Convention.

8.23 ONR’s full year total expenditure figures over previous financial years are as follows:

- 2015/16 - £64.5m;
- 2016/17 - £70.8m;
- 2017/18 - £70.4m.

Training of inspectors

8.24 All staff joining ONR directly into an inspector role are required to have good academic qualifications 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 training given to ONR inspectors is to equip them with detailed legal knowledge and skills required for core regulatory work rather than “convert” them to acquire another knowledge base.

8.25 To achieve this, inspectors receive training in two main areas:

- The mandatory core regulatory training (including refresher training); and
- Training to expand their technical expertise and to gain a working knowledge of other essential technical disciplines.

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

8.27 ONR has also addressed the challenge to maintain and grow 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 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.

8.28 ONR has recently opened the ONR Academy. Since the launch of the academy, there has been more than a 60% increase in the number of regulatory staff attending core skills training. ONR has also developed and introduced a host of e-learning modules. This replaces some classroom-based courses and making it easier to learn in a convenient location.

8.29 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.

Figure 8 – Opening of the ONR Academy

Warrants for new inspectors

8.30 All inspectors are formally appointed by ONR through 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 the TEA13 and HSWA74 etc. This is in recognition that it takes time to train new recruits and for them to develop sufficient experience and competency to use all of 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

8.31 In addition to recruiting experienced specialists ONR has now introduced three additional successful pipelines to bring people into the organisation:

- ONR sponsors and ultimately employs 'Graduates' (with 35 to date).
- 'Associates' (those with less nuclear/high hazard experience that ONR can develop and grow (12 currently at this level)). It also recruits those with unique skills from other industry sectors to undertake an 'equivalence role' which can lead to them becoming nuclear inspectors (22 currently on the route with 17 achieving full nuclear inspector status to date).
- New in 2019 is the intake of degree level apprentices, who will undertake a five-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.

This is directly related to **Challenge 2** from the Seventh Convention.

Continued professional development

8.32 Whist considerable effort is spent on the training of new recruits, ONR also has a refresher training programme to ensure 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 the professional leads. The professional leads have the responsibility for oversight of application of regulatory standards in their particular 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.

8.33 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

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

Knowledge management

8.35 The information herein is directly related to the major common issue on **knowledge management** from the Seventh Convention.

8.36 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 developed a knowledge and skills matrix that defines core knowledge areas, the specialism competencies required for inspectors to operate effectively and the level of knowledge team members have in each core knowledge area. ONR uses these matrices to identify organisational vulnerabilities and knowledge gaps, to inform the way ONR develops and trains its people and better defines recruitment needs.

8.37 Improvements already underway will move ONR to a mature knowledge management organisation. ONR has identified six key knowledge management activity areas, three of which focus on capturing and sharing knowledge in key parts of the organisation: specialisms, programmes and the corporate centre. The remaining activity areas focus on oversight of the knowledge management programme and creating the right environment for knowledge management, including the right organisational culture, processes and technology.

ONR WIReD Project

8.38 To further improve knowledge management in ONR, the WIReD project has been commissioned.

8.39 The outcomes ONR is seeking to achieve are:

- Increased knowledge, productivity, connectivity and mobility 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.

8.40 WIReD is to modernise ONR 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.

8.41 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, connectivity and mobility. 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.

- WIReD is being delivered using an agile project approach, engaging with staff continuously throughout the project so that the output is shaped by the user. Staff can provide immediate feedback to form the next iteration of these new process, providing continuous improvement.

Provision of financial resources

Adequacy of financial resources

8.42 The information herein is directly related to the major common issue on **financial and human resources** from the Seventh Convention.

8.43 Section 24A of NIA65 enables ONR to recover costs from licensees and licence applicants, for expenses associated with its nuclear site licensing 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.

8.44 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).

8.45 On an annual basis ONR publishes its annual report and accounts which provides information on its financial performance (Ref. 70). 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.

8.46 Section 41 of EA95 (Ref. 22) provides the Environment Agency, NRW and SEPA 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 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

8.47 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 GS-R-3 (Ref. 71) and as such, maps out all of 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. This is in line with **VDNS Principle 3**.

8.48 Technical guidance to specialist inspectors is contained in a suite of ONR SAPs, TAGs and TIGs (Refs. 55, 56 and 54). All SAPs, TIGs and TAGs are regularly reviewed and updated and are also publicly available through the ONR website.

Monitoring ONR's effectiveness

8.49 ONR has a framework for evaluating its own overall performance, through a number of performance indicators. The indicators cover key aspects of ONR's business and include key performance information relating to:

- Regulatory compliance of duty-holders, for example, inspection ratings or formal notices issued;
- Regulatory performance of ONR, for example, the number of regulatory inspections and reports to plan as well as delivery of ONR milestones;
- People and learning, for example, recruitment numbers, staff turnover, training days per person, health and safety incidents; and
- Financial performance, for example, spend against budget.

8.50 This framework provides ONR senior managers and the Board with a tool to monitor performance and manage corporate and regulatory priorities.

Integrated Audit and Assurance

8.51 ONR's Integrated Audit and Assurance Framework was introduced in 2017 and has proven effective in delivering independent oversight and assurance throughout the organisation. Three integrated tiers of assurance 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 in order to capture 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. The function is resourced by four staff with a combination of regulatory inspection experience and audit skills.
- Tier 3 – The UK Government's Internal Audit Agency provides ONR (under contract) with risk-informed audit coverage across its corporate functions.

Openness and transparency of regulatory activities

8.52 The information herein is directly related to the major common issue on **stakeholder** consultation **and communication** from the Seventh Convention.

8.53 For ONR, openness and transparency means adopting a presumption of disclosure of information on its regulatory activities.

8.54 ONR publishes details of enforcement notices, the full text of project assessment reports and summaries of intervention records on the ONR website. ONR also publishes all SAPs TAGs and TIGs on its website.

8.55 ONR has well-established mechanisms for communicating with the public and interested groups including attendance at quarterly Site Stakeholder Groups and Local Liaison Committees and scheduled twice-yearly meetings (in addition to other engagements), with nuclear-interest Non-Governmental Organisation (NGO) representatives.

8.56 Additionally, since 2018, ONR has introduced webinars to generate an open dialogue and build public understanding on key topics (for example, Enabling Regulation Principles, e.g. the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, ENSREG topical peer review, External Hazards and Hinkley Point C). These webinars are proactively promoted to encourage participation by NGOs, local interest groups from the vicinity of nuclear facilities and wider nuclear industry.

8.57 ONR engages through a combination of proactive reactive methods, publishes news stories and issues where appropriate. ONR's press office is staffed 24 hours a day for urgent issues and emergencies.

8.58 Non-routine matters on site are reported to the public in quarterly reports to Site Stakeholder Groups and Local Liaison Committees which are also published on the ONR website.

External technical support

8.59 ONR does not use technical support organisations in the way 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 respond to a high workload, or where the specialism is not available in ONR. To accommodate this, ONR has a technical support budget and 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.

8.60 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 or GDA requesting parties. ONR has robust processes in place to mitigate any conflict of interest. This includes:

- Consulting with and informing duty-holders on the use of a contractor for a particular piece of work, thus ensuring matters, such as conflicts of interest, are identified and addressed;
- 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

8.61 In 2016, ONR introduced the Chief Nuclear Inspector's Independent Advisory Panel (IAP) to provide independent advice to ONR on nuclear matters.

8.62 The IAP is now well-established and meets twice a year, bringing together experts from across the nuclear industry, academic community, UK Government Departments and other regulators who contribute to informed debate and provide advice on relevant topics. Their discussions range from regulatory strategies and policy to implications of developments in new nuclear technologies and the regulation of innovation.

8.63 To increase diversity of views and strengthen ONR's openness and transparency, the panel recently welcomed two new members from Non-Governmental Organisations (NGO) community.

Interface with other agencies/regulators

Environmental regulatory bodies

8.64 ONR and the environment agencies (the Environment Agency, SEPA and NRW) work closely together to ensure the effective co-ordination of their respective regulatory activities. ONR has Memoranda of Understanding with the Environment Agency and SEPA (Ref. 67), 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.

8.65 Similarly, the environment agencies must consult ONR (or HSE as appropriate) under EPR16 (Ref. 25) or RSA93 (Ref. 23) on proposed (new or varied) authorisations for disposals of radioactive waste including discharges to the environment from nuclear licensed sites.

8.66 In addition to their own routine inspection activities on nuclear licensed sites, the environment agencies carry out planned joint inspections with ONR and co-operate in the investigation of incidents where appropriate. Together with the ONR, the environment agencies form the relevant Joint Competent Authority at nuclear licensed sites for regulation of the requirements of the COMAH.

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

8.68 The environment agencies, together with the ONR, have published joint guidance on the management of higher activity radioactive waste on nuclear sites, which provides advice to nuclear licensees on the management of the safety and disposability of such wastes. (Annex 2 - The Environmental Regulatory Bodies provides more information on the mandates of the environment agencies).

Responsibilities of other agencies and bodies

8.69 Public Health England (PHE) is a non-departmental public body, whose statutory functions include:

- 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.

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

Reporting obligations

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

8.72 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.

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

9.1 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 five years. Any revisions to the strategy must be approved by the responsible Minister.

9.2 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

8.74 ONR is sponsored by the Department for Work and Pensions (DWP) ensuring independence from BEIS, which is the department responsible for ensuring energy supply, including nuclear energy.

8.75 ONR's independence as a regulator is ensured under TEA13, where ONR is given direct responsibility for the enforcement of the nuclear safety regulatory system. Similarly, the environment agencies are responsible for the environmental protection regulatory system under EPR16 (Ref. 25) in England and Wales and RSA93 (Ref. 23) in Scotland. ONR is a Competent Authority under the Control of Major Accident Hazard Regulations 2015, in conjunction with the relevant environment agency.

8.76 ONR provides factual information and advice to Ministers and the Government on nuclear safety matters, 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. ONR is sponsored by The Department for Work and Pensions (DWP) ensuring independence from BEIS, which is the department responsible for ensuring energy supply, including nuclear energy.

Article 9 – Responsibility of the Licence Holder

9.1 Compliance with this Article of the Convention is demonstrated in a way that has not

Each Contracting Party shall take the appropriate steps to ensure that each such licence holder meets its responsibility.

substantially changed since the Seventh UK report (Ref. 18) (i.e. 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 also for the health and safety of 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:

- NIA65 – Section 7
- HSWA74 – Section 2

Licensee discharge of its prime responsibility for safety – EDF Energy NGL

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 both documented as part of the licensing process. This document should set out the senior management structure, the health and safety responsibilities of key staff and, in particular, how health and safety performance is monitored and reviewed. A simplified diagram showing EDF Energy NGL's organisational structure is presented in Figure 9 and 10. Further information on how EDF Energy NGL is organised and manages its 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 discussed under Article 10 – Priority to Safety.

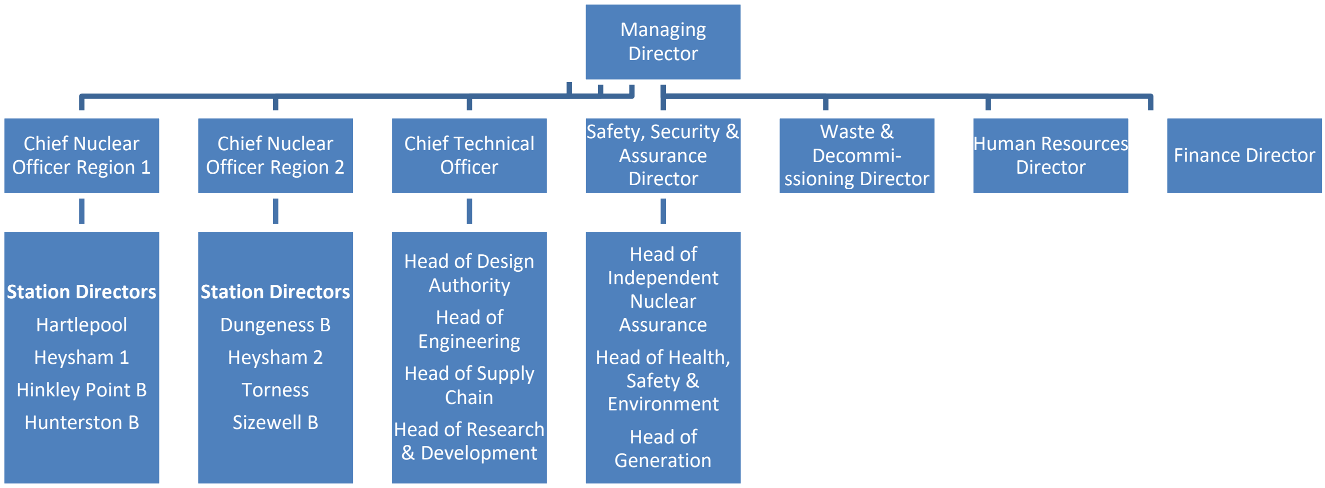


Figure 9 - Simplified diagram showing EDF Energy NGL's organisational structure

9.5 EDF Energy NGL comprises of centrally-based staff at offices near Gloucester, England, and also East Kilbride, Scotland, who set safety and operational standards, carry out reviews of safety and provide specialist support for a number of licensed sites. The licensee's responsibility for compliance with some site licence conditions may be held by a central part of its company, rather than the part of the company based at the site.

9.6 The regional chief nuclear officers are responsible for selecting station directors, monitoring their performance and ensuring that they have adequate corporate support. The nuclear fleet is divided organisationally into two regions. The two Chief Nuclear Officers of EDF NGL report to the Managing Director.

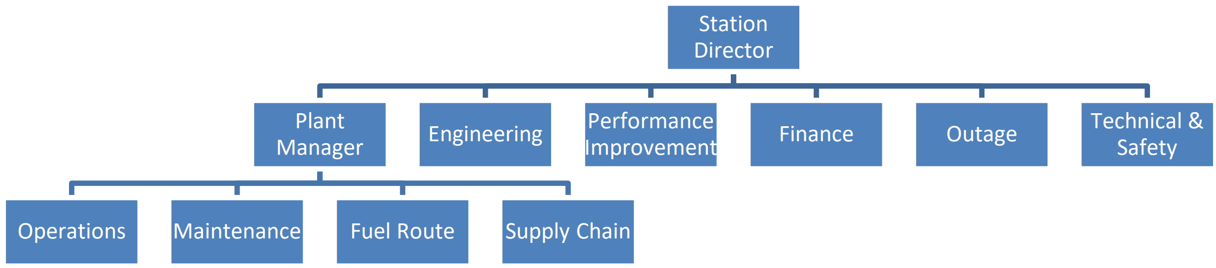


Figure 10 - Simplified diagram showing EDF Energy NGL's general station structure

9.7 All UK nuclear licensed sites have a designated Station Director, who has delegated responsibility for all day-to-day activities and operations. This includes responsibility for compliance with aspects of the nuclear site licence that are not covered by the centrally based organisation.

9.8 There are a number of key positions underpinning the role of station director. These are responsible for leading teams to deliver plant operations, maintenance, work-management, engineering 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 involved in engineering and maintenance activities.

9.9 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

9.10 Functional 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.

9.11 The licensee ensures that its organisation maintains effective control of operations at its licensed sites. The licensee is required to act as an 'informed or intelligent customer' when contracting out any work that could have an impact on safety. As an intelligent customer, in the context of nuclear safety, the management team of the facility should know what is required. It should fully understand why a contractor is needed, specify the requirements of the work supervise the work and technically review the output before, during and after implementation.

Licensee discharge of its prime responsibility for safety – NNB GenCo

Site Licence Compliance, phased implementation

9.12 NNB GenCo holds a nuclear site licence for the site at Hinkley Point C in south-west England where it intends to construct and operate two EPR pressurised water reactors. The licence alone is not sufficient to authorise construction or operation as ONR has elected to permission key activities. For each condition attached to its nuclear site licence, a Hinkley Point C compliance owner has been assigned, with responsibility for both documenting the arrangements to comply with the licence condition (LC), ensuring compliance.

9.13 Certain LC's will come into effect during later phases of the HPC project and the associated arrangements are not expected to be fully developed until such time.

Licensee Structure and Assurance

9.14 NNB GenCo is a limited company and as the licensee has sole responsibility for the conduct of all activities affecting nuclear safety at Hinkley Point C. The NNB GenCo (HPC) 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 project director who is a member of the NNB GenCo Board. The Project Director is accountable to the Board for the delivery of the project safely and to time, cost and in accordance with specified quality and engineering standards. The project delivery function includes engineering, procurement, project management, site construction and licensing, the latter including NNB GenCo's design authority.

9.15 The HPC 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. The law requires risks to be reduced so far as is reasonably practicable. Construction of the power station has commenced on site, and the plans, designs and safety cases are well developed.

9.16 The Security, Safety and Assurance (SS&A) director is independent from the construction/delivery reporting line within HPC and provides appropriate review and challenge in relation to nuclear safety. To reinforce their independence, the director has an additional direct reporting line to the Chief Executive of EDF Energy. The Safety and Assurance Directorate includes: safety, quality, health, safety and environment support, who supply specialist expertise and guidance in emergency planning, radiological protection, environment, industrial safety, occupational health and nuclear materials transport teams. The Directorate 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.

10.1 As part of demonstrating high standards in nuclear safety, NNB GenCo also has an assurance function. The function comprises an independent assessment, challenge and oversight team, Hinkley Point C site independent assessment team, independent technical assessment team and a supply chain oversight team. A targeted programme of audits and independent assessments is carried out to provide assurance of the adequacy of arrangements and design and safety cases, organisational capability, supply chain capability, etc for the Hinkley Point C project. The team also escalate advice to higher levels of management if the resulting action is deemed to be insufficient in scope or urgency.

9.17 All of 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 HPC has a corrective action programme and process that documents, reviews, evaluates and initiates remedial action to correct non-compliances or other anomalous findings. This process allows anyone to identify an issue or problem by raising a learning report. The report requires some level of 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.

Self-assessment and external assessment within HPC

9.18 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.

9.19 As part of maintaining HPC's ISO 9001 quality management certification, there are third party compliance audits carried out each year.

How the regulatory body ensures the licence holder discharges its responsibility for safety

9.20 The most frequent interfaces between the licensee and ONR arise through the assessment of safety cases and inspections at licensed nuclear sites. ONR conducts inspections to check the operator's compliance with licence conditions and other health and safety legal requirements. ONR has a nominated site inspector for each of the operational NPP 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 with regard to the licence conditions and safety case.

9.21 ONR has established a strategy for operating reactors, which provides a framework for the regulatory activities associated with all eight EDF Energy NGL sites. This is implemented through an Integrated Intervention Strategy (IIS) and 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 (SBIs) for a 12-month period. SBIs are described further under Article 14 – Assessment and Verification of Safety.

9.22 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. By definition, reactive inspections cannot be planned. However, experience suggests that up to 25% of available inspection time is spent on reactive work. Reactive inspections often includes 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.

Open and transparent communications

10.2 The information herein is directly related to the major common issue on **stakeholder consultation and communication** from the Seventh Convention.

EDF Energy NGL

9.23 EDF Energy NGL adopts a policy of openness and transparency and places importance on assuring the public that it can be trusted to act to the highest safety standards.

9.24 The openness and transparency policy requires Station Directors to write to local stakeholder groups regularly, providing updates on safety and operational performance and providing details of specific events reported through the recording processes. EDF Energy NGL also provides a report and attends the local site stakeholder meetings referenced above. In addition, monthly newsletters are circulated to the community and local media and published on the company website.

9.25 EDF Energy NGL's website provides daily updates on the current status of all of its reactors, information on the power outputs, status of the reactor (at power/shut down for maintenance) and provides an indication of when the reactor is due to return to service (Ref. 6863).

9.26 EDF Energy NGL has seven 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 electricity generation, through interactive models and information panels. The visitor centres all have an interactive exhibition, a classroom and offer pre-arranged tours of the power station for individuals and groups. They also explain safety on site, radiation, nuclear waste and other forms of electricity generation.

NNB GenCo

9.27 NNB GenCo adopts a policy of openness and transparency and places importance on assuring the public that it can be trusted to act to the highest safety standards.

9.28 The NNB GenCo website provides an overview of the technology, the benefits to the local community, and high-level updates on the progress of construction.

9.29 NNB GenCo has a visitor centre helping visitors to understand how HPC will contribute to electricity generation. The visitor centre offers pre-arranged tours of the construction site for individuals and groups.

9.30 In addition, the HPC 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.

ONR and BEIS

9.31 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 the ONR website and through the freedom of information and enquiries process (Ref. 74). ONR inspectors typically attend the quarterly local site stakeholder meetings held near to each reactor site. These formal meetings are chaired by individuals that are independent to the licensee and 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.70).

9.32 BEIS established the NGO forum in 2010 to engage in more open, transparent and constructive relationships with local and environmental NGOs, who are regarded as key stakeholders. The Forum meets three to four times a year in London and provides a space to discuss BEIS policy developments and any other matters of interest to the NGO members. BEIS Ministers have also attended NGO Forum meetings. Each event is attended by the Nuclear Directorate Directors and senior management team. The discussions at these meetings can focus on issues related to a specific nuclear site, as they are regularly attended by local nuclear NGOs.

Ensuring that the licensee has appropriate resources

9.33 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.

9.34 The nuclear site licence requires the licensee to have adequate human and financial resources in place to operate safely. This includes the engineering and technical resources provided centrally within EDF Energy NGL that provide support to the reactor sites. 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 NGL to assess and substantiate the potential impact of proposed organisation changes on safety.

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:

- HPC measures to implement arrangements for safety.

10.2 Otherwise, compliance with this Article of the Convention has not substantially changed since the Seventh UK report (Ref. 18) (i.e. in a way that has implications for the Convention obligations).

UK Government policy

10.3 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 BEIS Secretary of State carries overall Government responsibility for nuclear safety and reports to parliament on this matter. ONR is the UK's legally independent regulatory body for nuclear safety and provides advice to BEIS on nuclear safety matters when requested.

The regulatory body's priority to nuclear safety

10.4 As the principal regulatory body, ONR has core functions to licence, inspect, and assess nuclear installations in order to make judgements, on behalf of the public, that they are being managed and operated safely and within the law.

10.5 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. It must be adequately resourced to underpin safe operations and maintenance, understand the hazards and risks it is dealing with, and be committed to the adoption of relevant good practice through continuously seeking and making reasonably practicable improvements to safety. Relevant good practice 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.

10.6 ONR has established an enforcement policy which provides guiding principles for enforcing the law. As recommended by IAEA safety guide GS-G-1.3 (Ref. 71), ONR adopts a graded approach to enforcement, with any regulatory action taken being commensurate with the seriousness of the identified safety deficiency. ONR has legal powers to prohibit or shut down specified operations. The licensee has a strong culture of making conservative decisions to shut down reactors should a safety concern warrant such significant action. This is in line with **VDNS Principle 3**.

10.7 ONR's main aim is to regulate the nuclear industry 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 the response to Article 8 – Regulatory Body and Article 14 – Assessment and Verification of Safety in this report. Further information is also available in the ONR Strategic Plan 2016-2020 (Ref. 76).

Organisational leadership and management for a positive safety culture

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

10.9 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 a number of common factors have been identified from event investigations and research studies. These include:

- 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.

10.10 Leadership and cultural aspects of safety cannot be easily prescribed in laws, but poor leadership and culture may impact adversely on safety outcomes. Management and organisation for safety is more easily prescribed and requirements are outlined in the UK, for example, through MHSWR99 (Ref. 52) and LC17, the licence condition for management systems. Most UK licensees have adopted the recommendations contained in IAEA safety requirements GS-R-Part 2 (Ref. 71) and its associated safety guides (GSG 3.1 and GSG 3.5, Ref. 71) for implementing effective safety management systems. This is in line with **VDNS Principle 3**.

10.11 ONR has adopted the collective term 'leadership and management for safety' (LMfS). This identifies some important factors in 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.

10.12 ONR has established an LMfS annual review process to evaluate licensees' performance in relation to the four SAPs pertinent to LMfS (see Figure 11 on page 67). The outcome from the review process is shared with the licensee through a presentation made to its senior leadership team and for subsequent discussions with ONR managers. Evidence and intelligence gathered from a broad range of ONR interactions with the licensees, including less tangible cultural aspects provides the basis for this review. Areas for improvement are identified for the licensee to address.

10.13 The LMfS review is carried out by both specialist and site inspectors and makes reference to the wide range of ONR's interventions. Results are fed into ONR's inspection planning process and have contributed to the identification of 'themed' inspections where topics have been identified that warrant further regulatory attention. Recent examples (within the last three years) have included themed interventions on:

- Engineering governance;
- Control and supervision of operations;
- Control and supervision of contractors;
- Organisational learning;
- Organisational capability; and
- The licensee Board.

10.14 Themed interventions currently ongoing include:

- effectiveness of the internal regulatory function; and
- the safety case anomalies process.

10.15 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/corporate functions and ensure regular interactions with directors and senior management. This focuses solely on the oversight and management of activities within the scope of the nuclear site licence. 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 i.e. at the higher levels of management. Corporate inspectors are in place for both UK reactor licensees, EDF Energy NGL and NNB GenCo.

10.16 ONR's corporate discipline 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, human factors, and supply chain/quality (see Article 13 – Quality Assurance). This includes ownership of ONR 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:

- Leadership and culture (including engagement with the industry on safety culture through the Safety Directors' Forum and to take account of requirements in GSR Part 2 including a review of the LMfS SAPS);
- Nuclear safety governance (taking into account new guidance on corporate governance from the UK Financial Reporting Council Refs. 77 and 7368);
- Supply chain (see Article 13 – Quality Assurance); and
- Safety culture of the regulatory body.

10.17 The SAPs on LMfS outline four high-level interrelated principles:

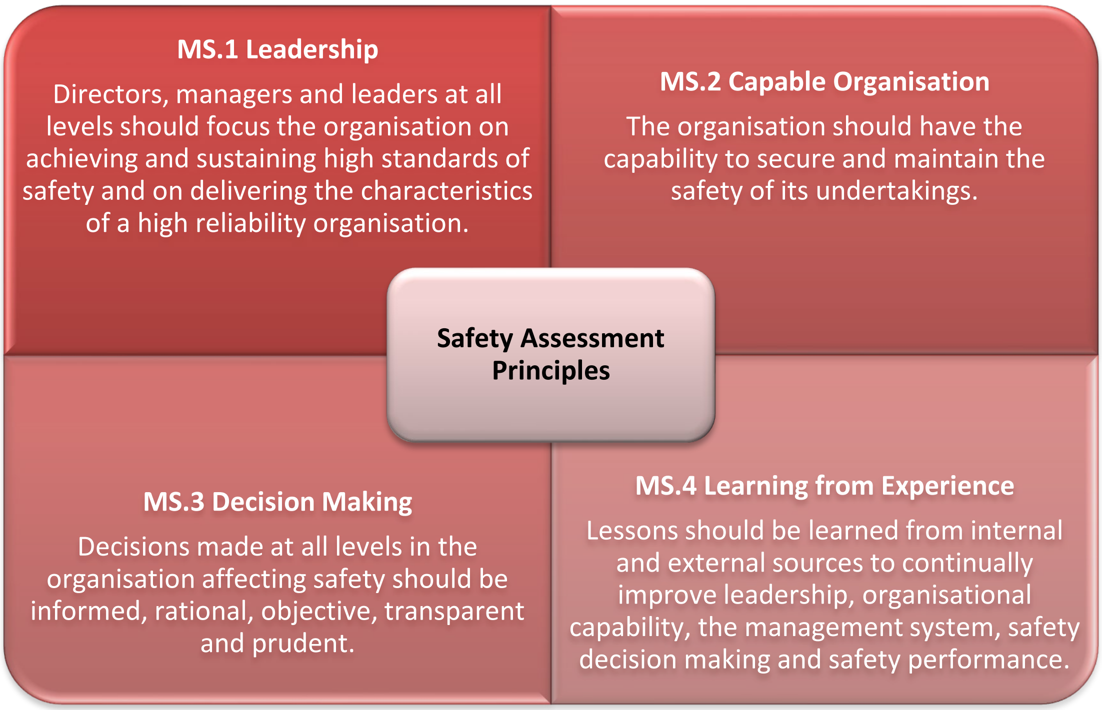


Figure 11 – Leadership and management for safety SAPs

10.18 The attributes are expressed as outcomes to be achieved for effective LMfS rather than prescribing specific systems, processes and procedures required to achieve safety.

Use of Safety Performance Indicators (SPIs) in the UK

10.19 International experience, particularly following major events has reinforced the usefulness of SPIs to manage and prioritise for safety. The use of SPIs is not mandatory in the UK but their use 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. 79). Pilot projects were undertaken to further refine the approach. This is in line with **VDNS Principle 3**.

10.20 The UK nuclear industry's safety directors subsequently published an industry endorsed good practice guide entitled 'Development and use of Safety Performance Indicators' (Ref. 80). 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.

10.21 SPI related data is collected, collated and analysed routinely at the EDF Energy NGL power station sites. 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.

