Department for
Business, Energy
& Industrial Strategy

THE UNITED KINGDOM'S SEVENTH NATIONAL REPORT ON COMPLIANCE WITH THE OBLIGATIONS OF THE CONVENTION ON NUCLEAR SAFETY

January 2017

Contributors to the United Kingdom's National Report

The Office for Nuclear Regulation (ONR) prepared this report on behalf of the Department of Energy and Climate Change, in consultation with and incorporating contributions from:

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Environment Agency
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Executive Summary

This is the seventh report to be submitted by the United Kingdom (UK) in compliance with Article 5 of the Convention on Nuclear Safety (hereafter referred to as 'the Convention'). Since the Convention came into force in 1996, the UK has participated in all six reporting cycles meeting its obligations under the Convention.

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.

Major legislative and regulatory changes

In accordance with the Convention's guidance on the scope and nature of national reports, the UK has highlighted the main developments to its legislative and regulatory framework since the Sixth Convention Review Meeting in April 2014, notably:

The UK made a significant change to its regulatory organisations on 1 April 2014, when the Office for Nuclear Regulation (ONR) vested as a standalone independent statutory public body, implemented through the Energy Act 2013. ONR is the UK regulator for nuclear safety, civil nuclear security and transport of civil radioactive materials. The Energy Act 2013 also provided ONR with the responsibility for regulating industrial health and safety on nuclear sites. Environmental regulation is the responsibility of each of the UK devolved administrations, the Environment Agency in England, the Scottish Environment Protection Agency (SEPA) in Scotland and Natural Resources Wales (NRW) in Wales.

Post-Fukushima improvements

The UK continues to report on improvements implemented to enhance nuclear safety following the Fukushima Daiichi accident and the findings from peer review missions. This includes the UK's position in addressing the European Nuclear Safety Regulators (ENSREG) stress test findings and the International Atomic Energy Agency (IAEA) Integrated Regulatory Review Service (IRRS) mission to the UK in 2013, which included a specific module on Fukushima.

The UK's approach to addressing the Vienna Declaration on Nuclear Safety is provided, along with the recommendations from the President's Report from the Sixth Convention Review meeting.

UK response to the Vienna Declaration on Nuclear Safety

The UK can confirm it has reflected on the three principles of the Vienna Declaration during preparation of this report, which focus on ensuring:

> *Principle 1 - New nuclear power plants are designed, sited and constructed to prevent accidents and mitigate any possible release.*
>
> 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 Safety Assessment Principles (SAPs). There is a clear national

policy on siting new reactors with a number of sites already identified. The final layer of defence-in-depth is emergency preparedness and response and the UK continues to develop and test local, regional and national plans to ensure emergency preparedness is maintained and improved.

Principle 2 - Comprehensive and systematic through-life safety reviews of existing installations and making timely reasonably practicable improvements.

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 UK, through ONR, maintains oversight of safety significant issues and ensures a proportionate response is taken by licensees in implementing improvements. The UK is leading a Western European Nuclear Regulatory Association (WENRA) initiated working group to establish guidance on the implementation of timely reasonably practical improvements.

Principle 3 - National requirements / regulations take due account of IAEA standards and other relevant good practice.

The UK actively participates in the Commission on Safety Standards and related committees. The UK applies IAEA Safety Standards and ensures consistency with its own regulations, regulatory requirements and guidance for existing and new nuclear facilities.

Challenges from the Sixth Review Meeting

The UK has met the five challenges identified by the Special Rapporteur in the President's Report, which include:

1) *Minimising gaps between Contracting Parties safety improvements.*

Oversight is maintained of the planned programmes of safety improvements, including those implemented post-Fukushima to ensure they are proportionate to the different natural conditions / extreme events predicted in the UK. Information is shared through international peer review processes, bilateral information exchange agreements with both established states and those with emerging nuclear markets, and through open and transparent reporting.

2) *Achieving harmonised emergency plans and response measures.*

The UK takes cognisance of European and international emergency preparedness developments to harmonise and enable improvements in response capabilities. The UK shares information and participates in working groups that support implementation of the European Commission Nuclear Directives and IAEA Basic Safety Standards. The UK collaborates with key European and International bodies including Heads of the European Radiological Protection Competent Authority (HERCA) and WENRA to develop common off-site cross-border emergency approaches.

3) *Making better use of operating and regulatory experience and international peer review services.*

The UK uses intelligence gained from its inspection, assessment and incident reports to identify areas for safety improvements and to inform regulatory strategies and plans. The UK actively participates in IAEA IRRS missions, embracing feedback to ensure continuous improvement. The UK recently hosted an IAEA Operational Safety Review Team (OSART) mission to Sizewell B, which provided a valuable opportunity to exchange technical and regulatory experience between experts and their station counterparts to achieve the common goal of excellence in operational safety.

4) *Improving regulator's independence, safety culture, openness and transparency.*

ONR's independence as a regulator is legally anchored in the Energy Act 2013. The Energy Act 2013 defined the purposes and powers of the statutory ONR, enshrining ONR's independence and key purposes in a single piece of primary legislation. ONR has a policy of presumption of disclosure of information about its activities. Information on regulatory decisions and judgements are made publicly available through the ONR website.

5) *Encouraging all countries to participate in international co-operation.*

The UK works closely with its counterparts in other countries to ensure its approaches reflect international good practice and that lessons are learned from experience elsewhere. ONR collaborates with other national regulators on new reactors, in particular the designs, as part of the Generic Design Assessment (GDA) process through the Multinational Design Evaluation Programme (MDEP). The UK promotes multilateral co-operation through the IAEA on the development of Safety Standards and works with fellow members of the European Union through ENSREG and the wider community via groups such as WENRA.

The UK has also made tangible and timely progress addressing feedback from the Special Rapporteur in 2014, notably:

- ONR published a revised version of its SAPs in 2014, taking account of the lessons learned from Fukushima.
- Implementation of the UK National Action Plan to improve safety post-Fukushima and resilience to beyond design basis events.

Other key issues

In order to deliver effective regulation of the challenges facing the nuclear industry the UK has adopted an 'enabling' and integrated approach to nuclear regulation. This is a constructive approach with licensees, duty holders and other relevant stakeholders that seeks effective delivery against clear and prioritised nuclear safety outcomes.

Challenges relating to the regulation of an ageing fleet of Advanced Gas Cooled Reactors (AGRs) arise, notably from graphite and boiler integrity issues and in combatting the threats from cyber security. Considerable focus has been placed on ensuring adequate programmes are put in place by

licensees to address ageing and obsolescence issues, notably in the area of control and instrumentation. The UK's security and safety experts work together using integrated approaches to ensure security threats do not have a detrimental effect on safety. The integrated approach taken by ONR is reflected in the UK's continuing transition to outcome-focussed security regulation.

The UK has faced challenges addressing international concerns raised relating to the manufacture of nuclear safety components, notably the reactor pressure vessel (RPV) components on Sizewell B, following the identification of flaws on two Belgian nuclear power plants and recently due to anomalies identified on RPV components supplied by Le Creusot forge in France. ONR worked with European regulators, international experts and licensees to understand these issues and ensure confidence in the quality and future safe operation of RPV components supplied for Sizewell B.

An additional area of focus is the potential for counterfeit or fraudulent items to enter the nuclear supply chain. The UK participates in collaborative working groups established to share supply chain good practice to mitigate such risks.

Challenges are also faced assessing new reactor designs and ensuring that prospective licensees develop appropriate arrangements, safety submissions and capabilities expected of a UK site licensee. Through the Generic Design Assessment process, ONR gives clarity on regulatory requirements, thereby optimising the safety aspects of the design and also reducing commercial risk.

In summary, ONR adapts its regulatory approach to meet the challenging needs of the UK's nuclear industry, enabling positive outcomes, whilst securing safe operation and holding the industry to account on important safety and environmental issues. Ultimately, responsibility for adequate safety rests with the UK's nuclear operators, who have to meet the expectations of a comprehensive, goal-setting, regulatory regime.

Conclusions

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 Seventh National Report demonstrates full compliance with the obligations of the Convention on Nuclear Safety.

Contents

Section A

1 Introduction

Objective

1.1 This is the seventh 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).

1.2 The scope of the report is outlined below. In accordance with established guidelines (Ref. 2), the remainder of this section concentrates on significant UK developments that are relevant to the Convention and have occurred since publication of the Sixth Convention Report in January 2014 (Ref. 3) and the related review meeting in April 2014. This includes the Vienna Declaration on Nuclear Safety (Ref. 4). Section B of this report addresses UK compliance with the Articles 6 to 19.

Scope of application / nuclear installations covered

1.3 The UK is made up of Great Britain (GB) (England, Scotland and Wales) and Northern Ireland. The devolved administrations of Northern Ireland, Scotland and Wales are able to exercise powers in relation to certain policy areas, therefore creating the potential for some differences in legislative approaches. ONR does not have regulatory powers concerning nuclear safety in Northern Ireland and licensing of a nuclear installation is vested in the government. However, as there are no nuclear installations currently in Northern Ireland, and none in the past or planned for the future, this does not represent a gap. In the event of any planned nuclear installations in Northern Ireland, the government would review the application of the law and make any necessary changes to ensure complete compliance with the Convention. ONR's powers to regulate nuclear safety do not vary across GB.

1.4 This report makes reference to the UK application of its regulatory framework, however, variances between administrations are highlighted and differentiation is made between GB and the UK where required to reflect aspects of law and practice (notably Article 7 – Legislative and Regulatory Framework).

1.5 For the purpose of this report, the term 'government' means the UK Government and the devolved administrations of Scotland, Wales and Northern Ireland, unless otherwise stated.

1.6 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. An overview of relevant facilities is provided in the ONR Guide to Nuclear Regulation (Ref. 5).

1.7 This report focuses on the UK's civil nuclear power stations, consisting of a fleet of 14 AGRs and a single Pressurised Water Reactor (PWR), for which Electricite de France Energy Nuclear Generation Ltd (EDF NGL) is the sole licensee. Facilities used for national defence purposes are excluded.

1.8 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 latest of which was submitted in October 2014 (Ref. 6). The Joint Convention covers

the management of the radioactive wastes and spent fuels that are generated at the UK's nuclear power stations.

1.9 The last Magnox station at Wylfa permanently ceased generation in December 2015 and is currently being defuelled in preparation for decommissioning. Wylfa will be covered in the next report to the Joint Convention.

1.10 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 where appropriate to demonstrate the application of modern safety standards and processes.

Implementation

1.11 The regulator for nuclear safety, civil nuclear security and the inland transport of civil radioactive materials across the UK is ONR. Three distinct pieces of primary legislation apply to the management of safety on GB nuclear sites, namely:

- The Energy Act 2013 (Ref. 7), which came into force on 1 April 2014, and established ONR as a statutory body and enforcing authority, separate and distinct from the Health and Safety Executive (HSE);
- The Nuclear Installations Act 1965 (NIA65, Ref. 8); and
- The Health and Safety at Work 1974 etc. (HSWA74, Ref. 9).

1.12 England and each of the devolved administrations has a dedicated environmental regulator, the Environment Agency in England, SEPA and NRW. A guide to devolution in the UK can be found on the UK government website (Ref. 10).

1.13 ONR works in partnership with the environmental bodies through memoranda of understanding (MoU's) (Ref. 11). The safety and environmental performance of all the facilities relevant to the Convention across the UK is managed to a consistent set of legal requirements, technical standards and associated regulatory expectations.

Basis of report

1.14 The UK report follows, where applicable, the guidelines provided in the IAEA document INFCIRC/572/Rev.5 (Ref. 2).

1.15 Most of the information cited in this report pre-dates 1 April 2016 except where it was considered to be sufficiently important to require an update and relevant information was available. Where this is the case an indicative date is included which is relevant to the information being provided.

1.16 The UK presentation to the Seventh Convention Review Meeting will be based on this report, augmented with any relevant developments that occur in the interim.

1.17 In addition to the requirements of the Convention Articles and guidance regarding the review process (Ref. 12) a number of other information sources have informed the scope and structure of this report. These include:

- Vienna Declaration on Nuclear Safety (Ref. 4);
- Summary report from the President of the Sixth Convention Review Meeting including the five challenges identified by the Special Rapporteur (Ref. 13); and
- Rapporteur's report to the UK from the Sixth Convention Review Meeting regarding key safety issues and challenges (Ref. 14).

1.18 Questions raised by other Contracting Parties on the UK's Sixth Convention report and answers provided by the UK (Refs. 15 and 16) are included within specific Sections / Articles where relevant.

1.19 This report takes note of the template developed by IAEA (Ref. 17) to assist in the preparation of Articles 17 (siting) and 18 (design and construction) to ensure consistency, promote the use of IAEA Safety Standards and other relevant good practice. Articles 17 and 18 have been extensively re-written to align with IAEA guidance and address the Vienna Declaration on Nuclear Safety.

1.20 Any significant changes in the UK's arrangements to comply with the Convention that have occurred since publication of the UK's Sixth Convention Report are noted at the beginning of each Article.

1.21 Legislation relevant to the Convention and the mandates and duties of the environmental bodies are summarised in Section C (Annexes 1 and 2). Relevant extracts from ONR's SAPs (Ref.29) and other detailed technical information are included in Annexes 3 and 4 respectively. References and a glossary can be found at the end of the report.

Overview of significant developments since the Sixth Convention

Changes relating to the regulatory body

The Energy Act 2013 and creation of ONR as a Statutory Public Corporation

2.1. As the nuclear industry in the UK continues to evolve to meet the demands of an expanding nuclear sector and a new generation of nuclear power stations, including the potential for Small Modular Reactors (SMRs), it was recognised that the regulatory body needed to evolve and modernise to meet these challenges. In February 2011, the UK Government announced its intention to bring forward legislation (implemented by means of the Energy Act 2013) to create ONR. The first step was the formation of ONR as an agency of HSE on 1 April 2011. At this point, ONR took responsibility for the regulation of nuclear safety, civil nuclear security, conventional health and safety, ensuring compliance by the UK with international safeguards obligations and regulation of the transport of civil radioactive material by road, rail and inland waterway.

2.2. On 1 April 2014 the ONR-related provisions of the Energy Act 2013 came into force and as a result, ONR ceased to be an agency of HSE and was vested as an independent statutory public body in its own right. The Energy Act 2013 defined the purposes and powers of the statutory ONR, improved ONR's ability to be demonstrably independent in its regulatory decision making and ensured ONR's key purposes were captured in a single piece of primary legislation.

2.3. The Energy Act 2013 provided ONR with responsibility for regulating industrial health and safety on nuclear sites, working in parallel with the lead UK regulator, the HSE.

2.4. The Energy Act 2013 did not affect the standards of safety or associated regulatory requirements that ONR places upon the UK nuclear industry. However, it reinforced ONR's independence in legislation to fulfil its mission: *"to provide efficient and effective regulation of the nuclear industry, holding it to account on behalf of the public."*

ONR structure

2.5. ONR has a Board comprising Executive and Non-Executive Directors and is led by an Executive Management Team (Figure 1). The Chief Executive, the Chief Nuclear Inspector and the Director of Regulatory Assurance Policy and International are all ONR Board Executive Directors. In March 2016 the ONR Board, with the approval of the Secretary of State, appointed Dr Richard Savage as its new CNI. This followed a period as Acting CNI after the retirement of Dr Andy Hall, the first CNI to hold this statutory office. ONR's current Board and Executive Management Team structure is shown in Figure 1 and published on the ONR website (Ref. 18).

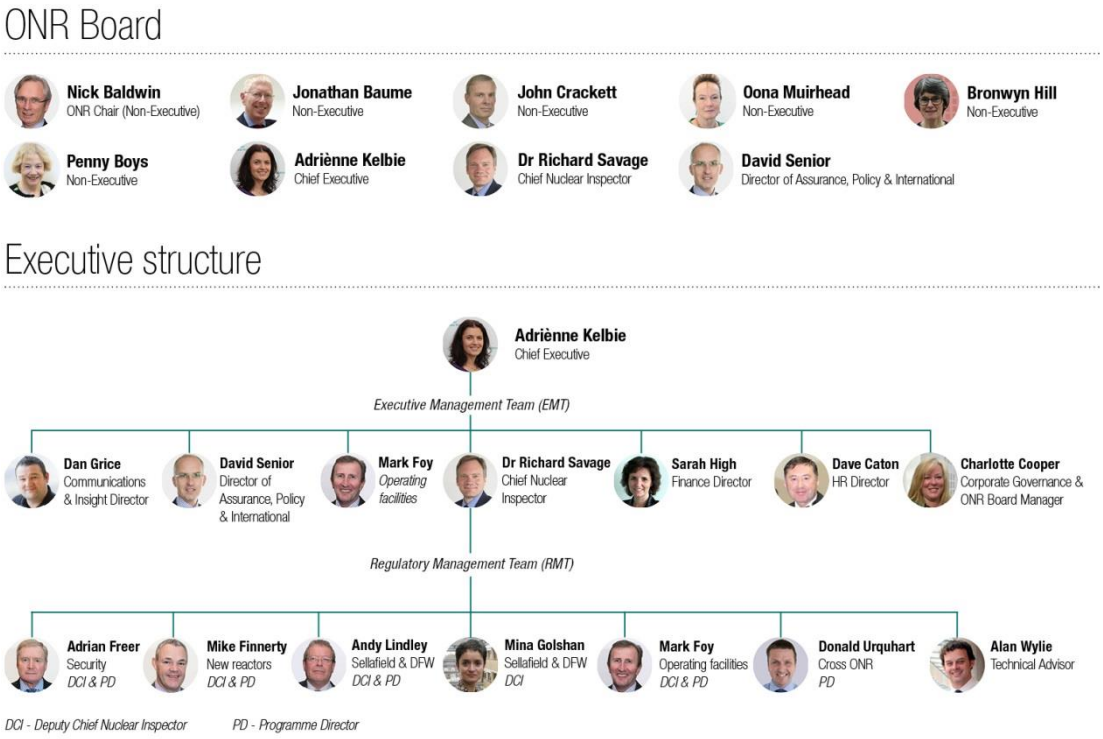

Figure 1 – ONR organisational structure

2.6. ONR's regulatory structure has developed 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 major programmes within the Regulatory Directorate reporting to the CNI as the authoritative regulatory head, which are outlined below and shown in Figure 2:

- New Reactors Programme, including GDA, new reactor licensing and new reactor construction.
- Operating Facilities Programme, including regulation of the operating reactors discussed in detail in this report, together with regulation of defence facilities.
- Sellafield, Decommissioning Fuel and Waste Programme, including regulation of shut-down Magnox reactors.
- Security Programme, regulating security across civil nuclear sites and safeguards.
- Cross ONR Programme; this consists of emergency preparedness and response, regulation of radioactive materials transport and conventional (industrial) health and safety.

2.7. The Assurance, Policy & International Directorate provides independent challenge and assurance about ONR's regulatory activities reporting directly to the Chief Executive and the ONR Board. The function operates independently of the Regulatory Directorate with a focus on assuring the regulatory decision making process and bringing about any necessary improvements to regulatory processes and systems. The Assurance, Policy and International Directorate also coordinates ONR's international activities as well as maintaining the key interfaces with government on policy and nuclear regulatory framework matters.

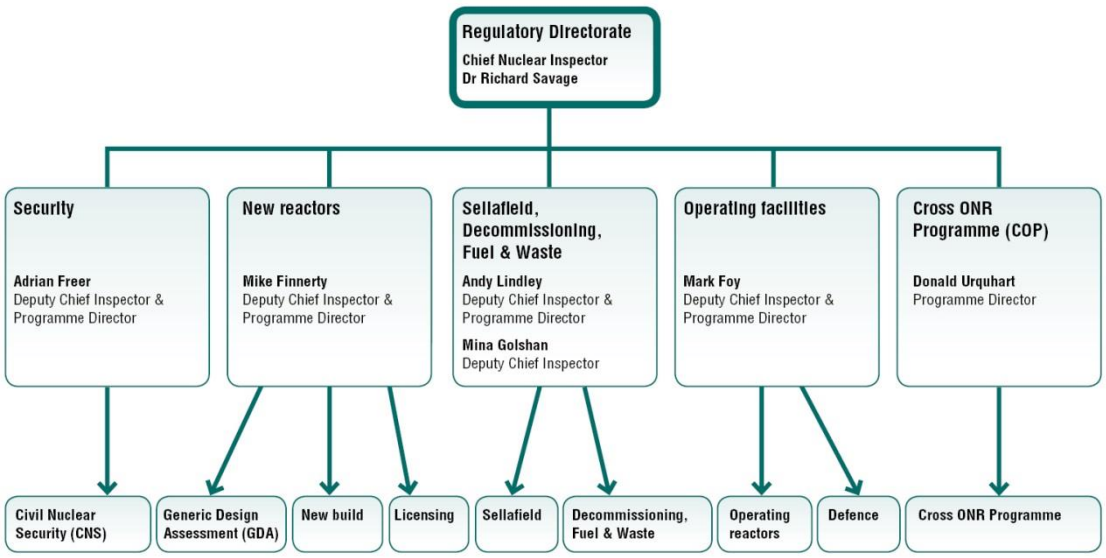

Figure 2 – ONR Regulatory Directorate structure

ONR – Regulatory approach

2.8. The UK operates a goal-setting approach to nuclear safety regulation and is moving towards an aligned approach for security regulation across the civil nuclear sector. This means that ONR sets its regulatory expectations, and requires dutyholders to determine how best to achieve them and justify their chosen approach. This enables dutyholders to be innovative and flexible in how they achieve the high standards of nuclear safety and security required by implementing arrangements that meet their particular circumstances. It also strengthens accountability and encourages the adoption of relevant good practice and continuous improvement.

2.9. The UK nuclear landscape is changing rapidly and it is important that ONR positions itself to ensure it can adequately meet the challenges that such a changing industry generates. Changes include a more globalised approach to the nuclear sector with increased influence of overseas organisations together with developments in site licence company business and organisational capability models. The UK Government's Regulators' Code (Ref.89) came into force in April 2014 and aims to provide a framework for how regulators should engage with those they regulate. ONR's compliance with the principles of the 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. This means that ONR works constructively with dutyholders and other relevant stakeholders to seek effective delivery against clear, prioritised safety and security objectives (see section below 'enabling regulation'). This approach has recently been strengthened and recognised as good practice, and is being disseminated across all of ONR's regulatory operational programmes.

Enabling Regulation

2.10. 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.