10.22 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 and the station and the EDF Energy NGL corporate centre. Each site holds an Annual Review of Safety 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 12 below.

No.	Indicator	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018
1	Number of events ranked 1 or higher on INES. per reactor	0.80	0.93	1.33	0.80	0.80	0.33	0.47	0.27	0.40	0.53
2	Number of nuclear safety events ranked 0 or higher on INES. per reactor	5.47	5.60	4.7	4.6	5.1	4.5	7.40	9.6	6.07	5.73
3	Number of cases of non-compliance with technical specifications. per reactor	0.13	0.60	0.33	1.67	0.67	1.53	1.00	0.80	0.60	0.53
4	Number of alignment errors. per reactor	0.13	0.60	0.33	3.07	3.33	2.80	2.87	3.07	0.93	1.60
5	Number of unscheduled trips. per reactor (for 7.000 hours of criticality) • Automatic • Manual	 0.82 1.44	 0.58 1.68	 0.74 1.22	 0.64 0.84	 0.45 1.03	 1.17 0.62	 0.57 0.19	 0.3 0.42	 0.49 0.37	 0.89 0.20
6	Average collective dose. per unit in service (in man-Sv) • PWR • AGR	 0.337 0.100	 0.271 0.018	 0.537 0.084	 0.037 0.063	 0.386 0.034	 0.365 0.074	 0.048 0.067	 0.544 0.021	 0.296 0.020	 0.100 0.050
7	• Number of individuals with doses above 15 mSv	0	0	0	0	0	0	0	0	0	0
8	Number of significant radiation protection events	31	43	43	50	27	27	18	20	10	23
9	Availability (%): • EDF Energy fleet • PWR • AGR	 71.0 87.4 69.8	 65.7 45.6 67.1	 72.0 82.5 71.3	 78.0 89.2 76.3	 78.9 83.0 78.2	 72.1 84.1 70.2	 77.30 100 73.7	 83.0 82.0 83.1	 81.6 83.8 81.2	 76.1 89.4 74.0
10	Unplanned inoperability (%) • EDF Energy fleet • PWR • AGR	13.2 0.9 14.0	19.6 54.3 17.1	13.0 3.4 13.7	8.9 9.9 8.7	6.9 0.2 7.9	10.7 0.7 12.3	2.3 0 2.7	5.1 0.1 5.8	5.0 0.0 5.7	3.1 2.2 3.3
11	Occupational accident rate with sick leave (per million hours worked)[1]	0.6	0.4	0.6	0.5	0.2	0.2	0.4	0.3	0.2	0.5

Figure 12 – Safety Performance indicators for the EDF Energy Fleet

The operator's priority to nuclear safety

10.23 In the UK there is a single licensee, EDF Energy NGL, for all operating civil nuclear power plants. Additionally, two 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 13 – EDF Energy NGL focus on priority to safety reiterated at site entrance

Organising and managing for safety in EDF Energy NGL

10.24 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 in a timely and transparent way, being conscious of risks and continually assessing them. The company values and encourages independent oversight and challenge.
- 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.

10.25 The commitment to give priority to nuclear safety is clearly established within company policies (Ref. 81). 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 GS-R-3. Further information can be found on the EDF website (Ref. 82).

10.26 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. Safe management of operations of the reactor fleet resides with the EDF Energy NGL executive team headed by the managing director, supported by the two regional chief nuclear officers, the chief technical officer, and the safety, security and assurance director alongside directors in areas such as 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. The safety and assurance division includes: safety and internal regulation; quality, health, safety and environment support, who supply specialist expertise and guidance in emergency planning, radiological protection, environment, industrial safety, occupational health and nuclear materials transport. 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.

10.27 In addition, each of the eight operating power stations has a station director who is responsible for effectively implementing the company's safety policy and standards on the licensed site.

10.28 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 on a monthly basis; this is a requirement of the site licence (LC13) 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

10.29 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

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

10.31 EDF Energy NGL subscribes to a planned programme of peer reviews by 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 four 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 2019.

10.32 In 2017, the PWR at Sizewell B hosted an IAEA follow up Operational Safety Review Team (OSART) mission. The IAEA found clear evidence that Sizewell B management had gained benefit from the OSART process. The plant had analysed in a systematic way the recommendations and suggestions and developed corrective action plans to address all of them. In February 2018, the AGR at Torness hosted a full scope OSART mission and EDF Energy NGL has, through BEIS, requested a follow up mission at Torness in 2019 and a further OSART mission at Heysham 2 in 2022. 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 IAEA, ONR and EDF Energy websites (Refs. 83 and 84).

Internal challenge and independent assessment

10.33 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 'independent' company nuclear inspectors who 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.

10.34 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 ISO14001, OHSAS 18001 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

10.35 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

10.36 All of 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

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

10.38 EDF Energy NGL has defined its nuclear safety culture using the IAEA safety series document INSAG-4, (Ref. 71) 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 ten 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.
- **Work processes**: The process of planning and controlling work activities is implemented so that safety is maintained.

10.39 The health of nuclear safety performance and culture is assessed typically biennially by the licensee.

10.40 EDF Energy NGL also reviews its safety culture using the 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.

10.41 The 2018 survey was further developed to incorporate items to measure nuclear security culture and for the first time, contract partners had the opportunity to complete the survey.

10.42 Additionally, a review of safety performance in 2018 led to a cross-fleet workshop (including contractors) to review learning from the safety events of the last few years and to map out the required changes. The themes identified were used to develop action plans for the medium and long term; these were integrated into the business plan.

10.43 Each team in EDF Energy NGL was also mandated to hold its own workshop to engage and discuss some of the key events from the year using a supplied information pack and video message from executive team members. Each location management team was required to use the feedback from these workshops to drive focussed interventions to ensure any significant gaps are targeted.

Safety culture during outages EDF Energy NGL

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

10.45 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.

10.46 During the planning stages of the outage process a defence-in-depth plan is drawn up to maintain nuclear safety at all times 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.

10.47 Pre-outage training includes references to operating 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 given to all personnel having access to the plant during outage execution. Operations staff receive training on shut down faults and the expected operator response, using the simulator for fault response training where appropriate.

10.48 At least weekly throughout the outage, a safety forum reviews the previous seven 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

10.49 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.

10.50 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 power 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.
- **Operational Safety Review Committee**: Provides oversight and review of operational risk and decision-making processes.

10.51 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.

10.52 In response to the licence conditions there is a requirement for operational nuclear power stations to have arrangements in place to identify operational limits and conditions 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 operational limits and conditions can be found under Article 14 – Assessment and Verification of Safety and Article 19 – Operation.

10.53 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 – Hinkley Point C Measures to implement arrangements for safety

10.54 NNB GenCo has an extensive framework of arrangements to ensure the existence of a strong nuclear safety culture throughout the Hinkley Point C (HPC) Project (this is directly related to the major common issue on **safety culture** from the Seventh Convention). 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, INPO and WANO organisations. This is in line with **VDNS Principle 3**.

10.55 The NNB GenCo nuclear safety policy identifies the policy 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 staff.

10.56 The organisational integrated management system (IMS) captures the processes and procedures to ensure implementation of the policy requirements and expectations, in compliance with the IAEA standard GSR-3. An assessment of the impact on the IMS of adoption of the GSR Part 2 standard is underway.

10.57 A nuclear baseline(an organisation structure that identifies the posts that must be staffed by persons that are suitably qualified and experienced in nuclear safety) is in place and is routinely updated, identifying those roles within the organisation that have a direct or indirect impact on or supporting role to nuclear safety. The baseline also identifies those positions that have an intelligent customer role.

10.58 Staff induction includes an introduction to nuclear safety culture, human performance and error reduction techniques, organisational learning, the Nuclear Site Licence and the regulatory interface, and the intelligent customer concept.

10.59 Organisationally, by way of nuclear safety oversight, the Nuclear Safety Committee considers and provides authoritative 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 group within the Safety, Security and Assurance Directorate provides an independent assurance function, assessing activities across the HPC project, and advising the NNB Executive. ONR An annual report of compliance with the thirty-six Nuclear Site Licence Conditions is prepared and provided to the ONR, and an action plan prepared to address any shortfalls.

10.60 NNB GenCo has 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 imperatives, values and behaviours for success, nuclear safety culture, organisational learning and leadership development. A strategy and plan have been developed which has been endorsed by the HPC Executive with progress against the plan being tracked through the year.

10.61 An organisational learning programme is in place which includes a tool for staff to raise learning reports on a range of issues. Learning reports are reviewed at a screening meeting, categorised and actions assigned and tracked.

10.62 NNB GenCo has developed a nuclear safety culture and human performance maturity assessment methodology with which it periodically assesses arrangements within the HPC supply chain. The assessment reports for key suppliers, such as the HPC Responsible Designer, are provided to ONR. The assessment identifies areas for improvement which are communicated to the supplier who then prepares and provides NNB GenCo an action plan to address the findings. Follow-up assessments are performed to assess progress by the supplier towards the desired level of maturity.

10.63 NNB GenCo has used the same maturity assessment methodology to perform a self-assessment of the organisational Nuclear Safety Culture, the outcome of which was reported to the NNB Executive and an action plan implemented to address areas for improvement.

10.64 Collaborative working arrangements are established to support suppliers in addressing any shortfalls in their nuclear safety culture arrangements, and nuclear safety culture workshops are held for supplier representatives who, in-turn can convey this learning to the staff within their organisation.

10.65 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.

10.66 Regarding site construction, mock-ups have been used to demonstrate capabilities and to provide opportunity to learn from experience, prior to nuclear safety-related concrete pours.

10.67 Each year, NNB GenCo holds a project survey which invites input from personnel across the HPC project, including NNB GenCo staff, staff of the responsible designer, contractors and suppliers on the HPC site. The survey has a focus on nuclear safety, and findings are communicated to all project personnel.

Article 11 – Financial and Human Resources

> ***1. 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.***
>
> ***2. 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 nuclear 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 Seventh UK report (Ref. 18) (i.e. 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 Seventh Convention.

Legal requirements

11.3 The principal legal requirement for nuclear site licensees to have adequate resources is contained in the licence condition on organisational capability. 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 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 appropriate 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 of NIA65 the Government approves a nuclear operator's third-party liability insurance (or other financial arrangements). ONR seeks assurance from 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 some 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);
- Staffs 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 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 in order to meet these costs. The costs associated with managing intermediate level and high- level radioactive wastes comprise of:

- Costs actually incurred during the operational phase; and
- Liabilities associated with the management of intermediate and high level waste before ultimate disposal during the decommissioning phase.

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 low-level radioactive waste where the operator of the facility sets a price that reflects all operational and liability cost considerations.

11.11 All disposals of radioactive waste, including those to the environment, are undertaken in accordance with regulatory authorisations. The environment agencies recover costs in granting, monitoring and enforcing the authorisations or permits from the operator.

Financing decommissioning programmes

11.12 UK government policy is that all nuclear operators take the necessary steps to ensure that the decommissioning work is adequately funded. These arrangements are set out in an FDP. Under the Energy Act 2008, 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 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.

11.13 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 and feasible, or to decommission them, for example by adding them to the Nuclear Decommissioning Authority's (NDA) portfolio of sites.

11.14 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 Nuclear Liabilities Funding Agreement. The current value of the fund today is circa £9.6 billion.

11.15 The funding arrangements for decommissioning EDF Energy NGL’s nuclear power stations and discharging its uncontracted liabilities are contained within the Nuclear Liabilities Funding (NLF) Agreement. Under this agreement, EDF Energy NGL is required to produce plans that look forward on both a three-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.

11.16 EDF Energy's future role in decommissioning is not guaranteed and the Government has an option to implement alternative arrangements. However, EDF Energy's Waste and Decommissioning Directorate has started to prepare the organisation (people, plant and process) for the progressive change from generation into decommissioning. These activities qualify for NLF funding if they are a qualifying liability under the Nuclear Liabilities Funding 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 handing to the higher rates required during defueling;
- 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
- Operating 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.

11.17 AGR Operating Plan (AGROP): There is a cross-industry collaborative programme to prepare for and execute AGR defuelling led by EDF Energy NGL. Other delivery partners include Sellafield Ltd, Direct Rail Services and the Nuclear Decommissioning Authority. Ultimately governed by the Department for Business, Energy and Industrial Strategy, 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 safely and efficiently move all nuclear fuel from the 14 AGR reactors into pond storage at Sellafield for a period of up to 70 years, prior to ultimate disposal within a geological disposal facility.

11.18 For new nuclear power stations, the Energy Act 2008 (Ref. 26) 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 a Funded Decommissioning Plan (FDP) which is approved by the Secretary of State prior to construction of the new nuclear power plant commencing. The FDP is required to be reviewed and updated on agreed timescales.

11.19 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

11.20 Several UK licence conditions set goals on management of human resources and training:

- LC 36 includes a specific requirement for the licensee to provide and maintain adequate human resources to ensure safe operation.
- LC 10 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.
- LC 12 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 operation.

11.21 ONR's nuclear safety inspectors review safety documentation against these licence conditions supported by ONR's guidance in relevant TIGs and TAGs, considering particularly whether the organisation has the capacity and capability to secure and maintain the safety of its operations.

11.22 In addition, HSWA74 (Ref. 20) 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 responsibilities. This responsibility includes the competence and training of staff with safety related roles. Specific requirements are included in the MHSWR99 (Ref. 52), in particular, Regulation 13 on capabilities and training.

11.23 ONR expects the licensee to show that provision of adequate resources, delivery of training and assuring competence are set out in policies and plans which are supported by commitment from senior managers.

Regulatory expectations for organisational capability

11.24 ONR has produced guidance to set out its expectations with regard to a 'capable licensee' in its TAGs and SAPs (Refs. 56 and 55). These guides address areas such as: managing organisational change; developing a 'nuclear baseline', 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. 8075).

11.25 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 maintain control and oversight of safety at all times. This includes technical (for example, design authority, engineering, safety case capability), operational and managerial elements. Together they combine to ensure that the safety case for the installation is understood and maintained, 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.

11.26 ONR expects that changes to the licensee's organisation (including structure, staffing, resources or competences) should be subject to systematic evaluation to ensure they do not adversely affect the capability of the organisation to deliver safety.

11.27 Prospective new nuclear licensees are required to submit a safety management prospectus which sets out and demonstrates how their organisational structures, resources, capabilities, governance and management arrangements are suitable to manage nuclear safety. ONR's expectations have been set out in "Licensing Nuclear Installations" (Ref. 16).

Regulatory expectations for training and qualification

11.28 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 plant 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 ONR TAG 'Training and Assuring Personnel competence' (Ref. 56).

11.29 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.

11.30 LC7 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 part of the cause. The licensee must then identify any necessary corrective actions. ONR expects the licensee to have robust management arrangements for conducting reviews of all available sources of internal and external operating experience and to adjust training provision accordingly.

EDF Energy NGL approach to human resources

Organisational capability

11.31 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 taking into account experience and length of time in post. Workforce planning is conducted at a local level and aggregated into company-wide plans.

Knowledge Management and Retention

11.32 The information herein is directly related to the major common issue on **knowledge management** from the Seventh Convention.

11.33 Within EDF Energy Nuclear Generation, there are a large number of processes which are routinely used to gather and manage knowledge. Knowledge management is a separate process, requiring additional personnel, and tools, to manage. Instead, it is a normal part of daily work, with identified knowledge being transferred into useful formats whenever the need is identified. This is shown graphically below:

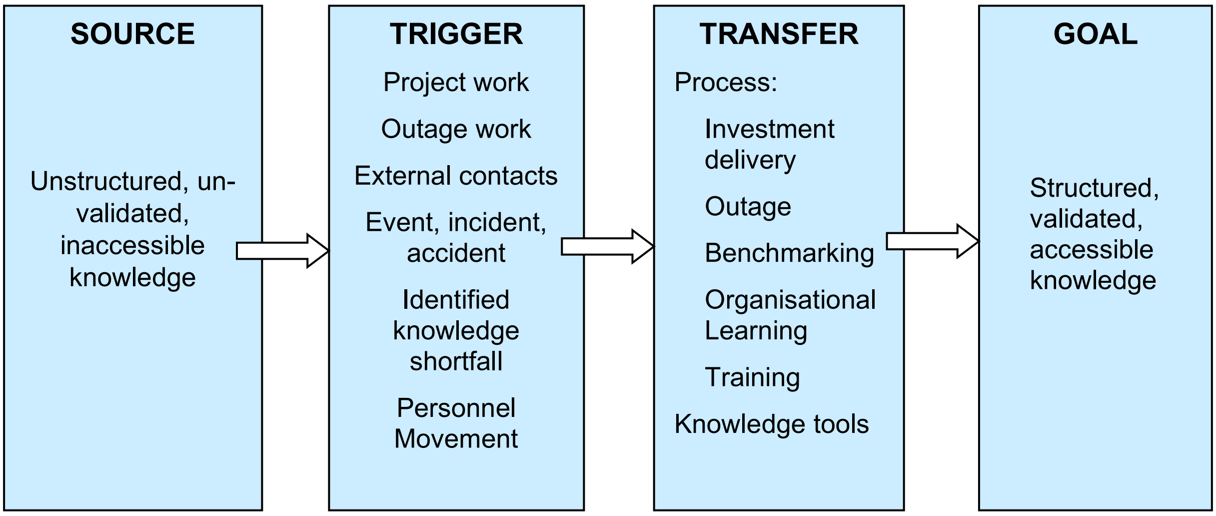


Figure 14 – Knowledge Management Process

11.34 In this figure, 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.

11.35 It is not possible to capture all knowledge, so, a risk based, graded, approach is needed to ensure that available resources are focussed 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.

11.36 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.

11.37 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.

11.38 EDF Energy NGL’s engineering and technical capability comprises staff at both operating nuclear power plants and at central headquarter locations. 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.

11.39 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.

11.40 An example of a staff retention issue and how it was managed is described below:

11.41 EDF Energy NGL has a 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.

11.42 The decision about whether to use contracted personnel on work which may affect nuclear safety is based on a number of considerations. EDF Energy NGL's guidance asks for a number of questions to be addressed as part of the decision-making to ensure that the nature of the work is suitable and that it can be controlled by the licensee.

11.43 During 2016 and 2017 Sizewell B lost a significant number of Main Control Room personnel to Nawah Energy Company, the operator of a new four unit PWR Power Station in the United Arab Emirates. Recruitment was expected to continue for several years and extend to additional specialist roles. The combination of good remuneration packages and interesting commissioning work provided a very attractive opportunity for station staff.

11.44 EDF Energy NGL put in place a number of actions in response to this issue, including a recruitment campaign initiated with a view to recovering headcount and ensuring sufficient resources were available to support the station. This resulted in the identification of a number of good candidates, with a focus on ensuring the relocation of coal and AGR operations staff from those stations that are due to close in the near future. Training time scales for operations staff are significant, reflecting the need to ensure high quality personnel to support safe nuclear operation. Therefore work was undertaken to streamline the existing high quality training programmes that demonstrably produce high quality operators without a drop in quality and standards. Where suitable candidates were available, individualised training courses were developed, building on their previous experience, to deliver newly trained people in advance of the usual timescales. A key constraint has been the need to ensure continued training of existing staff is not affected and this has required the recruitment of additional simulator tutors and the use of off-site limited-scope simulators for the more generic PWR training.

In addition EDF Energy NGL engaged in discussion with Nawah and WANO including a visit to the Barakah Power Station by the EDF Energy Chief Nuclear Officer (CNO) to meet their CNO. This enabled Nawah to understand the impact on the organisation of the losses, and also identified areas in which Nawah needed support going forward. EDF Energy NGL is now engaged with Nawah and has been working collaboratively to ensure the success of both organisations. WANO has confirmed that it is supportive of this approach.

Training and competence

11.45 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; and

- Regular evaluation of training.

11.46 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.

11.47 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.

11.48 Dedicated full-time certified training instructors at nuclear power plants 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, are capable of simulating a range of accident scenarios. International operating 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.

11.49 Simulator training takes place at a frequency defined within the EDF Energy NGL task to training matrix, which is derived using the systematic approach to training. The recommended annual minimum number of hours for simulator training and evaluation is 60 hours for AGRs and 120 hours for PWRs inclusive of emergency preparedness related simulator training. The performance needs of individual stations may dictate more hours of technical content. These recommendations may be met by averaging the time allocated to training over the duration of the established requalification program. For instance the station can flex the annual training hours by 20%. Any deviation from this recommendation should be infrequent and occur only after careful consideration and approval by the station Strategic Training Committee with additional functional oversight.

11.50 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.

11.51 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 through the use of 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.

11.52 Procedures for assessing competence prior to undertaking a safety related role are part of the arrangements made under the licence condition for training (LC10). 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.

11.53 Duly authorised persons are identified as individuals who are in direct control or supervision of operations or activities that 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 in order 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 suitably qualified and experienced persons and duly authorised persons.

Training of external personnel

11.54 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 oversight.

Improvements to training programmes

11.55 Within EDF Energy NGL, a series of training review committees (at operational, tactical and strategic levels) ensure that initial and continuing training programmes are kept up to date for example, taking into account operating 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 (the licence condition for modifications) should 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 may be a requirement prior to a Consent being granted to bring the modified plant into routine service.

11.56 Operating Experience 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.

- The use of WANO Significant Operating Experience Reports – predominantly on operations courses.

11.57 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 Mangers. Corporate and Station Training specialists also meet as a peer group to share good practice, monitor performance and identify improvements.

Training programme accreditation

11.58 EDF Energy NGL's accreditation process of its operations and technical training programmes (including maintenance) involves 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. It provides an independent view of the organisation's training programmes measured against six INPO objectives.

11.59 Since 2011, all eight of EDF Energy NGL's stations and the central engineering function have achieved full accreditation for all of their operations and technical programmes. From 2014 onwards the first renewal cycle commenced. EDF Energy NGL's accreditation process is now mature and, since it has remained relatively unchanged, it provides a consistent benchmark against which stations can be judged.

Hinkley Point C operational capability

11.60 The HPC operational capability requirement is set by the Pre-Operations directorate. Its key deliverables include:

- Defining the future operations culture and staffing requirements;
- Building on experience and learning from EDFSA and CGN; and
- Building operations team capability in preparation for commercial operation.

11.61 This work is being carried out in a broad team incorporating experience from HPC and generation; principally Sizewell B, EDF Energy NGL HR and the Nuclear Skills Alliance (NSA). This work is directly related to **Challenge 2** from the Seventh Convention.

11.62 **T**he Nuclear Skills Alliance (NSA) is a structured collaboration between EDF Energy NGL and NNB GenCo. The NSA brings together technical training teams from EDF Energy NGL and NNB GenCo 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 HPC.

11.63 To meet this need, the NSA is developing the training programmes needed to support the training of staff for operations at HPC. 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 HPC's intelligent customer and custodian of the arrangements to meet LC10 and LC12 (the licence conditions for training and duly authorised / suitably qualified persons). Oversight is provided by the joint Generation / HPC Programme Board.

11.64 Formation of the NSA, a structured collaboration between HPC 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 EPR across the world, significant benefit can be obtained from foreign EPR operational experience. The operational experience shared by CGN (Taishan) and EDFSA (Flamanville), has yielded useful methods, media and material which can support the development of training solutions for operations at HPC.

11.65 Analysis of the existing Flamanville programmes in maintenance, engineering support and technical and safety has begun to determine the extent to which they apply to HPC. The operations programme used to train and qualify Main Control Room operators has already commenced, with the first group of EPR operations instructors nearing completion of their simulator training. This group takes advantage of the availability of the Flamanville reference simulator, procedures and expertise. In parallel, the SAT development of the HPC reference Training programme necessary to authorise personnel before first operations at site has started.

11.66 Areas with significant technical differences between HPC and the Flamanville EPR design that would impact the EPR training programmes, (for example the additional safety features of the HPC 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 HPC Project Integrated Work Schedule includes the activities needed to develop these staff, procure the HPC reference simulators and complete the HPC site training facility. These are key deliverables of NSA on behalf of the Pre-Operations Directorate.

Maintaining and enhancing the national nuclear skill base in the UK

11.67 Existing operations, decommissioning and clean-up, together with a planned 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. The Nuclear Workforce Assessment 2017 report produced by the Nuclear Skills Strategy Group (NSSG) summarises the latest labour market intelligence currently available for the nuclear industry in the UK which is kept under review.

11.68 Occupations with potential demand/supply pinch points include: safety case preparation, control and instrumentation, reactor operation, site inspectors, project planning and control, commissioning engineers, electrical engineers, emergency planners, quality assurance staff, chemists. Other potential resource vulnerabilities include steel fixers, concreters, civil engineering operatives and scaffolders.

11.69 The 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 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 two hubs: one in the North West and the other in the South West of England. The college, set up with Government and industry funding, operates through a 'virtual college model' aiming to deliver industry specific courses.

11.70 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 NSSG was successfully formed.

11.71 The NSSG is now 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. In June 2018 the Government published the Nuclear Sector Deal as part of its modern Industrial Strategy, which includes a package of measures to support the sector as the UK develops low carbon power and continues to clean up its nuclear legacy. The NSSG is recognised in the UK’s Nuclear Sector Deal as the lead on skills for the sector and published its updated Nuclear Skills Strategic Plan on 6 December 2018, a key milestone set out in the deal.

11.72 The UK’s Nuclear Sector Deal commits 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.

11.73 The national skills base is also being enhanced through international collaboration. The UK and France held two Nuclear Skills Seminars in 2018 identifying future opportunities for collaborative working in mutual areas of interest on the capacity and capability of skills for nuclear.

11.74 The NDA has a statutory duty as set out in The Energy Act 2004 (Ref. 86) 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), based in Cumbria, 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. At the £250 million purpose-built facility, around 600 staff manage a wide range of radioactive and non-radioactive experimental programmes, as well as offering a wide range of analytical services. The UK Government is also acting to increase the numbers of young people with science, technology, engineering and mathematics (STEM) skills by working with schools and is committed to creating 3 million apprenticeships by 2020. All of these actions taken together will help to ensure the UK has the skilled personnel required to support the nuclear sector. This is directly related to **Challenge 2** from the Seventh Convention.

Article 12 – Human Factors

Each Contracting Party shall take the appropriate steps to ensure that quality assurance arrangements programmes 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 Seventh UK report (Ref. 18) (i.e. in a way that has implications for the Convention obligations).

Human factors in the design and assessment process

12.2 The UK’s nuclear installation operators and regulators recognise that human performance plays a vital role in ensuring safety. Human factors are concerned with all aspects of human performance, and the factors affecting this performance, which can impact on safe operation.

12.3 ONR’s SAPs (EHF series, Ref. 55), and TAGs (Ref. 56) set out ONR’s expectations for licensees’ treatment of human factors. It is also noted that many of the licence conditions (and therefore the TIGs, see Ref. 54) have strong human factors components.

12.4 Human factors analyses are applied, as appropriate, to all activities and functions related to nuclear safety. Licensees, prospective licensees and GDA requesting parties employ human factors specialists to carry out human factors assessments or to oversee work carried out by external consultancies on their behalf. EDF Energy NGL and NNB GenCo employ a number of human factors specialists and are also supported by specialist contractor support. ONR currently has a team of over twenty human and organisational factors specialists and supplements this with specialist contractor support when required.

12.5 Where new nuclear installations are proposed, human factors assessments are carried out to inform the design process, and to confirm that the designs take due account of the needs of the user. It is essential to engage human factors specialists at an early stage of the design process. This is to ensure that they can influence the design so that it reflects human capabilities and limitations and supports safe and reliable human action. All nuclear installations are also re-assessed as part of the PSR process (see Article 14 – Assessment and Verification of Safety), and human factors analyses form an integral part of these reviews. In addition, human factors analysis is expected, as appropriate, in the plant modification process. Where shortfalls in ergonomic standards are identified, licensees are expected to consider reasonably practicable improvements to the task design to provide a demonstration that the risk from human error remains ALARP.

12.6 As part of the safety case supporting the operation of a nuclear facility, the licensees carry out fault analyses to identify initiating events that may occur due to human error and to identify required operator safety actions. In general, where a plant failure or incorrect operation leads to a need for safety system operation, the plant is designed so that it is rendered safe by the action of passive or engineered features. These, in general, offer greater reliability than the human operator, especially where rapid safety system operation is needed. Where operator safety actions are identified, and it is not reasonably practicable to provide an engineered safety system, analysis of the operator actions is used to demonstrate that tasks required are feasible, and that they can be performed safely and reliably in the time available. Where the analysis indicates improvements to human, and hence plant reliability, these are considered as part of the ALARP review process. This is explained in the ONR’s SAPs (Ref. 55).

Human error identification and reduction

12.7 ONR’s SAPs and supporting TAGs cover identification, prevention, detection and correction of human errors in operation and maintenance of nuclear installations. This is achieved through undertaking task analyses that identify operator actions required to monitor the plant, diagnose plant state, make decisions and implement necessary actions. 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 actions successfully, and the potential for recovery from error. The analyses take account of, and also form primary inputs to inform decisions on, plant staffing, and on the equipment and other facilities which are provided to support the operator. In particular, the analyses are an important input to the design of the user interface, 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.

12.8 The design of the 'user interface' follows good human factors practice, to ensure that it is compatible with human psychological and physical characteristics, and to enable the required tasks to be performed reliably and efficiently. For new designs, a structured user interface design process is adopted and relevant standards applied. In particular, the user interface for the reactor main control room is based on a comprehensive and systematic task analysis, which identifies the operational requirements during normal, transient and fault conditions. The user interfaces of existing nuclear installations have been subject to scrutiny during the PSR and plant modification processes in order to ensure that they remain fit for purpose, and that operator actions are properly supported.

12.9 The design of the reactor control room enables the operator to carry out safety functions and tasks during normal operations, postulated fault conditions and, where practicable, severe accidents. Adequate provisions are available 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 all equipment having the potential to impact upon plant safety (for example, maintenance and testing equipment and computer-based systems used to present operating instructions).

12.10 The PSA undertaken on the nuclear installations provide quantitative assessments of the risk to safety arising from plant designs and operations. The PSAs highlight significant contributors to risk and consider the impact of human actions on safety. The licensees ensure that relevant operator actions are identified and modelled in the PSAs, and 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 (CNI)'s report on the Fukushima accident, licensees have, and continue to extend their PSAs and assessments of human actions to include those included within severe accident guidelines.

12.11 The initial stage of the human reliability analysis identifies potential human errors that can impact on safety. The error identification process is rigorous and thorough. 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. The probabilities derived draw on this and reflect influences on performance arising from 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 identified. 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. Licensees 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

12.12 Details of the licensee's human factors methods and programmes are presented in two parts. The first relates to NNB GenCo who are currently developing the design and assessment of the new facility at Hinkley Point C (HPC). The second relates to the methods and programmes employed by EDF Energy NGL who are responsible for operating the current reactor fleet.

NNG GenCo Human Factors

12.13 The strategy for implementing human factors on the HPC project is described in the HPC Human Factors Management Plan (HFMP) which is the lead document for all Human Factors integration, planning and strategy documentation for the HPC Project. It describes the project arrangements to ensure human factors (HF) considerations are appropriately integrated in all stages of the HPC Project, up to the Commercial Operating Date (COD). All other HF strategy and planning documents are subordinate to the HFMP.

12.14 The HFMP is produced and owned by the Design Authority Human Factors Team. The HFMP defines the expected scope of the HPC HF programme, defines an HF programme that will deliver effective HF and specifies the HF methods, tools and processes to be followed to achieve effective HF. In addition, the HFMP provides a basis for estimating HF resource requirements and describes the roles and responsibilities in relation to HF.

12.15 The HPC HF Programme is scoped to achieve two goals:

- To ensure that HF is sufficiently considered 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.

12.16 In order to ensure that HF is effectively implemented across all aspects of the design of HPC, the HF programme has been subdivided in to a number of targeted work-streams to address four areas of HPC design (civil work and building layout, mechanical and electrical systems design, human machine interface and control room design and procedure and operational documentation development) and two aspects of the HPC HF substantiation (human reliability analysis and HF design validation).

12.17 Each design work-stream follows a three-step process that involves assessing and screening of SSCs according to nuclear safety risk and complexity of human actions to assign HF risk significance level to each. The HF requirements and design inputs are then defined according to the HF risk rating. Finally, as the design work is completed it is assessed for HF compliance both progressively via HPC's review and acceptance processes and for more HF risk significant aspects via dedicated HF tests and trials.

12.18 The HPC Project has a core HF team in the Design Authority supported by sub-contractors delivering packages of HF. This team is responsible for defining the HF strategy, providing the overall HF assurance for the project, monitoring the effectiveness of all HF engineering in the HPC scope and developing the HF sections of the HPC safety case.

12.19 The principal coordination of the HF technical input to the HPC design is provided by a responsible designer (RD) HF team. This team is responsible for the implementation of the HPC

HF strategy across the design scope, including oversight of the HPC supply chain. The supply chain is responsible for the detailed design of the HPC SSCs and HF integration into that design. The level of HF risk associated with the SSC within the contractors' scope determines the HF expectations and requirements.

12.20 The RD has developed a Human Factors Integration Plan (HFIP) which defines the overarching HF delivery scope, strategy and technical programme of the RD. Implementation of the HFIP is supported by two Design Quality Plans (DQPs).

EDF Energy NGL – Human Factors

12.21 EDF Energy NGL includes consideration of human factors within its Nuclear Safety Principles which inform and govern the way in which they design and operate their 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.

12.22 The EDF Energy NGL 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 human factors significance of the work.

12.23 EDF Energy NGL have a team of human factors specialists who support delivery of their processes, and they work side by side with staff outside the discipline such architects, designers and engineers 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.

12.24 Specific examples of recent human factors initiatives run by EDF Energy NGL include:

- Provision of training to safety case authors covering human factors awareness training and human reliability analysis.
- Provision of safety case mentoring for human factors specialists and secondment of human factors specialists to other groups (such as Fuel Route Systems, Independent Assurance etc) to broaden their knowledge and support effective knowledge sharing and integration.
- Review of the procedures relating to the 'top twenty' tasks at each EDF Energy NGL station to improve quality and compliance with the procedures.
- The production of a human performance fleet dashboard on a monthly basis to monitor the health of the process. The dashboard presents data from station human performance improvement plans, human performance focus indicator (HUFI); and other human performance analysis activities such as coaching in the field, events and incidents where human performance was an identified factor.
- Re-invigorated human performance programmes including error avoidance training for knowledge workers. More recently, refinement of human performance programmes has also been undertaken to link and align with training provided as part of the leadership academy.
- Development of human performance evaluation tool (HUET) to optimise the quality of event investigation, in particular, where human and organisational factors are likely to be contributory causes.

12.25 EDF NGL has undertaken a number of initiatives to improve procedure quality, use and adherence, including development of a Corporate Working Group overseen by the Human Performance Fleet Lead. Good quality procedures minimise the potential for error and contribute to event free operation. An EDF Energy NGL procedure writer's guide for operations and maintenance procedures has been developed for technical authors to guide the development of quality procedures.

12.26 Approved procedures must always be adhered to and should be used with a questioning attitude. Procedures should be fit for purpose, and should be available, workable, and written in such a way 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 must be stopped, made safe, and the procedure changed using the document change process.

12.27 Prior to assigning a task or conducting a pre-job briefing supervisors review unfamiliar procedures in order to ensure that the task is assigned to someone who is a SQEP. As part of the pre-job briefing or setting to work process, supervisors identify the required procedures to staff and communicate adherence expectations. Detailed guidance is provided and is graded according to the nature of the task and on how the procedure must 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

12.28 EDF Energy NGL adopts approaches to assessing and monitoring nuclear safety performance. Stations are held to account by their Chief Nuclear Officer. Governance and oversight is also delivered via a number of 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. Fleet leads can also provide targeted support to sites as necessary. Other assessment activities include:

- A biennial safety culture assessment which is analysed at all sites, leading to identified improvement programmes if necessary.
- EDF Energy NGL's internal regulatory function undertakes management and leadership reviews of power stations in parallel with the Nuclear Safety Review Boards and also of 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. Five stations and the central technical organisation will have been reviewed by the end of 2019.

12.29 The information above is directly related to the major common issue on **safety culture** from the Seventh Convention.

12.30 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 the Station Director and 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.

12.31 The Boards take the form of a week-long review of operations and management at each nuclear power plant every two 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.

Arrangements for the feedback of experience in relation to human factors and organisational issues

12.32 EDF Energy NGL has developed an integrated ‘organisational learning’ process which aims to identify and fix performance gaps in behaviours, plant, processes or organisation, proactively as well as reactively and by using lessons learned from internal and external operating experience. Elements include the Corrective Action Programme (CAP), which is used to identify and resolve adverse conditions, OPEX and self-assessment / benchmarking. All stations and the Central Technical Organisation have performance improvement teams including organisational learning specialists.

12.33 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.

12.34 Specific examples of human and organisational factors initiatives run by EDF Energy NGL which have informed, or been informed by learning from experience include:

- Work to optimise the quality of event investigation at all levels and implementation of the significant adverse condition investigation review panel. This includes multidisciplinary review of the most significant event investigation reports, with a view to identifying common factors and providing feedback to lead investigators in the field;
- Learning from other organisations via routes such as intra and inter-industry groups. Experience from such events is fed into PSRs;
- Use of external organisations to assess organisational safety culture;
- Development and extension of EDF Energy NGL human factors arrangements to promote more consistent and proportionate application of human factors within safety cases. Key arrangements developed or updated include the development of specific safety case human factors guidelines for AGR fuel route safety cases;
- A revised approach to consideration of human factors as part of PSRs, with a focus on optimisation of processes and ongoing assessment;
- The review and update of reactor symptom-based emergency response guides and severe accident guides, and the development of fuel route severe accident guides in response to recommendations raised in the ONR Chief Nuclear Inspector’s report on the Fukushima accident;
- Development of suite of human factors technical guidance notes to facilitate consistent and integrated use of human factors guidance as part of the design process by non-human factors professionals;
- Delivering academic teaching to UK universities in the area of human factors to support the development of future industry human factors engineers; and
- The introduction of the EDF Energy NGL developed human reliability analysis tool, Nuclear Action Reliability Assessment, which was developed to improve the accuracy of human error probability estimates within the EDF Energy NGL PSAs.

12.35 The 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 operating experience internationally. In addition, ONR operates the IAEA's incident reporting system on behalf of the UK. Nuclear utilities co-operate in programmes of peer evaluation and operational experience feedback. They also participate in the programmes of WANO and the IAEA, which give an international perspective on performance levels. As well as the professional, focused critique which a station gains from an evaluation or an IAEA OSART mission, the many staff who help conduct such reviews bring valuable insights and ideas, which can be applied at their own stations.

Regulatory review and control activities

12.36 The ONR SAPs, 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.

12.37 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, the wider licence conditions also have human factors implications and in their totality 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.

12.38 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 operating experience, developments in human factors techniques and research, discussions with other UK regulators, the licensee’s personnel and other international regulators. 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.

12.39 As part of its wider regulatory activities, ONR publishes a research strategy (Ref. 87) and a Regulatory Research Register (Ref. 88) 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.

12.40 Current human factors research topics include:

- Human reliability data for modern control room environments. This aims to enhance understanding of the suitability of established human reliability methods to model advanced human machine interfaces.
- Advanced human machine interfaces with the aim of establishing relevant good practice.
- The efficacy of peer checking which seeks to better understand the effectiveness of peer checking and where it can be reliably employed.

12.41 Regulatory assessment of the licensee's treatment of human factors is made throughout the life cycle of a nuclear installation. When a safety 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 is 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 in order to ensure that the design properly reflects the capabilities and limitations of human performance, and that reliable operator performance is adequately supported.

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 Seventh UK report (Ref. 18) (i.e. in a way that has implications for the 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 IAEA Safety Standard GSR Part 2, “Leadership and Management for Safety” (Ref. 71). 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. 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’, which provides guidance on implementing the generic management system requirements, and GS-G-3.5 (2009), ‘The Management System for Nuclear Installations’. This is in line with **VDNS Principle 3**.

13.4 The ONR SAPs broadly reflect the IAEA requirements. The SAPs, supported by TAGs and TIGs (Refs. 55, 56 and 54) provide a framework to guide regulatory decision-making in the nuclear permissioning process. The SAPs recognise the importance of leadership and management for safety and expect quality management systems to be an integral part of this.

Status of integrated management systems

13.5 EDF Energy NGL uses an integrated management system approach. It promotes a more 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.

13.6 EDF Energy NGL has a mature integrated management system which continues to develop and improve as required and as opportunities are identified. The management system has fleet-wide, third party certification from an accredited external organisation. Internal independent oversight of the system is provided by the internal regulator and quality assurance functions. Adequate progress continues to be made on the development, production, implementation and improvement of the EDF Energy NGL integrated management system.

13.7 For the power station under construction at Hinkley Point C, the licensee NNB GenCo also uses an integrated management system approach. This is subject to development as the station moves from its current construction phase, through commissioning and eventual operation. Further consideration of the HPC integrated management system approach, is given below.

Main elements of quality management systems

Graded application of management system requirements

13.8 The application of management system requirements is graded by the licensee to provide a hierarchy of controls to activities depending on the safety significance and the related risk on which the activity is to be carried out. This approach ensures that appropriate and proportionate levels of controls are in place (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 itself.

Documentation of the management system

13.9 The licensee describes the management system documentation in a hierarchical structure. 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

13.10 The licensee develops 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

13.11 The management systems are authorised for use by the licensee's senior management and are mandatory for all employees. Licensee's arrangements include processes to inform senior management of the suitability, adequacy of and level of compliance with the management system. The licensee identifies clearly the key responsibilities and accountabilities of managers and others who carry out the work in related documents.

Process management

13.12 The management systems are developed by the licensee as part of its arrangements and to demonstrate compliance with licence conditions and national and international quality management requirements. The arrangements are subject to periodic review to ensure these processes remain fit for purpose and identify opportunities for continual improvement.

13.13 In order to optimise the effectiveness of processes, the licensee ensures 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 licensee retains overall responsibility and intelligent customer capability where processes are contracted to other organisations.

EDF Energy NGL

Performance monitoring

13.14 Monitoring and measurement are a fundamental element in the EDF Energy NGL management systems. EDF Energy NGL employs a multi-layered oversight, audit and review approach 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.

13.15 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 EDF fleet using reporting mechanisms of the organisation.

Independent assessment

13.16 EDF Energy NGL deploys diverse means of independent assessment of its management system arrangements, including the procurement of nuclear safety related items and services.

13.17 The following are some of the activities undertaken by EDF Energy NGL internal organisation and external independent bodies:

- An overall oversight programme which includes quality system compliance auditing and regulatory oversight by the internal regulator;
- EDF Group Inspector General Annual Report (an EDF Group corporate requirement);
- Internal control self-assessments of their processes;
- A fleet-wide third-party certification from Lloyd's Register which consists of annual assessment visits for ISO 9001:2015 (quality); ISO 14001:2015 (environment); OHSAS18001:2007 (occupational health and safety); and ISO 55001:2014 (asset management); and
- WANO IAEA peer reviews.

Management system review

13.18 EDF Energy NGL carries out reviews of its management systems to ensure its continued effectiveness of its arrangements and to provide a basis for continued improvement. These include executive summaries from the delivery teams (derived from prevention, detection and corrections reports in the fleet managed processes, self-assessments from the non-fleet managed processes), internal control self-assessments, process management arrangements, oversight reports and through station performance review meetings. Information from several sources is taken into consideration, including the licensee's performance, results from all forms of 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.

Improvement

13.19 EDF Energy NGL uses a number of processes to support continual improvement of the management system. Once the need for improvement is identified, corrective 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.

13.20 EDF Energy NGL considers the identification of opportunities for improvement as an ongoing responsibility and activity.

13.21 Multiple collaborative working groups have been established to share supply chain good practice and operational experience, such as the UK Safety Director's Forum and associated specialist sub-groups.

Audits of vendors and suppliers

13.22 EDF Energy NGL has arrangements to effectively manage its supply chain to assure itself of the quality of the items and services supplied to 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 management systems.

Graphite fuel sleeves

13.23 EDF Energy NGL routinely monitors the security of supply for AGR fuel components. It became clear that the manufacture of the graphite sleeves that surround AGR fuel elements was at risk because one of the facilities involved was under threat of closure.

13.24 The fuel element graphite sleeve serves several important functions. It is part of the structure of the fuel stringer, transferring the weight of the fuel stringer and part of the plug unit to the fuel support stool in-reactor, or to the tie bar via the bottom support assembly during fuel assembly handling. It also provides a pressure, thermal and flow barrier between the annular re-entrant coolant and the main coolant flow through the fuel stringer.

13.25 Graphite sleeves have a long lead time for procurement due to the nature of the manufacturing process. EDF Energy NGL had already built up a buffer stock of several years' requirement and on management becoming aware of the risk, negotiation to accelerate manufacture and secure a lifetime supply of the components was initiated. Contracts to achieve this have been agreed, which has mitigated the original risk.

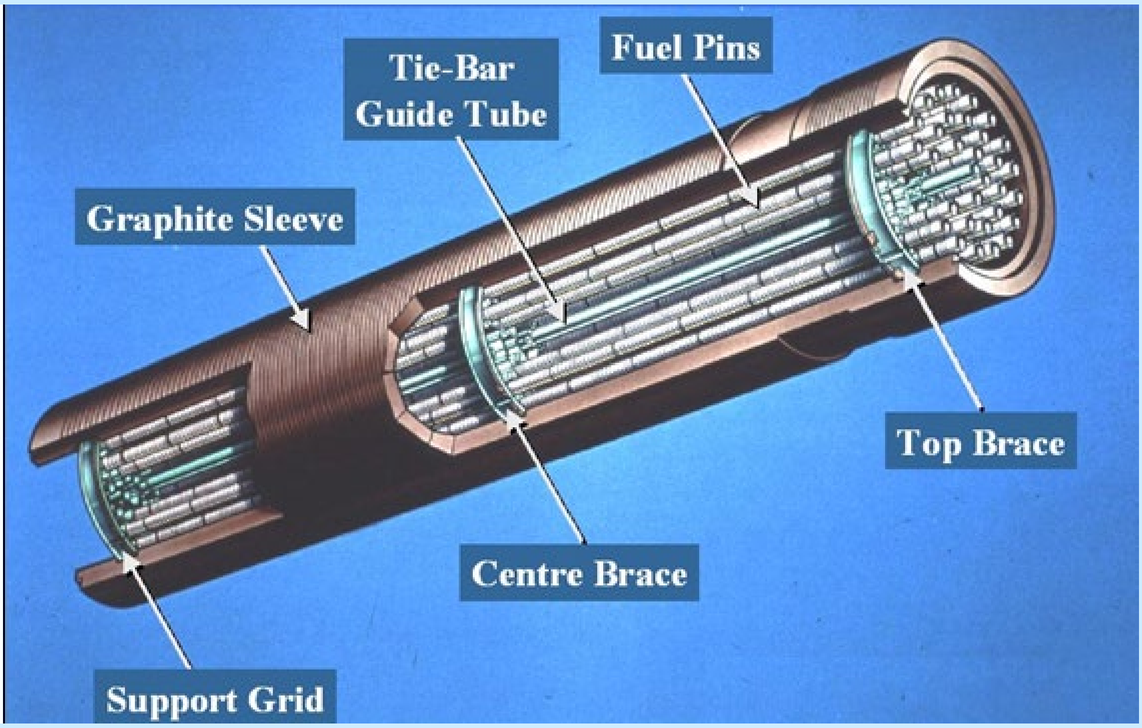


Figure 15 – AGR Fuel Assembly

13.26 All work on site carried out by contractors must be 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 the Maintenance Manager and is dependent on the complexity and location of the works.

13.27 Field Supervisors have specified training requirements and are responsible for:

- 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 party under the EDF Energy NGL safety rules and the associated requirements have been communicated to the work teams;
- Ensuring that the working party has been set to work using EDF Energy NGL setting to work process and pre-job brief process;
- Ensuring the work party fully understand and comply with the site requirements and procedures for working in radiation-controlled areas;

- Monitoring the work, and the health and safety performance, throughout the duration of the contract;
- Ensuring that the working party comply to the maintenance standards and expectations for work site management, procedure use and adherence compliance, management of foreign material control and the management of measure and test equipment control; and
- Ensuring all accidents are reported in accordance with site procedures and arrangements.

Hinkley Point C Project Quality

13.28 Quality management is integral to the successful delivery of the HPC Project.

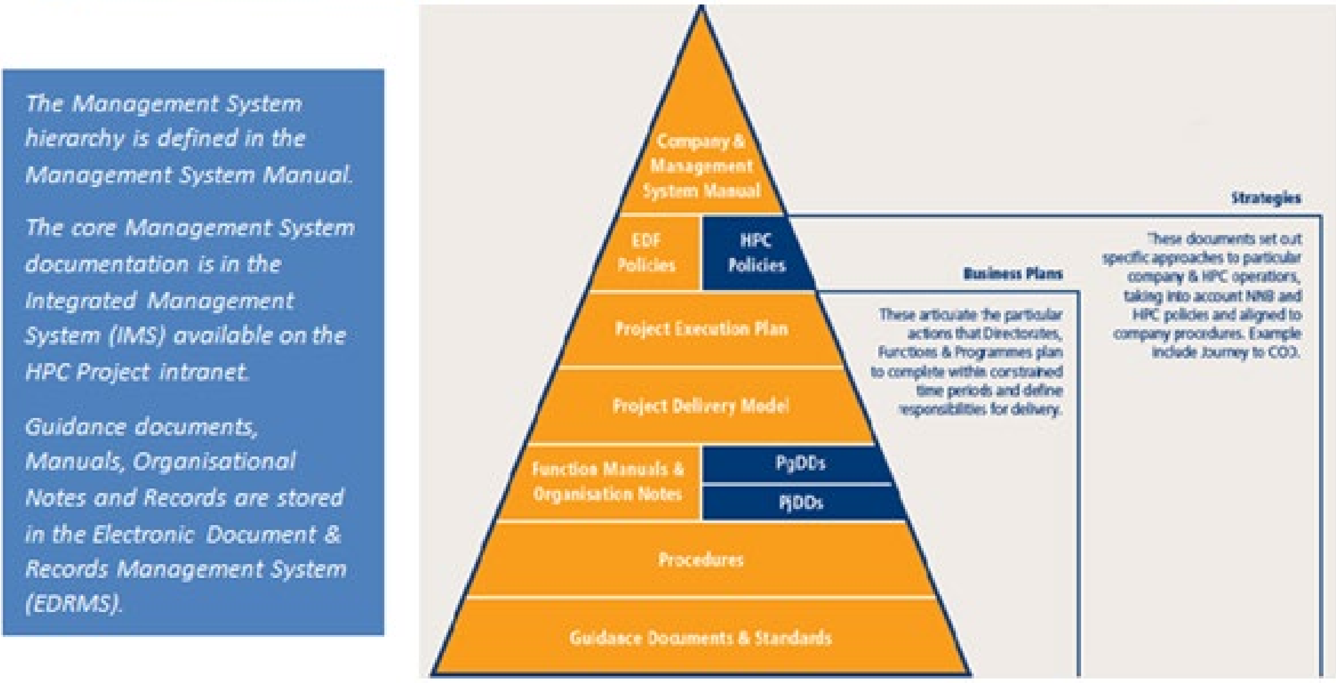
13.29 HPC Project has produced the 'Guide to HPC Project Quality', to help everyone working on the Project to navigate through the Quality Management arrangements. The diagram below provides an overview of the quality responsibilities across HPC Project.

Quality Roles	Procure	Design	Manufacture	Construct
Safety, Security & Assurance	• Maintain Key Quality Arrangements • Maintain 3rd party certification (ISO) • Supplier Audits • Oversight of Quality issues reported by Quality Delivery Managers			
Supply Chain Management	• Pre Start of Contract (SOC) Quality Management of Suppliers • Manage Procurement Process to SOC		• Supply Chain Policy Assurance • Assess risk of NCFSI in Supply Chain • Assess Suppliers' Nuclear Safety Culture	
Engineering PI / TMA / DA		• Review & Acceptance of Design Deliverables	• As-Built Design Surveillance	
Engineering MIT	• Oversight of Procurement Process		• Technical Assessment of manufacturers capabilities • Review Inspection & Test Plan (ITPs / PUDs) • Quality Release Certificates (QRCs)	• Site Installation Surveillance
Programmes 6 x MDTs	• Support evaluation of Supplier's Pre-Qualification Questionnaires (PQQ) and Tenders	• Review Designers Quality Plans • Review Quality Related Activities (QRAs)		• Review Suppliers' Inspection & Test Plans (ITPs) • Construction Surveillance • Review Life Time Quality Records (LTQR) • End of Construction Status Report (ECSR)

Figure 16 – Quality responsibilities across the HPC project

13.30 The following arrangements represent the core Quality Arrangements to define HPC Project and Contractors requirements.

HPC Quality Policy	Sets out the high level principles and requirements for Quality
Quality Execution Procedure	This procedure describes how each Programme monitors its compliance with HPC Project procedures. It refers to a template for Quality Execution Plans
General Quality Execution Specification (GQAS)	This document set out HPC Project's quality management requirements for the supply chain
Guidance for Quality Related Activities (QRAs)	GQAS defines Quality Related Activities and this document provides guidance on their identification, review/acceptance and implementation
Inspection & Test Plan Specification	This document defines HPC Project's requirements for suppliers' Inspection & Test Plans (ITPs)
Life Time Quality Record Specification for Contractors	This document specifies the contract requirements for suppliers to identify and provide LTQRs



Figures 17 and 18 – Core quality arrangements to define HPC project and contractor requirements

Regulatory requirements and review and control activities for quality management systems

13.31 TEA13 identifies ONR as the enforcing authority in relation to articles for use at work which are design, manufactured, imported or supplied. This gives ONR the power to inspect suppliers to UK nuclear licensed sites.

13.32 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, with its management systems, make and implement adequate quality management arrangements in respect of all matters which may affect safety.

13.33 ONR requires that the licensee's quality management arrangements are aligned with current national or international quality management system standards and that the arrangements adequately address all matters which may affect safety. The licensee may choose to use an integrated management system. This approach is a requirement of IAEA Safety Standard GSR Part 2 and is encouraged by ONR as it ensures that safety is considered in the licensee activities and is not confined to the quality / safety management systems.

13.34 An element of these arrangements is supply chain management. These arrangements, which include control of purchase of items and services and contract management activity, 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 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. 50).

13.35 In the last few years there have been two major international quality issues associated with reactor pressure boundary components produced at:

- Le Creusot Forge; and
- Kobe Steel Group.

13.36 UK has pressure boundary components that were manufactured at these two facilities. It has therefore undertaken activities to investigate the potential safety implications for UK plants and these are summarised below.

Response to the Kobe Steel Group event

ONR

13.37 Framatome (formerly Areva) Creusot Forge is a major supplier of forgings for the Hinkley Point C (HPC) steam generators and main coolant pipework, both items demanding very high structural integrity. Record anomalies and quality shortfalls had been identified at Framatome Creusot Forge. In response, Framatome Creusot Forge instigated a programme of reviewing the records of all forgings that may have been affected by the anomalies and embarked on an extensive quality improvement plan.

13.38 ONR decided that enhanced regulatory focus was required to ensure that high integrity forgings destined for HPC were of the appropriate quality. ONR exercised its permissioning approach to regulation by informing the HPC licensee that it would need formal ONR approval to receive the first shipment of the nuclear steam supply system at the HPC site. A significant basis for this approval would be that the forgings produced at Framatome Creusot Forge were acceptable.

13.39 ONR’s regulatory activity comprised of an intense scrutiny of the licensee’s oversight of the manufacture of the primary circuit, complemented by an ONR inspection of Framatome Creusot Forge. The latter was designated as a Chief Nuclear Inspector’s inspection targeted at areas of licensee or supply chain activity which ONR considers are of high risk or strategic importance.

13.40 ONR’s Chief Nuclear Inspector inspection involved a team of five inspectors examining a wide range of areas, such as resources, training, safety culture and management of non-conformances. ONR was able to confirm that significant progress had been made by Framatome 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. By interviewing staff on the shop floor, ONR judged that a positive safety culture was present. For example, staff had benefited from visits to operating French nuclear power stations to see how their work had a direct impact on nuclear safety.

13.41 ONR was satisfied that the risk to the quality of future forgings was minimised through the HPC licensee’s surveillance arrangements.

13.42 The French Nuclear Safety Authority (ASN) was also active in assessing the progress at Framatome Creusot Forge regarding both the review of records and quality improvements. ONR was also an active participant in the ASN-led MDEP inspection (see paragraph 13.37 to 13.50) of Framatome Creusot Forge. Consequently, both regulators benefited by working closely on this matter.

NNB GenCo

13.43 During 2017, NNB GenCo undertook a self-assessment of the supply chain arrangements which included peer reviews at Framatome's facilities at Creusot Forge, St. Marcel and Jeumont.

13.44 Chief Nuclear Inspector's findings, NNB GenCo developed and implemented the Supplier Quality Improvement Plan (SQIMP) sponsored by the Safety, Security and Assurance Director. The SQIMP is based on six themes: assurance, quality, supply chain, manufacturing inspection, construction, and existing actions contained in other plans.

13.45 A monthly SQIMP Steering Committee was established to monitor progress. By June 2018, sufficient progress and demonstration of improvements in NNB GenCo's supply chain arrangements was provided to support readiness for the Nuclear Island Concrete hold point in August 2018.

13.46 In addition, the key learning from Framatome Creusot Forge has been shared with NNB GenCo's Tier 1 Suppliers.

13.47 By improving NNB GenCo supply chain management arrangements, the SQIMP has ensured readiness for the commencement of the significant ramp-up of construction and manufacturing activities for the HPC Project.