2.11. 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, DECC, Nuclear Decommissioning Authority (NDA) to focus on a common overall objective and work together to achieve the desired outcome.
- **Communication** – having agreed priorities and real trust between all stakeholders and being clear about the outcomes 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 focussed** – 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 – seek fit-for-purpose solutions** – not prescribing to dutyholders what to do, but challenge their proposals if considered disproportionate and avoiding 'goldplating'.

2.12. This approach has produced some significant improvements to some long standing issues at the UK's reprocessing complex at Sellafield 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. Whilst all parties individually considered hazard and risk reduction as the number one priority for their organisation, in practice this was not always the case and therefore, the desired outcomes were not achieved. By inviting the heads of these organisations to discuss and commit to overcoming barriers to progress, ONR ensured commitments were upheld and encouraged the development of innovative solutions. This has resulted in tangible risk reduction in key legacy facilities and the alignment of key stakeholders, to the benefit of nuclear safety.

2.13. 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.

2.14. The enabling approach has also been used in regulating the UK's fleet of operating reactors. The cracking of a structural component on a boiler spine at Heysham 1 (described in more detail later in this section) and subsequent cooling modification, which allowed the reactor to return to full power operation, is a notable example. ONR is currently extending this enabling style of regulation across other regulatory programmes.

Licence Condition Review

2.15. ONR regulates through a standard set of 36 conditions attached to the nuclear site licence, which are held by the operators of nuclear facilities and published on the ONR website (Ref. 18). In order to ensure that the licence conditions (Ref. 19) remain fit for purpose, in a changing UK nuclear industry environment, ONR has completed the first phase review of the conditions and a number of recommendations have been identified. This review and the implementation of any agreed changes, including those arising from the revised Basic Safety Standards Directive is planned to be completed by February 2018.

Regulatory Research

2.16. The UK has published its strategic approach to regulatory research (Ref 110). ONR's research needs support its independent regulatory decision making and are based on securing the objective scientific and technical understanding of safety issues

The objectives for regulatory research are:

- to test claims made in licensees' safety cases where the state of the art recognises there may be significant uncertainties;
- to ensure ONR has continuing access to independent scientific and technical expertise in areas where this is scarce;
- to identify emerging technologies with the potential to provide licensees with new ways of managing and reducing existing risks;
- to identify new information and understanding that might undermine existing safety cases;
- to improve ONR's understanding of potential safety issues associated with technologies proposed for future deployment in the UK, where government has informed ONR that it has sufficient confidence that these may proceed; and
- to enhance the efficiency and effectiveness of the nuclear regulatory system.

2.17. Further detail is provided within Section B - Article 19 of this report.

Openness and Transparency

2.18. ONR continues to enhance its openness and transparency and operates with a presumption of disclosure of ONR activities, where documents are published unless there are compelling reasons not do so. Reports summarising regulatory decisions and inspection activities are published as a matter of course on the ONR website (Ref.18).

2.19. In addition, ONR publishes its annual report and accounts (Ref.93), which includes details of performance against its strategy, and contains the CNI's Annual Statement. The report provides an overview of regulatory

activity, performance against the regulatory priorities and a judgement on the regulatory attention necessary for each licensed site and licensee. This is informed by qualitative and quantitative measures including the number and significance of regulatory issues, events on the site, enforcement action, and safety and security performance. In 2016, ONR published a five year strategic plan (Ref. 20), which included the annual plan, which sets out ONR's regulatory priorities for the year ahead and how ONR intends to meet them. These are the areas that will enable ONR to have the most impact in achieving sustained compliance with the expected high standards and will influence improvement in health, safety and security across the nuclear industry.

2.20. To further enhance its openness and transparency arrangements, ONR published a report in February 2016, providing information on all safety events on all nuclear licensed sites in the UK from April 2001 to March 2015 (Ref. 21). This covered all facilities including those outside the scope of the operating reactors covered by the Convention. This report provides supplementary information to that in the 'Chief Nuclear Inspector's Annual Statement 2015/16' contained in ONR's Annual Report and Accounts 2015/16, and to that already placed into the public domain.

2.21. ONR uses the intelligence gained through event reporting, in conjunction with information gained through its other diverse regulatory activities, to inform its future regulatory focus and priorities. In this way, ONR is able to secure effective oversight of the delivery of safety improvements and to maintain a focus on addressing the themes and trends identified. It is ONR's intention to publish future reports of events reported to it, and to continue to review the nature of information reported in order to further increase its transparency and usefulness. Additional information on the findings from this report and event reporting specific to operating reactor sites over the reporting period can be found in Article 19.

Integrated approach to safety and security

2.22. The UK's security and safety experts work together using integrated approaches to ensure security threats do not have a detrimental effect on safety. The integrated approach taken by ONR is reflected in the UK's continuing transition to outcome-focussed security regulation. This started in 2012 with the publication of new regulatory guidance, which replaced an older, more prescriptive document. ONR is now preparing to take the next step by developing the security assessment principles document, which aligns with the well-established safety assessment principles; this document is currently with industry for consultation. The aim is to achieve more efficient and effective regulation of civil nuclear security. It will give sites and other dutyholders freedom to develop security arrangements that suit local conditions while meeting a range of regulatory objectives, as assessed by ONR.

Compliance with the Regulators' Code

2.23. The UK Government's Regulators' Code (Ref.89) came into force in April 2014 and aims to provide a framework for how all UK regulators (not just safety regulators) should engage with those that they regulate. The code is made up of the following principles:

- Regulators should carry out their activities in a way that supports those they regulate to comply and grow.
- Regulators should provide simple and straightforward ways to engage with those they regulate and hear their views.
- Regulators should base their regulatory activities on risk.

- Regulators should share information about compliance and risk.
- Regulators should ensure clear information guidance and advice is available to help those they regulate meet their responsibilities to comply.
- Regulators should ensure that their approach to their regulatory activities is transparent.

2.24. ONR produced a document which demonstrates how it complies with the Regulators' Code (Ref. 22).

2.25. The report concludes that ONR demonstrates compliance with the intent of the Regulators' Code, has comprehensive published procedures that explain the expectations and behaviours on our regulatory inspection staff and guidance for dutyholders to demonstrate compliance with the law.

2.26. The report recognises that there is always room for improvement, and ONR will seek, over the next twelve months, to further embed the Regulators' Code expectations into their everyday working practices.

International co-operation and exchange programmes

2.27. The UK undertakes a broad range of information exchange in order to fulfil safety obligations and to promote international co-operation. This includes multilateral co-operation through the IAEA, in particular on the development of safety standards and in peer review missions, which the UK has recently supported to Japan, Sweden and Lithuania. The UK is a member of the Organisation for Economic Co-operation and Development (OECD) Nuclear Energy Agency (NEA) and participates in a range of the agency safety work streams.

2.28. In the European context, the UK co-operates with both fellow members of the European Union through groups such as ENSREG and throughout the continent via groups such as WENRA.

2.29. 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.

2.30. ONR is a member of MDEP, collaborating with other foreign national regulators looking at new reactor designs on cross-cutting themes. These include designs with intent for deployment in the UK; the AP1000® PWR designed by Westinghouse Electric Company; the UK European Pressurised Reactor (EPR$^{TM)}$ PWR, designed and developed by AREVA; and the UK Advanced Boiling Water Reactor (ABWR), developed for the UK by Hitachi-GE. MDEP allows ONR to work in partnership with other regulators to leverage resource and knowledge to facilitate more efficient and effective design assessments.

2.31. The UK, through ONR takes an active role in the NEA Working Group on the Regulation of New Reactors co-operating with other regulators on the regulatory activities in the areas of siting, licensing and oversight for new nuclear power plants; in particular ONR is leading a sub-group looking at the regulatory oversight of new licensee organisational capability.

2.32. Alongside the multilateral cooperation described above, the UK has information exchange agreements with a range of relevant international regulators involved in the licensing and construction of similar reactor designs; for example ONR has agreements with China, France and Finland who are constructing PWRs.

Supporting nations with developing nuclear power programmes

2.33. As part of the UK's commitment to supporting nations with developing civil nuclear power programmes and the UK's co-operation with Vietnam on civil nuclear energy, a senior ONR inspector was seconded to the Vietnam Agency for Radiation and Nuclear Safety for 10 months from October 2014. The secondee provided advice on all aspects of nuclear regulation as Vietnam prepares to embark on a programme to construct several nuclear power plants. ONR has hosted a number of secondees from the regulatory body of Poland (Państwowa Agencja Atomistyki) to provide practical regulatory experience of nuclear installations.

International collaboration on digital technology

2.34. As part of the UK's regulatory framework, ONR is actively involved in assessing generic reactor designs, which can contain digital Control and Instrumentation (C&I) technology in a variety of forms. This is often a challenging area of work for licensees, requesting parties and ONR. ONR's regulatory position is informed by relevant good practice on nuclear power plants that utilise digital C&I technology in safety systems, IAEA guidance, international standards, and through involvement in a number international forums including MDEP.

2.35. On behalf of the UK, the ONR has recently collaborated with international regulators from Europe and the US Nuclear Regulatory Commission (NRC) to develop a common position on their expectations when licensing safety critical software for nuclear reactors. In addition, ONR is chair of the seven-party regulatory group on safety critical software and is working internationally within IAEA, OECD and MDEP to secure improvements in nuclear safety.

International peer review

IAEA Integrated Regulatory Review Service (IRRS) missions to UK

2.36. The UK has received a series of modular IRRS missions in 2006, 2009 and 2013. The findings from the 2013 mission and a follow-up expert mission completed in 2014 are reported below.

IAEA IRRS mission to UK in 2013

2.37. The 2013 mission reviewed the findings from earlier missions and in addition, assessed a number of different nuclear safety themes including; waste management; decommissioning; radioactive sources; radiation protection and lessons from Fukushima. The IRRS team also assessed compliance with IAEA's relevant standards and guides, overarching themes included: independence; funding/resource; resilience; competence and integration.

2.38. The mission opened with a high level presentations given to the IRRS team by Department for Work and Pensions (DWP), ONR's sponsoring government department, DECC and ONR. Additional information on more detailed technical topics was gathered through interviewing ONR staff, observing inspection activities at licensed sites, and interviewing UK nuclear and radiation safety stakeholders.

2.39. The 2013 IRRS mission report (Ref. 23) commended:

- the systematic way in which UK had taken into account the 2006 and 2009 recommendations and suggestions; and
- the significant progress and improvements made in many areas by the UK, such as how ONR engages with licensees, assesses

emergency preparedness and response capability, and ONR's regulatory guidance.

2.40. All except one of the 32 recommendations and suggestions made in 2009 were fully addressed and therefore considered closed. The suggestion that remained open related to the need to institute a programme for the reconstitution of an advisory committee on nuclear safety. This suggestion was subsequently closed at the 2014 Expert Mission (discussed below) as the committee had formed and met.

2.41. The 2013 IRRS mission report also explicitly highlighted six areas in which the IAEA consider that ONR delivers good practice. The review team identified 25 new findings (13 recommendations and 12 suggestions) relating to two main themes:

- responsibilities and functions of ONR (including organisational capability, communications and training); and
- supervision of non-nuclear power plant facilities (including regulation of radioactive sources, radioactive waste streams and decommissioning).

2.42. The UK accepted these findings as an opportunity to further enhance the regulatory framework and processes, and a detailed programme of work was drafted in December 2013 to address them.

IAEA follow-up expert mission to UK 2014

2.43. The UK (via ONR, in collaboration with DECC), requested the IAEA to carry out a progress review mission to the UK in 2014. This was the first time a member state requested assessment against findings within a year of a peer review mission, demonstrating the UK and ONR's commitment to continuously improving its regulatory effectiveness.

2.44. The mission reviewed progress against the findings made in the IRRS mission in 2013, comprehensive evidence supplied in advance and met with UK technical staff from ONR, DECC and the environment agencies, to conclude that 21 out of the remaining 26 findings could be closed. This included all 12 findings relating to radioactive waste and decommissioning.

2.45. The five remaining findings relate to longer term programmes of work, including findings on the ONR management system and the review of licence conditions. The 2014 mission report (Ref. 24) commended:

- the extent of progress made since 2013 demonstrating the continuous effort to improve; and
- the UK and ONR's commitment to high standards of nuclear safety and the benefits of the IRRS process.

2.46. The next full scope IRRS mission for the UK is anticipated in 2019 to confirm the UK’s strong commitment to the IRRS process and meet expectations set out in the European Union Nuclear Safety Directive.

IAEA Operational Safety Review Team mission to UK

2.47. At the request of DECC, an IAEA OSART mission of international experts visited Sizewell B Power Station in October 2015. The purpose of the mission was to review operating practices in the areas of leadership and management for safety; training and qualification; operations; maintenance; technical support; operating experience feedback; radiation protection; chemistry; emergency preparedness and response; and accident management. In addition, an exchange of technical experience and knowledge took place between the experts and their station counterparts on

how the common goal of excellence in operational safety could be further pursued.

2.48. The IAEA OSART mission identified areas for improvement as well as recognising areas of good practice. The Sizewell B management has expressed a determination to address these findings and is proceeding with improvement plans with the assumption of a follow-up review of progress being undertaken within an eighteen month period. The UK is supportive of the OSART mission to compare the plant's operational practices with best international practices and identify ways in which operational safety can be enhanced. The final report of the OSART mission will be made publicly available in July 2016 through IAEA, ONR and EDF websites (Refs. 47,18 and 48).

Report on the actions taken with regard to the lessons learned from the Fukushima Daiichi accident

2.49. The Sixth UK Convention Report discussed the UK response to the Japanese earthquake and tsunami and the impact for the UK nuclear industry. The report summarised the activities undertaken by the UK at national and international levels (through IAEA, European Commission and the Convention) to examine the circumstances of the Fukushima accident and identify lessons learnt to enhance the safety of the UK nuclear industry.

2.50. Over the three year reporting period, numerous assessments and analyses have been undertaken by ONR and licensees to identify if there were any weaknesses in the design basis of the UK nuclear power plants and non-power generating nuclear plants and the findings reported, notably:

- The ONR CNI interim and final reports on the UK response to the Japanese earthquake and tsunami for the UK nuclear industry (Refs. 25 and 26) and improvement implementation strategy (Ref. 27).
- The European Council (EC) "stress tests" for the UK nuclear power plants (Ref. 28).

2.51. Neither the reviews undertaken by the licensees nor earlier national reviews indicated any fundamental weaknesses in the design basis of the UK power plants. The outcome from these reviews provided confidence that the UK already had implemented a number of measures prior to the Fukushima accident to meet the expectations of the Vienna Declaration on Nuclear Safety. However, the work highlighted opportunities to make improvements to safety assessment methodologies covering "beyond design basis" events and in other areas, including:

- ONR's SAPs – re-issued in 2014 (Ref. 29).
- Emergency response arrangements (discussed below).
- Oversight of nuclear safety research – ONR produced a combined nuclear research index in 2013 (Ref. 29). ONR produced a revised strategy in 2015 (Ref. 110) to support its regulatory functions (research activities are discussed in more detail in Article 19).
- Openness and transparency – ONR's commitment to openness and transparency has been strengthened by the creation of ONR as an independent public body that has statutory responsibility for provision of relevant information. ONR's website (Ref. 18) is evidence of the commitment to deliver this policy

2.52. The CNI interim and final reports (Refs. 25 and 26), together with the stress test report (Ref. 28), formed the basis of the UK's report (Ref. 31) to the second Extraordinary Meeting of the Convention in August 2012. ONR

published a comprehensive summary on the implementation of the lessons learned from the Japanese earthquake and tsunami in October 2012.

2.53. ENSREG, who agreed the technical definition for the stress tests, also identified the need for each national regulator to develop and publish its national action plan in response to their report findings. In December 2012 the action plan (Ref. 32) was prepared, which summarised the UK's position in addressing the stress test findings, the European peer review conclusions, and other ENSREG recommendations and suggestions. The content of the action plan as drawn from and is consistent with ONR's implementation report.

2.54. In 2013 an IRRS mission to the UK included a specific module on Fukushima and concluded that ONR had exercised considerable efforts in order to collect information on the circumstances of the Fukushima Daiichi accident, to draw conclusions on the lessons learned and to initiate steps in order to enhance nuclear safety in the UK.

2.55. It also concluded that ONR's assessment of the implications of the Fukushima Daiichi accident covered all important issues and identified the respective recommendations. Thus no important new task remained to be performed in a long term.

Revisions to ONR's Safety Assessment Principles

2.56. In 2014 ONR produced a revised version of the SAPs (Ref.29), prompted by the publication in 2011 of the CNI's report on the implications of the Fukushima accident for the UK nuclear industry. This report concluded that there were no significant gaps in the 2006 SAPs, but recommended a review to ensure that lessons learned were incorporated.

2.57. In addition to the lessons from Fukushima, the SAPs have also taken account of recent work by the IAEA, in particular the development of IAEA's design standard on the safety of nuclear power plant (SSR 2/1) (refer to Article 18). As with the previous version of the SAPs, the principles were considered to be fully in line with IAEA guidance and standards. However, it was acknowledged that the SAPs could not reflect the breadth and depth of the entire suite of IAEA Safety Standard publications. However, they were explicitly identified as relevant good practices within ONR's Technical Assessment Guides (TAGs) (Ref. 33).

2.58. IAEA guidance recommends that regulatory bodies subject their principles, regulations and guidance to periodic review, and take account of internationally endorsed standards and guidance. Although the SAPs have been reviewed and revised a number of times over the years, the importance of regular reviews was recognised and formal arrangements are in place to carry out future reviews of the SAPs at least every five years.

Further progress addressing the implications of the Fukushima accident

2.59. ONR has re-evaluated the status of implementation regularly since 2012 and published updates on its website in 2013, 2014 and most recently in February 2016 (Ref. 34). Extracts from this latest progress update are given below for the general recommendations, the licensee facing recommendations and the stress test outcomes.

General recommendations

2.60. The general recommendations in the CNI's final report (Ref. 26) were principally aimed at the UK's response to civil nuclear emergencies, looking at international and national issues. These recommendations largely fell to the government and ONR itself, the majority of which were closed by 2014.

2.61. Significant progress has been made addressing recommendations concerned with emergency response, with tangible improvements already in place (see Article 16). These improvements include better access to detailed plant information to support ONR's emergency response and strengthening of ONR emergency planning and response function. At a national level, there is better understanding of the techniques for estimation of accident source terms, and the ability to provide information on the nature and magnitude of any releases has been reinforced. Improvements have been made in the oversight of nuclear safety research, as discussed in Article 19 and in siting arrangements for new nuclear facilities, which is discussed in Article 17.

2.62. ONR is content that the most significant of the CNI's recommendations and stress test outcomes directed towards licensees have been satisfactorily addressed. ONR will continue to regulate progress on any matters or work programmes that have resulted from consideration of recommendations and stress test outcomes as part of normal regulatory business.

Site licensee-orientated recommendations and stress test outcomes

2.63. In the implementation report (Ref. 27) ONR described how it intended to regulate the work of licensees in implementing further measures by embedding the work within the operational regulatory programmes. ONR's Operating Facilities Programme has published its own report outlining the status of the CNI report recommendations, and enhancement made to improve the resilience of nuclear power plant to beyond design basis / Fukushima type events (Ref. 35), for example in flood protection, emergency response capability, accident prevention and mitigation, which are in-line with the Vienna Declaration on Nuclear Safety, and are discussed in more detail in Articles 6, 14 & 18. In additional EDF NGL has produced a report on their Japanese Earthquake Response programme (Ref. 36). Both of these reports are available to the public for openness and transparency.

ENSREG National Action Plan

2.64. ONR provided an update to ENSREG on the implementation of the UK's response to events at Fukushima in December 2014 (Ref. 37), focusing on external events, loss of safety systems and severe accident management. A further update of the action plan is to be produced, on a timescale to be agreed with ENSREG, based on the information in ONR's 2016 progress update (Ref. 34), and it is expected that this will enable close out of the remainder of ONR's post-Fukushima reporting for nuclear power plants.

WENRA Reference Levels

2.65. ONR has taken a leading role in the revision of the WENRA reference levels post Fukushima (Ref. 38) which, together with associated guidance, provide an important means of harmonising nuclear safety requirements amongst the WENRA countries. In addition, ONR has ensured that its SAPs (Ref.29) are compatible with the WENRA reference levels and, furthermore, has processes in place to ensure that the reference levels are explicitly included in relevant ONR TAGs (Ref.33 - refer to Article 18).

IAEA

2.66. Recently IAEA published a comprehensive report on Fukushima (Ref. 39). ONR has disseminated the IAEA report to its key technical assessment functions. It is being reviewed to identify any further measures that the UK Government, ONR, or the nuclear licensees, need to consider. Thus far, ONR has not identified any such measures.

Progress with new nuclear power plants in the UK

UK Government policy on new nuclear power plants

2.67. In July 2011, the UK Government published a Nuclear National Policy Statement (Ref. 40), which listed eight sites as potentially suitable for new nuclear power station construction up to the end of 2025. It also sets out the basis for decisions on applications for development consent to build new nuclear power stations.

The licensing process for new nuclear power plants

2.68. The process for licensing new nuclear installations in the UK, including new nuclear power reactors, is outlined in the ONR document 'Licensing Nuclear Installations' (Ref. 41). This document reflects legal and policy developments and captures learning from application of the licensing process; it includes the law and the regulatory regime, the nuclear licensing process and de-licensing.

2.69. In particular, Licensing Nuclear Installations sets out regulatory expectations concerning the prospective licensee's development of its organisational capability, infrastructure and safety submissions, and its preparation and submission of its licence application dossier. It is supported by other reference documents that potential licensees need to be aware of and which inform the approach that ONR will take to engaging with prospective licensees.

2.70. 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 a pre-construction safety case.

2.71. ONR places particular emphasis on the need to gain confidence that the applicant has the organisational capability to lead and manage safety effectively. This means that ONR must be satisfied with the applicant's governance arrangements, resources, competencies and management processes before can consider recommending that the CNI grants a licence.

New reactor licensing activities

2.72. Three companies are currently engaging with ONR as they prepare nuclear site licence applications for proposed new nuclear power stations:

- Horizon Nuclear Power Ltd has confirmed its intention to apply for a nuclear site licence to construct and operate two Hitachi-GE ABWRs at Wylfa Newydd on Anglesey. This licence application is expected in towards the end of 2016;
- NuGen Ltd is progressing its plans to submit a nuclear site licence application in 2017 to construct and operate three Westinghouse AP1000® PWRs at Moorside in Cumbria; and
- NNB GenCo Ltd intends to seek a licence to construct two EPR™ at Sizewell in Suffolk.