EDF Energy NGL

13.48 The Creusot Forge facility also manufactured forged components for the Sizewell B (SZB) primary circuit pressure boundary. Specifically, these were forgings that were used to fabricate the reactor pressure vessel (RPV), and each of the four steam generators. Following release of the Framatome and ASN statements, several reviews of Sizewell B manufacturing records were initiated. Two reviews of archive records at Creusot Forge were conducted, during which the records for all Sizewell B forgings, manufactured at Creusot Forge facility, were reviewed. The vast majority of records did not contain any evidence of manufacturing or recording anomalies, nor inconsistency between archive wet records (original test documents), Framatome-held end of manufacture report records and EDF Energy NGL held lifetime records. The records demonstrate a high level of independent scrutiny and oversight during the manufacturing and fabrication of the Creusot Forge sourced components.

13.49 The reviews did not find any evidence of systematic irregularities within SZB records equivalent to those originally identified by Framatome. Five observations were made and examined individually to provide assurance that there were no implications for the safety of Sizewell B.

13.50 The overall conclusion from the extensive reviews undertaken confirms that there was no significant challenge to the integrity of Creusot Forge manufactured SZB primary circuit components, arising from the identification of irregularities within quality assurance records at the Framatome owned Creusot Forge facility.

13.51 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.

13.52 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.

13.53 The self-inspection identified examples of employees working in multiple departments, including manufacturing and quality assurance, being involved in misconducts over a "long period".

13.54 ONR became aware of the counterfeit, fraudulent, suspect items event as a result of its domestic and international regulatory activities in October 2017. The national press also published reports of risks associated with product supplied by Kobe Steel and its potential impact on over 500 customers worldwide covering a number of high hazard industries including manufacturers of cars, aviation and nuclear.

13.55 In order to assess the potential risk to the GB nuclear industry, the ONR Technical Director wrote to 16 Licensees and 3 other dutyholders for written confirmation on whether Kobe Steel Group products were installed within their facilities for nuclear safety-related applications or utilised to support nuclear safety-related operations; or, if such products had entered their supply chain, the risks have been considered and appropriate mitigating action taken.

13.56 The initial responses identified that two of the 19 dutyholders confirmed the presence of the implicated material being supplied by Kobe Steel. Both dutyholders committed to undertake full investigation and subsequently confirmed that there had not been any adverse safety implications as a result.

13.57 ONR completed its assessment of the potential risks to the UK nuclear industry and concluded that there was no evidence of any materials or products associated with Kobe Steel being considered unsafe for use.

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 Seventh UK report (Ref. 18) (i.e. 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 ONR's standard site licence conditions 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 licence conditions most relevant to safety assessment and/or safety verification are (see Table A6 - Table of Licence Conditions for further description of these conditions):

- 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, LC10, LC12, LC26 and LC36 deal with competency, capability and control and supervision of personnel who are involved in safety assessment and/or safety verification. The licensee must also have arrangements for compliance with relevant statutory provisions of the HSWA74 (Ref. 20). Examples include the MHSWR (Ref. 52) (which require the licensees to make assessments of the health and safety risks of their activities) and the IRR17 (which provide for the protection of all workers and members of the public from ionising radiations) (Ref. 43), as well as other appropriate legislation (see Article 7 – Legislative and Regulatory Framework for 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 GDA, (discussed in paragraph 14.24 to 14.33);
- 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 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.

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. 55) and TAG 'The Purpose, Scope, and Content of Safety Cases' (Ref. 56) 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 / hazards;
- Meet any relevant design safety requirements and criteria;
- Conform to 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 PSRs.

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 13.32), 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 – Radiation 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 both 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 nuclear power plants can be found under Article 18 – Design and Construction.

14.15 It is a dutyholder requirement 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 (i.e. the dutyholder has control over the initiating event in some form). 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 18.25 to 18.31.

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. Regarding the severity of the design basis event for natural hazards, a frequency of $1x10^{-4}$ per year (conservatively defined) is considered reasonable in the UK (SAP EHA.4). 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 18.42 to 18.46.

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, in order to demonstrate its acceptability. 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 approximately every three years, or sooner 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 used to provide revised Level 2 and 3 dose / risk information.

14.21 The PSAs for the AGRs 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 five 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 what is 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.

14.23 Sizewell B also has a seismic PSA. For the AGRs, comprehensive external hazards PSAs have not been carried out, although external hazards are to some extent represented in the PSAs – most design basis external hazards are shown to be bounded by internal plant based faults. Furthermore, the AGR level 2 PSA developed in response to the Fukushima accident included a selection of beyond design basis external hazards. ONR is continuing its engagement with the licensee and is seeking further improvements where these will provide additional risk insights. It is ONR's expectation that modern standards external hazards PSAs will be developed for any proposed new reactors in the UK.

NNB GenCo approach to safety assessment

14.24 This section gives evidence in support of UK's compliance with **VDNS Principle 1**.

14.25 In line with ONR regulatory expectations, as captured in the licence conditions for safety documentation and operating rules of the site licence, the HPC 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 HPC project procedures.

14.26 The starting point for the HPC safety assessments was the combination of a generic assessment of the UK EPR design, combined with site specific elements related to the HPC site. The UK EPR reactor design was subject to the UK GDA process and a Design Acceptance Confirmation (DAC) and Statement of Design Acceptability (SoDA) were issued when this process was successfully completed in 2012.

14.27 The GDA process is a four-stage process with the requesting parties for the UK EPR design being EDF and AREVA (now Framatome). The design assessed during GDA was based upon the Flamanville 3 (FA3) EPR design as it was at the start of GDA. Modifications to this design occurred during GDA as a result of feedback from the GDA assessment and this became the initial design for HPC. The FA3 design has remained the HPC reference design with modifications and learning continuing to flow from FA3 to HPC. 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.

14.28 The site-specific elements of the HPC 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). While this document was not used to permission the commencement of any site activities at that time, it was an important starting point for the HPC safety assessments with the combination of the generic and site-specific elements.

14.29 In accordance with LC19, the HPC 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, HPC has produced further safety assessments to justify the activities being undertaken. For HPC reactor 1, to launch construction of First Nuclear Safety Concrete (FNSC), the HPC Technical Galleries, Construction Safety Justification 1 (CSJ-01) was produced. This built upon PCSR 2012 and provided supplementary assessment to launch FNSC. To launch Nuclear Island Concrete (NIC) and support all further construction activities through to commissioning, PCSR3 was issued in 2017 and this supported the successful pouring of NIC in 2018. The next major safety submission for HPC will be the Pre-Commissioning Safety Report (PCmSR), to be implemented in 2023 to support active commissioning of HPC.

14.30 A key element of the site-specific parts of the HPC 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, HPC 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 HPC design (for example the HPC 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 HPC. 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 HPC and FA3.

14.31 A further key part of the site specific HPC safety case is in relation to the fault studies and the starting point for HPC is the GDA fault studies. The development of the HPC fault studies has taken account of modifications that have been made to the HPC 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 HPC. A further key evolution for the presentation of the fault studies at HPC, 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 HPC linking the fault studies to the lines of protection, levels of diversity, among other things.

14.32 Since the UK EPR is an evolutionary design, with many decisions on fundamental safety approaches dating back to the 1990s, the assessment that risks have been reduced ALARP needs to largely build on the evolutionary developments and the use of OPEX and learning from earlier plants. Where further decisions have then been made that alters the UK EPR 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 design being built at HPC already presents a very low risk in relation to nuclear safety frequency targets and there are few major changes that might be made that could be considered as reasonably practicable.

14.33 Strong configuration management is fundamental to maintaining a good quality safety case that is aligned to the current HPC design. The FA3 design was used as a starting point for HPC but has itself continued to evolve and this has included important learning for HPC. 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 HPC configuration control processes and introduced in batches that are termed Reference Configurations (RC). For HPC these have been RC0 (HPC starting RC), RC1 (including extensions RC1.1 and RC1.2) and RC2. The HPC PCSR3 was written against RC1.2 and the HPC PCmSR will be written against RC2. Any safety significant changes to the HPC design undergo formal safety assessment against HPC’s arrangements for LC20 (modification to design of plant under construction). The LC20 arrangements require the production of updates to the HPC 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

14.34 This section gives evidence in support of UK’s compliance with **VDNS Principles 2 and 3**.

14.35 Major safety reviews are carried out by licensees, every ten years (or more frequently, if necessary, for example following a major event). The legal basis for periodic safety reviews (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 (Ref. 56) sets out what ONR expects to see in the PSR.

14.36 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 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.

14.37 There has been a requirement for licensees to undertake PSRs since the introduction of the standard nuclear site licence in 1990. The programme for the UK's nuclear installations' PSRs is given in Table 4 below.

14.38 The PSRs aim to confirm that the arrangements are adequate to maintain safety until the time of the next review. As stated above, PSRs complement the normal operational monitoring of safety, which is also regulated by ONR. Therefore, although the PSRs may conclude that the arrangements are adequate for another ten 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 throw doubt upon the continuing validity of the safety case, this would require the licensee to resolve the matter to ONR’s satisfaction.

14.39 The second round of decennial PSRs (PSR2) for the EDF Energy NGL stations was completed in 2014. Following a review of their PSR processes, EDF Energy NGL identified improvements for the third round of PSRs (PSR3). The approach taken for PSR3 is closely aligned to the latest International Atomic Energy Agency (IAEA) guidance on PSRs (SSG-25, Ref. 71) and the focus was on the adequacy and effectiveness of the normal business arrangements in place to ensure plant safety. The main changes for 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 (Ref. 71) This is in line with **VDNS Principle 3**.

14.40 The third cycle of PSR reviews has been completed by EDF Energy NGL for all the AGR stations, and the submissions for Heysham 2 and Torness are currently being reviewed by ONR. The ONR findings from its assessments of the completed PSR reports for each station were published on the ONR website (Ref. 89).

Table 4 - Status of Periodic Safety Reviews (EDF Energy NGL Stations)

AGR/PWR 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	1995	2005	2014	Planned for 2024

Safety assessment by the dutyholder: improvements as a result of safety assessments and reviews

14.41 The results of the PSRs have produced, and continue to produce, worthwhile improvements to safety. Since the Seventh UK Convention Report, a number of 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 / Torness and Hartlepool / Heysham 1, to mitigate the potential for primary shutdown reliability to be affected by late life effects of graphite core brick cracking.
- 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.

Regulatory review of dutyholders' safety submissions

14.42 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.

14.43 In the UK, there are different regulatory requirements for nuclear safety, security and environment. To ensure that there are no inconsistencies in what the regulators do, they 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.

14.44 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 (Ref. 55) and TAGs (Ref. 56).

14.45 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 and Ref. 55).

14.46 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. An example of such a review can be found in Section 4.2.3.5 of the GDA Step 4 report on the Structural Integrity of the UK EPR (Ref. 90).

14.47 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.

14.48 ONR specialist inspectors have the capability to commission analysis work from a number of 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 authoritative advice to ONR inspectors. Funding for the work is charged directly to the relevant dutyholder.

14.49 The output of the assessment by an inspector from a particular technical discipline is captured in an assessment report. 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. 91).

14.50 The mechanics of assessment in GDA is 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. The regulators also publish quarterly updates describing the status of the assessment on their website (Ref. 14).

14.51 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. 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.

14.52 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 to be extremely unlikely with a high degree of confidence.

14.53 Ultimately, ONR seeks confirmation that the level of risk is reduced in so far as is reasonably practicable and that it would be disproportionate to reduce risk further by implementing further improvements

14.54 The approach adopted by ONR and described above meets the **first principle of the Vienna Declaration** which requires that new nuclear power plants are designed consistent with the objectives of preventing accidents.

Verification of safety

Examination, inspection, maintenance and testing

14.55 LC 28 requires licensees to ensure that all plant that may affect safety receive regular and systematic examination, maintenance, inspection and testing (EMIT). 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 EMIT that indicate that the safe operation or safe condition of the plant may be affected.

14.56 Significant amounts of EMIT can only be undertaken during shutdown conditions and in general this is carried out every 18 months (PWR) or 3 years (AGR) under LC30 arrangements requiring periodic shutdown. Restart following these planned shutdowns requires Consent from ONR. As reactors approach end of generation (EoG) the reactors may shutdown more frequently (for instance to allow additional inspections of ageing AGR graphite cores).

14.57 In order to justify operation until the next identified shutdown, the licensee should carry out analyses to predict that failures due to ageing processes, such as creep or fatigue, are unlikely in a defined future 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.

14.58 The licensees' overall EMIT 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.

14.59 In the design phase, diverse and redundant systems and plant are provided to ensure that safety-related systems meet the safety performance criteria and mitigate for active and passive failures and realistic maintenance requirements. These include issues such as the time taken to perform preventive maintenance and the time taken to correct defects.

14.60 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 EMIT 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.

14.61 Licence conditions require licensees to maintain adequate records of EMIT. This is subject to inspection via the ONR site inspection programme.

Surveillance of compliance with operational limits and conditions and configuration management

14.62 LC 23 (operating rules) requires the licensee to produce an adequate safety case for any operation that may affect safety and for the safety case to identify safe limits and conditions for operation. These (and relevant operating instructions) are in the form of technical specifications for the operating reactors in the UK. This is discussed in paragraphs 19.11 to 19.16.

14.63 EDF Energy NGL power plants have systems for verifying that the plant remains within the safe 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-focussed 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. 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. See page 181 for more information on event reporting.

14.64 PSA-based methods are used to support plant configuration control at all the operating plants in the UK. Older AGRs 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 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.

Ageing management programmes

14.65 The discussions in the sections below relate directly to the response to **Challenge 1** from the Seventh Convention.

14.66 ONR expects that licensees will take account of ageing from the design stage, through the operational life of the station and through 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. Examples are EAD.2 which 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. EAD.3 is another example – it states that where material properties could change with time and affect safety, provision should be made for periodic measurement of the properties.

14.67 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, ONR intends to focus more on the management of plant ageing to ensure decisions are made without eroding margins of safety.

Structural Integrity

14.68 One example is that on the AGR fleet, ONR is engaged to ensure that the degradation of the graphite core due to radiolytic oxidation does not exceed pre-determined thresholds. This degradation mechanism was recognised at the design stage, and significant research work has been undertaken to predict the rate of degradation, the effects of the degradation on graphite bricks making up the reactor core, and the effect on the overall safety case for reactivity faults. At periodic shutdowns, required under LC30, inspection and measurement of the graphite core is undertaken using cameras and other inspection equipment. Samples are removed from the core in order to confirm the rate of degradation and the effects of the degradation. Before granting consent to restart the reactor, ONR reviews the inspection evidence to satisfy itself that the core will remain within the limits defined in the safety case for the next period of operation. ONR would only grant consent to start up the reactor if the provided safety justification was judged to be adequate. Another graphite ageing mechanism is described below.

Graphite Ageing

14.69 Figure 19 shows an example of the graphite bricks that make up an AGR core. The internal stresses in the graphite bricks change over time and as a result it is expected that cracking will occur in some of the bricks as they age. This cracking is significant because such degradation could impede safe entry of control rods should the reactor need to be shut down. This is a well-known phenomenon which was fully considered as part of the stations’ design and included in their operational safety case.

14.70 EDF Energy NGL has a graphite research programme which benefits from the expertise of their own team of graphite specialists, along with expert academics at several universities and leading companies across the UK. EDF Energy NGL has been working over many years to fully understand and prepare for these late life changes to the reactor core and regular inspections at all the plants have provided a clear understanding of how the reactor core ages. More than £100m in the last five years and more than 1000 person years has been invested into research

14.71 EDF Energy NGL closely monitors the condition of the graphite in the reactors. Graphite inspections are normally carried out during a reactor’s periodic outage, which takes place every three years. Inspections are held more frequently at the longest-operating stations; Hunterston B and Hinkley Point B. EDF Energy NGL has been working over many years to fully understand and prepare for these late life changes to the reactor core and regular inspections at all its plants have provided a clear understanding of how the reactor cores age. The results of each of these inspections allow EDF Energy NGL to understand clearly how the reactor cores behave.

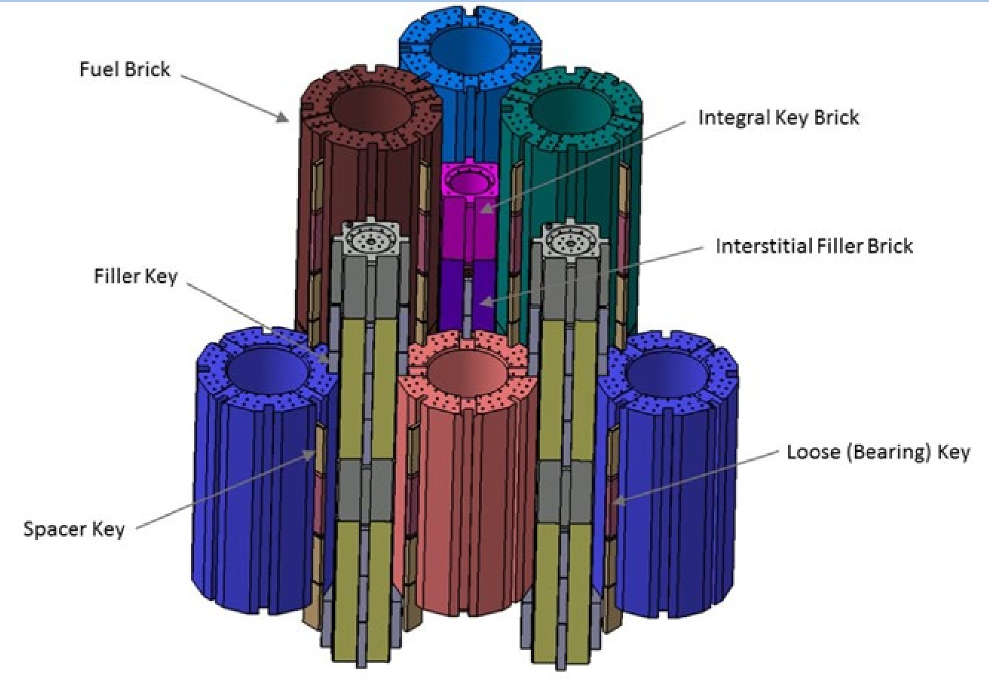


Figure 19 – Arrangement of graphite fuel bricks in AGR core

14.72 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 degrees C, which places a number of 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.

14.73 ONR has been engaging with EDF Energy NGL to confirm the adequacy of its arrangements for the management of corrosion on concealed systems (for example buried pipework and pressurised systems covered in insulation). This has involved a series of inspections across the fleet which has identified significant shortfalls at Dungeness B. These are being addressed by the licensee as part of their event recovery process. ONR continues to provide independent oversight in monitoring the progress. Both reactors will remain shut down at Dungeness B until the necessary remediation has been completed. This is discussed further below.

Corrosion at Dungeness B

14.74 In response to the potential threat to systems, structures and components (SSCs) by corrosion under insulation (CUI) and associated plant failures, ONR initiated a specific intervention to assess the adequacy of EDF Energy NGL's arrangements to manage the integrity of their concealed pipework. ONR targeted this intervention on concealed pipework as intelligence from previous failures / near misses on EDF Energy NGL sites suggested that concealed pipework was a particularly challenging area.

14.75 Since April 2016, ONR has completed several corrosion-focussed inspections at Dungeness B Power Station (DNB), one of which took place in July 2018. Its aim was to assess the adequacy of arrangements related to DNB's corrosion management programme; particularly focussed upon previously identified shortfalls. During this inspection, whilst it was clear that some improvements had been made, there were several substantial improvements still required, generally related to uncertainty relating to plant extent of condition and the basis for judgements made when allowing corroded plant to remain in service.

14.76 Using ONR’s Enforcement Management Model it was concluded that a Direction under licence condition 15 (periodic review) would be an effective and proportionate response. The Direction required EDF Energy NGL to carry out a review and reassessment of safety at Dungeness B, addressing the corrosion of concealed systems. In response to this Direction, EDF Energy NGL entered their event recovery process at DNB. Since issuing the Direction in September 2018, ONR has undertaken a number of inspections at DNB to monitor progress and provide early feedback on any issues. In addition, ONR has completed a review of the documents provided by EDF Energy NGL in response to the Direction.

14.77 At the time of writing, both reactors at DNB remained shut down as part of EDF Energy NGL’s ongoing corrosion and main steam event recovery programs. EDF Energy NGL has allocated significant resource, both in financial terms and with supply of expertise from across the fleet to assist DNB. In excess of 300m of pipework associated with reactor cooling systems has been renewed, along with renewal of numerous seismic pipework supports and remediation of CO2 storage vessels. In light of this, and from evidence gained during regular inspections at DNB, ONR has communicated to EDF Energy NGL that it is content the Direction issued under LC15 (4) can be considered closed. Representative photographs for some of the work completed by EDF Energy NGL during their event recovery are shown below:

Figure 20 – CO_2 tank 21 as found

Figure 21 - CO_2 HP tank 21 during remediation

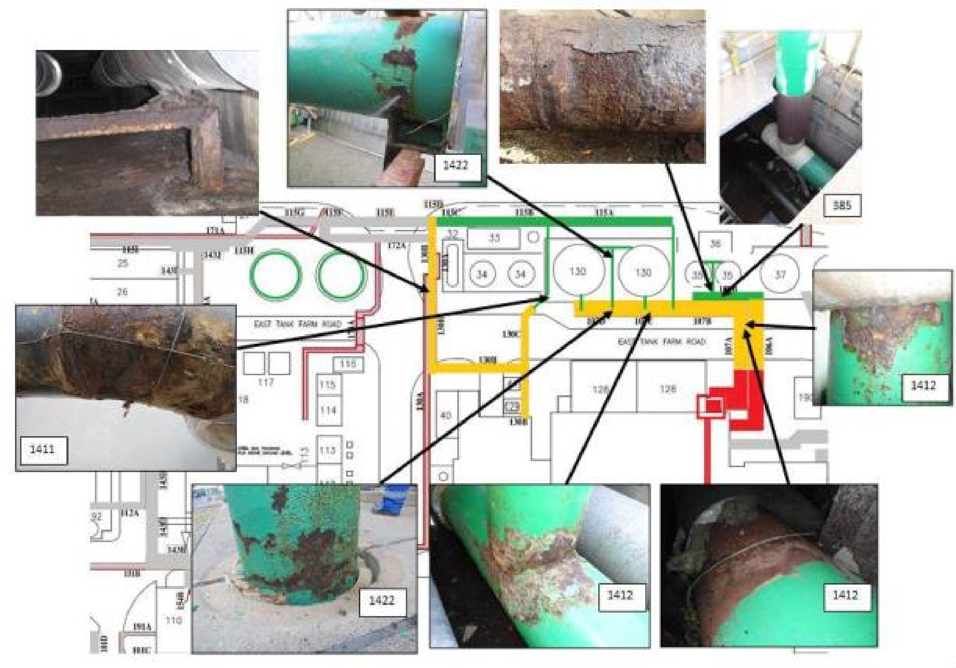


Figure 22 – Reserve feedwater pipework site layout, identifying areas requiring remediation before return to service

Figure 23 – Completed remediation on gas circulator fire pipework

14.78 EDF Energy NGL has identified several additional commitments that will be fulfilled prior to return to service of either reactor at DNB. These commitments will enable EDF Energy NGL to demonstrate to ONR that the risks posed by continued operation of the safety significant concealed systems at DNB are tolerable and ALARP. Most significant of these commitments is a demonstration that the bulk water storage tanks affected by corrosion remain suitable for service until their planned renewal. ONR continues to engage with EDF Energy NGL to monitor progress against commitments made.

14.79 For the remainder of EDF Energy NGL's UK operating reactor fleet, it should be noted that ONR has observed evidence of improvements in resolving most of its findings identified during the intervention. Notably, awareness of the significance of corrosion has increased and there is clear evidence of governance and oversight of the fleet approach to corrosion from EDF Energy NGL's central technical organisation and internal regulator.

14.80 From a fleet perspective, ONR is maintaining a programme of site-specific sampling to monitor progress. Three sites were identified for inspection during 2018/19 inspection period; Sizewell B, Hinkley Point B and Hartlepool. Three more will be selected for the 2019/20 inspection period. An "end-to-end" inspection of an appropriate nuclear safety significant system will take place to judge the adequacy of a range of compliance arrangements for concealed pipework, buried systems, storage tanks and pressure systems. Also, as part of routine inspections, ONR will continue to meet with EDF Energy NGL station corrosion co-ordinators during periodic shutdowns. Two Regulatory Issues remain in place to monitor progress made by EDF Energy NGL relating to corrosion management and its transition into "normal business"; one for DNB specific requirements and one for EDF Energy NGL's fleetwide management of pipework corrosion and CUI.

14.81 In addition to the corrosion issues discussed above, Dungeness B is also currently addressing issues with cracking of mainstream pipework. This is discussed below:

Main Steam Line corrosion at Dungeness B

14.82 During the 2018 R22 Statutory Outage at Dungeness B Boiler 27 main steam pipework was subject to planned in service inspection. A camera inspection identified surface breaking cracking at two locations in the bore where such defects were potentially not tolerable on main steam pipework. Samples of the crack sites were taken and identified the crack mechanism as predominantly stress corrosion cracking (SCC). Subsequent investigation of the extent of condition showed several other similar occurrences of cracking in the main steam lines and warming lines across different boilers.

14.83 EDF Energy NGL closely monitors feedwater quality, however during normal operation a level of chlorides and sulphates build up in the evaporator section of the boiler. The boiler tubes are tolerant to this because of their material composition. Post trip and when boilers are placed in flooded mode, these contaminants flow through into downstream pipework. Main steam pipework in the boiler house is 316 stainless steel, which is susceptible to SCC.

14.84 This is a known issue and is why the boilers are 'flushed' prior to return to service. Prior to 2008, this flushing regime was proven to not fully flush certain pipework sections where valves would be closed. At that time the flushing operation was modified and an inspection programme put in place focussed on low points in the steam pipework where boiler water could stagnate and evaporate. The discovery of defects indicates that there was some previously undetected historical damage on the plant.

14.85 Both reactors required boiler inspections to confirm absence of stress corrosion cracking in the main steam and warming lines and this, in combination with other emergent corrosion work led to extended outages on R21 and R22.

14.86 From the time of discovery of the first defects, ONR inspectors have engaged with the EDF Energy NGL to monitor reaction to the event by way of technical meetings, site inspections and document reviews. Evidence collected in this way will inform the eventual assessment of the licensee's safety case for return to service.

14.87 In Sizewell B's PWR reactor, an example of ageing management is the surveillance programme 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 and 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.

14.88 Considerable focus has also been placed on ensuring adequate programmes are implemented by licensees to address obsolescence issues, such as the example about AGR fuel tiebar obsolescence below.

AGR fuel tiebar obsolescence

14.89 The tiebar takes the full load of the fuel elements in AGRs during fuel handling operations. While not under a load bearing duty while resident in the reactor they are subject to a full dwell in reactor conditions and must perform with high reliability for multiple lifting operations when the fuel is removed from the reactor.

14.90 In 2003, EDF Energy NGL (then British Energy) learned that the supplier of the supplier of tiebar material intended to close down their manual hot rolling mill, which was part of the approved tiebar manufacturing route. A hot extrusion process was selected as a replacement step for hot rolling in the route. The upstream melting and downstream cold working and heat-treatment operations were unchanged.

14.91 A stock of tiebar material manufactured by the approved route was procured, but that stock was not sufficient to meet demand to end of station life. The modified route is required to ensure ongoing tiebar supply for all AGRs.

14.92 Whilst this modification to the manufacturing route was judged not to pose a significant threat to tiebar reliability, it was nevertheless proposed to support that judgement through a limited campaign of post irradiation examination (PIE) from a lead loading of modified route tiebars (MRTB) The lead load tiebars made using the modified route were manufactured and loaded with discharge restrictions into all four reactors at HPB and HNB power stations under engineering change control. Those tiebars were originally restricted to be discharged under extremely benign conditions. However, further safety cases were submitted in light of PIE evidence gained by testing some early discharged MRTBs, which enabled relaxation of the discharge conditions.

14.93 Additionally, the manual hot rolling mill remained in operation until 2010, which was longer than had been anticipated. This enabled the procurement of a further stock of current route tiebars, although still not sufficient for currently predicted end-of-life of AGR stations.

14.94 Due to the procurement of an additional supply of tiebars, the initial intent of a lead load effectively became a pilot load, where modified route tiebars are discharged at the end-of-life, with some of them being subjected to PIE before the mainstream loading safety case was required. This PIE will support the justification for mainstream loading of MRTB across all AGRs with intention to have no additional restrictions on handling conditions.

Electrical Engineering

14.95 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 in order to cool the fuel.

Neutron Flux Detector Obsolescence

14.96 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 enables the licensee to determine and implement those necessary measures needed for ensuring that the gas circulator winding insulation condition is adequate for carrying out its required safety function.

14.97 ONR routinely inspects a sample of the gas circulator stator insulation monitoring activities against LC28 requirements. Thismaintains confidence in the licensee’s arrangements for ensuring adequate stator winding insulation condition. The photographs are examples to show the material condition of the non-connection (drive) end of two separate gas circulator motor stators (one rewound and one aged).