2.73. During the period leading up to nuclear site licence application, ONR is engaging with the prospective licensees to help them understand regulatory expectations. ONR focuses on providing advice and constructive challenge on the licensing process and the companies' 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 and these are published on the ONR website (Ref. 42). Following receipt of a nuclear site

licence application, ONR will formally assess the application, culminating in a recommendation being made to the CNI as to whether or not a licence should be granted.

Generic Design Assessment

2.74. GDA is an upfront / pre-licensing assessment of a generic reactor design. It is a joint process between ONR and environmental regulators who work together to assess new reactor designs to ensure that they are safe, secure and environmentally acceptable. The principal aim is to reduce regulatory uncertainty and provide clarity on design and safety case changes required as a result of UK regulatory requirements, significantly ahead of any construction on site.

Hitachi-GE UK ABWR assessment

2.75. ONR's assessment of the UK ABWR® design is now in step 4 of GDA, and is expected to complete in December 2017. Hitachi-GE completed step 1 in December 2013; step 2 in August 2014 and step 3 in October 2015.

2.76. There have been some notable technical challenges in the preceding assessment steps, which have resulted in the publication of two regulatory issues. These are the most significant regulatory concerns and highlight areas of the design or safety case analysis that ONR considers will need to be resolved before the issue of a DAC could be considered. The issues relate to the provision of modern standards, full scope probabilistic safety analysis (PSA), and the determination of the radioactivity source terms. Since the publication of these issues, Hitachi-GE has made progress in both areas.

2.77. There have also been other challenges; principally relating to the difference in the UK's regulatory regime to that of other regulatory bodies, with the UK adopting a goal-setting, safety case based approach rather than a more prescriptive regime. However Hitachi-GE has implemented measures to bridge this gap and has made progress. At this time ONR considers that the GDA can successfully be concluded in December 2017.

Westinghouse AP1000® GDA closure phase assessment

2.78. Westinghouse was awarded an interim DAC in December 2011 for the AP1000® reactor design. There were 51 outstanding GDA issues which required resolution before a DAC could be awarded. In 2011 Westinghouse decided to pause the GDA process and only re-commenced regulatory assessment in mid-2014. Westinghouse is now working on resolving the outstanding issues as the AP1000® reactor is intended to be constructed and operated by NuGen on the Moorside site in Cumbria. Westinghouse has stated that it is their intention to complete the GDA process in early 2017.

Potential New Entrants to GDA

2.79. In October 2015 the UK Government announced a Heads of Terms Agreement with EDF and Chinese Companies relating to the funding of the Hinkley Point C, Sizewell C and Bradwell B new nuclear build projects. Part of this funding agreement involves the potential deployment of the Chinese HPR1000 reactor technology on the Bradwell site in Essex. As with any new reactor designs, the HPR1000 reactor will need to undergo the GDA process before it can be deployed in the UK. ONR has already undertaken preliminary discussions with the proposed GDA requesting party.

Small Modular Reactors

2.80. At the Spending Review and Autumn Statement 2015, the UK Government announced that DECC will invest £250m in an ambitious nuclear

research and development programme, enabling the UK to be a global leader in innovative nuclear technologies. This includes a competition to identify the best value SMR design for the UK. In March 2016, the UK Government launched the first phase of the competition. The objective of Phase One is to gauge market interest among technology developers, utilities, potential investors and funders in developing, commercialising and financing SMRs in the UK. The UK Government is keen to ensure that any subsequent stages of the competition are informed by participants' views on how to secure commercial deployment of SMRs and on potential timeframes for deployment. This phase of the competition, which will be the first opportunity to engage in discussions with government, will be a structured dialogue between government and participants.

2.81. In preparation for the possibility of needing to regulate small modular reactors, ONR has begun to identify the technical and regulatory areas of interest and challenges associated with these technologies. ONR is also reviewing its design and licensing processes to consider how they could be developed to support the UK Government's intent for SMR's, reflect the unique nature of their construction and deployment and the need to potentially undertake assessments of multiple designs in parallel.

2.82. The UK, though ONR has recently joined the SMR Regulators' Forum (under the auspices of the IAEA) and bilateral discussions have begun with the US NRC and the Canadian regulator to discuss technical challenges related to the assessment and licensing of SMRs.

Progress on new reactor construction

UK EPR™ assessment

2.83. In December 2012, ONR issued a Design Acceptance Confirmation (DAC) for the UK EPR™, indicating that the GDA issues had been successfully resolved and that ONR considered this reactor design to be suitable for construction in the UK subject to, amongst other things, the satisfactory resolution of assessment findings and the production of a site specific safety case. NNB GenCo was granted a site licence in December 2012 to operate two EPR™ reactors at Hinkley Point C. Since then, NNB Genco has been progressing with production of a site specific safety case for the proposed reactors at this site and continuing to close the assessment findings.

2.84. ONR's regulatory strategy for Hinkley Point C includes the staged permissioning of further activities on the site from start of construction, through receipt of fuel arriving on site to the first operation. ONR is also responsible for regulating the safety of construction activities. The first formal regulatory hold point for this site is planned to be first nuclear safety concrete. This will be technical galleries, which are underground "tunnels" used to transfer electricity, water and other services around the site. Following regulatory release of this hold point, the licensee will begin construction of these galleries. Subsequent regulatory hold points will be related to commencement of nuclear island construction. ONR may specify regulatory hold points at any other stage as the construction and commissioning proceeds.

Other Future Safety-Related Activities and Challenges

2.85. The UKs fleet of AGRs and one PWR are intended to continue to operate in the period until the eighth national report is due. In order to ensure that the UK's approach to ageing management remains robust and appropriate, the UK will participate in the ENSREG topical peer review of ageing management during 2017.

2.86. A technical specification is being developed, which is intended to enable participating countries to benchmark their ageing management programmes against international good practices. The process will examine the application of these ageing management programmes to the following systems structures and components.

- Electrical cables
- Concealed piping
- Reactor pressure vessels (or equivalent structures)
- Concrete containment structures.

2.87. WENRA is anticipated to approve its technical specification in Autumn 2016 and ONR is participating in the development of this specification and will participate in the review during 2017.

3 Nuclear safety issues at UK installations

3.1 This section provides an update on the significant technical issues at UK's nuclear power plants that were identified in the UK's Sixth Report to the Convention. Additional information is provided in Article 6.

AGR top dome temperatures

3.2 Modifications have been undertaken on the affected reactors to improve gas flow within the hot box and maintain temperatures within the specified limits. Monitoring of the effect of this work is ongoing by the licensee and ONR continues to monitor progress and to date has no regulatory concerns.

Flow Accelerated Corrosion

3.3 Flow accelerated corrosion is a significant deterioration mechanism and challenge on nuclear power plants and can have both nuclear and conventional safety implications. It occurs in steam/condensate pipework where areas of turbulent fluid flow occur (for example, elbows and bends). The turbulence helps to accelerate the corrosion process of the pipe material. Loss of steam containment on Surry unit 2 (1986) and Mihama unit 3 (2004) nuclear power plant, which resulted in nine fatalities, serves to illustrate the consequences of inadequate management of flow accelerated corrosion. EDF NGL undertakes inspection programmes on all of its stations, where flow accelerated corrosion has been observed with some deterioration sufficiently advanced to require remediation. ONR continues to engage with the licensee and is currently satisfied with progress in this area.

Carbon Deposition

3.4 Carbon deposition is a collective term used to describe the formation of carbon deposits in the primary circuit of an AGR. There are several forms of carbon deposition, which affect both the thermal efficiency of the reactor (by forming calcinated deposits on the fuel pins and boiler tubes) and the efficient working of mechanical and electrical components (by forming sticky resinous deposits on primary circuit equipment). Carbon deposition has been a continuing challenge for the AGR reactors, resulting in safety related issues such as increased probability of fuel pin failure as well as operational issues resulting in lost generation. It affects boilers, fuel, fuel routes, auxiliary gas plants, reactor core mechanical components and primary circuit control and instrumentation. EDF NGL has a programme of ongoing investigative and modification work with the aims of deriving and implementing the optimum control / mitigation strategy for the management of carbon deposition for the remaining lifetime of the AGR fleet. Measures currently under investigation include, oxygen injection into boilers, carbonyl sulphide injection into the reactor coolant circuits, modified fuel pin clad manufacture allied to research and a programme of operational experience feedback. ONR continues to engage with the licensee and is currently satisfied with progress in this area.

Graphite Integrity

3.5 Earlier reports to the Convention have highlighted the potential issues of both weight loss and cracking in the graphite reactor cores in AGR and Magnox reactors. Clearly, the end of generation at the Wylfa Magnox reactor means that this issue will be taken forward only in relation to EDF NGL's AGR fleet. The graphite core of the AGRs cannot be replaced and ageing mechanisms such as weight loss and cracking can change the mass, dimensions and material properties within the core. As such, they pose unique challenges to the operator, EDF NGL and to ONR as the regulator.

3.6 EDF NGL continues to take a multi-legged approach to managing these potential graphite issues. These include:

- predictions of component and core condition;
- assessing the tolerance of the core safety functions to any predicted damage;
- assessing the consequences of core damage for safety function; monitoring core condition during plant operation; and
- inspection and sampling during reactor outages to ensure that the core is behaving as predicted.

3.7 The criteria that would eventually bring about an end to reactor operation would be based on an overall judgement about the strengths of the various legs of the safety case and the confidence that the ONR has in further safe operation.

3.8 As well as moderation, the fundamental safety requirements of an AGR core include allowing free movement of control rods and directing the flow of coolant gas to ensure adequate cooling of the fuel and core structure. Essentially, significant weight-loss and cracking may compromise these safety requirements.

3.9 Two types of cracking can occur in graphite bricks: bore cracking and keyway root cracking (illustrated in Figure 3 below).

3.10 For bore cracking, the cracks originating at the surface of the brick bore or channel (closest to the fuel) and are a consequence of early life ageing behaviour, when the tensile stresses at the surface of the brick are at their greatest. This mechanism has only affected a small number of bricks that make up the cores of all fourteen AGR reactors and inspection data has shown that the number of cracks is not increasing at a greater rate than expected.

3.11 Keyway root cracking is considered by EDF NGL to be the likely phenomenon that will ultimately limit the lifetime of most of the AGRs. These cracks are characteristic of later life behaviour, when the stresses have reversed and the graphite at the outer surface of the moderator fuel bricks, rather than the inner surface, is in tension. This mechanism can only occur later in life as it is dependent on the total amount of irradiation received by the graphite. This phenomenon has been predicted by EDF NGL to first occur on the two Reactor 3 units at Hunterston B and Hinkley Point B (the two lead units in relation to burn-up), with onset initially predicted around 2019.

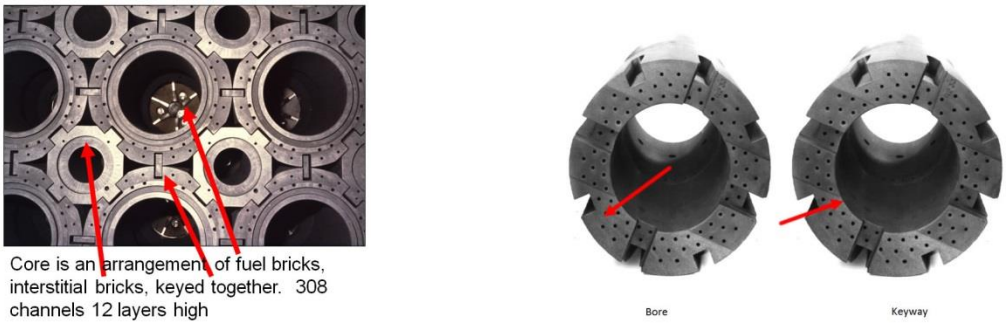

Figure 3 – Arrangement of graphite fuel bricks in AGR core

3.12 During operation, the graphite slowly loses weight due to oxidation caused by the reactor's carbon dioxide coolant gas. Loss of weight affects both the mechanical properties of the graphite brick, and reduces its effectiveness as a moderator. Weight-loss is potentially a life-limiting condition for the reactors, although it is believed that most of the AGRs will have their life limited by the progression of cracking.

Developments since 2014

3.13 During the periodic shutdown of Hunterston B Reactor 4 in 2014, EDF NGL observed keyway root cracks in two bricks that were previously identified to be part of a small anomalous population of high shrinkage bricks. EDF NGL considered that these bricks were not manufactured in the same way as the others and that the high shrinkage bricks are predominantly confined to Hunterston B Reactor 4. In addition, during the reactor's interim outage in 2016, two additional cracked bricks were identified as a result of key way root cracking. It is not believed that the onset of keyway root cracking within this small population of high shrinkage bricks will materially affect core integrity.

3.14 During the periodic shutdown of Hunterston B Reactor 3 in 2015, EDF NGL observed keyway root cracking in three bricks within the main population, approximately four years ahead of the previously predicted onset in 2019. However, recent developments in EDF NGL's research has anticipated earlier onset of keyway root cracking and so this outcome was not wholly surprising. As a result of this discovery in 2015, ONR has secured a commitment from EDF NGL to limit the operational period of Reactor 3 to twelve months; further core inspections are necessary for the licensee to better underpin predictions of crack progression and rate of crack opening in the core, and thus underwrite a longer term safety case. In light of the similar degree of core irradiation, Hinkley Point B Reactor 3 will be limited to a similar period of operation.

Ongoing regulatory focus

3.15 ONR requires EDF NGL to demonstrate through their safety case that they have adequate understanding of the graphite behaviour, to justify safe operation of the core in a clear, evidence-based manner. EDF NGL is therefore required to clearly define conservative limits of operation based on the extent and adequacy of their understanding of graphite core ageing.

3.16 Within their operational safety cases, EDF NGL sets safety limits on weight-loss and cracking for each reactor core based on extensive research and regular surveillance and analysis of the graphite behaviour. However, any proposed change to those limits must be presented to ONR through a robust safety justification, which demonstrates that it is safe to adjust the limits, based on the evidence provided.

3.17 EDF NGL is required to conduct regular inspections of all fourteen AGR cores to understand the changes in the core, and also remove samples of the graphite to conduct suitable examinations or experiments. Subsequent analysis of these results is used as the basis of the case for continued operation. At the end of each reactor outage, ONR inspectors conduct detailed assessments of the licensee's safety case that supports the proposed return to service, following the inspections of the graphite and supporting research, considering all of the evidence provided. This can include a proposal to change the limits based on the evidence provided.

3.18 Following ONR's own detailed assessment, which can include discussions with academic experts, and the evidence and safety justification provided by EDF NGL, ONR will make a decision to agree to the revised

limits. If there are any safety concerns, ONR would not permit the return to service of the reactor until they have been satisfactorily addressed.

Cracking in peripheral graphite shielding blocks

3.19 In 2015 a new type of crack in the outermost (shielding) region of the graphite core of the Torness AGR was observed, as part of the routine inspections carried out during the statutory outage. Four of the AGRs have a unique design, which includes outer shielding graphite blocks surrounding the graphite core. This design, which is specific to Heysham 2 and Torness power stations, has a number of functions, including directing the carbon-dioxide coolant and shielding the other components outside of the core. ONR was made aware in 2015 of cracking in a small number of blocks within this shielding outer layer in one of the four reactors.

3.20 ONR is satisfied that the cracks do not present a challenge to the safety of the graphite core at this time. However, in order to further understand the rationale and long-term consequences, EDF NGL has committed to conduct further investigation and analysis of the issue and carry out inspections of the other three reactors during their next periodic shutdowns.

Concealed systems

3.21 Earlier reports to the Convention have noted several events in recent years involving leaks from, and failures of, concealed pipework (for example, buried pipework and cables). EDF NGL established a fleet-wide project covering all concealed systems, including cables, civil structures and pipework for systematically identifying and inspecting all concealed nuclear safety related plant in order to establish its condition and to take any remedial actions necessary. A risk-based inspection strategy, based on the potential safety significance of each concealed system, is now in place and ONR continues to engage with the licensee, and is currently satisfied with progress in this area.

Flaw indications in Belgium reactor pressure vessel implications for UK installations

3.22 In 2012, in-service inspection of the steel RPV by ultrasonic testing revealed a large number of flaw indications in the forgings used in the construction of the RPVs at the Belgian plants Doel 3 and Tihange 2. The Belgian licensee (Electrabel) and the Belgian nuclear regulator the Federal Agency for Nuclear Control have undertaken an extensive programme of work to understand the root-cause of the defects. Electrabel has characterised the defects as hydrogen flakes: metallurgical laminations which crack open due to internal pressure of hydrogen, this was linked to poor controls during the original forging manufacture.

3.23 In response to the findings in the Belgian reactors, WENRA recommended that the nuclear safety authorities in Europe request the licensees verify the material quality and integrity of steel RPVs. ONR has participated in international regulatory expert working groups, to investigate this issue and has maintained a close understanding of developments and concurs with the root cause analyses accepted by the Belgian regulator.

3.24 The UK has one operating civil PWR reactor at Sizewell B operated by EDF NGL. NNB GenCo has a nuclear site licence for the construction of a twin PWR of the UK EPR™ design at Hinkley Point C. Horizon plans to build two ABWR plants in North Wales, and NuGen intends to build the AP1000® in Cumbria. All of these plants share the design feature of having a steel RPV.

Implications for Sizewell B

3.25 ONR has examined the safety case documentation for Sizewell B RPV and has published findings in full in an assessment report placed on the ONR website (Ref.18). ONR judged that the validity of the extant RPV safety case for Sizewell B is not affected by the observation of hydrogen-induced defects in the Doel 3 and Tihange 2 RPVs. Hence ONR is content for Sizewell B to continue to operate subject to satisfactory periodic safety reviews being carried out, and satisfactory results from routine maintenance, inspection and testing that continue to support the plant safety case. The reasons for this are:

- The 10 yearly in-service inspection of the Sizewell B RPV in April 2016 revealed no anomalies or defects (refer also to Article 6).
- The RPVs for Doel 3 and Tihange 2 were manufactured by a different fabricator to those used at Sizewell B, used forgings from a different forge-master and a different steel casting manufacturer. EDF NGL has supplied evidence of the additional measures taken to control the level of hydrogen and the number of metallurgical laminations by suppliers of Sizewell B plant. ONR judges that the Sizewell B RPV was produced in such a way that the hydrogen levels in the forgings were below the levels expected to lead to hydrogen induced defects and considers that all reasonably practicable measures were taken to ensure that the probability of hydrogen flaking was minimised.
- Multiple, diverse and independent inspections were performed on the Sizewell B forgings during manufacture. No indications of hydrogen flaking of the type seen at Doel 3 and Tihange 2 were recorded. ONR is satisfied with the recording and acceptance levels specified for these inspections. Consequently, ONR judged that defects of the type discovered in the Belgian plants should have been detected and reported using the inspection techniques employed for Sizewell B during manufacture. A review of manufacturing records provides evidence that manual and automated inspections found a small number of inherent manufacturing features, which were sentenced appropriately and all found to be within acceptance criteria. The review meets the WENRA requirements. The inspections validation process adopted for Sizewell B also provides assurance in the inspection reliability.

3.26 The manufacturing inspections give confidence that the presence of hydrogen flaking in the Sizewell core shell forging is unlikely. In support of the RPV steel surveillance programme, EDF NGL is extending the RPV inspection beyond the normal region of the core shell forging. An additional targeted inspection will provide further confidence in the absence of hydrogen flakes. The inspection is considered similar to those adopted at the Belgian plants and took place in April / May 2016. ONR will carefully consider these inspection findings when issuing the consent for the restart of the reactor following the statutory outage and will continue to monitor international developments in this area.

Implications for Hinkley Point C and other new plant

3.27 ONR judges that NNB GenCo has undertaken a well-reasoned comparison between the manufacturing routes for Hinkley Point C forgings with those used at Doel 3 and Tihange 2. ONR judges that this comparison has identified a number of factors likely to influence the formation of hydrogen-induced defects and that adequate controls are in place to minimise the likelihood of formation of hydrogen-induced defects in Hinkley Point C forgings.

3.28 The justification for no defects of significance entering service also depends on the adequacy of manufacturing inspection. NNB GenCo has expanded the range of the manufacturing inspections and provided detailed assessments of inspection capability. ONR judges that the NNB GenCo inspection techniques and procedures are adequate to detect and report defects of the type reported at Doel 3 and Tihange 2.

3.29 ONR has pressed the other requesting parties for new reactor designs to demonstrate that the learning from Doel 3 and Tihange 2 has been captured and action has been taken to prevent recurrence for their reactor technology. Both companies have responded appropriately.

Anomalies identified with RPV components supplied by Le Creusot forge

3.30 ONR was advised by the French nuclear regulator, Autorité de Sûreté Nucléaire (ASN) and EDF NGL, of possible inconsistencies, modifications or omissions in the quality documentation associated with RPV components manufactured by Areva at Le Creusot forge in France. Areva completed a review of its historical records and confirmed that the reactor components supplied to Sizewell B by the facility are not implicated.

3.31 Separately, ONR completed its own independent review of the lifetime records held by EDF NGL for the reactor component supplied to Sizewell B and no deficiencies were identified. Combined with the results of the comprehensive in-service inspections from the recent outage and third party inspections that were completed during manufacture, ONR is confident in the quality and continued safety of the RPV components supplied for Sizewell B.

3.32 ONR's understanding is that the irregularities identified at Le Creusot forge occurred prior to any procurement related to Hinkley Point C.

Challenges associated with manufacturing records

3.33 The flaw indications in the Belgian RPVs and the recent anomalies identified in the RPV components manufactured by AREVA serve to demonstrate the importance of original manufacturing and component fabrication records. Such records form a vital element of the overall design and construction of nuclear power plants at all stages of the reactors life from construction, through commissioning to operations and eventual decommissioning. In the UK the nuclear site licence requires the licensee to maintain records to demonstrate compliance with all of the licence conditions. The records maintained by the licensee have been crucial in allowing the UK and ONR to come to decisions relating to the future operations of reactors.

3.34 In addition to the UK's consideration of the potential impact of the Belgian RPV flaws and the AREVA anomalies, original manufacturing records have needed to be considered as part of ONR's ongoing assessment work for the graphite cores in some of the AGRs and; also, the work that was undertaken as part of the boiler spine work at the Heysham 1 and Hartlepool reactors.

3.35 Original manufacturing records can provide a means of demonstrating that suitable and sufficient checks and controls were implemented at the time of component manufacture to ensure the appropriate quality levels required. However, some challenges can be presented by the vast amount of records that exist and also the manner in which they are stored. Other challenges are presented by the interpretation of such records especially in establishing the auditable trail of records, particularly when the manufacturing processes have been subject to concessions etc. The amount

of work that has been undertaken recently in the UK, both by the licensee and ONR, in establishing and reviewing original manufacturing records to underpin ongoing plant operations has been significant.