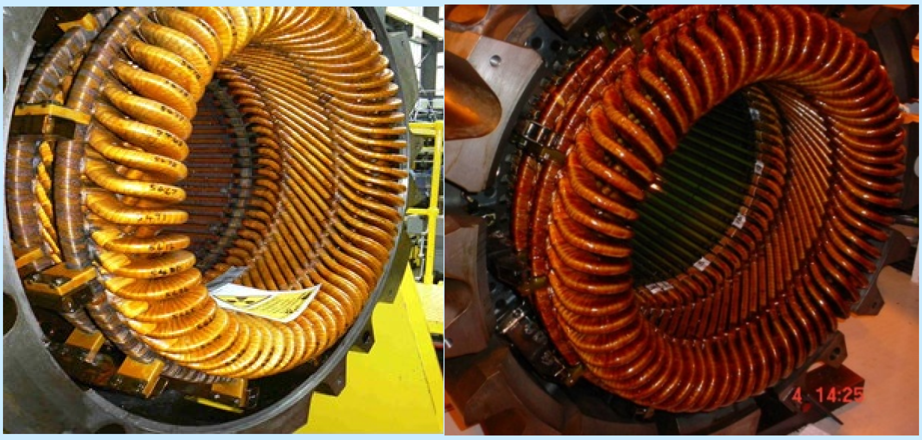


Figure 24 – Drive end of a rewound stator (left) and aged stator (right)

Control and Instrumentation (C&I)

A wide range of 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.

14.98 Inadequate ageing and obsolescence management 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.

14.99 ONR has also encouraged licensees to share ageing and obsolescence operational experience (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 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, (e.g. at quarterly meetings). An example of obsolescence issues being addressed on the AGR fleet is discussed below.

14.106 EDF Energy NGL operates in accordance with a single unified management system that integrates safety, health, environmental, security, quality and economic objectives. The

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 original equipment manufacturers (OEM) were Plessey and Centronic with the United Kingdom Atomic Energy Authority (UKAEA) acting as Detector Design Authority. ULTRA NCS (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 a number of in-core flux detectors across the AGR fleet, EDF Energy NGL established the AGR neutron flux detector programme (NFDP) to manage both operation and supply chain components, comprising:

- Operational focus; short-term activities to monitor and maintain the existing in-service and spare detectors to ensure they support safe, reliable generation, while the supply chain is being re-established. This is supported by the production of a guidance note within the technical governance process to cover:
  - Routine testing of neutron flux detectors and spares in storage;
  - Trending and condition monitoring to identify adverse trends;
  - Classification of detector status (healthy/degraded/failed) based on results of testing and trending; and
  - Guidance on the management of degraded detectors.
- Working with the successor to the OEM companies - ULTRA NCS (Nuclear Control System) to re-establish the existing supply chain and establish an alternative flux detector manufacturing facility

14.103 Detectors were produced to General Specifications (Gen Specs). These were not simply specifications but also include manufacturing, production, qualification and testing information in addition to functional requirements. Over time, the Gen Specs have been updated to capture the various failure modes to make detectors more reliable.

14.104 The principle of maintaining equivalence between the existing detectors and the replacement detectors has been adopted. Some changes have been made to the updated Gen Specs to improve reliability, manufacturability and to update to modern standards. The replacement detectors will not be identical to the originals. However, none of these changes have affected the fit, form or function of the new detectors.

14.105 The EDF Energy NGL safety case strategy for the NFDP is based on the classic C&I model of:

- Design and Build Prototype;
- Qualification;
- Substantiate Design;
- Complete Safety Case around the Design Substantiation Report; and
- Production.

The development of the first detector design has achieved design substantiation and work is focussed on developing a reliable production process to enable routine supply while maintaining compliance with the specification.

management system defines the responsibilities of key post holders, the line management organisation and the main interfaces between the company and other organisations.

14.107 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.

14.108 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 also has an independent reporting route to the EDF Group Inspector General for Nuclear Safety. INA has a team of three 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 and all significant changes to the safety case (including plant modifications and changes to organisational structure) before they are submitted to the 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 two 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.
- 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. Historically, the peer reviews were performed once every three years. The peer review frequencies have been aligned across the industry with routine reviews now being completed on a four-year cycle.
    - An OSART follow-up review took place at Sizewell B in 2017. Torness hosted a full-scope OSART mission in 2018 and EDF Energy NGL has, through BEIS, requested a follow up mission at Torness in 2019 and a further OSART mission at Heysham 2 in 2022.

14.109 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 HPC Design Authority, who own the HPC safety case, separate independent challenge forms additional layers of a barrier model approach to ensuring high quality submissions. As part of 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) in compliance with the licence conditions. The NSC advises the HPC Board in these matters. Their 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 activities

14.110 An 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.

14.111 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 a number of reasons , ranging from to, which also serves to ensure the continued independence of ONR inspectors.

14.112 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 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.

14.113 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 takes into account 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).

14.114 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. They make their findings known to the operator, so that improvements are made, where appropriate.

14.115 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 and the regulatory strategy for the site. Occasionally, ONR inspectors also undertake unannounced inspections and out of hours inspections.

14.116 LC29 requires licensees to carry out and report the results of tests, inspections and examinations specified by ONR. This condition may therefore be regarded as a verification activity by the nuclear regulator or to intervene to improve knowledge or secure a safety improvement.

14.117 ONR also carries out programme 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 five-year period.

14.118 Each SBI is undertaken by a small team of inspectors from appropriate disciplines. The SBI typically takes place over a two-day period and includes document review, discussions with licensee staff and plant walk-downs. SBIs are structured around compliance with six licence conditions; these cover training, operating rules, operating instructions, safety mechanisms, maintenance and leakage of radioactive materials.

14.119 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.

14.120 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.

14.121 ONR has recently reviewed its SBI programme following its first five-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 when 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 in order to get a fuller picture of the system and its interactions. The PWR SBIs at Sizewell B have not yet been reviewed.

14.122 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 potential of aged plant based on operational experience. This will be carried out at three stations.

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 Seventh UK report (Ref. 18) (i.e. 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 ALARP (as low as reasonably practicable) 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, but unlike ALARP, does not have a legal basis in UK law (see Annex 3 - SFAIRP, ALARP and ALARA for a more detailed discussion of these concepts). The ALARP principle requires all nuclear site operators to follow relevant good practice and adopt practices that could further reduce the risk if it is reasonably practicable to do so. Where relevant good practice is not clearly established, the operator must assess the significance of the risks (both their extent and likelihood) to determine what action is required. 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.

15.4 Licensees are required by the Ionising Radiations Regulations (IRR) 17 to restrict exposure by means of engineering controls. This includes shielding, physical separation, containment, ventilation and warning devices, where these are reasonably practicable, rather than by relying on systems of work or personal protective equipment.

15.5 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 licensees have considerable experience in developing dose databases which provide accurate dose forecasts for planned tasks.

15.6 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 ALARP.

Dose limitation

15.7 ONR's SAPs include some lower numerical 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 a radiation 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 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 a number of years.

15.8 IRR17 also allow the dose limitation for an individual worker in specified circumstances to be based on a dose of 100 mSv averaged over a period of five consecutive calendar years. This allows for a maximum 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.

15.9 If an employee is likely to receive a radiation dose greater than three-tenths of a relevant dose limit in a year (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 HSE. 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; this data is periodically analysed to identify any trends in dose uptake. Dose records are kept until the person has (or would have) reached the age of 75 years.

15.10 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.

15.11 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 or not sufficient action is being taken to restrict exposure to ionising radiations, SFAIRP.

15.12 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.

15.13 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.

15.14 An example of EDF Energy NGL's control of doses received by workers is discussed below.

Neutron Dose Control during the first Dry Fuel Store campaign at Sizewell B

15.15 During the first dry fuel storage (DFS) campaign at Sizewell B, neutron electronic personal dosimeters (EPD) were integrated with real-time HD camera, teledosimetry and communications systems to reduce neutron doses around casks containing irradiated fuel.

15.16 The DFS pre-campaign ALARA report identified the monitoring and control of neutron exposure as a key Radiological Protection (RP) concern, with changing neutron to gamma ratios occurring during fuel cask draining and helium purging, variable neutron to gamma ratios caused by equipment and shielding around the top of the cask and neutron scatter in the cask preparation bay. 'Passive' neutron badges can have a high minimum dose threshold so the EDF Energy NGL RP team proposed using neutron EPDs to measure real-time doses and compare with the 'passive' badges. Neutron EPDs were integrated with the existing plant remote monitoring system, which features high definition cameras, telecommunications headsets and remote monitoring terminals. Rather than depending upon a fixed neutron to gamma ratio, RP team members and cask supervisors could exercise real-time dose control for workers in the elevated neutron and gamma dose rate areas. This enabled the movement of gamma or neutron shielding or critique of worker positioning and task performance based directly on the neutron EPD result rather than causing additional dose by requesting RP to make additional field measurements.

15.17 All casks were delivered below their ALARA goals, with each cask being subsequently delivered for a lower dose. The maximum individual dose was delivered below the campaign 2 mSv target. Neutron doses were approximately 20% of the total collective radiation exposure. The use of neutron EPDs in the remote monitoring system made a significant contribution to dose reduction and was recognised by WANO as a unique strength.

15.18 Most of the doses on site relate to vessel entry work which is largely undertaken by contract staff. For EDF Energy NGL sites (which are all operational sites) data for all employee and contractor doses for 2011-2018 is given in Table 6 below.

15.19 The total collective dose to all persons working on EDF Energy NGL sites during calendar year 2018 was 0.82 manSv, 0.26 manSv to employees and 0.56 manSv to contractors.

15.20 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.

15.21 The maximum individual dose received by an EDF Energy NGL employee in 2018 was 5.69 mSv. The maximum individual dose received by a contractor in 2018 was 4.68 mSv. In 2018, the average dose received by EDF Energy NGL employees was 0.045 mSv and by contractors was 0.065 mSv.

15.22 Electronic Personal Dosimeters are used at all EDF Energy NGL sites as the legally approved dosimeter to make assessments of individual radiation exposure.

Table 6 – Doses at EDF Energy NGL sites

		2015	2016	2017	2018
Employees	Collective dose – (man-mSv)	308.64	318.780	259.448	255.763
	Average dose – (mSv)	0.056	0.059	0.047	0.045

	Maximum dose – (mSv)	6.827	5.188	5.542	5.693
Contractors	Collective dose – (man-mSv)	674.44	535.114	313.249	560.684
	Average dose – (mSv)	0.074	0.069	0.040	0.065
	Maximum dose – (mSv)	7.781	3.993	4.168	4.682
Total		983.08	853.894	572.697	816.447

15.23 An example of good dose management practices during an outage is discussed below.

Heysham 2 / Torness Vessel entry

15.24 Two extensive repair and inspection outages requiring entry into the reactor vessel at Heysham 2 and Torness were undertaken during 2018.

15.25 There were 3 main areas of work:

- Repair to peripheral in-service inspection standpipes.
- Inspections of the behaviour of creeping stainless steel components in CO2 reactor gas environment conditions in AGRs (high temperature behaviour of austenitic stainless steels – HTBASS).
- Installation of 15 thermocouples at the reheater inlet, boiler gas inlet and upper transition joint levels of boilers A1 and D3 at Torness only. These provide peak temperature data to which the boilers are exposed and assess the validity of station operating instruction limits.

15.26 Vessel entrants wear full enclosure ‘hot entry’ suits to provide them with an independent air supply from outside the vessel and to keep them cool during the work. Unless this suit is damaged then radiation dose to vessel entrants from skin contamination or inhalation of airborne radioactivity is negligible. Radiation dose to vessel entrants is dominated by external gamma radiation, which is variable within the different areas within the vessel. Although radiological conditions are fairly predictable radiation surveys are carried out in each area of the vessel prior to commencement of work to confirm dose rates are acceptable for the planned work, provide information for re-assessment of doses if necessary, identify any work areas where specific radiation dose rate reduction measures may be required for ALARP purposes (for example dust redistribution and possibly shielding) and confirm areas / locations within the pressure vessel that are suitable for use as low dose rate sanctuaries. The dose uptake to workers is monitored by the work Technical Controller in real time using teledosimetry, which allows them to make real-time decisions regarding worker dose and communicate with the workers via radio in vessel.

15.27 Both campaigns exhibited good radiological controls with both sites coming in under the predicted collective exposure. A small increase to vessel entry dose constraints, from 1.5mSv to 2mSv per operator per entry, allowed more work to be completed per entry. As per the intention this yielded a significant saving in ‘lost’ transit dose due to reducing the dose accrued during transit to the point of work and hence resulted in an overall reduction in collective and individual doses. Site specific and company level ALARP committee engagement was effective in ensuring oversight of radiological protection standards and promulgating any learning between the sites.

Public doses

15.28 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.

15.29 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 RSA93 and EPR16, respectively.

Control of exposure

Qualified experts

15.30 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 to appoint and consult a RPA, under IRR17, to provide expert advice on compliance with those regulations. HSE has published a statement (Ref. 92) on RPAs, setting out criteria for core competences of individuals and bodies intending to give advice as RPAs.

Controlled areas

15.31 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.

15.32 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.

15.33 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.

Local rules and procedures

15.34 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. 93 paragraphs 329 – 338) 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 in compliance with the arrangements licensees have put in place to comply with IRR17, in particular, 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

15.35 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. 8984).

Environmental discharges and monitoring

15.36 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 as required by the Basic Safety Standards Directive.
- Require sampling and analysis to determine compliance with authorisation conditions, reporting of the quantities of radioactive waste disposed of, non-compliance with limits;
- May specify improvements in waste management arrangements; and
- Require operators to use best practicable means in Scotland or best available techniques in England and Wales to minimise discharges to reduce impacts to ALARA.

15.37 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. LC34 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 arrangements (Refer to Table A6 - Table of Licence Conditions).

15.38 EPR16 (Ref. 25) includes the concept of best available techniques. This is broadly equivalent to the application of best practicable means and the best practical environmental option (as described below), with essentially the same assessment and determination processes and which deliver the equivalent level of environmental protection. Further references to best practicable means in this document should be interpreted as:

- Best practicable means applied to authorisations granted under RSA93 (Ref. 23) and The Environmental Authorisations (Scotland) Regulations 2018 in Scotland (Ref. 90); and
- Best available techniques applied to permits granted under EPR16 (Ref. 25) in England and Wales.

15.39 The limits on radioactive discharges are set on the basis of the 'justified needs' of the licensees, i.e. licensees must make a case that the proposed limits are necessary to allow safe and continued operation of the plant. Licensees are required to use all best practicable means 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 best practicable environmental option studies at nuclear sites (Ref. 9186).

15.40 The Environment Agency has also published ‘Radioactive Substances Regulation – Environmental Principles’ which are modelled on the SAPs (Ref. 97). In setting limits, the environment agencies use monitoring and discharge and plant performance data with suitable modelling to ensure that the radiation exposure to the public as a consequence of the discharges would be less than the dose constraints and limits set in the Basic Safety Standards Directive as implemented by the UK Government and devolved administrations. 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 two 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.

15.41 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. 98 Annex 2). A summary of total doses received from nuclear power stations between 2004 and 2017 can be found in figure 25 and 26 below.

Key points

- *Total doses* for the representative person were less than 4 per cent of the dose limit for all sites assessed

Berkeley, Gloucestershire and Oldbury, South Gloucestershire

- *Total dose* for the representative person was less than 0.005 mSv and decreased in 2017
- Gaseous discharges of tritium decreased from Berkeley, and liquid discharges decreased from Oldbury, in 2017

Bradwell, Essex

- *Total dose* for the representative person was 0.011 mSv and decreased in 2017
- Enhanced monitoring continued in 2017

Chapelcross, Dumfries and Galloway

- *Total dose* for the representative person was 0.035 mSv and increased in 2017
- Gaseous discharges of "all other radionuclides" increased in 2017

Dungeness, Kent

- *Total dose* for the representative person was 0.021 mSv and unchanged in 2017
- Gaseous discharges of tritium and of sulphur-35, and liquid discharges of sulphur-35, decreased from Dungeness B in 2017

Hartlepool, County Durham

- *Total dose* for the representative person was 0.031 mSv and increased in 2017
- Gaseous discharges of carbon-14 increased, liquid discharges of tritium and sulphur-35 increased, in 2017
- Polonium-210 in winkles was enhanced above that value expected due to natural sources in 2017

Heysham, Lancashire

- *Total dose* for the representative person was 0.025 mSv and increased in 2017
- Gaseous discharges of carbon-14 and sulphur-35 decreased at Heysham 1, liquid discharges of tritium and sulphur-35 decreased from Heysham 1 and tritium decreased from Heysham 2, in 2017

Hinkley Point, Somerset

- *Total dose* for the representative person was 0.032 mSv and increased in 2017
- Gaseous discharges of carbon-14 increased from Hinkley Point B in 2017

Hunterston, North Ayrshire

- *Total dose* for the representative person was 0.023 mSv and increased in 2017
- Gaseous discharges of carbon-14 increased from Hunterston B, liquid discharges of alpha and plutonium-241 decreased from Hunterston A, in 2017

Sizewell, Suffolk

- *Total dose* for the representative person was 0.021 mSv and unchanged in 2017
- Liquid discharges of tritium increased from Sizewell B in 2017

Torness, East Lothian

- *Total dose* for the representative person was 0.021 mSv and unchanged in 2017

Trawsfynydd, Gwynedd

- *Total dose* for the representative person was 0.024 mSv and increased in 2017

Wylfa, Isle of Anglesey

- *Total dose* for the representative person was less than 0.005 mSv and decreased in 2017
- Gaseous discharges of tritium, carbon-14 and sulphur-35 decreased, and liquid discharges of tritium increased, in 2017

Figure 25 – Total dose at nuclear power stations, 2004-2017 (Small doses less than or equal to 0.005 mSv are recorded as being 0.005 mSv)

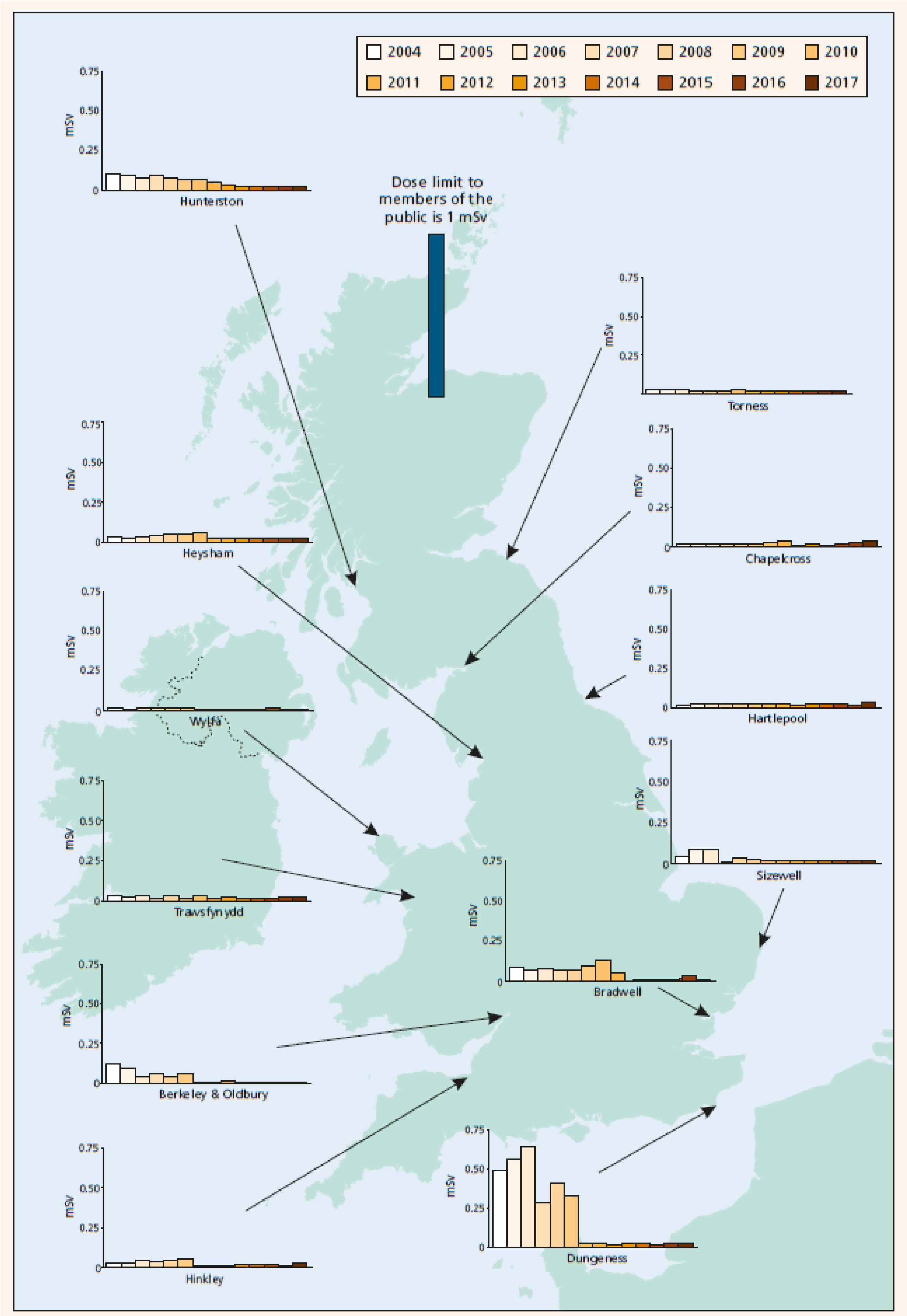


Figure 26 – Total dose at nuclear power stations, 2004-2017(small doses less than or equal to 0.005 mSv are recorded as being 0.005 mSv)4

4 Higher doses from Dungeness reduced significantly once Dungeness A was defuelled in 2012.

Regulatory review and control of radiation exposure

15.42 ONR seeks to ensure that licensees have adequate arrangements in place to restrict exposures to ionising radiations so far as is reasonably practicable (SFAIRP) in a number of 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 periodically undertakes reviews across all GB nuclear sites, and recently completed a project involving assessment and inspection to provide assurance that occupational exposures are ALARP across the whole of the nuclear sector. To take a view on doses to the public, ONR requests information on exposures from licensees on an annual basis. Using a sampling approach, ONR undertakes assessment of licensees' arrangements and arranges verification of off-site dose rates through monitoring radiation levels by an independent technical support contractor.

15.43 In addition to the requirements placed on operators to monitor environmental radioactivity around their sites, the environment agencies undertake their own independent monitoring programmes. Radioactivity in surface and ground water, radiation dose rates on beaches and public occupancy areas, radioactivity in sediments and environmental material etc are monitored. Monitoring results are published annually. The Food Standards Agency (FSA) 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 2018 which contains 2017 monitoring data (Ref. 98). 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 16 – Emergency Preparedness

> ***1. 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.***
> ***2. 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.***
> ***3. 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:

- Measures to enhance emergency preparedness programmes.
- The UK has taken part in IRRS missions and will receive an IRRS mission in 2019.

16.2 Otherwise compliance with this Article of the Convention has not substantially changed since the Seventh UK report (Ref. 18) (i.e. 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**.

Emergency Arrangements

On-site emergency arrangements

16.4 All UK civil nuclear sites are licenced by ONR under the NIA65. The provisions of this Act enable ONR to set requirements on licensees through licence conditions. In particular, LC11 requires the licensee to make and implement adequate arrangements for dealing with any accident or emergency arising on the site and its effects. REPPIR also puts duties on operators to make and test emergency arrangements. REPPIR requires the operator to provide ONR with details of the onsite emergency plan where requested. ONR may then scrutinise it and has a broad range of regulatory powers to ensure the onsite 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 action 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; and, what protective action is proposed to be taken, and how far each such action extends within any detailed emergency planning zone. In addition, REPPIR requires licensees to co-operate with local authorities in the production and implementation of off-site emergency arrangements.

16.5 ONR obtains a view of all the licensee's arrangements through the use of on-site emergency planning and response capability maps. These maps assess both the security and safety aspects of each site's emergency response, identify any improvements that may be required, and provide a transparent, proportionate and consistent regulatory approach across the UK nuclear industry.

16.6 The emergency arrangements for all nuclear installations are subject to inspection, and revision as appropriate. ONR observes the demonstration of the emergency plan at every reactor site on an annual basis.

16.7 The Radiation Emergency Preparedness and Public Information Regulations 2019 (REPPIR) requires the operator to provide ONR with details of the onsite emergency plan where requested. ONR may then scrutinise it and has a broad range of regulatory powers to ensure the onsite emergency plan meets requirements. The plan must include:

- The arrangements to prioritise keeping doses within the reference levels; and, what protective action is proposed to be taken, and how far each such action extends within any detailed emergency planning zone.
- In addition, REPPIR requires licensees to co-operate with local authorities in the production and implementation of off-site emergency arrangements.

16.8 ONR obtains a view of all the licensee's arrangements through the use of on-site emergency planning and response capability maps. These maps assess both the security and safety aspects of each site's emergency response, identify any improvements that may be required, and provide a transparent, proportionate and consistent regulatory approach across the UK nuclear industry.

16.9 The emergency arrangements for all nuclear installations are subject to inspection, and revision as appropriate. ONR observes the demonstration of the emergency plan at every reactor site on an annual basis.

Off-Site Emergency Arrangements

16.10 REPPIR requires offsite emergency plans to be produced where it is commensurate to do so. Where this is the case the offsite emergency plan must be reviewed and tested at least every three years and kept up to date in the event of any material changes.

16.11 The COMAH Regulations 2015 aim to prevent and mitigate the effects of major accidents involving dangerous substances, such as chlorine, liquefied petroleum gas, explosives etc. Licensees of nuclear facilities that have quantities of such substances above a prescribed threshold level must notify ONR. Under REPPIR and COMAH, the relevant local authority is required to prepare a written off-site emergency plan that describes the emergency arrangements of all hazardous installations in the area. These emergency plans are publicly available and so the existence of nearby hazardous materials which could affect a nuclear site can be used by the licensees in their hazard analyses.

16.12 ONR inspects local authorities to determine compliance with REPPIR. Recent inspections have focused on, amongst other areas: governance, training of all responders, continuous improvement (implementing learning from exercises) and co-operation with responders and operators.

16.13 REPPIR requires a determination of 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 determined taking into account 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 countermeasures.

16.14 REPPIR also requires outline planning for very low probability but high severity events that might extend over a wider area.

16.15 An operator must bring its onsite emergency plan into effect without delay if a radiation emergency occurs or an event occurs which might lead to one. When doing so, the operator must at the same time inform the local authority and ONR. When informed by the operator, the local authority must then bring its offsite emergency plan into effect without delay. A cascade notification mechanism is put in place at each site so the operator can focus on dealing with the nuclear emergency itself.

16.16 The agencies that provide a local response are located at the off-site Strategic Coordination Centre (SCC) (see Figure 27 below). At this facility the Strategic Co-ordinating Group's (SCG) prime function is to decide on and action the appropriate protection measures to be taken off-site to protect the public. The SCG ensures that measures are implemented and that authoritative information and advice is provided to the public (the facility includes media briefing centres). Decisions would generally be made through regular coordinating group meetings.

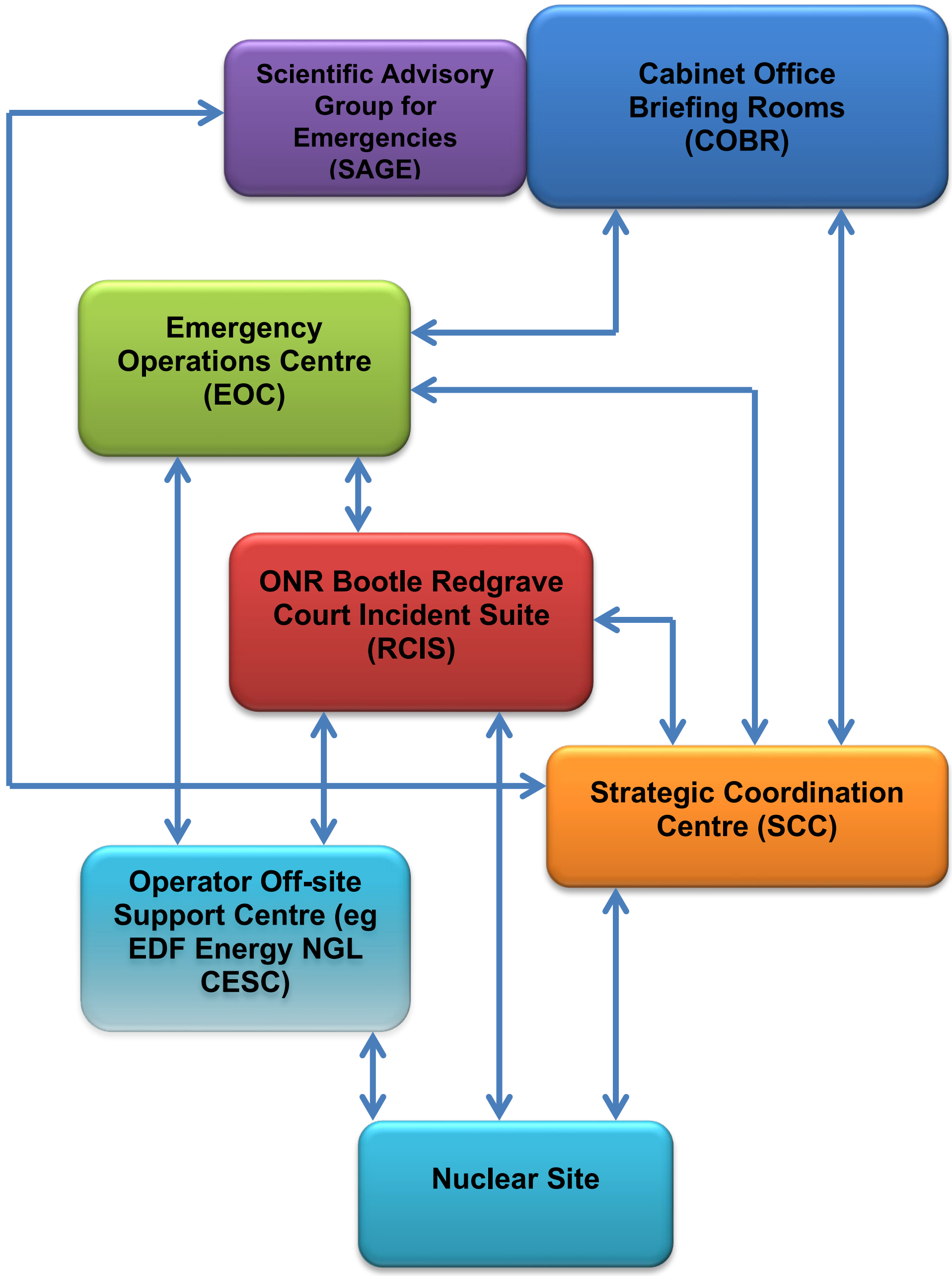


Figure 27 – Control Centres

16.17 Each organisation with responsibilities for dealing with the emergency is represented at the SCC. These would generally include the operator, police, local authority, national health authority, local water company and the fire and ambulance services. PHE. 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 protection measures for different areas such as sheltering, evacuation, stable iodine, 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 the protection measure advice.

16.18 The operator has an important role in regaining plant control on site and ensuring that any radiological release is terminated. 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 two 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 measure that could be taken to protect the public. For example, sheltering, taking of stable iodine tablets or evacuation particularly in the early stages of an emergency.

16.19 In the event of an off-site nuclear emergency in England or Wales, the central government Emergency Operation Centre (EOC) and the Cabinet Office Briefing Rooms (COBR) would be activated. In Scotland, the Scottish Government Resilience Room (SGoRR) would be activated. Central government would be supported by the Scientific Advice 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 SCG, except for all but the most severe events.

16.20 In response to the declaration of an off-site nuclear emergency at a GB Nuclear Site, ONR will also independently monitor and record the operator's actions, take enforcement action if appropriate, and provide advice to relevant authorities. 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 appropriate to the nature and location of the emergency.

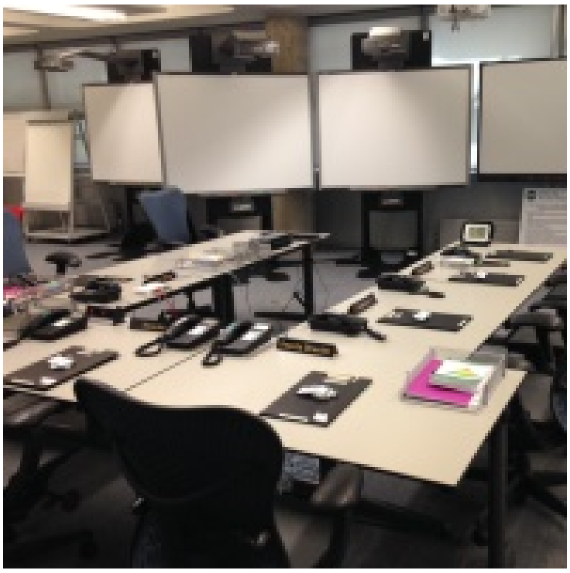


Figure 28 – ONR's emergency control room, the Redgrave Court Incident Suite. The Suite is maintained and ready to be activated at short notice 24 hours a day and 365 days a year.

EDF Energy NGL Arrangements

16.21 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.

16.22 In the event of an emergency, trained station staff form a site emergency response organisation under the command of the Emergency Controller based on the site. They operate from 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 offsite organisations which have responsibility for initiating countermeasures 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.

16.23 The onsite response is supported by the Central Emergency Support Centre (CESC). The CESC is a large control room in EDF Energy NGL's headquarters in Barnwood. It provides for the off-site support for a nuclear power station in an emergency situation. Command, technical and health physics support teams are available at short notice during working hours and within an hour or so out of hours. The technical team helps to understand the situation on the site and provide 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 Strategic Coordination Centre.

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. Emergency exercises are also the main way that EDF Energy NGL demonstrates the effectiveness of their emergency arrangements to the regulator and external agencies.

16.25 There are three main types of regulatory exercises, which have evolved in the nuclear industry: Level 1, Level 2 and Level 3. These regulatory exercises vary in the involvement of organisations locally and nationally.

Level 1

A Level 1 exercise involves all station staff, visitors and contractors and will take up to six hours to complete. This type of exercise takes place annually and demonstrates existing emergency arrangements to the Office for Nuclear Regulation.

Level 2

A Level 2 exercise demonstrates how the Strategic Co-ordination Centre (SCC) and the Central Emergency Support Centre (CESC) deal 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 three years for each SCC.

Level 3

A Level 3 exercise involves all the organisations in a Level 2 exercise, but also includes full government departmental involvement. These exercises may occur over several days and may move into the recovery phase of the emergency.

16.26 Emergency response role training is an important part of the 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 role has a number of 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 organisation which carries 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 lead by the INA function. Swift. This allows actions to be prioritised, planned, tracked and checked for effectiveness.

Deployable back-up equipment

16.28 EDF Energy NGL developed and procured a comprehensive array of deployable back-up equipment (DBUE) and a large fleet of emergency response vehicles for people and equipment transportation. particularly Sets of DBUE have been situated at each of four strategically selected locations in the UK. One of these is the Emergency Response Centre in close proximity to Sizewell B, and the other three are situated in northern, central, and southern locations in the UK. They are all if required This is in line with the requirements of the **VDNS Principle 2**.

Testing of emergency arrangements

16.29 ONR observes, 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 a period of time the site exercises test all aspects of the approved site emergency plans such as minimum manning levels and common mode failure events with the potential to affect adjacent sites. Since the events at Fukushima, 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.

16.30 ONR observes 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 since the seventh report are listed in Table 7 below.

Table 7 – Level 1 exercises completed between March 2016 and December 2018

Site	Exercise Type	Date
Heysham 2	Joint Level 1 and counter terrorism (CT)	2nd March 2016
Hunterston B	Level 1	17th March 2016
Torness	Level 1	4th May 2016
Heysham 1	Level 1	9th November 2016
Hartlepool	Joint Level 1 and counter terrorism (CT)	30th November 2016
Heysham 1 & 2	Level 1	18th January 2017
Torness	Level 1	1st March 2017
Hunterston B	Level 1	16th March 2017

Dungeness B	Joint Level 1 and counter terrorism (CT)	22nd March 2017
Sizewell B	Joint level 1 and level 2	17th May 2017
Hunterson B	Level 1	1st June 2017
Hinkley Point B	Level 1	14th June 2017
Sizewell B	Level 1	27th June 2017
Heysham 1	Level 1	8th November 2017
Hartlepool	Level 1	21st November 2017
Heysham 2	Level 1	14th February 2018
Dungeness B	Level 1	2nd May 2018
Hartlepool	Level 1	22nd November 2018
Heysham 1	Level 1	5th December 2018

16.31 Level 2 exercises 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 three years. 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 observes 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.

16.33 Level 3 exercises rehearse 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. Table 8 below lists all the Level 2 and 3 Exercises that have taken place in the UK since the Seventh CNS report.

Table 8 – Level 2 and 3 exercises from May 2016 to February 2019

Site	Exercise	Date
Hartlepool	Exercise Jackdaw (Levels 2 and 3)	11th May 2016
Hunterston B	Exercise Kestrel	21st September 2016
Heysham 1 & 2	Exercise Kingfisher	18th January 2017
Sizewell B	Exercise Eagle	17th May 2017
Torness	Exercise Magpie	27th September 2017

Dungeness B	Exercise Nightingale	23rd May 2018
Hinkley Point B	Exercise Nighthawk	6th June 2018
Hartlepool	Test of New SCC facility	3rd July 2018

16.34 The ONR produces an annual report which summarises the lessons of Level 2 and 3 exercises held during the previous emergency exercise planning year. This report is a statement of the overview of exercises, together with a summary of the overarching issues which need to be considered or resolved. The 2017/2018 report identified a number of areas where work is being done to improve capability. The national level lessons learned working group reviews, 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:

- New guidance is being produced for the logistics and use of radiological monitoring units during an emergency.
- Familiarisation training was rolled out which included updates to local emergency plans.
- Wider use of Resilience Direct, a UK wide secure on-line platform for real time information sharing during emergencies and use of new features such as mapping.
- In addition, local authorities that have responsibility for planning for radiation emergencies meet biannually to solve common issues and share best practice under the Local Authorities Working Group.

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- New guidance is being produced for the logistics and use of radiological monitoring units during an emergency.
- Familiarisation training was rolled out which included updates to local emergency plans.
- Wider use of Resilience Direct, a UK wide secure on-line platform for real time information sharing during emergencies and use of new features such as mapping.

16.36 In addition, local authorities that have responsibility for planning for radiation emergencies meet biannually to solve common issues and share best practice under the Local Authorities Working Group.

Measures to enhance emergency preparedness programmes

16.37 The new REPPIR regulations will improve the UKs readiness to response to radiation emergencies. It will 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.

16.38 In addition, the new regulations bring into use emergency reference levels, which optimise radiological protection for the public.

16.39 An Approved Code of Practice and Guidance will be published in 2019 which will assist duty holders in complying with the new regulations.

Provision of prior information to the public

16.40 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 three 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

16.41 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.

16.42 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 course of the nuclear emergency. An on-line real time platform is used 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 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 a period of 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 would take the responsibility for notifying other countries and initiate requests for international assistance. Under existing early notification conventions, BEIS would inform the European Community (ECURIE), the IAEA

United System for Information Exchange (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 International Nuclear and Radiological Event Scale (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 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 lead government department for coordinating the response to an overseas nuclear emergency. The UK has signed a number of international agreements covering exchange of information in the event of a nuclear emergency. The UK is a member of IAEA's global assistance mechanism in the event of a nuclear emergency, Response and Assistance Network (RANET). RIMNET is the database for inward notifications under these arrangements.

16.48 National planning, implemented by BEIS with support from other agencies, provides arrangements for dealing with an overseas nuclear emergency. This includes BEIS maintaining contact arrangements and duty officers that ensure the UK can be notified of an emergency at any time. RIMNET (and its successor once implemented) is the UK's national radiological database. The UK has a nationwide network of gamma dose rate monitors, including 96 via fixed communications with a further 107 available through mobile communications that provides a secondary alert mechanism in the event of non-notification. RIMNET is due to be upgraded in 2019.

16.49 BEIS has established procedures including the notification and alert of organisations within the UK with responsibilities for dealing with an overseas nuclear accident. It maintains the Emergency Operations Centre containing the equipment required for management of the response.

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 and IAEA Emergency Planning and Response Standards Committee (EPReSC). ONR has recently contributed to the ongoing review of IAEA-GS-G-2.1 "Arrangements for Preparedness for a Nuclear or Radiological Emergency". The UK also participates in the IAEA National Competent Authorities Coordinating Group, 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 Competent Authority (HERCA) Board of Heads and the Working Group on radiation emergencies. The UK hosted the 2017 meeting of the radiation emergencies working group and is currently co-leading in the production of complementary guidance for the HERCA-WENRA approach.
- WENRA, ENSREG, the European Commission Article 31 group (who advise on radiation protection issues, including Basic Safety Standards and Emergency Preparedness and

Response), the European Community Urgent Radiological Information Exchange (ECURIE), the European Radiological Data Exchange Platform (EURDEP), the EU platform on preparedness for nuclear and radiological emergency response and recovery (NERIS) and the OECD Working Party on Nuclear Energy Matters (WPNEM).

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 Seventh UK report (Ref. 18) (i.e. in a way that has implications for the Convention obligations).

17.2 Significant portions of this Article demonstrate compliance with **VDNS Principle 1**.

17.3 Proposed nuclear power stations 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 BEIS Secretary of State, under the Planning Act 2008. The current National Policy Statement (NPS) for Nuclear Power Generation (EN-6) sets out the policy framework within which applications for development consent will be decided for sites capable of deployment before 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, in order 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 NIA65 and any necessary environmental permits as required by EPR16 or RSA93.

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 NPS, as material considerations within the planning process, and in detail through the licensing and permitting regimes.

17.6 The Government is currently working towards designation of a new National Policy Statement for nuclear power stations with gigawatt-scale reactors at sites capable of deployment between 2026 and 2035 (Ref. 94)

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 three 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 for nuclear identified eight sites in England and Wales as potentially suitable for deployment of a nuclear power station before 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 also 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. 95).

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 the ONR SAPs and as low as reasonably practicable.

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 as a framework for assessing the adequacy of the licensee's application.

17.11 The IAEA safety requirements for siting, set out in 'Site Evaluation for Nuclear Installations' (NS-R-3, Ref. 65) 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 earthquake, were not considered at all, 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 relevant good practice 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 relevant good practice 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 in plant. Also, licensees receive advice from government agencies responsible for weather and flood forecasting, and advice on the occurrence and location of earthquakes.

17.17 In addition to the analysis of external hazards as initiating events that could lead to accidents, the site selection process has to consider other external factors that relate to geological suitability, the availability of external supplies 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. 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 (Ref. 96) 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, taking into account 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 particular 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 other 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, so far as is reasonably practicable, the radiation exposure to the workers and general 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 has to 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 will take into account all the commissioning tests and the validation of any initial assumptions. This will be reviewed during the course of the plant's life in the periodic safety reviews required by LC15.

17.24 On multi-facility sites, the safety case must consider the site as a whole to establish that hazards from interactions between facilities have been taken into account (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, in paragraphs 752–758 and target 9, address societal risk. As a measure of the societal concerns that would result from a major accident, a target based on a representative accident leading to 100 or more fatalities is defined. The target does not in itself cover all the factors related to societal concerns. In demonstrating that the legal requirement to reduce risks so far as is reasonably practicable has been met, the consequences in terms of other societal effects must also be considered. The safety case should identify accidents that result in source terms that could cause 100 or more deaths.

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 authorised radioactivity discharged from the site, both in normal operation or 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 In particular, 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; and
- The operator's use of probabilistic safety analysis (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).

17.29 Relevant TAGs (Ref. 50) that inform such assessment include, PSA, validation of computer codes and calculation methods and radiological analysis – fault conditions.

Planning and demographic controls

17.30 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. 97) 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.*"

The intent of this policy is expected to be maintained in the draft NPS to be published, which will be subject to public consultation.

17.31 Local planning authorities consult the ONR regarding proposed developments close to nuclear sites that may lead to an increase in residential or non-residential populations, thus impacting on the off-site emergency plan or posing an external hazard to the site. ONR also provides advice with regard to local plans, in which authorities set out the policies that will inform their long-term development aims and allocate sites for residential, commercial and industrial development, in order to secure their planning objectives. When consulted on site allocations for residential development, ONR advises that, where reasonably practicable, only sites outside of the detailed emergency planning zone should be allocated. Otherwise, ONR will advise that sites that are further from the nuclear site boundary should be preferred over those that are closer.

17.32 The National Planning Policy Framework (Ref. 98) and Planning Practice Guidance on Hazardous Substances (Ref. 99) (in England), Panning Policy Wales supplemented by a series of Technical Advice Notes, Welsh Government Circulars, and policy clarification letters (Ref. 100) (in Wales) and Scottish Planning Policy (Ref. 101) and Planning Circular 3/2015 Planning Controls for Hazardous Substances (in Scotland) (Ref. 102) 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 consultation zones around certain nuclear sites (within development management procedures covering England, Wales and Scotland) (Ref. 103) 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.

17.34 ONR requires assurances that the developments in the immediate vicinity of a nuclear installation can be accommodated by the existing 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 above sections so as 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 now committed to undertaking reviews every 10 years in their land use planning guidance, based upon up-to-date population data provided by a third-party supplier.

17.38 In the event of a 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 In accordance with Articles 37, 41 and 43 of the Euratom Treaty (Ref. 104), the UK Government provides the European Commission with general information relating to a plan for the disposal of radioactive waste (including details of the site and its surroundings, the nature of the installation, radioactive waste discharges from normal operations and potential unplanned releases). This is to enable the Commission to determine whether the implementation of such plan is liable to result in the radioactive contamination of the water, soil or airspace of another Member State.

17.41 The UK undertakes a broad range of information exchange in order to fulfil safety obligations and to promote co-operation. This includes multilateral co-operation through the IAEA – in particular on the development of safety standards and in peer review missions for which the UK has recently supported those to Japan, Sweden and Lithuania. The UK is a member of the OECD 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 members of the EU through groups such as ENSREG and throughout the continent via groups such as WENRA.

17.42 The UK, via the ONR, has entered into bilateral 'information exchange agreements' with a number of international regulators 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 G7, 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.

17.44 In the event of a nuclear emergency within the UK, the nuclear radiation monitoring and nuclear emergency response system (RIMNET) (and its successor once implemented), operated by BEIS, acts as the national point of contact to fulfil UK obligations under the Convention on early notification of a nuclear accident (via the IAEA's unified system for information exchange in incidents and emergencies) and European Council decision of 14 December 1987 on community arrangements for the early exchange of information in the event of a radiological emergency (via the European community urgent radiological information exchange (ECURIE)).

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 Seventh UK report (Ref. 18) (i.e. 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 ONR's SAPs, which have been benchmarked against 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 SAPs (Ref. 49), together with supporting TAGs (Ref. 50), 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 IAEA and contributes actively to the development of Safety Standards that the IAEA publishes. 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. 65). 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 However, during the 2015 and 2017 IAEA OSART and OSART follow up missions to Sizewell it became apparent that whilst robust in many areas, there may be gaps in the EDF Energy NGL knowledge and ownership of some IAEA safety series standards / guidance. They commissioned the owner to review the document and satisfy themselves that their arrangements do indeed comply with the IAEA standards, or determine if there were differences and whether these are significant and justifiable.

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.

Hinkley Point C

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 GS-R-3 (now superseded by GSR Part 2).

18.11 In addition, the requirements of individual IAEA technical documents (for example IAEA Technical Report 380) are contained within the HPC Integrated Management System process documents. Compliance is assured through a system of internal independent process audits at an annual frequency.

18.12 Impending changes to IAEA standards are reviewed for impact prior to implementation, by process owners who have been identified within HPC.

Implementation of defence-in-depth

Contracting Party’s arrangements and regulatory requirements

18.13 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 take into account the age of the facility or plant.

18.14 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. 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

18.15 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 DBA, PSA and 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 three 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.

18.16 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 x 10^{-5} per year and natural hazards that conservatively have a predicted frequency of down to 1 x 10^{-4} per year.

18.17 ONR has not chosen to prescribe terminology such as 'design extension conditions'. However, 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.

18.18 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 should assist 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.

18.19 The 2014 SAPs do not vary significantly regarding their requirements to 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 should be 'practically eliminated'.

Consideration of external and internal hazards

18.20 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. 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.

18.21 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.

18.22 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 x 10^{-4} per year. Beyond design basis analysis (BDBA) is also performed to consider more severe hazard events at frequencies below 1 x 10^{-4} per year in order 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.

18.23 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, tsunami. ONR inspectors look for licensees to have accounted for credible combinations of external hazards in their safety analyses (SAP EHA.6).

18.24 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 (SAP EHA.1) should include reasonably foreseeable combinations of hazards and consequential events.

18.25 ONR's TAG 13, 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.

18.26 was Released in November 2018, 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 projections of sea level rise, giving greater regional detail and providing more information on potential extremes of climate change. The use of UKCP18 is considered to be relevant good practice in determining climate change allowances for relevant natural hazards at UK licensed sites.

18.27 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 form. 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).

18.28 Detailed knowledge of the plant and site layout is required for internal hazards assessment. Hazard identification and impact assessment involve 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.

18.29 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.

18.30 More information on the regulatory expectations in relation to internal hazards can be Status of application of the defence-in-depth concept

Consideration of defence-in-depth

18.31 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. 49) 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 reactor programme and continues to be a requirement for new build.

18.32 Defence-in-depth is generally applied in five levels, which should be, as far as practicable, independent from one another (Ref. 49). 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 Table 9 below.

Table 9 – 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.

18.33 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 (i.e. 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.

18.34 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).
- 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).

18.35 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.

18.36 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

18.37 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.

18.38 The AGRs employ CO_2 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 two diverse and redundant post-trip feed water systems.
- AGRs do not have a containment building around the pressure vessel. None of the design basis loss of coolant 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.

18.39 The UK also operates a single Westinghouse-designed four-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.

18.40 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 that proposed new reactors should be at least as safe as modern reactors anywhere else in the world.

External hazards

18.41 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 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.

18.42 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.

18.43 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 considered in the UK as external hazards, and there is ongoing close liaison between ONR, reactor licensees and relevant government departments, to ensure that appropriate security protection arrangements are in place.

18.44 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.

18.45 Sizewell B has modern standards seismic PSA. For the operating reactors as a whole and for other external hazards the quantitative risk analysis of plant response to external hazards does not fully comply with modern standards, however where this is so PSRs, Safety Case Health Reviews and safety case updates have presented arguments to demonstrate that the risks are ALARP or identified remedial actions to address shortfalls.

Use of design principles

18.46 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 UK. They are essential to achieve the necessary high levels expected for nuclear safety, 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

18.47 ONR’s SAPs set out engineering principles that have been benchmarked against IAEA and other international guidance, examples are summarised in Table A3 – Engineering principles set out in the SAPs. 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

18.48 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 two 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.
- For the AGR’s 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 CO2 coolant (if pressurised).
- 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.
- 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.
- In the event of a loss of coolant accident, Sizewell B has passive injection of borated water into the reactor core via accumulators.
- The four 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 two separate buildings.

18.49 The designs for the proposed new reactors have been / are being assessed by the regulator against the latest SAPs and relevant international good practice.

Implementation of beyond design basis design measures

18.50 EDF Energy NGLAs a result of a renewed consideration of modern safety case practice, a number of 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 using the latest calculation route 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 boiler feed, 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

18.51 Two objectives have been set for the external hazards beyond design basis (BDB) assessment strategy used for the HPC:

- 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. i.e. 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).
- 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.

18.52 For HPC, the design basis hazard levels were defined based on conservative estimates for the 10^{-4} p.a. (or 10^{-5} p.a. for man-made hazards) hazard level for the site.

18.53 The jBDB hazard level is defined as the best estimate of the 10^{-5} p.a. hazard, and is intended to represent a small increase on the design basis hazard level for the purpose of preventing cliff-edge effects. Care has to 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) should only occur if undue consequences are found as a result of the assessment and following an ALARP assessment.

18.54 The sBDB hazard level is generally defined as the best estimate of the 10-6 p.a. hazard, which is considered a significant increase on the design basis hazard.

18.55 A pictorial representation of the approaches for the design basis, jBDB and sBDB is provided below:

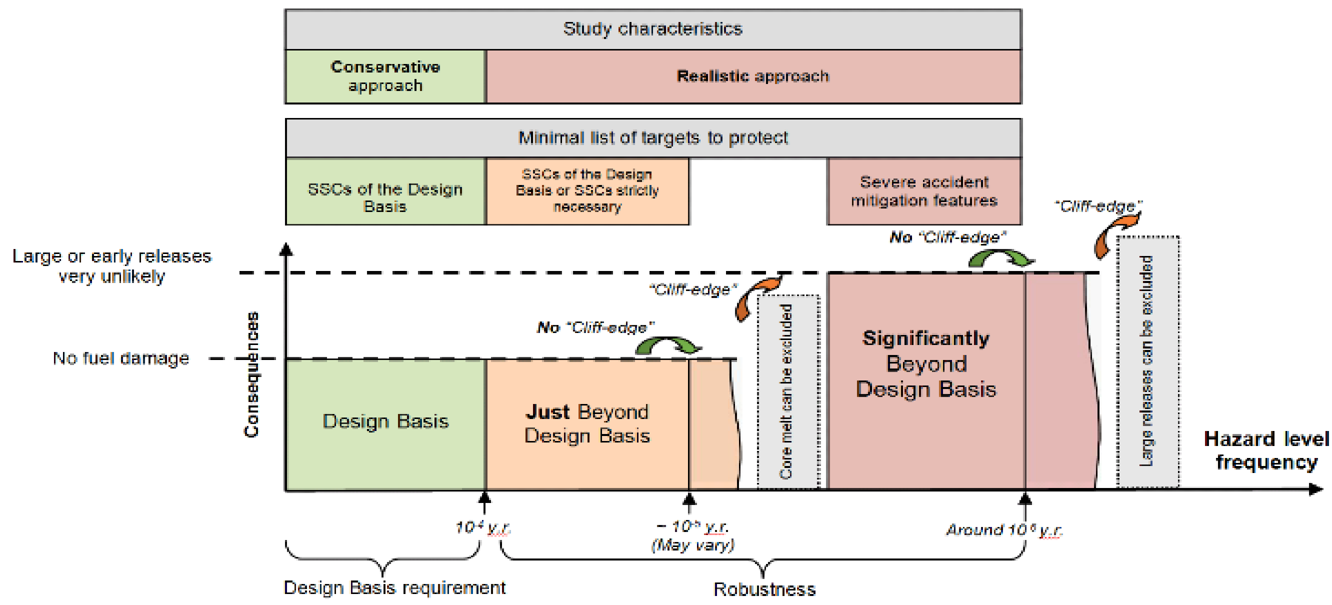

Figure 29 – The approaches to the design basis jBDB and sBDB for HPC

Severe Accidents and post-Fukushima Safety Features

18.56 A severe accident is a term used to describe any sequence leading to at least partial fuel damage. If unmitigated the phenomena involved could jeopardize the structural integrity of containment and could lead to major radiological consequences. The sBDB approach aims to demonstrate that in the event of a sBDB hazard causing a severe accident, the preventative and mitigating safety features will remain available so that they can prevent large or early radiological releases.

18.57 There is a link between the sBDB approach and NNB GenCo's response to the Fukushima event. 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.

18.58 The objective of the sBDB approach is consistent with post-Fukushima general safety objective. Therefore, where required SSCs are already protected against hazards within the framework of post-Fukushima analysis, the sBDB approach can incorporate the existing post-Fukushima work for those hazards. Post-Fukushima work can be used to support the sBDB approach, but the two are not equivalent. In particular, the Emergency Control Centre and the Back-Up Emergency Equipment Store structures are required to have 'enhanced resilience' to Fukushima-type events as they are part of the emergency response infrastructure, but they are not facilities which contain SSCs required to prevent or mitigate a Severe Accident.