Counterfeit Fraudulent and Suspect Items

3.36 The UK nuclear industry has observed an increasing trend of counterfeit, fraudulent and suspect items related events both at the national and international level. Some of these events have impacted significantly on plant operations, for example the Republic of Korea's cable falsification event in 2012 resulted in the Korean regulators applying their enforcement powers to shut down three reactors, and the licensee (Korea Hydro & Nuclear Power Co Ltd) voluntarily shutting down their other two reactors once they had confirmed the initial issues.

3.37 In June 2015, the UK licensees (current and future licensees) provided written confirmation to the CNI on the adequacy of their arrangements to mitigate against counterfeit, fraudulent and suspect items entering their facilities. The CNI's request also influenced licensees to consider counterfeit, fraudulent and suspect items in the context of recent Operational Experience (OPEX), raise awareness internally within their organisations and their key suppliers and, encouraged cooperation between licensees to develop improvement activities.

3.38 A number of collaborative working groups have been established to share supply chain good practice and OPEX for example; UK safety directors forum and associated specialist sub groups including supply chain sub-group which is proactively supported by future licensees including NNB Gen Co (for Hinkley Point C) and Horizon. Supply chain management is discussed in more detail in Article 13.

Security of computer-based systems important to safety

3.39 An additional focus for the UK and ONR on operating nuclear power plant relates to the threat from cyber security, which requires additional controls to be put in place to protect computer-based systems important to safety. ONR's security and safety specialists work together to ensure situations where security threats could have a detrimental effect on safety can be avoided.

3.40 ONR's objective is to influence licensees to understand how the threats and risks associated with cyber security could affect these computer-based systems important to safety. As part of this work, ONR considers the governance arrangements and the processes and procedures in place to deliver compliance. Within the cyber security environment the potential threats are constantly changing; highlighting the need for regular review.

3.41 ONR's approach to the assessment of the security provisions for computer-based systems important to safety is based on the principle that the protection applied should reflect the safety classification assigned to the system in accordance with IEC 61226 (Ref. 43). ONR ensures that the security risk assessments undertaken by licensees are targeted at those systems with the highest safety significance in line with ISO/IEC 27001 and ISO 15408 (Ref. 44).

3.42 From these assessments security risks based on their likelihood and nuclear safety significance are prioritised to identify adequate mitigation measures. It is accepted that effective cyber security also requires strong organisational culture and a positive attitude to security.

3.43 Many computer-based systems important to safety are sufficiently 'segregated' although there may be occasions when this segregation cannot

be maintained, for example due to software updates. In this context, it is essential that the procedures and control of equipment for loading software into a system important to safety is included as part of any security evaluation.

3.44 In addition, potential threats exist during maintenance activities such as calibration or data exchange, from removable media and in the connection of mobile devices such as laptops to computer-based safety systems, particularly where such devices are not owned by the licensee. Robust procedures are required to manage these risks.

3.45 While there is a well-established safety culture at EDF NGL sites, an important challenge has been to extend training and awareness to ensure its security culture, including cyber security, becomes equally embedded.

3.46 ONR has seen a significant improvement in the delivery of mitigation to reduce the cyber risk to computer-based systems important to safety and importantly an improvement in the understanding of the cyber risk by staff at all levels on licensed sites. ONR recognises the importance of ensuring that any new equipment or plant designs that utilise computer-based systems important to safety take into account cyber security as an integral part of the design phase. This has resulted in the development of appropriate security cases to augment the nuclear safety case.

3.47 In addition, the UK, through ONR and the nuclear industry is engaged in research in respect of cyber security for industrial control systems and also engaging across industry and government to gain learning and intelligence from other sources.

4 UK Response to the Vienna Declaration on Nuclear Safety

4.1 Following the nuclear accident at the Fukushima-Daiichi nuclear power plant, a number of initiatives were implemented firstly within the UK by ONR making recommendations to industry and through ENSREG, IAEA, the World Association of Nuclear Operators (WANO), and the Convention. The Sixth Review Meeting called for all national regulators to identify provisions to prevent and mitigate the potential for severe accidents with off-site consequences and improve emergency preparedness and response capabilities.

4.2 Subsequently, the Vienna Declaration on Nuclear Safety was adopted, which includes three principles to guide Contracting Parties in implementing the objectives of the Convention. The UK's response / actions taken to address the principles are outlined below.

Vienna Declaration on Nuclear Safety

Principle 1: New nuclear power plants are to be designed, sited and constructed, consistent with the objectives of preventing accidents in the commissioning and operation and, should an accident occur, mitigating possible releases of radionuclides causing long-term off site contamination and avoiding early radioactive releases or radioactive releases large enough to require long-term protective measures and actions.

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 (Ref.29), 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 in Article 18.

- ONR expects licensees' safety cases to consider the full scope of operational occurrences, design basis events, low frequency fault sequences beyond the design basis and severe accidents predicted for the UK that could lead to a radiological release.
- In all cases, the requirement is to demonstrate that the plant has been designed to prevent accidents, mitigate any possible release and ensure risks are reduced as low as reasonable practicable (ALARP) (the concept is discussed in more detail in Annex 3).

The UK adopts a clear policy on siting of new reactors and applies procedures for evaluating site-related factors likely to affect the safety of nuclear installations for the projected lifetime (see Article 17).

- Government policy is set out in the Nuclear National Policy Statement for Nuclear Power Generation (ref.135).

- Regulatory assessment considers IAEA safety requirements set out in Site Evaluation for Nuclear Installations and other relevant guidance when determining the adequacy of licensees' safety cases.

The final layer of defence-in-depth is emergency preparedness and response and the UK continues to develop and test local, regional and national plans to ensure emergency preparedness is maintained and improved (see Article 16).

- The requirement for emergency planning is covered in the UK as part of ONR's regulatory function for enforcing the Radiation Emergency Preparedness and Public Information Regulations 2001 (REPPIR) (Ref.66).
- DECC co-ordinates emergency preparedness policy at national level, as the lead government department for the UK.
- The UK has signed a number of international agreements covering exchange of information in the event of a nuclear emergency.
- EDF NGL has enhanced its arrangements to respond to severe accidents through the development and implementation of improved training in respect of the symptom based emergency response guidelines and severe accident guideline.

Principle 2: Comprehensive and systematic safety assessments are carried out periodically and regularly for existing installations throughout their lifetime in order to identify safety improvements that are orientated to meet the above objective. Reasonably practicable or achievable safety improvements are to be implemented in a timely manner.

The periodic safety review (PSR) requirements of UK nuclear site licences have meant that for many years the UK has been regularly reviewing and re-assessing safety of its nuclear installations, and making improvements where necessary. ONR maintains oversight of safety significant issues and ensures a proportionate response is taken by licensees to implementing improvements.

- The process of routine integrated interventions (assessment and inspection), the status of the PSRs and improvement made are discussed in Articles 6 and 14.
- Reappraisals are undertaken at intervals to confirm continued safe operation and also to examine plant safety in the foreseeable future, reflecting changes in safety standards.

Principle 3: National requirements and regulations for addressing this objective throughout the lifetime of nuclear power plants are to take into account relevant IAEA Safety Standards and, as appropriate, other good practices as identified *inter alia* in the Review Meeting of the Convention.

The UK applies IAEA Safety Standards and ensures that its own regulations, regulatory requirements and guidance (SAPs) for existing and new nuclear facilities are consistent with them (refer to Section A and Article 18).

- The UK actively contributes to the development and revision of the

IAEA's Safety Standards.

- The SAPs were benchmarked against IAEA's Safety Standards and revised in 2014 to reflect changes, including work by the IAEA in its revision to the Design Standard on the safety of nuclear power plants (SSR 2/1) and insights post-Fukushima.
- The principles contained in ONR's SAPs are supported by more detailed ONR TAGs, which together reflect the relevant recommendations made in the IAEA's Safety Standards as well as other relevant good practices.

5 Feedback from the Sixth Convention Review Meeting

President's Report - Challenges from the Special Rapporteur

5.1 The Summary Report to the Sixth Convention Review Meeting identified five challenges, following the Fukushima-Daiichi accident, to be addressed in the reports of Contracting Parties to the Seventh Review Meeting. The challenges were put forward because differences were observed in the objectives, priorities and implementation of schedules of safety improvements. Factors included different natural conditions / extreme events, different regulatory approaches and applications of periodic safety assessments in order to make safety improvements.

5.2 The UK's response / actions taken to address the principles are outlined below.

Presidents Report - Challenges from Special Rapporteur

Challenge 1: How to minimise gaps between Contracting Parties' safety improvement

Oversight is maintained of the safety improvements, made post-Fukushima to ensure they are proportionate to the predicted environmental conditions and extreme events credible for the UK. Information is shared through International peer review processes and open and transparent reporting.

- Progress addressing the implications of the Fukushima accident is discussed in Section 2. Examples of improvements made are provided in Articles 6, 12, 14, 16 to 19.

Challenge 2: How to achieve harmonised emergency response plans and response measures

The UK takes cognisance of European and International emergency preparedness developments to harmonise and enable improvements in response capabilities (as outlined in Article 16). The UK:

- Participates in work that will support the UK implementation of the EC (and IAEA) Basic Safety Standards Directive.
- Collaborates with key European and International bodies including HERCA / WENRA to develop common off-site cross-border emergency

approaches.

- Engages with European radiation protection authorities, IAEA, and other bodies on key radiation issues affecting UK nuclear regulation.
- Undertook benchmarking by inviting IAEA IRRS missions including a follow-up mission in 2013 that included review of UK arrangements for emergency preparedness and response. All recommendations were closed out and areas within the UK were identified as examples of international good practice.

Challenge 3: How to make better use of operating and regulatory experience, and international peer review services

The UK uses intelligence gained from its inspection, assessment and incident reports to identify areas for safety improvements and to inform regulatory strategies and plans.

- The insights gained from incident reporting for all nuclear licensed sites is summarised over a fourteen year period in Article 19, along with specific data collated for operating reactors over the three year report period and improvements made based on insights gained.
- The UK actively participates in IAEA IRRS and OSART missions, embracing feedback to ensure continuous improvement, as discussed in Section A.

Challenge 4: How to improve regulator's independence, safety culture, transparency and openness

- ONR's independence as a regulator is legally anchored in the Energy Act 2013. The Energy Act 2013 defined the purposes and powers of the statutory ONR, improved ONR's ability to be demonstrably independent in its regulatory decision making and ensured its key purposes were captured in a single piece of primary legislation (refer to Article 7).
- ONR has a policy which has a presumption of disclosure of information related to its activities and information on regulatory decisions and judgements are made publicly available through the website, as discussed in Section A and Article 8.
- Organisational leadership and management for a positive safety culture are discussed in Article 10.

Challenge 5: How to engage all countries to commit and participate in international co-operation

- The UK works closely with its counterparts in other countries to ensure its approaches reflects international good practice and that lessons are learned from experience elsewhere as outlined in Section A, notably:
    - The Belgian Regulator (FANC) and French Regulator (ASN) to understand and investigate flaws in the forging of RPV components and the potential impact on Sizewell B to ensure confidence in the future safe operation.
    - Regulators from Europe and the US NRC to develop a common position on licensing safety critical software.
    - Collaborating with international regulators (for example, Japan) on cross-cutting themes through MDEP to facilitate more efficient and effective design assessments.
- The UK undertakes a broad range of information exchange in order to

fulfil safety obligations and to promote co-operation (for example, through ENSREG, WENRA).

- The UK has information exchange agreements with a range of relevant international regulators involved in the licensing and construction of similar reactor designs; for example China, France and Finland who are constructing PWRs.

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Rapporteur's Report - Planned UK Measures

5.3 The UK Country Group Rapporteur summarised planned measures to improve safety that were identified during the UK presentation. Where appropriate, progress on each of these matters has been summarised within this report. The key issues, as identified by the Rapporteur, are summarised below.

Rapporteur's Report – Planned UK Measures

Planned Measures

Completion of the review of ONR's Safety Assessment Principles

- ONR completed its review of the SAPs and issued a revised version in 2014 as discussed in Section A.

Host the IRRS follow-up "mini-mission"

- ONR hosted the IRRS modular mission in 2013 and reported on the findings in 2014 (refer to Section A). The IAEA team commended the extent to which progress had been made and the UK's and ONR's commitment to high standards in nuclear safety. The next full-scope IRRS mission for the UK is anticipated to be in 2019.

Future nuclear emergency exercise programme to consider testing of the on-site and off-site government responses for extended periods

- The UK has undertaken emergency exercise programmes for extended periods to test on-site and off-site reposes, as outlined in Article 16.

Completion of level 2 PSAs and implementation of reasonable practicable improvements

- As a result of the UK response to the Fukushima accident, EDF NGL has developed a representative Level 2 PSA for the AGRs. ONR continues to engage with the licensee regarding the adequacy of its current approaches to external hazards PSA, and is seeking further improvements and risk insights (refer to Article 14).

Implement the National Action Plans to improve the safety in response to the lessons from Fukushima-Daiichi

- ONR provided an update to ENSREG on the implementation of the UK's response to events at Fukushima in December 2014. An update of the national action plan is to be produced, on a timescale to be agreed with ENSREG and it is expected that this will enable close out of the remainder of ONR's post Fukushima reporting for nuclear power plants (see Section A).

Challenges

Recruitment and training of staff

- ONR continues to undertake external recruitment campaigns to bring in the necessary specialist skills to meet the demands presented by proposals for new nuclear build. ONR's strategy for the recruitment and development of resources is outlined in Article 9.

Life time management of ageing reactor fleet

- EDF NGL is managing the UK fleet of AGR reactors through to end of life and has implemented lifetime management projects aimed at optimising the remaining lifetime and generating capacity. A number

of age related issues, including graphite cracking which pose challenges are discussed in Section A.

- The current Plant Life Extensions (PLEX) and closure dates for each of the AGR stations are presented in Article 6. ONR assesses the adequacy of EDF's PLEX submissions as part of the PSR process under licence condition arrangements to determine if, on the basis of current knowledge and experience, they provided a reasonable approach and evidence in support of EDF NGL's decision to proceed with its intended PLEX campaign (refer to Article 14).
- The management of ageing is an important and challenging issue. Ageing management programmes in the areas of structural integrity, electrical and control and instrumentation are discussed in Article 14.

Safety aspects of carbon deposition

- The safety aspects of carbon deposition are covered in Section A.

C&I obsolescence and cyber security

- The challenges faced and work undertaken to address C&I obsolescence are outlined in Articles 6 and 14.
- The UK's approach to addressing the threat from cyber security on nuclear power plants is outlined in Section A.

<u>Suggestions</u>

Invite OSART Mission

- The UK (DECC) invited an IAEA OSART team of international experts to visit Sizewell B Power Station in October 2015 to compare the plant's operational practices with international standards and exchange technical expertise and knowledge (refer to Section A).
- The IAEA OSART mission highlighted areas of good practice and areas for improvement, which the licensee intends to progress and implement improvements. The final report of the OSART mission will be made publicly available in July 2016 through IAEA, ONR and EDF websites (Refs. 47,18 and 48).

Presidents Report - Topics of Mutual Interest

5.4 The President of the 2014 review meeting identified a number of topics of mutual interest and encouraged Contracting Parties to address these in their reports to the Seventh Convention Review Meeting. A number of these topics overlap with those discussed earlier in this report and are covered in Section B. The table below provides a brief discussion of how the remaining topics are addressed and a route-map to direct to relevant information to aid the peer review process.

President's Report -Topics of Mutual Interest

Demonstrating the independence of regulatory bodies / ensuring openness and transparency in policies and regulatory processes

- Discussed in Section A and covered by Article 8.

Promoting safety oversight within licensees

- EDF NGL has a mature internal regulator, the function and examples of their internal and external review and verification processes can be found in Articles 10, 13 and 14.

Consideration of safety culture and organisational factors through inspection

- Important aspects of safety culture and organisational capability, including inspection strategies are covered in Article 12.
- Articles 10 and 12 discuss how safety culture is assessed and enhanced by EDF NGL.

Knowledge management and maintaining competence

- ONR has identified core knowledge areas required to effectively regulate the dutyholders and has developed information maps to enable the effective capture, storage and retrieval of information. Improvement strategies are discussed in Article 8.

Measures in place to improve quality and availability in the supply chain

- Supply chain management, notably measures to address the increasing threat of counterfeit items entering the nuclear supply chain is a key focus. Supply chain management is discussed in Article 13.

Challenges faced licensing nuclear power plants with digital C&I systems

- Covered in Section A.

Challenges faces making decisions for Plant Life Extensions (PLEX)

- Covered in previous table, Articles 6 and 14.

Implementation of effective measures to reduce radioactive release

- Covered in Articles 15 and 19.

Severe accident management and emergency response

- Discussed in Articles 16 to 19.

Bilateral / International co-operation and international peer review

- Discussed in Section A and B to this report where relevant.

Section B – Articles

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

6.1 Under this Article, compliance with the Convention is demonstrated in a way that has not substantially changed since the Sixth UK Convention Report (i.e. in a way that has implications for the Convention obligations).

6.2 Although the UK has an ageing fleet of reactors, which give rise to age related safety issues (as outlined in Section A), there are no nuclear installations where significant corrective actions were necessary to comply with the requirements of this Convention.

Nuclear installations in the UK

6.3 There are 15 reactors operating within the UK that meet the definition in Article 2 of the Convention, consisting of 14 AGRs and a single PWR, located on seven licensed sites within England and Scotland, for which EDF NGL is the sole licensee. The locations of the operating reactors and that planned for Hinkley Point C are indicated on the map shown in Figure 4. The operating parameters for the existing fleet are summarised in Table 1.

Reactors outside the scope of the Convention

6.4 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 reactors on 11 sites. They have all been defuelled, except for Calder Hall, which is part of the Sellafield site, and principally a reprocessing complex, and Wylfa on Anglesey, which permanently ceased operation in December 2015. Final defuelling is currently underway and is due to be completed by the end of 2018.

6.5 Calder Hall and all other Magnox reactors discussed in the UK’s Sixth Convention Report, including the two fast breeder reactors at Dounreay in Scotland are covered by the Joint Convention (Ref. 6). Wylfa will be covered in the next report to the Joint Convention and is therefore outside the scope of this report. For reference, the location of the defuelling reactor at Wylfa is also shown in Figure 4.

Figure 4 – Location of operating reactors in the UK
(defuelling reactor at Wylfa and planned reactor at Hinkley Point C are also shown)

Table 1 - UK Civil Nuclear Power Reactors – Key Parameters

Nuclear Installation	**Dungeness B**	**Hartlepool**	**Heysham 1**	**Heysham 2**
Licensee	EDF NGL	EDF NGL	EDF NGL	EDF 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
<u>Reactor core</u>				
Fuel channels	408	324	324	332
Assemblies per channel	7	8	8	8
Fuel pins /assembly	36	36	36	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 (^oC)	650	660	660	660
Steam turbine inlet pressure (Bar)	163	159	159	159

Steam turbine inlet temp. (^{o}C)	555	517	547	538
Gross electrical power (MWe)	**1170**	**1280**	**1260**	**1340**

Heysham 1 and 2 operate independently on one site licence

Table 1 (continued) - UK Civil Nuclear Power Reactors – Key Parameters

Nuclear Installation	**Hinkley Point B**	**Hunterston B**	**Torness**	**Sizewell B**
Licensee	EDF NGL	EDF NGL	EDF NGL	EDF 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
<u>Reactor core</u> Fuel channels Assemblies per channel Fuel pins /assembly	 308 8 36	 308 8 36	 332 8 36	 - 193 264
Coolant	CO2	CO2	CO2	Water

Coolant containment	PCPV	PCPV	PCPV	Steel PV
Coolant pressure (Bar)	41	40	43	150
Coolant max. temp (^{o}C)	583	583	660	323
Steam turbine inlet pressure (Bar)	126	126	159	67
Steam turbine inlet temp. (^{o}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)

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

6.6 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 licensees. In addition, there is external review and assessment from the independent safety regulator, ONR. The legislative and regulatory framework is outlined in Article 7; supplemented by Annex 1 which provides a summary of the legislation relevant to the Convention. The 36 licence conditions attached to the site licence are also summarised in Annex 1.

6.7 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 PSR every 10 years in accordance with LC 15. The PSR reviews power plant arrangements, the effectiveness of ongoing safety reviews and continuous improvement programmes that will deliver improvements to safety operate the plant to the end of station life. These reviews require that reappraisals are undertaken not only to confirm continued safe operation, but also to examine plant safety in the foreseeable future. The review should also identify emerging shortfalls between standards achieved on site and modern standards. These shortfalls are graded according to their safety significance and improvements and modifications may be required.

6.8 The nuclear site licence requires that the safety significance of proposed modifications are categorised by the licensee. The arrangements require that no modifications are implemented until an appropriate safety analysis has been carried out and that adequate safety documentation has been produced to justify the proposal. The safety documentation which supports modifications with the highest category of safety significance needs to be submitted to ONR for its formal agreement before they can be implemented. ONR maintains oversight of the areas of higher significance and ensures that the licensee takes action to modify the plant or process. ONR also assesses the outcomes from PSRs to judge if the power station is safe to continue to operate for a given period of time. Completion of comprehensive

and systematic periodic safety assessments has been a requirement of the UK nuclear site licence for many years and meets the aim of principle two of the Vienna Declaration on Nuclear Safety. Further information on the PSR programme is provided below; the safety assessment process is covered in Article 14.

6.9 In addition to decennial PSRs, each operating power reactor is required to undertake a periodic shutdown (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, and for Sizewell B the operating period is typically 18 months.

6.10 After these shutdowns, the licensee must apply for a legal 'consent' from ONR to restart the reactor. Consents are issued following a review of the licensee's inspection and maintenance programme, the operational performance of the station during the previous operating period and a review of any changes to the safety case. Consent for start-up is not given by ONR until it is satisfied that the reactor is safe to operate for the period up to the next periodic shut down.

6.11 Any safety concern on one reactor may have implications for other reactors in the EDF 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.

Safety upgrade programmes

6.12 The UK has been undertaking safety reviews of its civil nuclear power stations for many years as part of its regulatory process as part. There has been a requirement for 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 2 below.

6.13 The second round of decennial PSRs (PSR2) for the EDF NGL stations was completed in 2014 and ONR findings from its assessments for each station were published on the ONR website (Ref. 45). Following a review of their PSR processes, EDF NGL identified improvements for the third round of PSRs (PSR3) currently underway, these 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. 46)

6.14 The third cycle of PSR reviews has been completed for Hinkley Point B and Hunterston B, and the submissions are currently being reviewed by ONR.

Table 2 - Status of Periodic Safety Reviews (EDF 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	Planned for 2017
Heysham 1	1983	1998	2008	Planned for 2018
Hartlepool	1983	1998	2008	Planned for 2018
Heysham 2	1988	1999	2009	Planned for 2019
Torness	1988	1999	2009	Planned for 2019
Sizewell B	1995	2005	2014	Planned for 2024

Justification for continued operation of nuclear reactors

6.15 In the UK, nuclear site licences have no time limit. The onus is on the licensee to demonstrate the plant is safe to operate and shut down when it is no longer safe to do so (or for other reasons such as commercial viability).

6.16 EDF NGL is managing the UK fleet of AGRs through to their end of operating life, electrical generation, and eventual entry into decommissioning. As part of a lifetime management project, EDF NGL has conducted studies aimed at optimising the remaining lifetime and generating capacity. Table 3 indicates the 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 3 – 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

6.17 To support its decision to extend the life of the AGR stations, EDF NGL prepared a series of life extension business cases. These business cases contained assessments aimed to identify the potential risks to safety and considered financial viability and stakeholder acceptance to fully inform its decision.

6.18 The assessments included consideration of the significance of the technical issues that could prevent safe operation throughout the PLEX period as well as considering the efficiency of the processes that manage nuclear safety. These reviews focused on key irreplaceable life-limiting plant, for example, boilers, graphite gore and reactor internals. The safety reviews followed the IAEA guidance for PSRs, SSG-25, and considered the adequacy of EDF NGL's processes that manage nuclear safety.

6.19 EDF NGL requested that ONR review the technical aspects of the PLEX business cases in conjunction with supporting documentation and provide a view on the on the appropriateness of their assessment. This activity fell outside the scope of ONR's formal permissioning process; however, it was associated with the stations' third cycle of periodic safety reviews submissions (PSR3), due from 2016 to 2019. In recognition of the regulatory significance of the forthcoming PSR3 cycle, 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 in support of EDF NGL's decision to proceed with its intended PLEX campaign.

6.20 For each station, ONR considered the approach taken was reasonable and agreed with the overall conclusion that the through life management processes should enable effective management of ageing for the proposed period of continued operation / generation. Although the life-limiting components were similar (graphite cores and boilers), each station had different limiting degradation mechanisms due to variations in design and operating histories.

6.21 The PLEX business cases suggested a substantial investment by EDF NGL in both major safety improvements and a large number of smaller but still significant modifications to improve reliability / safety. The safety improvements need to be made in a timely manner so that risks are maintained ALARP. ONR recognised the considerable investment being made by EDF NGL to manage the ageing of life-limiting systems, structures and components and welcomed its approach and commitment.

6.22 ONR provided feedback on the structure and content of the PLEX safety reviews to support the ongoing PSR3 work programmes. The PSR3 work will provide a detailed and systematic assessment of the adequacy of the safety cases for the stations against modern standards. It will also review the continuing suitability of the plant against likely ageing effects that may render the plant unsafe to operate.

6.23 Continued operation will be subject to satisfactory PSRs; and confirmation that the results from routine maintenance, inspection and testing continue to support the agreed plant safety case. ONR carries out a full assessment of PSRs and subject to a satisfactory outcome, issues its decision on whether future operation is supported. The report of ONR's decision on the outcome of its assessment is published on its website (Ref. 45).

Continued safety upgrading for longer-term operations

6.24 EDF's aspirations for PLEX across its AGR fleet are underpinned by significant investment and upgrade plans for each reactor, in order to secure continuing high levels of nuclear safety. Key elements of the improvements are focused on equipment reliability, outage improvements, and a programme of work to ensure that ageing and obsolescence is managed throughout the remaining life of the reactors.

6.25 Significant items of equipment have been replaced, including several gas circulators, a turbine rotor, temperature monitoring devices (which were subject to neoprene degradation), pipework exposed to flow assisted corrosion, and station transformers. Future improvements may also be identified as a result of inspections of the graphite core, boilers, pressure vessels and control and shutdown systems.

6.26 There are some irreplaceable components and structures within the AGRs, such as the graphite bricks within the core and the boilers. The ageing of the graphite core and boilers will be key considerations in making decisions on when to cease operation of the reactors. Recent developments in relation to the boilers and graphite at a number of the stations have been previously covered in Section A. ONR ensures that the licensee is able to demonstrate the continued safety of these reactors by requiring rigorous in-core inspection regimes which are underpinned by ongoing research and development, computational analysis and the development of extensive safety documentation to support future operations.

6.27 A limited number of the plant safety improvements have been implemented on different sites to address plant safety or reliability issues as a result of revealed failures, for example, failure of equipment leading to an automatic reactor trip. Detailed information on event reporting is provided in Article 19. It should be noted that there have been no nuclear safety significant events rated at Level 2 (or above) on the International Nuclear and Radiological Event Scale (INES) since 2009.

6.28 Specific safety upgrades at each of the AGR sites are outlined in the relevant sections below. However, the range of plant upgrades which have been, and continue to be made at a number of the reactors typically include:

- Upgrading of the material condition of carbon dioxide (CO_2) storage and distribution systems:
- Installation of 'super-articulated' control rods
- Fuel route improvements
- Replacement of nitrogen plant and reactor hold-down system
- Reactor quadrant protection and guard-line relays
- Replacement of generator and station transformer phases
- Refurbishment or replacement of essential diesels and gas-turbine generator sets
- Essential and no-break electrical supplies including replacement of batteries, safety inverter and instrumentation
- Central control room alarms
- Control and instrumentation replacement
- Reactor simulator upgrades
- Replacement of 11kV electrical cables and upgrading of civil trenches
- Gas circulator protection systems
- Site civil structures
- Marine ingress protection
- Improvements to site security
- Corrosion management
- Fire detection and suppression systems

6.29 In the case where the safety significance of the improvements listed above have warranted regulatory oversight, ONR has undertaken an assessment and issued its formal agreement to permission the installation of the plant modifications.

Summary of safety upgrades at nuclear power plants

Hinkley Point B

6.30 Significant modifications completed in 2015 at the Hinkley Point B site included the installation of a new set of super-articulated control rods and the commissioning of a new nitrogen injection system (for shutdown / hold down). This was introduced to enhance the diversity of the existing shutdown system to cope with the most severe type of seismic event evaluated (shown in Figure 5).

6.31 EDF NGL achieved this by replacing a number of the existing control rods, with rods with enhanced articulation to ensure that they could be can be inserted if a channel becomes significantly distorted, and by provision of a new seismically qualified nitrogen injection system. Nitrogen gas injected into the reactor core will absorb neutrons, effectively reducing the reactivity of the nuclear reaction.

6.32 ONR monitored progress implementing these improvements and the quality of the safety submissions through assessment and review meetings. Future planned improvements include modifications to the sea defences, additional turbine rotor replacements, work on generator exciters, installation of a new coolant gaseous activity monitoring system, improvements to the decay heat boilers, diversification of the in reactor moisture monitoring system and other work that may be identified by the PSR3 work that is currently in progress.

Figure 5 – Super-articulated control rods and seismically qualified nitrogen system at Hinkley Point B reactors

Hunterston B

6.33 Similarly to Hinkley Point B, the installation of super-articulated control rods and a seismically qualified nitrogen injection system have also been introduced at the Hunterston B.

6.34 In addition, a number of improvements have been made over the last three years to address ageing and obsolescence issues, with over £30m invested in 2015. Notably, the replacement of gas circulators, turbine rotor exchange, temperature monitoring devices (which were subject to neoprene degradation) and three transformers phases for both units. Extensive upgrades have been made to fire detection and suppression systems, and engineering improvements made to

seawater intake systems. Major upgrades have also been made to main cooling water pumps.

6.35 Future near-term investment will focus on completion of extensive refurbishment to the CO_2 storage vessels and new auxiliary boilers, which will improve their material condition and reliability.

Dungeness B

6.36 Following the Fukushima accident, the flooding risk at the Dungeness B site was reassessed by the licensee. It concluded that the site was liable to inundation during coastal flooding events predicted at 1 in every 1000 years. After due consideration, EDF NGL took the decision to construct a new flood wall around the site perimeter to preserve a dry site. This resulted in a flood wall 1.4 kilometres in length, constituted of 3000m^3 of concrete and 6500 tonnes of steel reinforcement, as shown in Figure 6. Additionally, rock armour was added to the shingle bank between the station perimeter wall and the sea to ensure its stability in the event of high waves.

Figure 6 – New flood wall at Dungeness B

6.37 Other upgrades include replacement of the obsolete data processing system, which provided alarms in the central control room and other safety functions, with a more reliable modern system. Within the boiler house and gas circulator hall, the fire protection system has been upgraded, including the installation of aqueous foam fire-fighting systems where there is a potential for oil fires. Equipment reliability workshops have been used to improve the reliability of a range of key plant items and reduce transients that place demands on the safety systems.

6.38 Future planned improvements include the replacement of obsolete neutron flux detectors and the installation of additional protection systems to prevent or mitigate leakage of water from boiler tubes into the primary circuit.

Heysham 1

6.39 The issues relating to the cracks found in the boiler spine of Reactor 1 at Heysham 1 and ONR's permissioning of the introduction of cooling modifications to the boiler spines on the two reactors (and the two reactors at Hartlepool) are described in Section A of this report.

6.40 In addition to the extensive work to allow the return of service of the reactors, the station has made significant improvements to a number of plants, such as the CO_2 plants and the fuel and water bulk storage tanks to address ageing and corrosion issues. Furthermore, EDF NGL has made significant investment to support the PLEX of the station, including the replacement and upgrading of the fire protection systems.

6.41 To address obsolescence issues, a number of electrical and C&I systems such as data loggers and gamma monitors have been replaced or upgraded. Substantial upgrades of the boilers have been implemented to improve their life and efficiency as well as to increase the safety case margins and reduce the likelihood of radioactivity release following a boiler tube leak. This work has resulted in significant plant improvements including additional protection systems such as a vessel overprotection and quadrant feed trips.

Hartlepool

6.42 Following the discovery of a crack in the boiler spine at Heysham 1 Reactor 1 (discussed in Section A), EDF NGL shut down its reactors at Heysham 1 and Hartlepool as a precautionary measure to allow accelerated inspection of all boilers of similar design. Following completion of modification designed to reduce the temperature of the boiler spines in the affected region, EDF NGL submitted a safety case for full power operation of both reactors at Hartlepool (and at Heysham 1 Reactor 2). Following detailed assessment of this safety case, ONR granted permission for full power operations.

6.43 The station has made investments (circa £25m per annum) to improve equipment reliability and support lifetime extension with the replacement of obsolete components in the station's no-break power supplies and the essential cooling water system. Substantial progress has also been made in addressing ageing neoprene insulation in the primary safety circuits. Recognising the importance of skills and capability in sustaining high standards of operational safety, the station continues to enhance its training facilities, training provision and is undertaking recruitment to improve resilience to the end of life.

Heysham 2

6.44 A number of improvements to address ageing and obsolescence issues have been made during past three years. Significant items of equipment have been replaced including major upgrade work on the 400kV system, new variable speed drives installed for gas circulators, replacement of reactor sea water system pipework with carbon steel pipework, two gas circulators and a defective impeller exchanged during one of the reactor periodic shutdowns.

6.45 Other improvements, which can be made whilst the reactors are at power include pipe bridge repairs, emergency diesel generator maintenance, improvements to the emergency diesel generator's roof mounted equipment, repairs to bulk fuel tanks and burst can detection systems. Work is also ongoing with the main data processing system lifetime support project.

6.46 Future investments will include gaseous activity monitoring, reactor gas conditioning, make up water treatment plant improvements, reactor seawater strainer pit pipework replacement with high-density polythene, main blowdown gaseous sampling equipment and other work that may be identified by the third PSR, which is currently in progress.

Torness

6.47 In recent years, the station's key focus for improvements on nuclear safety has centred around equipment reliability and in particular the elimination of automatic

reactor trips. The station's improvement plan includes the identification and management of single point vulnerabilities, the management of plant ageing and obsolescence, and investments to improve the resilience of sea water cooling systems against marine ingress and adverse weather conditions.

6.48 A current example of the active management of ageing of nuclear safety interlock components is the ongoing programme of replacement of relays in the quadrant guard-line protection systems. This work is being phased over a number of years, and is aimed at reducing the number of spurious interlock trips.

6.49 With regard to cooling systems, the station is putting in place a number of measures to improve the resistance of the station to the combined effects of severe marine conditions and debris (principally seaweed and jellyfish). Improvements include sea water drum screens, the configuration of water channels, cleaning spray mechanisms, remote monitoring, access for operations and maintenance, prediction of weather and marine conditions, and cooling water level detection.

Sizewell B

6.50 An issue related to hydrogen flaking within the RPV was identified in Belgium several years ago and its applicability to Sizewell B has been considered but deemed not to be a risk. The inspections conducted during original manufacturing provide evidence that the presence of hydrogen flaking in the Sizewell B core shell forging is highly unlikely. However, during the plant's periodic shutdown, there was an extensive RPV inspection programme undertaken; including a 10 yearly American Society of Mechanical Engineers (ASME) inspection in support of the RPV structural integrity safety case (a photograph of the RPV at Sizewell B is shown in Figure 7). The inspection programme went beyond the normal region of the core shell forging, and also included targeted inspection similar to those adopted at the Belgian plants. None of these inspections revealed any significant anomalies or defects. ONR considered these inspection findings as part of its assessment prior to issuing consent for the reactor to restart in May 2016 and the UK will continue to monitor international developments in this area.

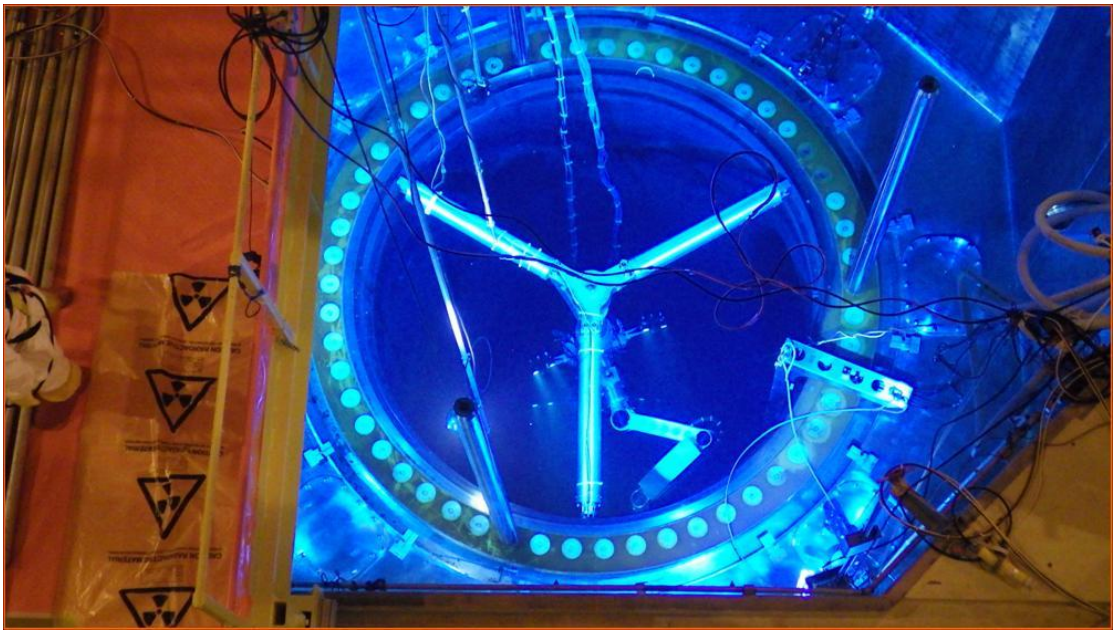


Figure 7 – Photograph of reactor pressure vessel (RPV) at Sizewell B

6.51 As discussed in Section A, an IAEA OSART mission was carried out in October 2015 and the outcome of this mission has been made publicly available on the IAEA, EDF, DECC and ONR websites (Refs 47, 48, 49 and 18).

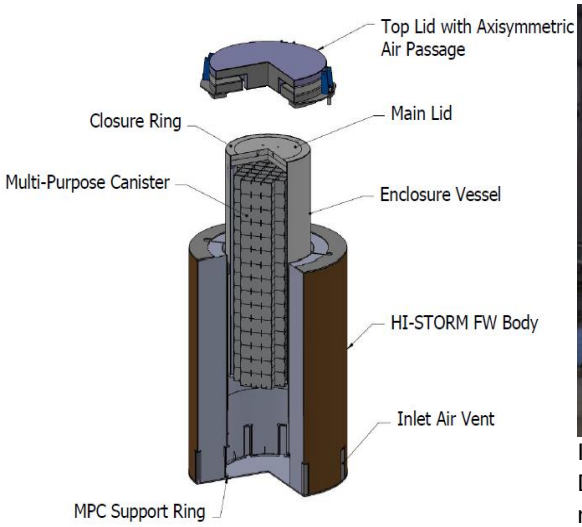
6.52 There have been a number of significant improvements carried out at the Sizewell site in light of the Fukushima accident, which include the installation of seismically qualified passive autocatalytic re-combiners. These are intended to provide diverse capability in the event of the severe accident management of a high concentration of explosive gas in containment. Separately, the battery charging diesel generators have been replaced to improve the seismic and flooding resilience of the site. A dedicated off-site emergency response facility has been set up and provision of electrical and fluid system tie-in points to enable connection of portable equipment to the plant in a beyond design basis event. These improvements were managed as part of a fleet-wide improvement project.

Sizewell B dry store

6.53 Since the Sixth Convention Review Meeting, one of the major developments at the Sizewell B plant is the construction of a dry fuel store. The store is currently expected to become operational in 2017 and has been designed with sufficient storage capacity for the remaining operational life of the reactor. Currently, the spent fuel, once discharged from the reactor core, is stored on site at Sizewell B in a water-cooled storage pond which is approaching its capacity.

6.54 The long-term interim dry fuel store on the Sizewell B site was developed as a result of a combination of factors arising from the government decision to phase out spent nuclear fuel reprocessing and move to underground geological disposal. As the plans for the UK's underground geological disposal facility are still under development, there is a need for interim spent nuclear fuel storage to ensure that Sizewell B is able to meet safety requirements by making space available in the cooling and storage pond.

6.55 Dry fuel storage is based on the use of discrete modular storage containers. The technology underpinning this approach is well developed and supported by IAEA guidance with this type of fuel storage currently operating in a number of countries around the world (as shown in Figure 8).



Exploded view showing Spent Nuclear Fuel Container (Multi-Purpose Canister) locating with

Image of HI-STORM located within Sizewell Dry Fuel Store. HI-STORM will contain spent nuclear fuel when the facility becomes fully operational

Figure 8 – Sizewell B dry store

6.56 ONR's regulation of the dry fuel storage facility at Sizewell B has been targeted to assess the integrity of fuel to be placed into dry storage, the design of the fuel storage container, the processing operations and the storage considerations in recognition of the proposed facility life of 100 years.

6.57 In the case of fuel integrity, the licensee's arrangements require that appropriate evaluation and inspection is carried out to demonstrate that primary containment (fuel clad) is intact before fuel is placed into storage containers and throughout the storage period.

6.58 ONR considers that any safety risks in the design of fuel storage containers have been mitigated through the selection of highly corrosion-resistant material which mitigates risks of stress corrosion cracking. The fuel container is fabricated with twin walls, the external wall acting as a sacrificial layer in the event of environmental degradation.

6.59 In the processing operation, where there is a requirement for the lid of the container to be welded to its shell, improvements have been made by the introduction of a method to cool the fuel storage container. In addition to standard dye penetrant inspection, the integrity of the lid to shell weld is justified further by the development of an ultrasonic inspection technique.

6.60 During storage, a surveillance programme of the fuel containers will be implemented. This includes a full size corrosion simulator and eddy current inspection equipment to detect surface defect initiation and growth (Eddy-current testing is one of many electromagnetic testing methods used in non-destructive testing. It makes use of electromagnetic induction to detect and characterize surface and sub-surface flaws in conductive materials). This is backed up with regular visual inspection of fuel storage canisters and thermal monitoring to confirm that the quality of the helium environment inside the fuel container is maintained, together with the integrity of secondary containment.

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

7.1. Under this Article, compliance with the Convention is broadly demonstrated in a way that has not substantially changed since the Sixth UK report. Although the Energy Act 2013 did create the ONR as a separate legal entity and principal nuclear safety regulator in the UK, this did not represent a change to the duties on the licensees imposed through the licence and other statutes, which remain largely unchanged.

7.2. The following paragraphs describe the UK's nuclear safety legislative and regulatory framework applicable to those nuclear installations defined by the Convention. Its content has been informed by relevant IAEA safety standards. The UK has a full suite of primary and secondary legislation that meets international legal requirements and expectations.

Application of the legal and regulatory framework

7.3. As discussed in Section A, the majority of this report makes reference to the UK application of the legal and regulatory framework. However, where necessary, within this Article, variances between administrations in England, Scotland and Wales (GB), are highlighted.

Primary legislation

7.4. This section describes the primary legislation that forms the nuclear regulatory regime, defines the duties of the operators of nuclear installations, and enables the development of secondary legislation.

7.5. UK Government policy is to consult on establishing or revising regulatory requirements where it is appropriate or where there is a legal duty to do so. This is an integral part of the UK's process when establishing or revising regulatory requirements and this applies to both legislation (Acts and Regulations) and other measures such as the nuclear site licence conditions and to key guidance documents (such as ONR's SAPs). ONR's current, and details of previous consultations can be found online at (Ref. 50). Government consultations on statutory measures can be found at (Ref. 51).

The Energy Act 2013

7.6. The Energy Act 2013 (Ref. 7) sets out the provisions which set up the ONR as a statutory body, establishing its purpose, its powers and functions. 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.

7.7. The Energy Act 2013 also allows for 'nuclear regulations' to be made to provide additional law with respect to nuclear safety, security, safeguards and the transport of radioactive material. Non-nuclear safety specific regulations, including those for radiation protection at any site are covered by the Health and Safety at Work Act 1974 (HSWA74) described below.