18.59 The following diagram explains the linkages between the jBDB, sBDB, post-Fukushima, PSA and severe accident analyses:

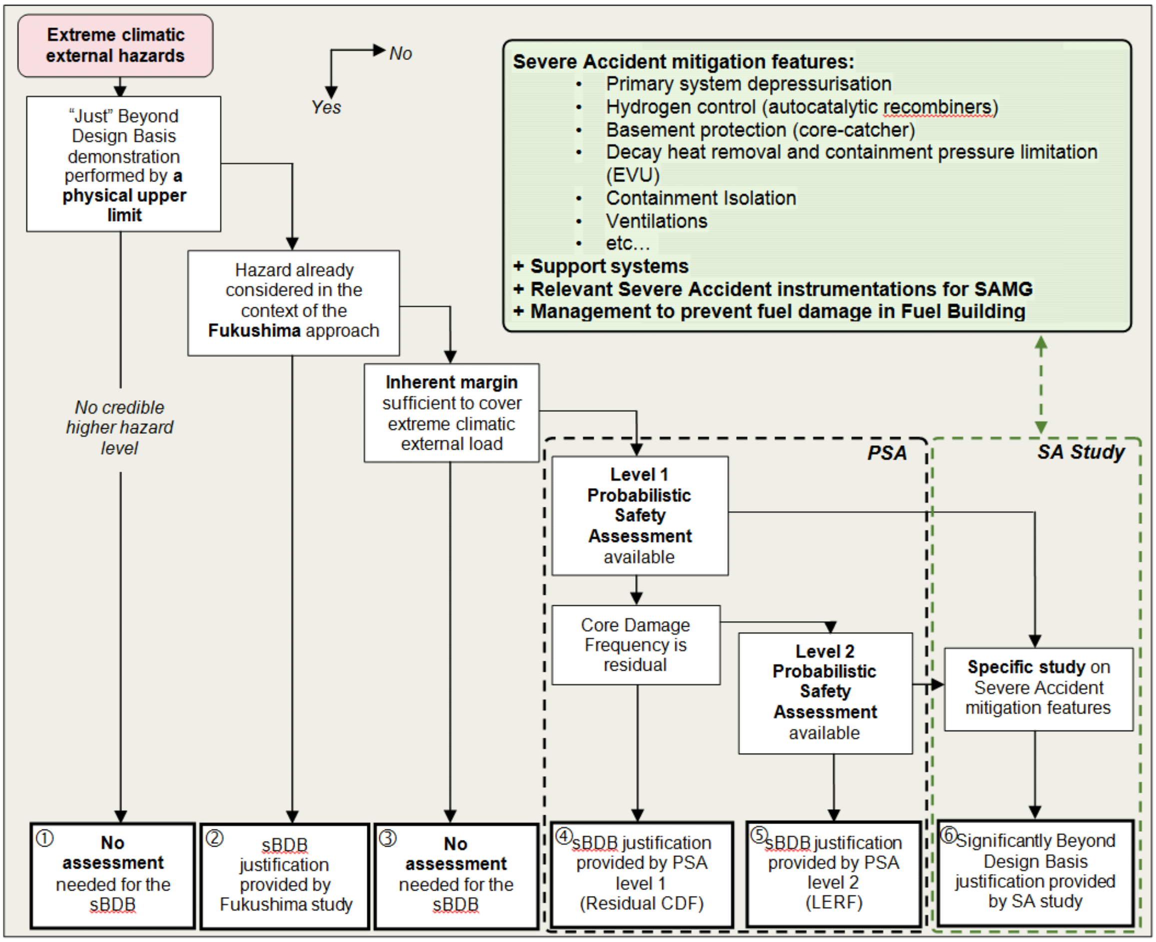

Figure 30 – Linkages between the jBDB, sBDB, post-Fukushima, PSA and severe accident analyses

Procedure ○	If a physical upper limit has been identified and the design withstands to this load, no further assessment is needed.
Procedure ○	If the hazard is already considered in the framework of Fukushima, sBDB analyses should rely on these existing analyses.
Procedure ○	If the inherent margin (margin between the HPC site Challenge (10^{-4}) and the Design Basis) is significant and deemed sufficient to cover the sBDB, no further assessment is needed.
Procedure ○	If the core damage frequency provided by Level 1 PSA is deemed reasonably low, no further assessment is needed.
Procedure ○	If the large release frequency provided by Level 2 PSA is deemed reasonably low, no further assessment is needed.
Procedure ○	The justification of the SBDB conformance is provided by specific study on Severe Accident mitigation features. The resilience enhancements can be credited if available (the verification is on SA mitigation features).

Fukushima Improvements – Hinkley Point C

18.60 Following the Fukushima event, NNB has reviewed the recommendations arising from a number of different reports produced by the Office for Nuclear Regulation, WANO, INPO and IAEA. Learning from other EPR sites and Nuclear Generation was also taken into account.

18.61 The Hinkley Point C design was reviewed to determine whether any feasible improvements to nuclear safety could be implemented to provide resilience to Fukushima type scenarios. This review lead to enhancements 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 time frames and appropriate storage requirements identified.

18.62 To aid with the development of the emergency response arrangements, a bounding beyond design basis scenario was produced to give the most onerous scenario which the emergency teams could be expected to face. The resilience of facilities required during an emergency was reviewed which lead to the inclusion in the design of an emergency control centre which is resilient to external hazards up to Beyond Design Basis level. Welfare needs were taken into account in the design of the facility and storage for stocks of food, water is included as well as space for sleeping. Robustness of communications was considered, leading to satellite and sound powered telephones being included in the equipment inventory.

18.63 Detailed design of the facilities and equipment is continuing, to ensure learning from emergency exercises on other stations is taken into account.

Implementation of measures to maintain containment integrity

AGRs

18.64 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.

18.65 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.

18.66 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.

18.67 A major objective for the operators when dealing with a beyond design basis event would be to secure feed of water to the boilers and to the vessel cooling system. In a loss of primary coolant accident, the depressurising AGR still has relatively good heat transfer from the core and, therefore, the vessel, in severe conditions, would fail by creep rupture before gross fuel damage occurred. For this reason, a pressurised severe accident is not likely.

Sizewell B PWR

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 are the reactor building spray system cooling train or initiation of the fire suppression sprays following vessel failure. It is also predicted that recovery of one fan cooler would be sufficient to prevent containment overpressure.

18.69 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 structures.

Hinkley Point C

18.70 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.

18.71 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

18.72 UK EPR 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. 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.

18.73 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 have to be capable of ensuring the supply of adequate cooling water in the face of all potential debris quantities and types.

18.74 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.

18.75 The development of the safety case has continued in parallel and there are a number of 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 assessments

Overview of main improvements since commissioning

18.76 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, a number of 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, taking into account 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.
- Single channel trip system (specifically at Dungeness B).
- Electrical overlay systems (diverse electrical supplies).

18.77 This section is in line with **VDNS Principle 2**.

Regulatory review and control activities

GDA and new reactor build

18.78 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 is currently being modernised. This will result in a more flexible process to suit the range of future nuclear technologies: conventional GWe designs, SMRs and AMRs. (Ref. 14).

Licenced sites

18.79 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. But 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.

18.80 LC 14 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. Refer to Article 14 – Assessment and Verification of Safety for further discussion on nuclear power plant safety cases.

18.81 Subsequent design and construction changes are controlled by LC19 and LC20. LC19 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.

Incorporation of proven technologies

Contracting Party's arrangements and regulatory requirements

18.82 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 updated its TAG providing guidance / expectations on the requirement to categorise safety functions and the classification of structures, systems and components to deliver the safety function. The class of an SSC is fundamentally linked with its reliability (TAG 94, Ref. 50). The reliability claimed for any SSC should take into account its novelty, experience relevant to its proposed environment, and uncertainties in operating and fault conditions, physical data and design methods (SAP ERL.1).

18.83 A graded approach should be followed, consistent with UK and international relevant good practice. The ONR SAPs recommend a three-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;
- ECodes 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;
- EThe 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).

18.84 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).

18.85 Through the application of appropriate codes and the standard requirement to use of technologies proven by experience or qualified by testing or analysis is typically met.

18.86 ONR's SAPs (Ref. 49) 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.

18.87 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.

18.88 SAP EQU.1 requires 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.

18.89 SAPs EAD.3 – EAD.5 require that arrangements should be in place for the recording and retrieval of lifetime data. This is supported by LC28 which requires adequate arrangements for 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 taken into account as part of routine maintenance programmes.

18.90 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.

18.91 Where there is relevant operating 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. Article 19 - Research and development – regulatory focus addresses operational feedback and nuclear safety research.

Measures taken by the licence holders to implement proven technologies

18.92 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.

18.93 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.

18.94 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.

18.95 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 undertakes a significant research programme 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.

18.96 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, the irradiation damage to 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 C&I

18.97 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.

18.98 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.

18.99 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

18.100 Article 14 - 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

18.101 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).

18.102 For new plants, ONR expects that a robust, modern-standards human factors integration process has been followed (SAP EHF.1), 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 supported by effective administrative controls.

Implementation by the dutyholders

18.103 New designs currently being 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

18.104 For new nuclear build projects, 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 the area of human factors, through to witnessing verification and validation trials, where the human-technology system performance is tested and demonstrated.

18.105 The GDA process for assessing new reactor designs is very similar to that of licensing in terms of regulatory expectations and uses the same standards and criteria.

18.106 Review and control are enhanced by a programme of regulatory continuous improvement in the area of human factors, which ensures that relevant good practice is always considered in ONR's regulatory judgements. ONR 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 the area of advanced interface design. This is discussed in more detail under Article 12 – Human Factors.

Regulatory review and control for construction

18.107 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 A6 - Table of 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 inspector (or team of inspectors) identified within ONR as having specific responsibilities for the regulation of the nuclear licensed site.

18.108 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.

18.109 There is a requirement to produce adequate documentation to justify safety of the proposed construction. 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 called a Consent. 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 LC14 – safety documentation.

18.110 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

Strategic Approach

18.111 NNB GenCo is constructing two EPR reactors at Hinkley Point C (HPC). ONR's approach to regulating the ongoing construction and commissioning of HPC is based on the following strategic objectives:

- to secure ONR's timely and effective regulation of the construction, installation and commissioning, by NNB GenCo, of two EPR reactor units at HPC;
- to implement a programme of interventions or multi-discipline team inspections aimed at gathering evidence to form a judgement on the capability of the NNB GenCo organisation and the effectiveness of its management arrangements.

18.112 The strategic approach is designed to secure interventions that align with the ONR Strategic Plan 2016-2020 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;
- actively promote self-regulation of day-to-day nuclear safety and security by NNB GenCo and other duty-holders.

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 take into consideration conditioning and disposal.***

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

- EDF Energy NGL has now completed an ownership report for Level 2 PSA.

19.2 Otherwise compliance with this Article of the Convention has not substantially changed since the Seventh UK report (Ref. 18) (i.e. in a way that has implications for the Convention obligations).

19.3 The UK currently has 15 reactors operating on 8 sites owned by EDF Energy NGL and is constructing two EPR reactors at Hinkley Point C. The main focus in this section of the report is on the operating reactors. Hinkley Point C has not yet entered commissioning but will likely begin before the next CNS meeting in 2023. This section therefore briefly covers the intent for commissioning of these reactors, but does not describe site-specific elements of operation, as that is not expected until 2025. 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.

Initial authorisation

19.4 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 A6 - Table of 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 LC21. 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.

19.7 Prior to commencing commissioning, ONR expects the licensee to update the pre-construction safety report that provided the basis for proceeding with construction, to reflect the plant as built (i.e. including modifications to the initial design, or those made during the course of 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 may also allow for the detection of 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 requires operating limits to be derived from the safety cases, and these in turn 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 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 implemented in 2023 to support active commissioning.

Operational limits and conditions

19.11 LC 23 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 plant within this envelope. These limits and conditions are referred to as the operating rules.

19.12 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.

19.13 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.

19.14 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.

19.15 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.

19.16 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 the ONR is required.

Procedures for operation, maintenance, inspection and testing

19.17 LC 24 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.

19.18 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.

19.19 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.

19.20 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.

19.21 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.

19.22 LC 28 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.

19.23 All UK operating nuclear reactors are required to shut down at specified intervals for inspection and testing. These periodic shutdowns (required under LC30) occur every 18 months for Sizewell B and three 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.

Procedures for responding to operational occurrences and accidents

19.24 The information in this Article is directly related to the major common issue on **emergency preparedness** from the Seventh Convention and **VDNS Principle 2**.

19.25 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.

19.26 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).

19.27 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, 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.

19.28 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.

19.29 ONR's SAPs (Ref. 49) 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 design basis. These analyses should inform preparation of accident mitigation strategies and emergency plans.

19.30 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. There are also plans to update the relevant Sizewell B station operating instructions.

EDF Energy NGL has now completed an 'ownership report' for Level 2 PSA that is used to cascade insights from the pilot Level 2 PSA study that was completed. ONR is planning an inspection at Heysham 2 in 2019 to confirm some of these items. The intent of this inspection is to look at some of the lessons learnt from the ownership report on Level 2 PSA, especially in the area of emergency equipment, and applicable items from the JER improvement work.

19.31 The arrangements for dealing with accidents and emergencies are set out under Article 16.

Engineering and technical support

19.32 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 risk to operating facilities, resolve operational problems in a timely manner and facilitate the definition of standardised methods of working and fleet approach.

19.33 Although the majority 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.

19.34 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.

19.35 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.

19.36 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.

Research and development – regulatory focus

19.37 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 Government has given ONR the responsibility to oversee long-term generic (i.e. not site specific) safety research.

19.38 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.

19.39 Nuclear site licensees are responsible for managing the risks of their operations, and the designers and manufacturers of nuclear plant are responsible under the Health and Safety at Work Act 1974 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 (as reinforced by the revised European Nuclear Safety Directive).

19.40 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

19.41 There are legal requirements outlined in various regulations and in some of the licence conditions (most significantly LC7, the licence condition for incidents on site) for notifying ONR of significant events occurring on nuclear sites.

19.42 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.

19.43 LC 7 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:

Overview of established reporting criteria and reporting procedures

19.44 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.

19.45 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 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

19.46 An important part of ONR's role is to investigate incidents, and where appropriate to take proportionate enforcement action. Further information on enforcement by ONR, see Article 7 – Legislative and Regulatory Framework.

19.47 The UK complies with the requirements of the IAEA's International Nuclear and Radiological Event Scale (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.

19.48 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 case investigation. As a result, it is not uncommon for the INES rating to be revised subsequent to an investigation being carried out by the licensee or ONR.

Reported incidents significant to safety for the past three years

19.49 This report includes events that have occurred over a reporting period, from January 2016 to December 2018. Since the Seventh UK Convention Report, there have been a total of 17 incidents rated at INES Level 1 and one event at INES Level 2 on the operating reactor fleet, which are summarised in Table A4 – Summary of incidents and INES ratings.

6.34 The list of events and outcomes presented in Table A4 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

19.50 ONR reports incidents to the public through two 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 committees 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 particular site for the particular period.

19.51 Additionally ONR regularly publishes a document detailing nuclear safety and radiological safety events reported to ONR. The latest of these reports covers the period April 2015 to December 2017 (Ref. Going forward ONR intends to publish these reports annually; the first of these annual reports will cover events reported in 2018.

19.52 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". 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

19.53 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' operating experience feedback programmes. One of the SAPs for leadership and management for safety (MS.4, Ref. 49) 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."*

19.54 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.

19.55 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.

19.56 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 on the basis of 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.

19.57 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 best practice 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.

19.58 EDF Energy NGL's operating 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 operating 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. Operating experience related information is screened and analysed to select and prioritise potential learning opportunities.

19.59 EDF Energy NGL has well developed mechanisms to distribute learning identified through its operating 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.

19.60 As part of its international operational experience feedback processes, ONR liaises routinely 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 reporting authority, i.e. INES and the IAEA/NEA International Reporting System (IRS) for operating experience.

Regulatory review of licence holder

19.61 In determining its response to incidents notified to ONR, it applies the key principles underpinning its Enforcement Policy Statement 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).

19.62 Consequently, when incidents of a minor nature occur (those that present minimal, if any, risk to workers or the public, and which represent the large majority of incidents reported to ONR), ONR's main focus is to review the nature of the event and the dutyholder's response, in order 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 (in order to minimise the potential for a recurrence).

19.63 In cases where the actual or potential consequences are judged to be more significant, ONR may elect to investigate the incident in order 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.

19.64 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.

19.65 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.

19.66 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 Emergency Preparedness.

Management of spent fuel and radioactive waste on the site

19.67 Information on radioactive discharges, and on the disposal of solid radioactive waste, is provided in the UK's sixth national report for the Joint Convention (Ref. 3).

19.68 LC 34 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 have to 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 (the licence condition for incidents on the site). Each site has a discharge authorisation issued by the appropriate environment agency. The licensee must demonstrate how it complies with such authorisations.

19.69 LC 32 requires that, as 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.

19.70 LC 33 requires the disposal of radioactive waste to be in accordance with an authorisation granted under RSA93 in Scotland and 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 RSA93 and EPR16. These authorisations or permits also require that operators use best practicable means or best available techniques, respectively, to minimise the creation of radioactive waste.

19.71 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. 108). 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.

19.72 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.

19.73 After a suitable further cooling period, skips are loaded into transport flasks and dispatched off-site for reprocessing or further storage. There are three classes of radioactive waste produced as a result of operation of an AGR:

- High level waste is a by-product of the fuel reprocessing process at Sellafield. The waste is currently stored at Sellafield and will ultimately be vitrified for long term storage. 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).
- Low Level Waste from operational power stations is principally lightly contaminated miscellaneous waste arising from maintenance and monitoring, such as plastic, paper and metal.

19.74 For the PWR at Sizewell B the reactor is refuelled roughly every 18 months, 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. Since the last report, the dry fuel store has completed construction and started receiving casks of spent fuel for long term storage. The store will house spent fuel from Sizewell B until a geological disposal facility is available for the longer-term storage of spent fuel.

Tables

Table A1 - UK Civil Nuclear Power Reactors – Key Parameters

Nuclear Installation	Dungeness B	Hartlepool	Heysham 1	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
Reactor Thermal Power (MWth) (per reactor)	1550	1575	1575	1700
Electrical Gen. Power (MWe) (per reactor)	585	640	630	670
Total exported (MWe)(per reactor)	520	590	580	610
Nuclear fuel	UO2	UO2	UO2	UO2
Fuel cladding	S. Steel	S. Steel	S. Steel	S. Steel
Nuclear moderator	Graphite	Graphite	Graphite	Graphite
Reactor core Fuel channels Assemblies per channel Fuel pins /assembly	 408 7 36	 324 8 36	 324 8 36	 332 8 36
Coolant	CO_2	CO_2	CO_2	CO_2
Coolant containment	PCPV	PCPV	PCPV	PCPV
Coolant pressure (Bar)	30	42	42	42

Coolant max. temp (°C)	650	660	660	660
Steam turbine inlet pressure (Bar)	163	159	159	159
Steam turbine inlet temp. (°C)	555	517	547	538
Gross electrical power (MWe)	1170	1280	1260	1340

Heysham 1 and 2 operate independently on one site licence

Nuclear Installation	Hinkley Point B	Hunterston B	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
Reactor Thermal Power (MWth) (per reactor)	1320	1320	1700	3425
Electrical Gen. Power (MWe) (per reactor)	525	530	645	1260
Total exported (MWe) (per reactor)	475	480	595	1198
Nuclear fuel	UO2	UO2	UO2	UO2
Fuel cladding	S. Steel	S. Steel	S. Steel	Zr-4
Nuclear moderator	Graphite	Graphite	Graphite	Water
Reactor core Fuel channels Assemblies per channel Fuel pins /assembly	 308 8 36	 308 8 36	 332 8 36	 - 193 264

Coolant	CO_2	CO_2	CO_2	Water
Coolant containment	PCPV	PCPV	PCPV	Steel PV
Coolant pressure (Bar)	41	40	43	150
Coolant max. temp (°C)	583	583	660	323
Steam turbine inlet pressure (Bar)	126	126	159	67
Steam turbine inlet temp. (°C)	435	435	538	283
Gross electrical power (MWe)	1050	1060	1290	1260

U metal	Natural Uranium Rods	UO2	Enriched Uranium Oxide Pellet
Steel PV	Welded Steel Pressure Vessel	PCPV	Pre-stressed concrete pressure vessel

AGRs have one fuel assembly per channel with 8 elements; the table indicates the number of pins per element

Heysham 1 is currently limited to operating at 84% power (7 out of 8 boilers are in service)

Nuclear Installation	Hinkley Point C (Under Construction)
Licensee	EDF NNB
Reactor type	PWR
No. of reactors	2
1st Power Operation	TBC
Reactor Thermal Power (MWth) (per reactor)	4500
Electrical Gen. Power (MWe) (per reactor)	1780
Total exported (MWe) (per reactor)	1650
Nuclear fuel	UO2
Fuel cladding	zirconium alloy

Nuclear moderator	Water
<u>Reactor core</u> Fuel channels Assemblies per channel Fuel pins /assembly	 - 241 265
Coolant	Water
Coolant containment	Steel PV
Coolant pressure (Bar)	155
Coolant max. temp (°C)	312
Steam turbine inlet pressure (Bar)	76
Steam turbine inlet temp. (°C)	291
Gross electrical power (MWe)	3560

Table A2 – Summary of nuclear safety assessments

Name of Assessment/Consent	Category	Outcome	Description
Heysham 2 Power Station – Data Processing and Control System (DPCS) Phased Reinforcement.	1	Acknowledgement	Report not formally assessed. ONR acknowledged receipt of the document and following a brief review recommended assessment by a number of specialists of the subsequent more detailed stage submissions.
Hinkley Point B and Hunterston B Power Stations - Boiler Tube Failure Safety Case	1	Agreement	ONR assessed the updated boiler tube safety case, which incorporated a number of modifications into

			the safety case and recommended further modifications. ONR agreed to the implementation of the safety case and is tracking the completion of the identified further modifications.
Granting Consent allowing Sizewell B Dry Fuel Store Project Commence Active Commissioning	1	Consent	Consent to active commissioning of the dry fuel store was given based on ONR's judgement that an adequate safety justification was provided, the project had effective governance, equipment had been suitably qualified, appropriate training was provided to operators and appropriate control and supervision was in place.
Agreements to revised graphite safety cases for Hunterston B and Hinkley Point B Power Stations	1	Agreement	Following assessment, ONR agreed to the implementation of the revised graphite safety case. This safety case justified increasing the operating limit for the number of cracked graphite bricks present in the core, demonstrating large safety margins remaining.
Hartlepool and Heysham 1 – Boiler tube leaks on a shutdown reactor	1	Agreement	Following a number of safety driven modifications, the safety case for boiler tube leaks at Heysham 1 and Hartlepool was updated to incorporate these modifications. Following assessment, ONR agreed to the implementation of this safety case.
Agreement to the modification to optimise	1	Agreement	This safety case justified a reduced

the inspection requirements of welds within the superheater outlet headers and reheat inlet headers at Dungeness B			inspection plan of superheater/reheater welds by providing evidence that the welds have a high defect tolerance and the inspection itself could cause a safety challenge to the welds. Following assessment ONR agreed to the implementation of this reduced inspection plan.
Hartlepool and Heysham 1 Power Stations - Updated Steam Release Safety Case	1	Agreement	This case set out the principles for protection against steam release and addressed a number of shortfalls identified in the previous periodic review of safety. ONR agreed to the implementation of the updated steam release safety case but also identified a number of shortfalls, the resolution of which are being tracked through Regulatory Issues.
Safety Case for Operation of the Hot Box Dome with Regions of Elevated Temperature	1	Agreement	ONR Agreed to the implementation of an increased temperature limit in the hot box dome. This magnitude of the increase was 10 degrees, with ONR accepting the claim that safety margins to failure remain large.
Assessment of the Justification for Continued Operation of Heysham 1 R2 Following Detection of Multiple Fuel Failures in 2016.	1	Agreement	ONR Agreed to the implementation of the safety case, judging that the submission demonstrated that sufficient risk reduction countermeasures were implemented at Heysham Reactor 2 to reduce risk due to the increased rate of fuel

			failures as far as is reasonable practicable.
Paper of Principle for Extended Loss of Grid	1	Review and consideration	The paper of principle set out a work programme to address extended loss of grid and justified continued operation of the eight stations until the final safety cases are provided. ONR reviewed the documentation and judged the justification for continued operation to be sufficient. ONR is attaching significant attention to the forward programme and is tracking this through Regulatory Issues.
Dungeness B Power Station, Long Term Fire Safety Case	1	Agreement	ONR assessed the long term fire safety case which provided a full survey of the fire safety case, incorporating a number of key safety modifications. ONR Agreed to the implementation of the case but also committed to monitor further improvements to the case. These further improvements are being tracked through Regulatory Issues.
Review and Consider – Paper of Principle Removal of Carbon Deposit on Fuel Pins by Injection of Oxygen into the Primary Circuit	1	Review and Consideration	ONR reviewed the Paper of Principle for Removal of Carbon Deposit on Fuel Pins by Injection of Oxygen into the Primary Circuit and decided to place a hold point on the modification. ONR will formally assess the Category 1 modification submission; issue of a Licence Instrument will

			be required to release the hold point.
Extension to the Safety Case for the Reactivity Effects of Boiler Tube Failure Including an Increase in the Graphite Weight Loss Limit to 10%.	2	Review and Consideration	ONR chose to assess this modification since it sought to increase in the Graphite Weight Loss from 8% to 10%; this is a change to a significant safety limit. ONR concluded that the submission demonstrated that the risks had been reduced as low as reasonably practicable and raised no objections to its implementation.
Assessment of Heysham 2/Torness Graphite Post-Stress Reversal Safety Case	1	Agreement	This safety case set out to justify the operation of the Heysham 2 and Torness graphite reactor cores, beyond the point of stress reversal, up to the onset of keyway root cracking. ONR assessed this submission and Agreed to the implementation of the safety case.
Corrosion Management Arrangements at Dungeness B Power Station	N/A	Direction	Following a number of corrosion focussed inspections at Dungeness B, ONR found a number of significant shortfalls in their corrosion management arrangements. In response, ONR issued Dungeness B with a Direction to Carry Out a Review and Reassessment of Safety Addressing the Corrosion of Concealed Systems.
In-Reactor Detection and Management of AGR Fuel Failures Occurring during Normal Operation for	1	Agreement	This safety case is intended to provide generic (i.e. across its seven operating AGRs) in-reactor safety case

Torness (TOR) Power Station			for the detection, location and management of fuel failures occurring during normal operation of the reactors. This submission is generic to all seven AGR sites but the permission requested is specific to Torness. Following assessment of the safety case ONR Agreed to its implementation at Torness.
Approval of Revised Emergency Plans for all EDF Energy Nuclear Generation limited Nuclear Licensed Sites	N/A	Approval	For each of its nuclear licensed sites, the Licensee requested ONR's approval under Licence Condition 11(3) to replace the current approved emergency plans with revised plans to reflect changes in the organisations, practices and scope of the emergency plans. Following ONR assessment of the updated plans by nuclear safety and security inspectors, the updated emergency plans were Approved.
Heysham 1/Hartlepool Extension of the Safety Case for the Reactivity Effects of Boiler Tube Failure Faults to End of Station Life	1	Agreement	This safety case was produced to increase the Graphite Weight Loss limits at Heysham 1 and Hartlepool power stations to 17% and 20% from 12% and 17% respectively. Following assessment of the case, ONR agreed to the implementation of the changes proposed to the Graphite Weight Loss limit, concluding that the risks associated with steam

			driven reactivity faults at Heysham 1 and Hartlepool power stations had been reduced so far as is reasonably practicable.

Table A3 – Engineering principles set out in 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 have to deliver safety functions should be identified and classified on the basis of 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.
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 A4 – Summary of incidents and INES ratings

Dungeness B

Significant Events Reported to ONR: INES Rating 2 – Incident			
Date	**Event Description**	**Dutyholder Response**	**ONR Action**
31/12/18	In September 2018, as part of a regulatory intervention on external corrosion management, ONR issued a Direction for Dungeness B nuclear power station to carry out a review and reassessment of safety addressing the corrosion of concealed systems that fulfil a safety function. Inspections carried out by the site nuclear licence holder (licensee) in response to this direction identified that seismic restraints, pipework and storage vessels associated with several systems providing a safety function were found to be corroded to an unacceptable condition. This condition would have been present whilst the reactor was at power, although, the affected systems were not called upon to perform their safety function. There were no safety consequences to people or the environment as a result of this event.	See paragraphs 14.74 to 14.80	See paragraphs 14.74 to 14.80

Significant Events Reported to ONR: INES Rating 1 – Anomaly			
Date	**Event Description**	**Dutyholder Response**	**ONR Action**
16/09/16	During testing of the additional feed system diesel engines, it was found that the diesels could not operate as	An interim justification for continued operations was developed, which required the improvement of cooling to the building in which the diesels were located. The maintenance	ONR followed up this issue during pre-planned site interventions. No further regulatory action was deemed necessary.

	intended during high ambient temperatures.	schedule was also improved to ensure conformance.	
24/01/17	During testing Superheater Safety Relief Valves were found to potentially not be qualified against high ambient temperatures that may occur in the boiler house. This could undermine the steam release safety case.	An interim justification for continued operation was developed incorporating the necessary engineering changes.	ONR followed up this issue during pre-planned site interventions. No further regulatory action was deemed necessary.
23/03/17	Support for a length of pipework in the Auxiliary Cooling Water system was found not to have been installed. Without this support the pipework may have failed in a seismic event.	The dutyholder produced an interim justification for continued operations which was based on the temporary fitting of scaffolding either side of the valve to provide suitable restraint. The dutyholder has since installed further permanent supports.	ONR followed up the issue during planned regulatory interventions and was satisfied with both the remedial action taken as well as the dutyholder investigation into the event.
09/05/17	Upon arrival at Sellafield, a Fuel Transport Flask from Dungeness B was found to have bolts only tightened up to 'hand tight. The flask design is such that the lid shield is retained in place by chocks which are independent to the bolts in question. Consequently it is likely that during a severe accident the lid would remain in place because of the shield chocks. Nevertheless, the transport package was not compliant with the relevant transport manuals.	The dutyholder performed a root cause analysis to determine the cause and found it to be procedural use and adherence. The dutyholder created a corrective action plan to determine and complete the steps required to correct the issue.	ONR issued an enforcement letter and required a resolution plan to be made to prevent reoccurrence of this incident. In April 2018 ONR inspected the station's progress against their resolution plan and judged that they had taken appropriate action to address the requirements of the Enforcement Letter through amendments to process documentation, equipment and training. Consequently ONR closed the regulatory issues raised.
28/12/17	Review work undertaken to improve the lifetime operation of boilers revealed that some safety assumptions were not accurate.	Interim work has been done to justify the safety of continued operation of the reactor and changes made to the operating instructions.	ONR considered that the dutyholder had implemented reasonably practicable measures in the short term but that further improvements could be made in the future. ONR is continuing to monitor the improvements being made to the safety case.