7.8. The Energy Act 2013 establishes ONR's ability to appoint inspectors and provides those inspectors with powers similar to those conferred under HSWA74. These include powers to enter premises, to preserve evidence, to take samples, to take statements from individuals, to enforce through issuing formal notices etc. Enforcement of nuclear safety is also possible using the powers granted to inspectors under HSWA74.

Health and Safety at Work etc. Act 1974

7.9. Under HSWA74 (Ref. 9) 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) (refer to Annex 3), the health and safety at work of their employees and also those affected by their work activities. This Act also created a statutory body, the HSE, which ONR was part of until April 2014. Extracts from HSWA74 relevant to this Convention are included in Annex 1. An important provision of the HSWA74 is that it permits the development of secondary legislation in the form of regulations. ONR has enforcement powers under this legislation.

Nuclear Installations Act 1965

7.10. Under the Nuclear Installations Act, 1965 (NIA65) (Ref. 8) no site can be used for the purpose of installing or operating a nuclear installation unless a nuclear site licence is currently in force, granted by ONR. Only a corporate body, such as a registered company or a public body can hold a licence and the licence is not transferable. Those parts of the NIA65 relevant to safety and licensing (sections 1, 3 to 6, 22 and 24A) are 'relevant statutory provisions' of the Energy Act 2013, which means they are enforced by ONR under this legislation. The parts of each of these sections relevant to the Convention are contained in Annex 1.

7.11. An important provision of the NIA65 is that it 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 to not comply with the licence conditions.

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

Radioactive Substances Act 1993 (RSA93) and Environmental Permitting (England and Wales) Regulations 2010

7.13. The Environment Act 1995 (EA95) (Ref. 52) establishes the Environment Agency as the environmental regulatory body for England, Natural Resources Wales (NRW) for Wales, and the Scottish Environment Protection Agency (SEPA) as the equivalent for Scotland. EA95 also provides for the transfer of functions to the Environment Agency and SEPA, including powers and duties in relation to radioactive substances regulation. On 1 April 2013, NRW, established by the Welsh Government under the Natural Resources Body for Wales (Establishment) Order 2012, took over responsibility from the Environment Agency as the body responsible for environmental protection, including radioactive substances regulation, in Wales.

7.14. Until April 2010 both the Environment Agency and SEPA regulated the disposal of radioactive waste on or from nuclear licensed sites, and storing and use of radioactive material by tenants on nuclear licensed sites, under the Radioactive Substances Act 1993 (RSA93) (Ref. 53). In England and Wales, the permitting requirements of RSA93 have now been incorporated into the Environmental Permitting (England and Wales) Regulations 2010 (EPR10) (Ref. 54). EPR10 does

not materially change the radioactive substances regulation, but aims to provide a consistent approach to permitting and compliance across various regimes including pollution prevention and control, water discharge consenting, and waste. EPR10 also makes provision for a new power to allow staged regulation of geological disposal facilities for higher activity radioactive waste.

7.15. The staged regulation process starts when a developer decides to proceed with intrusive investigation work, such as drilling boreholes, at a potential disposal facility site. Prior to commencing, the developer would need to be granted an environmental permit under the EPR10. Staged regulation continues and updated environmental permits are required before each stage i.e. the start of initial underground operations at a site; the start of construction of the facility and starting disposal operations. The regulatory process would then continue through the operational period to the eventual sealing and closure of the geological facility. Additional information on staged regulation is available in the regulatory guidance on geological disposal (Ref. 55).

7.16. RSA93 still applies in Scotland. Therefore, all references to RSA93 in this report should be read as RSA93 as it applies in Scotland and EPR10 in England and Wales.

7.17. Disposal of radioactive waste under EPR10 and RSA93 includes the discharge of radioactive waste to the environment, incineration of solid or liquid radioactive waste, burial of solid radioactive waste or the transfer of radioactive waste to another site. Conditions in permits issued by the Environment Agency and NRW and authorisations by SEPA control the types and quantities of radioactive waste that may be disposed of, the disposal routes that may be used and impose requirements to minimise radioactive waste creation. Conditions are also imposed in relation to management systems, maintenance, monitoring and record-keeping.

7.18. The permits held by operators on nuclear licensed sites may be transferred in whole or in part. Such transfers can only be granted if Environment Agency, NRW or SEPA, as appropriate, is satisfied that the transferee will have operational control, and is willing and able to ensure compliance with the existing conditions of the permit.

7.19. The accumulation of radioactive waste, and the keeping and use of radioactive material, by the nuclear site licensee is regulated by ONR under NIA65. This is addressed in Article 19.

7.20. More generally, the EA, SEPA and NRW (collectively termed 'the environment agencies') have regulatory responsibilities for a range of other activities on or from nuclear sites, including the regulation of:

a. mobile High Activity Sealed Sources (HASS) on nuclear sites, and all HASS owned by tenants on nuclear licensed sites
b. the transfrontier shipment of spent fuel and radioactive wastes
c. abstraction from and discharges to controlled waters, including rivers, estuaries, the sea and groundwaters
d. operation of specific 'conventional' plant,
e. assessment and, where necessary, clean up of non-radioactive contaminated land
f. disposal of conventional waste
g. certain flood risk management matters, and, with the ONR as the joint Competency Authority, requirements under the Control and Management of Major Accident Hazards Regulations (COMAH) at nuclear sites.

Energy Act 2004

7.21. The Energy Act 2004 (Ref. 58) established the Nuclear Decommissioning Authority (NDA) as a new non-departmental public body which came in to being in April 2005. It took over the responsibility for decommissioning, and operation via civil contracts with operators pending decommissioning, of designated civil nuclear sites, including the sites operated by Magnox Limited.

Energy Act 2008

7.22. The Energy Act 2008 (Ref. 59) made provision for the management and disposal of waste during the operation of nuclear installations and introduced requirements for funded decommissioning programmes (FDP). 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 how the decommissioning of the site and the clean-up of the site is to be funded.

Freedom of Information Act 2000

7.23. The Freedom of Information (FOI) Act 2000 (Ref. 60) 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 ("EIRs") 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 that 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.

Secondary legislation

7.24. 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 the Energy Act 2013. The key regulations applicable to nuclear installations are set out below. Currently there are no new nuclear safety related regulations under development.

Ionising Radiation Regulations 1999

7.25. The nuclear site licensing regime is complemented by the Ionising Radiations Regulations 1999 (IRR99) (Ref. 61) that provide for the protection of all workers and members of the public, whether on licensed sites or elsewhere, from ionising radiations. IRR99 implements aspects of the European Council (EC) Directive establishing Basic Safety Standards (Ref. 62) and includes the setting of radiation dose limits for employees and members of the public for all activities involving ionising radiation. IRR99 also implements EC Directive 90/641/Euratom (Ref. 63) on the operational protection of outside workers exposed to the risk of ionising radiation 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 IRR99 can be found in Article 15.

Nuclear Reactors (Environmental Impact Assessment for Decommissioning) Regulations 1999

7.26. The Nuclear Reactors (Environmental Impact Assessment for Decommissioning) Regulations 1999 (EIADR99) (Ref. 64) implement the requirement for an environmental impact assessment for decommissioning nuclear power stations and nuclear reactors arising from EC Directive 85/337/EEC (as amended by EC Directive 97/11/EC) (Ref. 65) on the assessment of the effects of certain public and

private projects on the environment. Before decommissioning or dismantling of a nuclear reactor or power station can take place, a licensee must apply to ONR for consent, undertake an environmental impact assessment (EIA) and provide an environmental statement. The information to be included in an environmental statement is referred to and specified in Schedule 1 to the Regulations.

7.27. ONR has sole responsibility for all aspects of regulating and administering the EIADR99. When ONR receives an application for consent to decommission a nuclear power station or nuclear reactor, it is required to conduct a public consultation on the EIA. The appropriate environment agency and some other regulatory bodies are statutory consultees in this process. This gives the environment agencies and other stakeholders the opportunity to conduct a detailed peer review and critical appraisal of the EIA, and to provide these to ONR for consideration. ONR takes into account comments received during the consultation to inform its decision on whether to grant consent.

Radiation (Emergency Preparedness and Public Information) Regulations 2001

7.28. The Radiation (Emergency Preparedness and Public Information) Regulations 2001 (REPPIR) (Ref. 66) implemented in GB the radiation emergency in EC Directive 96/29/Euratom (Ref. 67). It also partly implements EC Directive 89/618/Euratom (Ref. 68) on informing the general public about health protection measures and steps to be taken in the event of an emergency. A radiation emergency is defined as an event that is likely to result in any member of the public receiving an effective dose of 5 milliSieverts (mSv) during the year immediately following the emergency.

Management of Health and Safety at Work Regulations 1999

7.29. The Management of Health and Safety at Work Regulations 1999 (MHSWR99) (Ref. 69) are relevant as they place requirements on employers, and hence nuclear site licensees, to:

(i) make assessments of the health and safety risks of their activities;

(ii) make, give effect to and record the appropriate health and safety arrangements;

(iii) ensure that their employees are provided with appropriate health surveillance;

(iv) appoint an adequate number of competent persons to assist them in complying with health and safety legislation;

(v) establish and give effect to procedures to be followed in the event of serious or imminent danger arising;

(vi) provide employees with information concerning the:-

(a) risks to their health and safety;

(b) preventive and protective measures;

(c) procedures necessary in the event of serious or imminent danger; and

(d) persons nominated to implement evacuation procedures;

(vii) co-operate with other employers to enable statutory health and safety obligations to be met, including the provision of health and safety information; and

(viii) to ensure that employees, taking into account their capabilities, have adequate health and safety training which is repeated periodically as appropriate.

7.30. MHSWR99 is 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.

7.31. As part of the suite of supporting regulations to the HSWA, the MHSWR99 sets the expectations on duty-holders 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.

Health and Safety and Nuclear (Fees) Regulations 2016

7.32. The Health and Safety and Nuclear (Fees) Regulations 2016 (Ref. 70) provides for the charging of fees for work by ONR in relation to the assessment of a proposal for any new nuclear installation. This includes all matters relating to the installation's construction, commissioning, operation and decommissioning, which are assessed by ONR. The charges apply to assessment work undertaken associated with a particular design proposal prior to any application for a nuclear site licence under NIA65 (Ref. 8).

Obligations under international Treaties, Conventions or agreements

Euratom - Nuclear Safety Directive

7.33. The EC Directive 2009/71/Euratom of 25 June 2009 (the 'Nuclear Safety Directive' (NSD)) (Ref. 71) establishing a community framework for the nuclear safety of nuclear power plants, was adopted on 2 July 2009 by publication in the Official Journal, and implemented in the UK by 22 July 2011. The Directive establishes a community framework to maintain and promote the continuous improvement of nuclear safety and its regulation, and to ensure high levels of safety to protect workers and the general public.

7.34. The UK's Fifth report to the Convention (Ref. 72) reported on how the UK complies with the Directive utilising the system of licensing and licence conditions provided for in the NIA65. The UK approach for compliance with this Directive remains unchanged.

7.35. Council Directive 2014/87/Euratom amending directive 2009/71/Euratom (Ref. 73), establishing a community framework for the nuclear safety of nuclear installations, was adopted on 8 July 2014, and will be implemented by all Euratom Member States by 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 NSD intent, shared by the UK, that the highest standards for nuclear safety should be implemented and continuously improved in the Euratom Community.

Euratom - Basic Safety Standards Directive

7.36. Council Directive 96/29 Euratom (Ref. 74) lays down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionising radiation (Basic Safety Standards Directive (BSSD)). It was adopted on 13 May 1999. Council Directive 2013/59 (Ref. 75), consolidates and repeals Directives 96/29 Euratom, 89/618/Euratom (Ref. 76), 97/43 Euratom (Ref. 77), and 2003/122/Euratom (Ref. 78). The 2013 directive must be implemented by EU Members States, including the UK, by 6 February 2018.

7.37. HSE has policy responsibility for the legislation relied upon to implement the occupational and emergency exposures aspects of the BSSD. ONR enforces this legislation on GB nuclear sites (licenced and defence).

7.38. The Environment Agencies implement provisions within the Directive relating to the protection of public health and the environment associated with the management of radioactive wastes through the RSA93 and EPR10.

Euratom Treaty – General provisions

7.39. The environment agencies also co-ordinate, on behalf of UK government, the delivery of relevant Articles of the Euratom Treaty. These responsibilities include:

a. Article 37 of the Euratom Treaty, which requires that, before a permit for the disposal of radioactive waste can be issued, the UK provides the European Commission with general data relating to any plan for the disposal of radioactive waste. This information makes it possible to determine whether the implementation of any such plan is liable to result in the radioactive contamination of the water, soil or airspace of another member state.
b. Articles 35 and 36 of the Euratom Treaty require compliance with measures to monitor radioactivity in the European environment and to submit data to the EC.

Licensing system

Authority to issue licences

E.1. ONR derives its licensing authority from the NIA65. This requires nuclear reactor sites, and any installation prescribed under the Nuclear Installations Regulations 1971 (Ref. 79), is not installed or operated unless ONR has granted a site licence. The NIA65 also requires ONR to attach such conditions to the licence as it considers necessary in the interests of safety. On matters affecting the management of radioactive wastes on nuclear licensed sites, ONR takes account of the interests of the relevant environmental regulator – either the Environment Agency in England, SEPA, or NRW.

7.40. These powers, to grant a licence and to attach conditions, are delegated to the post of the ONR CNI. Failure to comply with conditions attached to a site licence is an offence.

Licence conditions

7.41. ONR has promulgated 36 standard licence conditions (LCs) that together form a legal basis for requiring high standards of nuclear safety and radioactive waste management (Ref. 18). The conditions are non-prescriptive but set goals for all aspects of managing and assuring nuclear safety (listed in Annex 1). Each licensee can develop licence condition compliance arrangements that best suit its activities, while demonstrating that safety is being managed properly. The arrangements may change as the facility progresses through its life from initial design to final decommissioning. Licensees' compliance with the conditions and with their own compliance arrangements is mandatory. 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. The licence conditions provide the basis for effective regulation by ONR. The powers conferred to ONR under the licence are supplemented by enforcement inspection and investigation powers derived from HSWA74 for both nuclear safety and conventional (industrial) health and safety and the Energy Act 2013 (as discussed above). ONR's enforcement powers are discussed below.

Basis for licensing

7.42. ONR's publication "Licensing Nuclear Installations" (Ref. 41) provides guidance on the licensing process and the factors that ONR takes into account when reviewing licence applications.

7.43. 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:

- adequacy of its licence condition compliance arrangements
- adequacy of its safety documentation
- its organisational capability (including financial standing)
- emergency arrangements
- security of tenure over the site

7.44. On being granted a nuclear site licence, the licensee is responsible for meeting all of the licence conditions attached to the licence. ONR requires the licensee to provide evidence that it can do this; ONR also conducts a series of interventions. ONR published the project assessment report for the licensing of Hinkley Point C, which provides the details of the process applied to the NNB Genco application (Ref. 80).

7.45. A licence is issued for an indefinite period – potentially covering all phases of the life of the site from construction and commissioning through operations and then decommissioning and site remediation. The issue 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. Regulatory control of activities on a licensed site is exercised using the site licence conditions. Routine regulatory inspection and assessment, and the PSR process ensure that the licensing basis is maintained.

Licensees' continuity of responsibility

7.46. Under the NIA65, a nuclear site 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" can end only when a new licence has been granted for the site, the site is used by the Crown 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. Before such a notice is issued, ONR needs to be satisfied that the site has been decommissioned and adequately decontaminated. ONR has published a policy statement (Ref. 81) setting out its criteria for judging when risks have been reduced sufficiently to satisfy the 'no danger' requirement of NIA65. Nuclear site licensees, like all duty-holders under the Energy Act 2013 and HSWA74, have the right of appeal to an employment tribunal in respect of Improvement and Prohibition Notices issued by ONR. In addition, a licensee or licence applicant who is dissatisfied with a particular regulatory decision may raise their concerns with the relevant ONR inspector or senior management. Should issues not be resolved at this level, they may request a 'decision review' to be undertaken by ONR's Chief Executive, who will review the process by which the original decision was made. The administrative process for appealing licensing decisions is available on ONR's website (Ref. 82).

7.47. Within UK law, Judicial Review is always available to challenge regulatory decisions, but this applies only to a review of process and not to the final decision itself. If a Judicial Review is successful, the court requires the regulator to make a fresh decision.

Involvement of public in the licensing system

7.48. There is no legal requirement to consult members of the public with respect to licensing decisions. However, ONR aims to be open and transparent in publishing the basis for its regulatory decisions to help all of its stakeholders, including the public, to understand its work. The development of UK legislation that sets out safety

requirements will always involve some engagement with the public, and the government has produced overarching guidance on how this should be done (Ref. 83). Requirements to consult on various matters are written into legislation. An example is at section 81(3) of the Energy Act 2013, which stats that ONR should consult on proposals about regulations before submitting them to the Secretary of State.

7.49. Each of the nuclear power station sites have established a local stakeholder group, that includes local authorities, trade unions, interested local groups and members of the public. These meet routinely and ONR site inspectors regularly attend to present their quarterly report on inspection and regulatory activity. These quarterly reports are also published on the ONR website (Ref. 84). These meetings provide an opportunity for the local populace to discuss matters of interest and to raise any concerns they may have with the operators. ONR also attends meetings with non-governmental organisations, some of which represent the views of the public near nuclear licensed sites, and responds openly to public enquiries and requests for information.

7.50. ONR also publishes an annual statement by the CNI which provides an assessment of the safety and security of the nuclear industry. ONR's internal operational instructions and guidance documents are published on its website, so stakeholders can gain understanding of how decisions are made. ONR routinely publishes all of its regulatory decisions, through full project assessment reports and executive summaries of inspection reports which are written by its inspectors following site visits. ONR is committed to responding openly to any questions on its published information.

7.51. There are specific regulations requiring sharing environmental information related to decommissioning activities: The Nuclear Reactors EIADR99 (Ref. 64) - Statutory Instrument 1999 No. 2892 (Ref. 85). ONR has a procedure for dealing with applications submitted to it for consent under EIADR99. In addition to information provided to consultees, information is also sent to ONR.

7.52. As part of stakeholder engagement arrangements for potential new nuclear reactors, a public comments process is now included in the GDA process (Ref. 86), through which ONR and environmental regulators assesses new nuclear power station designs. This allows the public to participate by viewing and commenting on detailed design information and have access to reports prepared by the design companies.

Regulatory inspection and assessment

7.53. As explained above, ONR is established as the UK independent regulator for nuclear safety under the Energy Act 2013, which also enables ONR to appoint inspectors and give them regulatory powers (see Article 8) of inspection and investigation. Similarly, EA95 (Ref. 52?) enables the environment agencies to appoint 'authorised persons' with regulatory powers to carry out similar duties and inspections.

7.54. ONR has responsibility for the day-to-day exercise of the nuclear licensing function. The regulatory functions are vested in the CNI, as the authoritative regulatory head, who delegates these functions as appropriate to nominated inspectors.

Regulatory strategy

7.55. Further information on ONR's regulatory strategy and how ONR delivers its mission can be found in Article 8 and in ONR's strategic plan 2016 – 2020 (Ref. 20).

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

7.56. This is mainly done 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 ONR's site inspectors who spend about 30% of their time on site. Additionally, ONR undertakes team inspections on particular topics. Additional information on ONR's inspection work can be found under Article 14.

Assessments carried out in support of permissioning activities

7.57. This entails the assessment of licensees' safety cases. 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 SFAIRP. ONR technical specialist assessors, who are themselves inspectors and technical experts in specific fields, will examine aspects of the safety case to establish whether a licensee has demonstrated that it understands the hazards associated with its activities and how to control them adequately. The technical principles which ONR uses to judge safety cases are set out in its SAPs (Ref. 29). ONR's assessment work is discussed in more detail in Article 14. Relevant extracts from ONR's SAP can be found in Annex 3.

Enforcement powers

7.58. There are a range of enforcement powers available to ONR, these arise from both the Energy Act 2013 and HSWA74, and in the case of the notices and prosecution powers described below they are broadly the same across both Acts. ONR has an Enforcement Policy Statement (EPS) (Ref. 87) that sets out the purpose of enforcement, and the principles that should be applied. Inspectors are guided by an Enforcement Management Model (EMM) (Ref. 88) to assist in determining which enforcement measure is the most appropriate in a given situation. The EPS and EMM are discussed in more detail in Article 8. Individual inspectors are appointed through a legal instrument called a warrant and this document confers a wide range of powers on the inspector (see Annex 1 for more details), 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. It also provides enforcement powers to issue legal notices and take prosecutions in a court of law (except in Scotland). Enforcement action taken within the reporting period is discussed in Article 19.

Improvement Notice

7.59. If an inspector is of the opinion that one or more applicable legal provisions has been contravened or that contravention will continue or be repeated, they can serve an Improvement Notice (IN). The Notice requires that the stated improvements be made within a specified timescale. Should the licensee fail to make the necessary improvements within this timescale, it has committed an offence under the law and is open to prosecution. ONR has put in place internal processes which require senior level approval before an improvement Notice can be issued.

Prohibition Notice

7.60. 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 Prohibition Notice (PN) to immediately halt an activity. In practice, this power is rarely used by ONR for nuclear safety purposes, as there are other powers available under the licence conditions to use.

Prosecution

7.61. 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. In Scotland, an inspector can recommend that a prosecution be initiated

to the Crown Office Procurator Fiscals Service. Again, ONR's own administrative arrangements require senior approval to exercise this power.

Other regulatory and enforcement powers

7.62. ONR has other regulatory powers conferred on it through the standard LC's, 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 ONR when it requires the licensee to take a particular action. For example, LC 31(1) (shutdown of specified operations) gives ONR the power to direct a licensee to shut down any plant, operation or process. Such a direction would relate to a matter of major or immediate safety importance.
- **Specification:** This power gives ONR discretionary controls with regard to a licensee's arrangements. For example, in LC 23(2) (operating rules), if ONR issues a specification LI, the licensee is required to refer the operating rules to its Nuclear Safety Committee (NSC) for consideration.
- **Notification:** This power gives ONR the ability to request the submission of information by notifying the licensee of the requirement. For example in LC 21(8) (commissioning) the licensee shall, if issued a notification LI by ONR, submit a safety case and shall not commence operation of the relevant plant or process without the consent of ONR. In addition to direction, specification and notification, the site licence conditions provide further powers that may result in ONR's permission being needed before an activity can proceed or arrangements can be changed; these are consent, approval and agreement. Withholding such permission could be considered as part of enforcement should there be any unresolved safety issues.
- **Consent:** A consent is required before the licensee can carry out any activity which has been specified or directed to require a consent from ONR. For example, a consent LI is required before a reactor is allowed to be started up again following its periodic shutdown. Before being given consent, the licensee must satisfy ONR that the proposed action is safe and that all procedures necessary for control are in place.
- **Approval:** An approval can be used to control a licensee's arrangements. Once formally approved by ONR, such arrangements or procedures cannot be changed without the licensee seeking a further approval from ONR. For example, for nuclear power stations ONR has approved operating rules important to safety in order to ensure that licensees cannot change these without seeking ONR's agreement to the change.
- **Agreement:** An agreement LI issued by ONR allows the licensee to proceed with a particular activity or course of action. For example, LC 28 (examination, inspection, maintenance and testing) permission for licensees to carry out activities via specifications and consents. However, in some cases the conditions attached to the licence give ONR specific powers to agree to certain specific activities, for example, ONR may agree, under LC 28(7) to extend the

maintenance interval from that already identified on the plant maintenance schedule.

Enforcement action taken within the reporting period

7.63. IAEA guidance requests that a summary of the enforcement actions taken within the reporting period are included in Article 7. ONR served an Improvement Notice on EDF NGL following notification of an incident at Heysham 1 power station on 16 March 2015. The incident led to the release of around 30 tonnes of non-radioactive clean CO_2 from a failed pipe in the carbon dioxide storage and distribution plant on site. There was no release of radioactive material, no persons were injured and the two reactors remained operational during the event. This incident is discussed in more detail in Article 19.

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

8.1 Under this Article, compliance with the Convention is demonstrated in a way that has not substantially changed since the Sixth UK report (i.e. in a way that has implications for the Convention obligations).

Establishment of the regulatory body

Legal foundation and statute of the regulatory body

8.2 These aspects are covered in Section A, Article 7 and Annex 1.

ONR's mandate, mission and tasks

8.3 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 work with the international inspectorates to ensure that safeguards obligations for the UK are met. 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 first priority however is regulating the safety and security of nuclear facilities.

8.4 ONR's role, captured in the mission statement, is to: - *"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. 18).

8.5 The vision for ONR over the lifetime of this strategy and beyond is: - *"to be an exemplary regulator that inspires respect, trust and confidence."*

8.6 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 has published its EPS (Ref. 87); this is to be implemented in accordance with the UK's Regulators' Code (Ref. 89) and the regulatory principles required under the Legislative and Regulatory Reform Act 2006 (Ref. 90). The EPS explains how ONR will act with respect to regulating duty-holders. There are five specific principles explained in the EPS. These are:

- proportionality in applying the law and securing compliance;
- consistency of approach;
- targeting of enforcement action;
- transparency about how the regulator operates and what those regulated may expect; and
- accountability for the regulator's actions.

8.7 These principles apply both to enforcement in particular cases and to management of enforcement activities as a whole.

8.8 The proportionate use of enforcement powers, is important, both to secure compliance with the law and to ensure that those who have duties under it may be held to account for failures to protect the health and safety of workers and the public.

8.9 The EPS sets out the purpose of enforcement, which is to:

- ensure that duty-holders take action to deal immediately with serious risks;
- promote, achieve and sustain compliance with the law; and
- ensure that duty-holders who breach regulatory requirements, and directors or managers who fail in their responsibilities, may be held to account, which may include bringing alleged offenders before the courts in England and Wales, or recommending prosecution in Scotland, in the circumstances set out later in this policy.

8.10 Enforcement can range from verbal advice by inspectors to formal letters, legal notices, and ultimately for significant failings prosecution in a court of law. In addition ONR uses powers made available under the licence conditions. ONR makes use of this wide range of enforcement tools to secure compliance with the law and to ensure a proportionate response to criminal offences (see Article 7).

Organisational structure of ONR

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

8.12 ONR's inspectors / staff are assigned to specialisms, from which they are allocated to ONR's programmes. The current ONR regulatory structure is outlined in Section A, Figure 2. In addition, there are enabling programmes for corporate services and other assurance and support function.

Governance of ONR

8.13 ONR was established, under Part 3, Section 77 of the Energy Act 2013 (Ref. 7). The ONR Board is made up of non-executive and executive members – non-executive members always being 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.

Provision of adequate human resources

8.14 ONR employs suitably qualified technical specialists as inspectors as well as generalists and support staff to enable it to deliver the core regulatory work and other obligations. At the time of writing ONR's technical cadre is approximately 360 technical staff and 170 other support staff.

8.15 Given the plans for the expansion of the nuclear industry in the UK through planned construction of several new nuclear power stations, ONR needs to be able to meet the predicted increasing work-load and therefore continues to recruit more staff. In addition the age-profile of the inspector-cadre means that experienced inspectors are nearing the end of their careers and a number are retiring; this brings additional challenges for ONR.

8.16 ONR's external recruitment campaigns continue to bring in specialist skills in an increasing competitive market. ONR's Cheltenham office in the south-west of England continues to attract new recruits and ONR has significantly enhanced its recruitment pool. In addition to recruiting experienced specialists ONR now

sponsors recent university graduates (14 to date), associates (those with less nuclear/high hazard experience that ONR can develop and grow (five to date) and those with niche skills from other industry sectors that ONR recruit to undertake an equivalence role to become a nuclear inspector (five to date).

8.17 Guidance on the development of graduates, associates and those inspectors in their early careers (equivalence role) has been produced and includes ONR core competencies, technical / regulatory competencies and formal / on-the-job training. Since 2014, ONR has participated as a sponsor in the UK Industry "nuclear graduates scheme", which trains and develops graduates for roles within the nuclear industry. ONR supports graduates in order to develop their skills both personally and professionally to become the nuclear inspectors of the future. Over the past two years, ONR has welcomed 14 graduates from the scheme, and has recruited two past nuclear graduates into roles within the organisation. This year, ONR has successfully recruited the seven graduates from the 2014 intake into permanent roles within the organisation; this is a testament to ONR as an employer.

8.18 ONR has successfully recruited 46 additional nuclear safety and security specialists since 1 January 2015, with this expected to reach around 57 by completion of the current campaign. ONR is also developing proposals for degree level apprentices who, in small numbers, would be brought into the organisation to develop to become a warranted nuclear inspector. 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 nuclear new build, ONR has developed a five-year resource plan which provides detailed resource needs over the coming years to 2020/21. This results in a total requirement for 510 nuclear specialists by 2020, a number which has been endorsed by the ONR Board. This planning ensures that ONR have detailed recruitment and training plans in place that can be flexible should the demands over the time period change. In addition to permanent resource, ONR continues to offer and receive secondees from across the industry. This provides opportunities to share best practice and provides insight into the regulatory regime.

Measures to develop and maintain competence

8.19 The intensive recruitment campaigns since 2011 have necessitated a review of and revision to the training and assimilation of new inspectors. Recruitment in excess of 70 new inspectors means that ONR can no longer just rely on external training courses and ad-hoc internal peer group assistance from experienced colleagues. Training and assimilation is resource intensive so it has to be structured, planned, properly resourced and continually evaluated to ensure it meets all needs. ONR therefore put in place a dedicated team of experienced inspectors led by a training manager to develop specialist and core regulatory training courses and expanded its capacity to meet the increasing training needs of the organisation.

8.20 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 be able to transfer its wealth of experience to new inspectors and to acquire, develop and share new knowledge to maintain its ability to regulate in the future. At the core of its approach is an ambition to always have the right people, with the right knowledge, using the right processes to achieve its objectives.

8.21 ONR is further developing its training and knowledge management system to ensure an effective succession plan for its core resource capability. Each of these aspects are covered separately in the following paragraphs.

Warrants for new inspectors

8.22 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 Energy Act 2013 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. 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".

Training of new inspectors

8.23 All inspectors joining ONR 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 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.

8.24 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.

Training methods

8.25 In addition to the mandatory core regulatory training, a new inspector's training programme is developed on a personal basis and is based on a training needs analysis. The delivery of the training relies extensively on an interactive tutorial approach as well as specific technical training courses. Training documentation signposts to additional information and detailed training material.

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 are 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.

Continued professional development

8.27 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.

8.28 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

8.29 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

8.30 Key to improving knowledge management and the delivery of our vision, mission and strategy, is recognising the importance of our 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 'resilience map' 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 maps to identify organisational vulnerabilities and knowledge gaps, to inform the way ONR develop and train its people and better define recruitment needs.

8.31 ONR's programmes have identified core knowledge areas required to effectively regulate duty-holders and have developed information maps to enable the effective storage and retrieval of information. These maps link the knowledge areas to the key documents used by our inspection teams to understand and keep up to date with developments on the programme such as regulatory strategy and the findings of regulatory interventions.

8.32 Improvements already underway in knowledge management strategic management 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.

Provision of financial resources

Adequacy of financial resources

8.33 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 done under each contract.

8.34 The Health and Safety (Fees) Regulations 2012 (Ref. 91) made under the HSWA74 enables ONR to recover the costs of pre-licensing assessments, including GDA of new reactor designs, and the cost of advising prospective licence applicants during the pre-application phase.

8.35 The Nuclear Industries Security (Fees) Regulations 2005 (Ref. 92) allows ONR to charge for the majority of its security regulation.

8.36 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 government (currently approximately 5% of ONR's costs).

8.37 On an annual basis ONR publishes its annual report and accounts which provides information on its financial performance (Ref. 93?). ONR's income could be significantly reduced should a major duty-holder experience financial difficulties. In this situation, the government will ensure that ONR has sufficient resources to discharge its functions, thereby also ensuring that the government complies with its international duties to ensure that the regulator is adequately resourced. In such circumstances, ONR will provide Government details of the funding requirement, including the impacted duty-holder, the action taken and the outcome of that action.

8.38 Section 41 of EA95 (Ref. 52) 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

8.39 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. 94) 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.

8.40 Technical guidance to specialist inspectors is contained in a suite of ONR TAGs (Ref. 32), which are aimed at providing further guidance for inspectors on the interpretation and application of the ONR's SAPs (Ref. 29). For inspectors inspecting the sites there is a series of Technical Inspection Guides (TIGs). All TIGs and TAGs are regularly reviewed and updated and are also publicly available through the ONR website.

Monitoring ONR's effectiveness

8.41 ONR has a framework for evaluating its own overall performance, through a number of performance indicators and is presented as a" balanced scorecard" on a single page. 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, formal notices issued;
- regulatory performance of ONR, for example, the number of regulatory inspections and reports to plan, 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.

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

Regulatory assurance function

8.43 ONR established a regulatory assurance function in April 2014 in order to provide an independent view of ONR's regulatory performance through oversight and review of regulatory processes and key regulatory decisions across all operational programmes. The primary aim of the function is to secure the confidence of key stakeholders (including the ONR CNI, the ONR Board and relevant sub-committees, and relevant government departments) in the robustness of ONR's regulatory processes and decision making. ONR's assurance framework was developed by taking into account international good practice and is based upon government 'Assurance Frameworks' guidance (Ref. 95).

8.44 In recognition of the significant investment that ONR makes in employing and maintaining competent nuclear resource, the assurance function operates on the premise that ONR specialists are trusted to do the right thing, with robust in-line checks already in place. In this regard, the assurance function does not quality check each and every decision.

8.45 Consistent with international good practice (Ref. 96) and in order to maximise efficiency and effectiveness, the assurance function prioritises its strategic focus on:

- mandatory legislative requirements (in particular pursuant to the Energy Act 2013);
- ONR's critical risk areas (across the ONR operational programmes); and
- ONR's strategic priorities (Ref. 20).

8.46 A regulatory assurance review plan is produced at the start of each financial year that is informed by the above focus areas, and also aligns with the IAEA IRRS modular approach (Ref. 97). This is an additional benefit and adds value to ONR's assurance activities by enabling longer term preparation for future IRRS missions. Assurance information is pro-actively captured against the IRRS core modules and aggregated over the long term to complement the completion of the IRRS self-assessment tool.

8.47 ONR has developed a formal process for internal reviews that leads to an assigned assurance rating and the capture of areas for improvement and good practices for the topic reviewed. The assurance ratings make use of a standardised assurance rating framework for consistency. Areas for improvement and good practices are then progressed to completion via a formal advice note process. Progress with advice notes is monitored by an ONR performance indicator.

8.48 Good progress has been made in developing the regulatory assurance approach in ONR since its introduction in 2014. Tangible improvements have been made to ONR's effectiveness and regulatory processes and there has been an increase in key stakeholders' confidence in the quality and consistency of ONR's regulatory decision making. Assurance reviews have revealed both good practices which have been shared across the organisation as part of ONR's commitment to continuous improvement, as well as identifying areas for improvement, such as risks to the delivery of one of ONR's statutory functions.

8.49 ONR continues to develop its approach to regulatory assurance including closer working and sharing of intelligence with the ONR regulatory intelligence function to further improve ONR's regulatory effectiveness.

Openness and transparency of regulatory activities

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

8.51 ONR demonstrated its commitment to openness and transparency during GDA by publishing the final assessment reports on the UK EPR™. The good practices on openness and transparency identified during the GDA process have been captured and transferred to the rest of ONR's programmes where appropriate.

8.52 In addition, ONR publishes summaries of its inspection reports on its website (Ref. 18). These reports provide a summary of ONR's findings while carrying out its inspection and other regulatory activities.

8.53 Furthermore, in common with all other government departments, ONR must comply with the FOI Act 2000 (Ref. 60) (see Article 7) and the Environmental Information Regulations (EIR 2004) (Ref 98). ONR has a dedicated team to handle requests of this nature.

8.54 ONR also participates in international initiatives initiated by the OECD, the NEA and WENRA to promote openness and transparency.

External technical support

8.55 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. To maintain this situation, ONR periodically reviews its expertise and its likely needs for the near and intermediate term, and adjusts its recruitment and training activities accordingly. There are occasions, however, when specialist advice and/or additional resources are needed to respond to a high workload, or the specialism is not available in ONR. To accommodate this, ONR has an extramural support budget and technical support framework agreements with outside bodies in specifically identified areas, to enable contracts to be placed quickly. The technical areas being supported and contractors providing support are published on the ONR website.

8.56 ONR recognises that with the scarcity of nuclear expertise, many of the companies contracted to deliver work on our 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 that it will be using a contractor for a particular piece of work, thus ensuring matters, such as conflict of interest, are identified and addressed;
- ensuring detailed work specifications are agreed at the outset;
- implementing strong contract management procedures;
- following ONRs openness and transparency agenda and ensuring relevant information about the use of contractors is put into the public domain;
- having detailed non-disclosure agreements in place; and
- all parties know 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

8.57 Following a recommendation from the House of Lords Science and Technology committee, ONR has established the ONR Independent Advisory Panel to obtain external independent expert advice on a diverse range of nuclear safety and security matters. The panel comprises eminent scientists, engineers and security professionals with a broad range of experience gained both inside and outside the nuclear sector. The panel is chaired by the CNI. The role of the panel is to:

- Provide independent external advice to inform ONR's proposals for development of regulatory policies and strategies;
- Identify and advise ONR on future developments in nuclear technology and their implications for nuclear regulation;
- Advise on the adequacy and balance of the safety and security research needs identified by ONR and the work commissioned to meet them; and
- Facilitate ONR's engagement with external centres of expertise.

Interface between ONR and other government departments

8.58 The Secretary of State for Works and Pensions has the principal responsibility to Parliament for ONR governance and finance, and performance in relation to conventional health and safety at nuclear sites.

8.59 A number of other Secretaries of State are answerable in Parliament for aspects of ONR's activities:

- The Secretary of State for Energy and Climate Change is accountable to Parliament for development and effective delivery of the UK nuclear regulatory framework and policies including civil

nuclear safety and security; emergency planning and response; nuclear safeguards; and the transport of radioactive material by road, rail and inland waterways.

- The Secretary of State for Defence is accountable to Parliament for nuclear safety and security at nuclear sites operated wholly or mainly for defence purposes.

Interface with other agencies/regulators

Environmental regulatory bodies

8.60 The Environment Agency is the principal environmental regulator in England and NRW has this responsibility in Wales. SEPA has the equivalent responsibilities in Scotland. Their regulatory responsibilities include the authorisation or permitting of the disposal of radioactive wastes and discharges from nuclear licensed sites.

8.61 NRW is responsible for regulating the nuclear industry in Wales on environmental matters such as disposals and discharges of radioactive waste, discharges of cooling water and operation of standby generators.

8.62 There are no nuclear installations in Northern Ireland to which the Convention applies (Annex 2 provides more information on the mandates of the environmental regulatory bodies).

8.63 ONR, the Environment Agency, SEPA and NRW work closely with one another to ensure the effective co-ordination of their respective regulatory activities at nuclear installations. ONR has Memoranda of Understanding with the Environment Agency and SEPA (Ref. 11), the objective of which is to facilitate the minimisation of the overall detriment due to radioactive waste management on licensed sites, from generation to disposal. Under NIA65, ONR consults 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.

8.64 Similarly, the Environment Agency, NRW or SEPA consult ONR or HSE under EPR10 (Ref. 99) or RSA93 (Ref. 100) on proposed (new or varied) authorisations for disposals of radioactive waste including discharges to the environment.

8.65 In addition to their own routine inspection activities on nuclear licensed sites, the EA, NRW and SEPA carry out planned joint inspections with ONR and co-operate in the investigation of incidents where appropriate.

8.66 Together with the ONR, the environment agencies form the relevant joint Competency Authority at nuclear licensed sites for regulation of the requirements of the Control and Management of Major Accident Hazards Regulations (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 Generic Design Assessment of Candidate Nuclear Power Plant Designs (the ‘GDA’ process).

8.68 Similarly, the environment agencies, together with the ONR, have published Joint Guidance on the Management of Higher Activity Radioactive Waste on nuclear sites, working closely to provide advice to nuclear licensees on the management of the safety and disposability of such wastes arising from nuclear activities.

Responsibilities of other agencies and bodies

8.69 On 1 April 2013, the Public Health England (PHE) was established as a non-departmental public body, replacing the Health Protection Agency and other health related organisations, with radiation protection incorporated in its remit. Its 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 also technical services to persons concerned with radiation hazards.

Reporting obligations

8.71 ONR must publish an annual 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 Schedule 7, Section 24 of the Energy Act 2013. The accounts are prepared in accordance with the relevant statutes and specific accounts direction issued by DWP as well as with the Treasury's Financial Reporting Manual.

8.73 The annual report and accounts is laid in Parliament and made available on ONR's website.

8.74 In accordance with Schedule 7, Section 22 of the Energy Act 2013, ONR shall submit a strategy for carrying out its functions to the responsible 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.

8.75 In accordance with Schedule 7, Section 23 of the Energy Act 2013, each year ONR must submit to the responsible Minister for approval an annual plan for the performance during that year of its functions. The annual plan shall include key targets for the year in question and shall include budgeting information so that resources allocated to achieve specific objectives can be readily identified.

Independence of the regulatory body

8.76 ONR's independence as a regulator is currently ensured under the Energy Act 2013, 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 Environmental Permitting Regulation 2010 (Ref. 99) in England and Wales and Radioactive Substances Act 1993 (Ref. 100) in Scotland and Northern Ireland ONR is a Competent Authority under the Control of Major Accident Hazard Regulations 2015, in conjunction with the relevant environment agency.

8.77 ONR provides assurance through factual information and advice to Ministers and Government on nuclear safety matters, but operates its regulatory functions 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. The HSE is sponsored by the DWP and retains regulatory policy responsibility for conventional health and safety on nuclear sites.

8.78 The Environment Agency (in England) is sponsored by the Department for the Environment, Food and Rural Affairs. It works closely with ONR and the Department of Health, and on radioactive substances matters with DECC.

8.79 NRW is responsible for regulating the nuclear industry in Wales on environmental matters such as disposals and discharges of radioactive waste, discharges of cooling water and operation of standby generators.

8.80 SEPA is sponsored by the Scottish Government. On radioactive waste matters, it works closely with the Rural and Environment and Public Health Directorates of the Scottish Government.

8.81 Concordats or Memoranda of Understanding exist between the regulators and the environment agencies and regular liaison meetings take place (Ref. 11). In addition, the Food Standards Agency acts as statutory consultee to both the Environment Agency and SEPA under RSA93.

8.82 Enforcement can range from advice by inspectors to warnings, letters, notices, use of powers under the licence conditions and other nuclear safety and security legislation or prosecutions. ONR will make use of this wide range of tools at its disposal to secure compliance with the law and to ensure a proportionate response to criminal offences.

Article 9 - Responsibility of the licence holder

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

9.1 Under this Article, compliance with the Convention is demonstrated in a way that has not substantially changed since the Sixth UK Convention Report (Ref.3) (i.e. in a way that has implications for the Convention obligations).

Formulation of legislation assigning prime to the licence holder

9.2 The legislation assigning primary responsibility for safety to the licence holder is covered in detail in Annex 1.

9.3 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.

9.4 The non-prescriptive licensing regime in the UK ensures that the licensees recognise and accept their responsibilities, whilst allowing them to determine their own methods of demonstrating compliance with the law. This is subject to the regulator being satisfied that the requirements of the licence are adequately fulfilled. The way in which this responsibility is carried out is monitored and, if necessary, ONR will enforce safety improvements, as described in Article 7.

9.5 With regard to the financial responsibilities of the operator for potential damages to the public or the environment, under Section 19 of NIA65 (Ref. 8) operators are required to maintain insurance or other financial security to cover their third party liabilities. The operators' arrangements are subject to DECC approval. EDF NGL insures its sites liabilities, and the government has financial responsibilities as a Contracting Party to the Paris and Brussels Conventions. Before ONR grants a nuclear site licence, it seeks assurance from DECC on the prospective licensee's ability to meet its potential financial liabilities as a nuclear site licensee, but does not have any review responsibilities.

9.6 None of the UK's other legislation for health and safety, for example, HSWA74 (Ref. 9), relieves the licensee of its responsibility for the nuclear safety of its licensed sites.

9.7 A licensee has to demonstrate the acceptability of the safety provisions for its activities to the satisfaction of the regulator.

9.8 On granting a nuclear site licence, NIA65 enables ONR to attach any conditions to the licence in the interests of safety or radioactive waste management. Currently, ONR attaches 36 standard conditions to a nuclear site licence that the licensee must comply with.

Licensee's discharge of its prime responsibility for safety

9.9 In meeting its legal obligations for ensuring that it manages 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 sets 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 NGL's organisational structure is presented in Figure 9. Further information on how EDF NGL is organised and manages its operations to ensure safety can be found throughout this report but particularly under Articles 6, 10, 14 and 19. EDF NGL's safety policies are discussed under Article 10.