19/09/18	During a visual inspection of welds on a main steam riser pipe, a crack indicating thermal fatigue damage was noted. Structural Integrity calculations indicated potential issues for the pipework integrity. Both Reactors were shutdown at the time for routine outages.	See paragraphs 14.82 to 14.86.	See paragraphs 14.82 to 14.86.

Hartlepool

Significant Events Reported to ONR: INES Rating 1 – Anomaly			
Date	**Event Description**	**Dutyholder Response**	**ONR Action**
17/09/18	During a plant walkdown an issue was noted with cable routing between segregated cable routes. It was identified that cables installed during recent projects from 2008 have bypassed a fire stop in the Reactor Basement. The cable used has fire protection and will carry out its function under fire conditions, however it does not stop fire from propagating therefore breaching the fire stop. Although unlikely, a significant fire in the reactor basement could therefore cause the loss of operation of a number of gas circulators	The dutyholder conducted a root cause investigation, and produced a safety case to justify the safety of continued operation until remedial work can be completed.	ONR was satisfied with the dutyholder's initial response. The monitoring of the dutyholder's internal investigation and resulting action plan was added to the routine regulatory work programme.

Heysham 1

Significant Events Reported to ONR: INES Rating 1 – Anomaly			
Date	**Event Description**	**Dutyholder Response**	**ONR Action**
12/07/16	During a routine calibration check, a safety system differential pressure transmitter was found to be out of calibration. This resulted in a situation where the actual boiler low feed flow trip setting was 10kg/s instead of the required 14.4kg/s.	The dutyholder declared the transmitter as unavailable and set it into a tripped state. Following this a replacement transmitter was installed and calibrated. A review was performed on other units of the same type and no issues were found.	ONR was satisfied with the dutyholder's response to this event.

03/04/17	While carrying out outage deluge testing of the turbine a suspected pressure surge occurred on the fixed jet fire system (FJFS) which resulted in a significant flange leak resulting in a large influx of water into the turbine hall basement. Unit 2 was manually shut down on the evening of 3rd April, following the implementation of suitable mitigations to compensate for the unavailability of the FJFS. Very shortly afterwards, a hydraulic oil leak developed on a valve on a section of hydraulic pipework, which resulted in oil ignition when some of the oil came into contact with high temperature pipework below. The oil ignition self-extinguished within a minute and remained extinguished, but as a precaution, Lancashire Fire and Rescue Service was summoned to site.	The dutyholder shut down the operating reactor and extended the outage on the shutdown reactor. The dutyholder conducted an in-depth investigation into the event and highlighted a number of corrective actions to prevent recurrence as well as a recommendation for other operating stations to review their arrangements. The investigation highlighted that the direct cause was due to a significant volume of air that had accumulated in the FJFS Main; as a result, water hammer induced a pressure surge when the system underwent routine test. The dutyholder conducted a review for all possible sources of air ingress and rectified as necessary.	ONR conducted follow up enquiries into the event. The monitoring of the dutyholder's internal investigation and resulting action plan was added to ONR's routine regulatory work programme.
25/11/17	The reactor tripped automatically. This was triggered by an earth fault occurring on a Unit Auxiliary Transformer which eventually led to conditions resulting in the automatic tripping of the reactor.	The dutyholder conducted an investigation into the event. Following this the dutyholder created a workstream to modify the engineering components to ensure that the root cause does not occur again.	ONR specialist inspectors reviewed the adequacy of the dutyholder's internal investigation. ONR was satisfied with the dutyholder's response and action plan.
14/12/18	When repairs to Reactor 1 firefighting suppression system for the gas circulator lube oil package were restarted after a short break a fire watch (individual employed to watch for the occurrence of a fire) was not reinstated as required by procedures resulting in a reduction in the defence in depth caused by the removal of a fire watch during the repair work.	The situation was rectified and a formal investigation is being undertaken by the dutyholder.	ONR was satisfied with the initial response of the dutyholder and will follow up of this event as part of routine interventions.

Hinkley Point B

Significant Events Reported to ONR: INES Rating 1 – Anomaly			
Date	**Event Description**	**Dutyholder Response**	**ONR Action**
21/11/16	A fire occurred within an electrical cabinet in a switchroom within the Control Building. The fire was limited to a single board within the cabinet and was promptly extinguished by the on-site fire team. Both reactors were unaffected and essential post trip cooling plant remained available.	The dutyholder performed an investigation to discover the cause, which was found to be rainwater ingress via rooms above the cubicle. The dutyholder repaired the roof and conducted a review of roof conditions over electrical cubicles.	ONR conducted follow up enquiries and advised the dutyholder that progress towards compliance would be monitored by ONR as part of normal regulatory business and an ONR Issue was raised to monitor completion of the identified improvements.

Hunterston B

Significant Events Reported to ONR: INES Rating 1 – Anomaly			
Date	**Event Description**	**Dutyholder Response**	**ONR Action**
11/04/18	During shutdown for a planned core inspection, a leak was discovered in the Reactor 3 Decay Heat System. The system was isolated and alternative cooling was provided to Reactor 3 via the emergency boiler feed system. The purpose of the Decay Heat System is to remove residual heat from the reactor once it has shutdown. Other heat removal systems were available, which are designed to adequately cool the reactor in the event that the DHS becomes unavailable.	A project team was established to repair the leak, investigate the condition of other welds on the Reactor 3 Decay Heat System and determine the likely fault mechanism. Reactor 4 was operating at power and the project team considered the potential for the same defect to be present. An interim availability assessment was prepared that justified the continued safe operation of Reactor 4 pending inspection. The defective weld was remade using a new spool piece and the cracked pipework section sent off site for metallurgical analysis. Following inspection repairs were carried out on a number of welds. A Safety Case was prepared and approved to justify that the repairs were adequate to allow the Reactor 3 Decay Heat System to be returned to service. The Reactor 4 Decay Heat System was subsequently made unavailable to allow inspections and associated remedial works to be carried out.	ONR carried out an assessment of the dutyholder's investigation and repair strategies, and ensured that an adequate safety case was in place to justify safe return to service and operation. An ONR issue was raised to monitor the completion of follow up actions.
30/10/18	During a review of the safety case for the Irradiated Fuel Disposal Facility a shortfall	The dutyholder suspended fuel handling operations at the Irradiated Fuel Disposal Facility whilst a safety	ONR is monitoring the improvements being made to the safety case.

	for dropped fuel at the dismantling tube was identified with respect to the ability to cool fuel with boronated water in the event that a dropped fuel assembly occurs.	case is produced to justify the safe continued operation of the facility.	

Sizewell B

Significant Events Reported to ONR: INES Rating 1 – Anomaly			
Date	**Event Description**	**Dutyholder Response**	**ONR Action**
04/11/17	During an inspection of the build-up of boric acid conducted as part of outage operations, deposits of boric acid were identified in the vicinity of a steam generator channel head drain line.	The dutyholder performed an investigation to identify the source of the boric acid, which was found to be a pin-hole leak within a weld area. The dutyholder also removed the affected weld material and repaired the area. Following the event an action plan was put in place to address the risks from this type of weld.	ONR conducted follow up enquiries into the event. The monitoring of the dutyholder's internal investigation and action plan were added to ONR's routine regulatory work programme. ONR provided close oversight of the repair of all four steam generators and ensured an adequate safety case was in place prior to agreeing the reactor's return to service.

Torness

Significant Events Reported to ONR: INES Rating 1 – Anomaly			
Date	**Event Description**	**Dutyholder Response**	**ONR Action**
27/04/16	During a non-routine operation, the Temporary Operating Instruction put in place to maintain safety was deviated from because the operators undertaking the work judged that the deviation was a more conservative approach.	The dutyholder reinforced the standards and expectation of procedural use and adherence and decision making. The dutyholder also included a module on Formal Decision Making in the Fuel Route Engineer Curriculum.	ONR was satisfied with the actions taken by the dutyholder and followed up the event as part of routine regulatory work

24/09/18	During the flask receipt process at Sellafield an Irradiated Fuel Flask despatched from Torness was found to have eight lid bolts out of 28 at a lower-than-specified torque.	The next three flasks which were due for despatch were embargoed, the Torque tool which was utilised was confirmed as operable and an independent torque tool was utilised to confirm there was no further extent of condition on lid bolts of the loaded flasks at Torness. Following a route cause investigation a Foreign material exclusion policy was drafted in order to prevent foreign material entering the flask cell area, and an additional independent check of the flask lid bolts was introduced into procedures.	ONR was satisfied with the dutyholder's response to this event.

Table A5 – Examples of learning from operating experience

Event Description	Main Action Taken
During May and June 2018, EDF Energy was at risk of not being able to secure sufficient supplies of CO_2 to meet the operational requirements of the AGR fleet from its contracted sources due to multiple plant failures in the UK and mainland Europe.	Full review of risks within commodity areas Changes to stocking policy
A leak from a waste water pipe into a cable race passed through cracks in the concrete of the cable race onto electrical boards in a switchroom below affecting control of feedwater valves resulting in the need to shutdown the reactor.	Installation of permanent covers over safety-related electrical boards to protect them from water. Review structural report for the services building to identify any other potential defects that could allow water to enter or traverse between floors.
During a 12 hour return to service test run of High-Pressure Backup Cooling (HPBUC) Engine no 1 at a fuel injector pipe failed due to a double sided fatigue crack, caused by excessive tightening of the injector pipework coupled with cyclic vibration from the engine. This in turn led to the fuel injector line disconnecting from the cylinder and spraying fuel oil onto the running engine. This subsequently led to a minor fire on the HPBUC engine. The pump was shutdown and the fire extinguished using a portable fire extinguisher. There were no safety consequences to people or the environment as a result of this event.	Detailed quality plan for all aspects of the independent review of Diesel Engines. QA audit of arrangements at contractor site. Independent expert review of other diesel engines on station
The reactor Decay Heat System was made unavailable due to the discovery of a leak on the discharge line of the Decay Heat boilers during the return to service from the outage	Design and install permanent instrumentation that will in future assist operators in controlling the Decay Heat system. Review all issued operating instructions for the Decay Heat system to ensure system operation is optimised. Review all training packages for the Decay Heat system with the objective of ensuring the operation of the system falls within the design intent.
During the nightshift with the reactor operating at nominal full load, the Enhanced Shutdown System (ESD) control rods were spuriously driven into the core by a fault which lasted for a 10 second period. This caused a reduction in indicated thermal power of approx. 195 MWTh. The ensuing transient caused the automatic shutdown of the reactor.	Replace the Control Rod ESD Control Supplies Auto Changeover Panel contactors Create routines for future planned replacement of the control supplies changeover panel contactors. Amend the routine ESD contactor testing to include functional testing of the contactors.
While carrying out Statutory Outage deluge testing of the turbine, a pressure surge occurred	Determine how EDF Energy NGL ensures that the combination of defects on a system is risk assessed

on the fixed jet fire system (FJFS) which resulted in a significant flange leak from a common section of FJFS pipework. The isolation of the leak resulted in the unavailability of all 5 FJFS pumps and entry into a Tech Spec 4hr LCO to shutdown any running unit.	and the impact on operability and health of the system is known documented and justified. Determine whether any design changes are required to the FJFS to minimise air ingress into the system.
A fire occurred during recommissioning of a 50V Battery Charger. Prior to the fire the charger unit was de-isolated and switched to float charge by the working party. This allowed the battery to be recharged on float charge after a discharge test which had been completed that day.	Take into account the forensic findings in establishing a battery charger maintenance policy for all plant battery systems on site, including the requirement for periodic checks and replacement of electrolytic capacitors
A Site Incident was declared on 6th December 2016 following the discovery of elevated levels of hydrogen close to a battery room within the Turbine Hall. Prior to the Site Incident, a Maintenance Team had been undertaking boost charging in the 220/250v battery room for a number of days.	Human performance standards and behaviours were not at an acceptable level during the task: Implement maintenance non-conforming reporting process Carry out more focussed observations of individuals completing work order tasks
During inclement cold weather conditions two of the four Reactor Water Storage Tank (RWST) level transmitters went 'bad data'. Shift Operations declared the transmitters inoperable and placed them into bypass, which reduced the Reactor Protection System voting logic from 2oo4 to 1oo2; and subsequently resulted in the station issuing an 'Operational Alert'. Further investigation found that the inoperable transmitter capillary lines were frozen.	Ops Plant Tour to be updated to included checks of the RWST and RWST Level Transmitters (including Trace Heating) during the Winter period. Engineering/Maintenance to conduct a walkdown of the RWST and RWST Level Transmitters (including Trace Heating panel) during the Winter period.
The Power Station retained full accreditation for their technical training programmes in March 2018, however only the Technical and Safety Support programmes achieved a green rating. The Engineering Support Personnel and Maintenance programmes both received an amber rating, with the accreditation board looking to return to site in a year's time to review progress in both of these areas.	Implement a new programme health reporting format including accountability and oversight arrangements. Establish formal role descriptions and mentor guides for key governance roles in the process

Table A6 - Table of Licence Conditions

Description	
Defines expressions used in the conditions.	
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.
Engine no 1 at a fuel injector pipe failed due to a double sided fatigue crack, caused by excessive tightening of the injector pipework coupled with cyclic vibration from the engine. This in turn led to the fuel injector line disconnecting from the cylinder and spraying fuel oil onto the running engine. This subsequently led to a minor fire on the HPBUC engine. The pump was shutdown and the fire extinguished using a portable fire extinguisher. There were no safety consequences to people or the environment as a result of this event.	
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.
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.	
Instructions to persons on the site	The licensee shall ensure that the combination of defects on a system is risk assessed and the plant and health of the system is known documented and the FJFS to be taken in the system.
LC10	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	The licensee shall make and implement adequate arrangements for dealing with any accident or emergency arising on the site and their effects.
Duly authorised and other suitably qualified and experienced persons	Implement a new programme health reporting format including accountability and oversight arrangements. Establish formal role descriptions and mentor guides for key governance roles in the process

Annexes

Annex 1 - Extracts from legislation relevant to the Convention

Extracts from the Nuclear Installations Act 65 (NIA65) relevant to the convention

A1.1. **NIA65 Section 7 - Duty of licensee of licensed site.**

(1) 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

A1.2. **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.

A1.3. **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.

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) (Ref. 22) 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 As a modern regulator, the Environment Agency uses approaches based on assessing environmental risks to ensure society and the environment reap the maximum possible benefits. In targeting its resources at the highest environmental risks and the poorest performing operators, it has developed outcome-focused and risk-based approaches to regulation that are communicated clearly and delivered in a consistent manner.

A2.4 The Environment Agency works in partnership with the nuclear industry to develop and implement new approaches to regulation and recognise and reward good environmental performance. A good example of this is its Nuclear Sector Plan that outlines eight environmental objectives for the nuclear sector; voluntary activities which will be carried out by the industry, over and above their statutory responsibilities; and areas where it has agreed to improve its work as an environmental regulator.

A2.5 The Environment Agency follows the principles for a modern regulator as set out by the Better Regulation Taskforce (Ref. 104):

- Transparent - with clear rules and processes
- Accountable - the Environment Agency will explain its performance
- Consistent - the same approach will be applied within and across sectors
- Proportionate - resources will be allocated according to environmental risk
- Targeted - the desired environmental outcome will be central to EA planning
- Regulations must be practicable

Structure

A2.6 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.

A2.7 In April 2014, the Environment Agency, following a review and update of its corporate plan, restructured from a three-tier (national, regional and area) to two-tier structure (national and area), removing the regional tier. These changes have not affected the structures in place within the Environment Agency to deliver nuclear regulation.

A2.8 The Environment Agency's regulation of the nuclear sector is delivered through its two 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. 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)). Within these groups are a number of 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 2017 (Ref. 88).

A2.9 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

A2.10 The Environment Agency's annual gross expenditure for 2014 to 2015 was £1.3 billion, over half of which is spent on flood and coastal risk management. Income is derived chiefly from three 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.

A2.11 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.

A2.12 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 2014/15 were approximately £15 million.

Human resources

A2.13 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 60 technical staff, with additional administrative support.

Inspectors' qualifications

A2.14 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

A2.15 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.

A2.16 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.

A2.17 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

Mandate and duties

A2.18 The Scottish Environment Protection Agency was set up by EA95 to provide environmental protection and improvement in Scotland. SEPA is a 'non-departmental public body' which is funded by a combination of Grant in Aid provided by the Scottish government and fees paid by environmental licence holders in accordance with the "polluter pays" principle

A2.19 SEPA's statutory purpose, as set out in EA95, is to: carry out its functions for the purpose of protecting and improving the environment (including managing natural resources in a sustainable way) and in doing so, except where it would be inconsistent with carrying out this duty, contribute to improving the health and well-being of people in Scotland and achieving sustainable economic growth.

A2.20 Using its statutory functions, SEPA issues various permits, licences, consents and registrations, ranging from major industrial authorisations, such as a licence to operate large combustion plant, down to domestic matters such as sceptic tank licencing.

A2.21 SEPA's statutory functions include administering the Radioactive Substances Act 1993 (RSA93, Ref. 23) in Scotland. The provisions of RSA93 fall within the competence of the devolved administrations in the UK, including the Scottish Government.

A2.22 SEPA manages a monitoring programme that assesses levels of man-made radioactivity in the environment using a number of environmental indicators. The samples of water, food, soil etc., collected as part of SEPA's programme act both as indicators of the state of the environment and to verify that the levels of radioactivity present within these commodities have low radiological significance to man.

A2.23 Results from the environmental monitoring programme are used as the basis for dose calculations to members of the public from consumption of food and exposures of members of the public from waste disposals.

A2.24 In Scotland, the FSA and SEPA liaise closely together to ensure that the environmental monitoring programme for radioactivity is appropriate. Annual results from the environmental monitoring programme in the UK are published jointly by the environment agencies and the FSA in a report entitled 'Radioactivity in Food and the Environment' (RIFE) (Ref. 88).

Structure

A2.25 Legally, the Agency Board constitutes SEPA. The members of the Board are appointed by Scottish Ministers and, as well as appointing the Chairman of SEPA, the Scottish Ministers appoint a member as Deputy Chairman. The Chairman is personally responsible to Scottish Ministers. The Board has responsibility for ensuring that SEPA fulfils the aims and objectives set by the Scottish Ministers and membership of the Board includes a Chief Executive to whom is delegated the day-to-day management of SEPA. The Board has ultimate responsibility for the organisation. It meets regularly and is specifically concerned to:

- establish the overall strategic direction of the organisation within the policy and resources framework agreed with the responsible Minister;
- oversee the delivery of planned results by monitoring performance of the organisation against agreed objectives and targets;
- ensure that SEPA operates sound environmental policies in relation to its own operations;
- demonstrate high standards of corporate governance at all times; and
- ensure that statutory requirements for the use of public funds are complied with.

A2.26 The nuclear regulation and radioactive substances policy unit is a specialist team within SEPA that deals with the radioactive waste disposals from nuclear sites in Scotland. This unit covers the day-to-day regulatory activities such as issuing authorisations, inspection, and enforcement etc. It also covers more strategic matters such as liaison with government or other bodies, influencing the development of forthcoming policy or legislation. This Unit is also responsible for managing part of the UK's Radioactive Incident Monitoring Network (RIMNET) in Scotland and leads on environmental monitoring such as the collection and assessment of samples. In all there are 21 technical staff dealing with radioactive substances, the majority of whom have some involvement in matters relating to nuclear sites.

Financial resources

A2.27 SEPA's income is derived chiefly from three sources:

- Income raised from charging for regulation
- Government grant-in-aid, which helps to finance amongst other things, pollution prevention and control activities
- Other sources (like financial agreements with NDA for work for its Radioactive Waste Management Ltd. (RWM)

A2.28 SEPA charges operators for its nuclear regulatory activities on the basis of a daily rate for an inspector, which includes an appropriate overhead allowance. The prices for all SEPA charging schemes are updated annually by the Retail Price Index. In the event that SEPA prices have to increase by more than the Retail Price Index, or a scheme requires other changes, a public consultation is held. All changes which have been the subject of consultation have to be approved by the Scottish Minister before SEPA can implement them.

Human resources

A2.29 SEPA has approximately 1250 staff, around 17 of whom are involved in nuclear site regulation.

Inspectors' qualifications

A2.30 Nuclear regulatory staff recruited by the Agency are required to have a degree in a relevant discipline.

Inspectors' training

A2.31 SEPA 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.

A2.32 SEPA's grading structure for regulatory staff starts at trainee Environmental Protection Officer (EPO). Trainee EPOs are required to complete a training programme in order to progress onto Environmental Protection Officer grade. This will include training in general inspection techniques, evidence gathering and enforcement etc. Thereafter EPOs can progress to a more general promoted post as Senior EPOs or move into a specialist area.

A2.33 Specialist staff regulating nuclear facilities, who are normally recruited from outside SEPA, are required to have minimum of 3 years (Specialist 2 grade) technical or scientific professional experience upon appointment but the majority have at least 5 years (Specialist 1 grade). Staff who enter SEPA at specialist level will be trained in the relevant general inspection techniques, enforcement etc. and the more specialised radioactive substances courses, dependent on their existing experience and training.

Natural Resources Wales

Mandate and duties

A2.34 From April 2013, Natural Resources Wales (NRW) became responsible for the enforcement of environmental protection in Wales. NRW took over the EA'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.

A2.35 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).

A2.36 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.

A2.37 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 licencing.

A2.38 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.

A2.39 Through a standing Service Level Agreement (SLA) the EA 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 EA 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.

A2.40 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 Radioactivity in Food and the Environment (RIFE) jointly produced by NRW, EA, SEPA, NIEA and the FSA.

Structure

A2.41 Members of NRW 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.

A2.42 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.

A2.43 Day to day running of the organisation is delegated to the Executive team.

A2.44 The delivery of nuclear and non-nuclear radioactive substances policy, strategy and regulation is delivered by a number of functions within the organisation including engagement with UK and Welsh government, regulatory partners, operators and stakeholders.

Financial resources

A2.45 NRWs comprehensive expenditure for 2014/2015 was £198 million over half of which is spent on flood and coastal risk management.

A2.46 NRW's income is derived chiefly from three sources:

- Income raised from charging for regulation
- government grant-in-aid, which helps to finance amongst other things, pollution prevention and control activities
- Other sources (like financial agreements with NDA)

A2.47 Through the SLA, NRW pay EA a fee to undertake regulatory activity within Wales.

Human resources

A2.48 NRW has approximately 1900 staff although having undergone an internal review; it is undergoing an internal restructuring programme. This may lead to a reduction in head count over three years. In terms of nuclear regulation, there are 2 policy advisors in the Radioactivity and Industry Regulation (RAIR) team working on nuclear policy, strategy and regulation, splitting time between nuclear new build GDA, environmental permitting and decommissioning of the existing sites in Wales. NRW belong to a number of nuclear policy and strategy regulatory working groups, working closely with partner regulators, (specifically the ONR, EA and SEPA) as well as government departments, nuclear operators, designers and developers.

A2.49 Within the Operational functions, 5 specialist non-nuclear compliance officers work within three area teams (North and Mid Wales, South East and South West Wales) delivering compliance of non-nuclear radioactive substances regulation. In addition, a number of specialists from other operational teams work closely with EA 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

A2.50 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 three nuclear licensed sites. NRW employs a number of nuclear specialists to deliver the policy, strategy and guidance and oversight functions across the nuclear sector.

Inspectors' training

A2.51 As above.

Annex 3 - SFAIRP, ALARP and ALARA

A3.1 The SAPs are consistent with 'Reducing Risks, Protecting People: HSE's Decision-Making Process' (R2P2, Ref. 105), which provides an overall framework for decision making to aid consistency and coherence across the full range of risks falling within the scope of the HSW Act. This extended the framework in The Tolerability of Risks from Nuclear Power Stations (TOR, Ref. 106). 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 can be 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.

Glossary and Abbreviations

ABWR	Advanced Boiling Water Reactor
ACoP	Approved Code of Practice
ADS	Approved Dosimetry Services
AGR	Advanced Gas Cooled Reactors
ALARA	As Low As is Reasonably Achievable
ALARP	As Low As is Reasonably Practicable
ASME	American Society for Mechanical Engineers
ASN	Autorité de Sûreté Nucléaire
BDBA	Beyond Design Basis Analysis
C&I	Control and Instrumentation (alternative I&C)
CNI	Chief Nuclear Inspector
COBR	Cabinet Office Briefing Rooms
COMAH	The Control of Major Accident Hazard Regulations 2015
CO_2	Carbon Dioxide
DAC	Design Acceptance Confirmation
DAP	Duly Authorised Person
DBA	Design Basis Analysis
DWP	Department for Work and Pensions
EA95	The Environment Act 1995
EC	European Council
EDF Energy NGL	Electricite de France Energy Nuclear Generation Ltd
EIA	Environmental Impact Assessment
EIR	Environmental Information Regulations 2004
EMM	Enforcement Management Model (ONR)
ENSREG	European Nuclear Safety Regulators Group
EOC	government Emergency Operation Centre
EPR	European Pressurised Water Reactors
EPR10	Environmental Permitting (England and Wales) Regulations 2010
EPR16	Environmental Permitting (England and Wales) Regulations 2016
EPS	Enforcement Policy Statement (ONR)
EU	European Union

FOI	The Freedom of Information Act 2000
FSA	Food Standards Agency
GB	Great Britain (England, Scotland and Wales)
GDA	Generic Design Assessment
HERCA	Heads of the European Radiological Protection Competent Authority
HIRE	Hazard Identification & Risk Evaluation report
HSE	The Health and Safety Executive
HSWA74	The Health and Safety at Work Act 1974
IAEA	International Atomic Energy Agency
I&C	Instrumentation and Control (alternative C&I)
IIS	Integrated Intervention Strategy
INA	Independent Nuclear Assurance
INES	International Nuclear and Radiological Event Scale
INPO	Institute of Nuclear Power Operations
IRR99	Ionising radiations Regulations 1999
IRRS	Integrated Regulatory Review Service
KPI	Key Performance Indicator
LC	Licence Condition
MDEP	Multinational Design Evaluation Programme
MHSWR99	The Management of Health and Safety at Work Regulations 1999
MoU	Memoranda of Understanding
NAcP	National Actions Plan
NARA	Nuclear Action Reliability Assessment
NCA CG	IAEA National Competent Authorities Coordinating Group
NDA	Nuclear Decommissioning Authority
NEA	Nuclear Energy Agency
NEAF	Nuclear Emergency Arrangements Forum
NEPPB	Nuclear Emergency Planning Programme Board
NEPRP	UK Nuclear Emergency Planning and Response Programme
NIA65	The Nuclear Installations Act 1965
NNB	Nuclear New Build
NNL	National Nuclear Laboratory
NPP	Nuclear Power Plant
NRC	Nuclear Regulatory Commission (US)

NRW	Natural Resources Wales
NSC	Nuclear Safety Committee
OECD	Organisation for Economic Co-operation and Development
ONR	Office for Nuclear Regulation
ONR IAP	ONR Independent Advisory Panel
OPEX	Operational Experience
OSART	IAEA Operational Safety Review Team
PAR	Project Assessment Report
PLEX	Plant Life Extensions
PSA	Probabilistic Safety Analysis
PSR	Periodic Safety Review
PWR	Pressurised Water Reactor
RANET	Response and Assistance Network
REPPIR	Radiation Emergency Preparedness and Public Information Regulations 2019
RIFE	Radioactivity in Food and the Environment
RIMNET	Radioactive Incident Monitoring Network
RoA	Report of Assessment
RPA	Radiation Protection Adviser
RPV	Reactor Pressure Vessel
RS	Radiological Safety
RSA93	Radioactive Substances Act 1993
RWA	Radioactive Waste Adviser
SAA	Severe Accident Analysis
SAPs	Safety Assessment Principles
SBERGs	Symptom Based Emergency Response Guidelines
SBIs	System Based Inspections
SCC	Strategic Coordination Centre
SCG	Strategic Coordinating Group
SEPA	the Scottish Environment Protection Agency
SFAIRP	So Far As Is Reasonably Practicable
SGoRR	Scottish government Resilience Room
SMR	Small Modular Reactor
SPIs	Safety Performance Indicators
SyAPs	Security Assessment Principles
TAGs	Technical Assessment Guides

TIGs	Technical Inspection Guides
UK	United Kingdom
WANO	World Association of Nuclear Operators
WENRA	Western European Nuclear Regulators Association

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