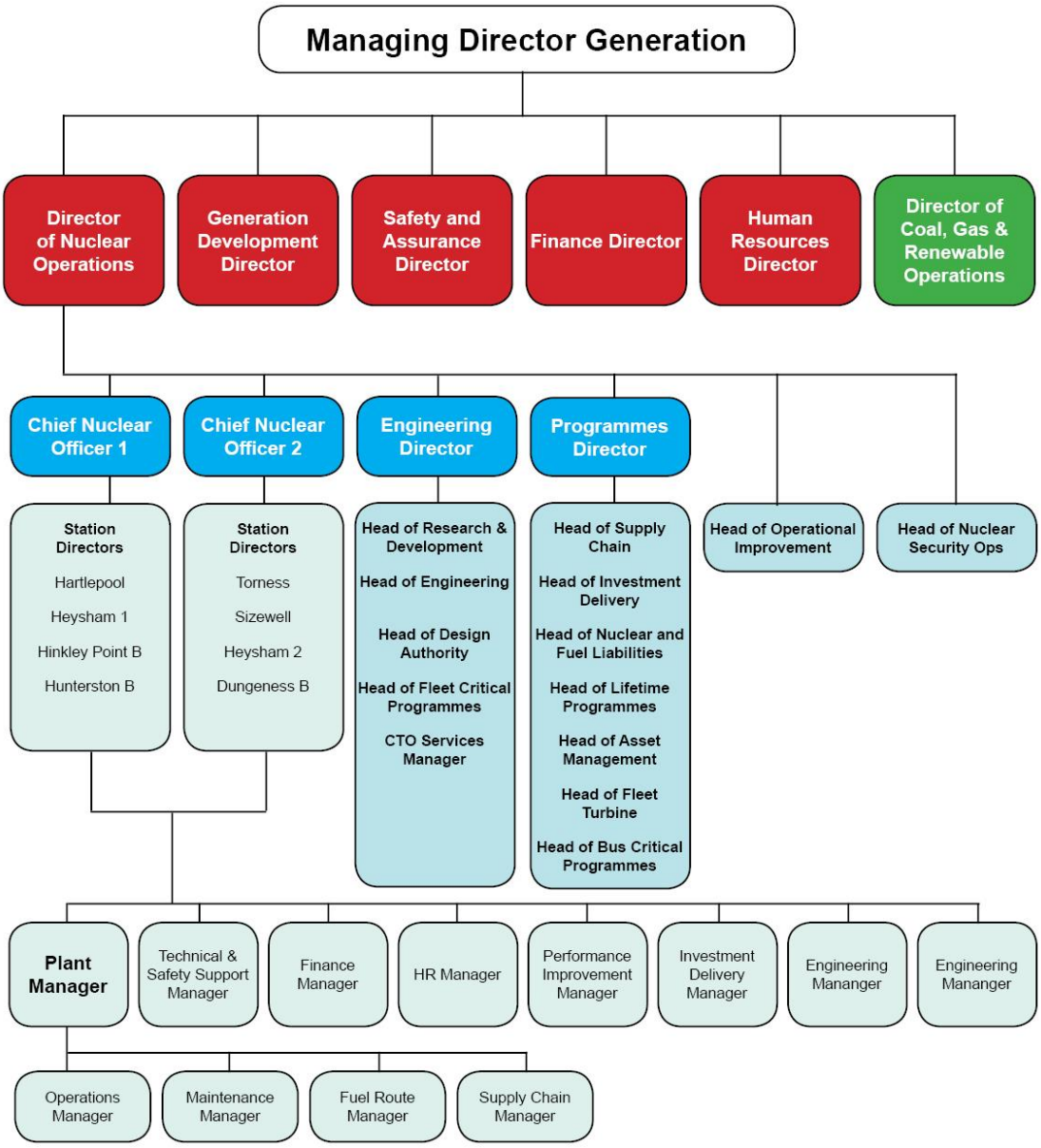


Figure 9 - Simplified diagram showing EDF NGL's organisational structure

9.10 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 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.

9.11 EDF NGL makes use of centrally-based staff at its offices near Gloucester, UK, and also East Kilbride, who set safety and operational standards, carry out reviews of safety and provide specialist support for a number of licensed sites. The responsibility for compliance with some site licence conditions for a specific site may be held centrally by the licensee. 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.

9.12 The regional chief nuclear officers are responsible for selecting station directors, monitoring their performance and ensuring that they have adequate corporate support. The responsibility for the safe and reliable operation of the reactor sites is directly delegated from the Licensee Board to the station director. The nuclear fleet is divided organisationally into Regions 1 and 2. Region 1 includes Hunterston B, Hinkley Point B, Hartlepool and Heysham 1. Region 2 includes Sizewell B, Torness, Heysham 2 and Dungeness B. The two chief nuclear officers report through the director of nuclear operations to the managing director. 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 550 staff with an additional 250 contract partners involved in the day-to-day operations. During outage periods, this figure increases by a further 1000 contractors involved in the engineering and maintenance activities.

9.13 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.

9.14 Functional oversight is provided by fleet managers, with independent oversight by Independent Nuclear Assurance (INA) teams, located at each site. They have separate reporting lines through the safety and assurance director to the managing director.

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

9.15 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 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.

9.16 The licensees and ONR adopt a formal hierarchy for meetings to address and resolve issues arising from our regulatory processes. The interface includes meetings at different organisational levels, each based on the seniority of the representation and the breadth of the issues considered. The top level involves representatives of the Licensee Board and the CNI. At a lower level, meetings which are still formal in nature are devoted to technical discussion and clarification.

9.17 ONR has established a strategy for operating reactors, which provides a framework for the regulatory activities associated with all eight EDF 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 in Article 14.

9.18 In addition to compliance inspections and SBIs, additional reactive inspection, or inspection associated with intervention projects may also be appropriate. ONR inspectors may also carry out unannounced inspections at any time. By definition, reactive inspection cannot be planned. However, experience suggests that up to 25% of available inspection time is spent on reactive work. Reactive inspection 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. An enforcement management model is in place to assist inspectors in applying their judgement to any particular situation where they are considering taking enforcement action. The process for determining ONR's formal enforcement response to an incident or event is set out in internal guidance (Ref. 88).

9.19 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. 101). 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. 84).

9.20 ONR Conventional Health & Safety inspectors utilise a modern enabling approach to the regulation of conventional health and safety at licensed nuclear sites. This is achieved by: ensuring the industry has robust health and safety management systems in place; is complying with relevant statutory provisions, and; where dutyholders are non-compliant with the law, taking proportionate action where appropriate to secure compliance within a reasonable timescale. Inspectors undertake proactive and reactive regulatory work across the nuclear industry via:

- strategic nuclear site topic interventions of national health and safety priorities to secure continuous improvements to reduce injuries, ill-health, and dangerous occurrences; and
- the investigation of site accidents, ill-health and dangerous occurrences reported to ONR under the Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 2013, and workplace concerns.

Maintenance of open and transparent communications by licensee

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

9.22 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 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.

9.23 EDF NGL's website provides daily updates on the current status of all of its reactors, providing 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. 102).

9.24 EDF NGL has seven visitor centres across the UK. The interactive exhibitions 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.

Ensuring that the licensee has appropriate resources

9.25 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 in Article 11.

9.26 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 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 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

10.1 Under this Article, compliance with the Convention is demonstrated in a way that has not substantially changed since the Sixth UK Convention Report (Ref.3) (i.e. in a way that has implications for the Convention obligations).

UK government policy

10.2 DECC 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 DECC Minister is responsible to parliament for nuclear safety. ONR is the UK's legally independent regulatory body for nuclear safety and provides advice to DECC on nuclear safety matters when requested.

The regulatory body's priority to nuclear safety

10.3 As the principal regulatory body, ONR has core functions to licence, inspect, and assess nuclear installations in order to judge, on behalf of the public, that they are being managed and operated safely and within the law. It is axiomatic that safety is ONRs main priority. The UK operates a goal-setting, non-prescriptive regime for regulating nuclear safety, described in Section A and Article 9. This approach enables novel safety features to be considered and provides flexibility for the licensee to meet nuclear safety standards through arrangements that meet their particular circumstances.

10.4 In pursuit of its mission, ONR is seeking to ensure that the operators of the nuclear sites have made, and are implementing, adequate arrangements for complying with all relevant legislation. They must be adequately resourced to underpin safe operations and maintenance, understand the hazards and risks they are dealing with, and be committed to the adoption of relevant good practice through continuously seeking and making reasonably practicable improvements to safety.

10.5 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. 103), 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 shutdown specified operations. These powers have never been used for a nuclear safety matter on an operating nuclear power plant. The licensee has a strong culture of making conservative decisions to shut down reactors should a safety concern warrant such significant action.

10.6 It is ONR's declared aim 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 our response to Articles 8 and 14 in this report. Further information is also available in the ONR Strategic Plan 2016-2020 (Ref. 20).

Organisational leadership and management for a positive safety culture

10.7 ONR is cognisant 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.

10.8 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 organising for safety is more easily prescribed and requirements are outlined in the UK, for example, through MHSWR99 (Ref. 69) and LC17 related to management systems. Most UK licensees have adopted the recommendations contained in IAEA safety requirements GS-R-3 (Ref. 94) and its associated safety guides for implementing effective safety management systems.

10.9 ONR has reflected on the above, and has adopted the collective term 'leadership and management for safety'. 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. ONR's expectations for leadership and management for safety are set out in four of its SAPs as follows:

- **Leadership:** Directors, managers and leaders at all levels should focus the organisation on achieving and sustaining high standards of safety and on delivering the characteristics of a high reliability organisation.
- **Capable organisation:** The organisation should have the capability to secure and maintain the safety of its undertakings.
- **Decision making:** Decisions made at all levels in the organisation affecting safety should be informed, rational, objective, transparent and prudent.
- **Learning:** Lessons should be learned from internal and external sources to continually improve leadership, organisational capability, the management system, safety decision making and safety performance.

10.10 ONR has established a leadership and management for safety annual review process to evaluate licensees' performance in relation to the four SAPs. 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 those less tangible cultural aspects provides the basis for this review. Areas for improvement are identified for the licensee to address.

Use of Safety Performance Indicators (SPIs) in the UK

10.11 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. 105) and pilot projects were undertaken to further refine the approach. SPI data is made available by the licensees to ONR on a routine basis to assist in targeting regulatory attention, particularly where trends adverse to safety may be indicated.

10.12 In 2016 the UK nuclear industry's safety directors published an industry endorsed good practice guide entitled 'Development and use of Safety Performance Indicators' (Ref. 106). 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.

The operator's priority to nuclear safety

10.13 In the UK there is a single licensee, EDF NGL, operating civil nuclear power plants that generate electricity. There are currently no nuclear installations under construction; however some information is included on planned construction of new nuclear power plants. The following sub-sections provide further information on how EDF NGL demonstrates its commitment and priority to safety.

Figure 10 – EDF NGL focus on priority to safety at reactor sites

Organising and managing for safety in EDF NGL

10.14 EDF 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.

10.15 The commitment to give priority to nuclear safety is clearly established within company policies (Ref. 107). 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. Further information can be found on the EDF website (Ref. 48).

10.16 The ultimate responsibility for setting policy and ensuring that the company operates safely and complies with legislative and regulatory requirements lies with the EDF NGL Board. The Board monitors safety performance routinely. Safe management of operations of the reactor fleet resides with the EDF NGL Executive team headed by the managing director, supported by the director of nuclear operations and other programme directors. The director of nuclear operations is supported by two regional chief nuclear officers, an engineering director, and a safety and assurance director.

10.17 The safety and assurance director is independent from the operational reporting line within EDF 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.

10.18 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.

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

Operating within safe limits and making conservative decisions

10.20 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 in our response to Article 14(2). The management system and conduct of operations at the power stations, together with the principles of defence–in-depth that the installations are designed to meet, are all aimed at ensuring that the plant remains safe and is within the identified limits and conditions. Plant operating instructions also identify the actions required if these limits and conditions are not being met, the time limits by which those actions must be carried out and the

circumstances in which the reactor plant should be shut down in the event of non-compliance.

10.21 EDF 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. Since the last UK report, several safety issues have been identified such as issues related to boiler structural elements at two stations and anomalies within the graphite cores at one station (Section A provides further details). In these instances, EDF NGL has responded by acting conservatively in shutting down reactors for additional inspections or extending periodic shutdowns to undertake the necessary examinations to demonstrate that operations can be safely resumed; including operating at reduced power. ONR did not need to use its enforcement powers in any of these cases, as EDF NGL took conservative decisions, demonstrating a clear priority to safety.

Review and challenge to EDF NGL processes and procedures

10.22 EDF 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 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

10.23 EDF NGL has subscribed 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 and good practices, 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 recognition of the benefits of performing these reviews, EDF NGL has undertaken to have each nuclear installation reviewed every four years with an interim follow-up visit to review progress.

10.24 In October 2015, the PWR at Sizewell B hosted a full scope OSART mission (Section A provides more details) and it is EDF NGL's intention, through DECC, to invite further missions to the UK. By these means, performance is benchmarked against international standards and good practices are shared.

Internal challenge and independent assessment

10.25 EDF 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.

10.26 As part of maintaining EDF 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. In addition, 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.

Self-assessment within EDF NGL

10.27 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

10.28 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 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 anyone to identify an issue or problem by raising a condition 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. For the most significant actions, additional effectiveness reviews are included following their implementation.

Enhancing safety culture in EDF NGL

10.29 EDF NGL has defined its nuclear safety culture using the IAEA safety series document INSAG-4, 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.

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

Use of Safety Performance Indicators by EDF NGL

10.31 As mentioned above the UK nuclear industry has produced a good practice guide which EDF NGL has adopted. SPI related data is collected, collated and analysed routinely at the 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 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.

10.32 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 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, each site produces a comprehensive information pack to match the agenda, 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.

Construction of the new power station at Hinkley Point C

10.33 NNB GenCo Ltd, part of the EDF group, holds a nuclear site licence that authorises it to use the site at Hinkley Point C in south-west England to construct and operate two EPR™ pressurised water reactors. The licensee has defined the following project fundamental: - *"Nuclear safety requires us to protect individuals, society and the environment by establishing effective defences against radiological hazards throughout the Project and future plant operation and decommissioning."*

10.34 Furthermore NNB GenCo has made some high-level commitments to demonstrate its priority to safety. These are to:

- Design and build the plant to ensure it has effective multiple defences against radiological hazards including maintenance of the containment arrangements, the provision of adequate cooling and the ability to control the reactor systems under all credible scenarios;
- Continually emphasise that quality in construction and commissioning drives future nuclear safety;
- Encourage an open reporting culture;
- Maintain effective communication with the adjacent nuclear facilities to ensure construction activities will not impact the nuclear safety of these existing nuclear sites;
- Establish and regularly test emergency arrangements to safeguard our workforce against the risks of an event at the adjacent nuclear facilities;
- Establish strict safeguards during construction of the 'Nuclear Island' to protect against the introduction of reactor poisons and other foreign materials;
- Review and revise arrangements in advance of nuclear fuel being brought onto the site for commercial operation of unit 1 whilst construction of unit 2 continues; and

- Maintain a strong interaction with the regulators to support compliance and assist in securing and maintaining any consents, permits and licences.

10.35 This approach is in line with the expectations of the Vienna Declaration on Nuclear Safety.

Organising and managing for safety at Hinkley Point C

10.36 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 Board is responsible for effective governance of the project, including implementing EDF group policies mentioned above so that nuclear safety risks are adequately managed and controlled. The executive arm of the licensee is headed by the Hinkley Point project director who is a member of the NNB GenCo Board and 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.

10.37 The station safety report, or safety case, is key to the licensee's demonstration that the nuclear safety risks arising during all phases of the nuclear installation's life cycle are compliant with the law and meet the prevailing standards. Construction of the power station has not yet commenced on site, however the plans, designs and safety cases are well developed to enable an application for ONR's consent to commence construction of safety related civil structures. ONR also has the regulatory responsibility for construction activities at all nuclear sites.

Safety advice and assurance

10.38 Although construction has not yet commenced NNB GenCo established a NSC that has been meeting regularly for several years. It acts as an independent advisory body providing nuclear safety advice to the Hinkley Point C project and NNB GenCo Board to support its responsibilities as the licensee. The Hinkley Point C project seeks advice from the NSC for the most significant nuclear safety decisions, which must be presented for review prior to implementation. The NSC also reviews safety cases, construction safety justifications and other proposals such as major design changes.

10.39 As part of demonstrating high standards in nuclear safety, the licensee has also established an assurance function. The responsibility for this rests with the safety director, who discharges it through a full-time head of assurance. The function comprises an independent assessment, challenge and oversight team, Hinkley Point C site independent assessment team and independent technical assessment team. A targeted programme of audits and independent assessments is carried out to provide assurance of the adequacy of arrangements and safety cases for the Hinkley Point C project.

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-

11.1 Under this Article, compliance with the Convention is demonstrated in a way that has not substantially changed since the Sixth UK Convention Report (Ref. 3) (i.e. in a way that has implications for the Convention obligations).

Financial resources - background

11.2 Under UK company law, a registered company must have sufficient assets to meet all of its liabilities to continue in business. A balance sheet of assets and liabilities is a required element of the annual accounts (of medium and large registered companies), which must also be audited and made available to the public. All of the UK's AGR stations and the PWR station at Sizewell B are owned by EDF NGL who must comply with UK company law as described above.

11.3 The assets and liabilities of all of the Magnox reactors transferred to the NDA in April 2005.

11.4 Special financial provision is made for the particular liabilities relating to the reprocessing and storage of spent fuel, the storage and disposal of nuclear waste and a nuclear installation's decommissioning costs. In particular, EDF NGL's decommissioning costs are to be met from the Nuclear Liabilities Fund established for this purpose when the company was restructured in 2005 (see below).

11.5 With regard to 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 DECC on the issue of liability before issuing a nuclear site licence. Should an operator's arrangements change, approval of new arrangements must be re-sought from the government.

Regulatory approach

11.6 When issuing a licence to an organisation for the first time, ONR seeks advice from DECC 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.

11.7 In July 2011, ONR modified the standard set of conditions that are attached to the nuclear site licence for all licensed sites. This modification required licensees to provide and maintain adequate financial and human resources to fulfil their obligations in respect of nuclear safety, to include the requirement as LC 36 (1). This change was made to make explicit in the UK regulatory regime how compliance with the intent of Article 6.5 of the Nuclear Safety Directive (Ref. 108) is implemented in the UK.

11.8 ONR has issued guidance on how this requirement should be interpreted by its inspectors. 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

SFAIRP and implementing improvements in a timely manner; maintaining an adequate organisational capability; assessing what financial resources are necessary to continue to meet those needs; and assigning those resources accordingly. Although it has not yet happened, if a safety issue could not be resolved to the satisfaction of the inspector, and financial resource issues were identified as a possible factor, ONR would seek appropriate external advice on the issue before taking a decision on appropriate enforcement action.

11.9 One objective of the PSR is to identify reasonably practicable safety improvements. In determining whether a particular improvement is reasonably practicable, the regulator will look at a number of factors including the remaining lifetime of a reactor, the safety benefit and whether there is any gross disproportion between this and the cost of the improvement (the ALARP process).

Financing safety improvements during operational life

11.10 The costs of making any necessary safety improvements during the operating life of a nuclear installation are treated as part of the installation's normal operating costs. The principal elements of operating costs comprise:

- maintaining and enhancing safety;
- fuel (including the cost of new fuel and treatment of irradiated fuel);
- materials and services (the cost of engineering, including contractors, and consumable spares for maintaining the nuclear installations, and other miscellaneous charges such as insurance);
- staff costs (salaries and pension provisions); and
- depreciation (representing the proportion of the fixed assets written off in relation to the accounting life).

11.11 EDF 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, make available and control the financial resources necessary to achieve safety standards; meet liabilities; maintain an effective management system and achieve the company's objectives.

11.12 As with any other expenditure, the operators' internal financial control processes determine the necessary authority required before commitments are made to make safety or any other improvements. These processes examine the impact on the operators' financial accounts of any proposal for improvement work, using discounted cash flow and cost-benefit analyses. Such analyses take into account both the immediate costs of carrying out the improvements and future income through continued electricity generation.

Financing radioactive waste management at nuclear installations

11.13 The published audited accounts of UK nuclear installation operators include details of waste management costs and of the provisions made in order to meet them. However, there is currently no disposal route for intermediate level radioactive waste and high level radioactive waste in the UK. The costs of storing these wastes comprise:

- 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.

11.14 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 disposals of low level radioactive waste where the operator of the facility sets a

price that reflects all operational and liability cost considerations. All disposals of radioactive waste, including those to the environment, are undertaken in accordance with regulatory authorisations. The regulators, the Environment Agency, NRW and SEPA, recover costs in granting, monitoring and enforcing the authorisations or permits from the operator.

Financing decommissioning programmes

11.15 The NDA was set up under the Energy Act 2004 (Ref. 58) when it took over the liabilities and assets of the vast majority of the UK's civil nuclear decommissioning licensed sites and Magnox reactors previously owned by British Nuclear Fuels Ltd.

11.16 Funding of the operation, clean-up and decommissioning of these nuclear legacy sites falls to the UK Government. Public funding is currently being maintained at around £3 billion a year, with a declining proportion being offset by the commercial income from the NDA's operations. This funding relates only to public sector nuclear sites and their associated plant and facilities. EDF NGL is a private sector company with its own duties and responsibilities.

11.17 The Nuclear Liabilities Fund was established in January 2005 and took over the assets of the previous Nuclear Generation Decommissioning Fund Ltd. Upon restructuring, the fund was given the assets of the previous fund and £275 million of bonds in British Energy Holdings plc. In addition, British Energy (previous owner of the UK's AGR stations and PWR station) was committed to providing additional funds to the Nuclear Liabilities Fund through:

- an annual lump sum based on the number of remaining operating facilities, plus a fixed amount for each tonne of uranium in fuel loaded into the Sizewell B nuclear power station (these sums are subject to indexation); and
- paying 65% of its free cash flow into the fund annually.

11.18 The Nuclear Liabilities Fund provides for a larger scope of funding compared with the previous arrangements and is used solely to fund EDF NGL's existing liabilities (i.e. the AGR fleet and the Sizewell B PWR). It is separate from the funds required to clean up the NDA's sites. The fund is managed by a board of trustees appointed by DECC and EDF NGL.

11.19 The UK Government will underwrite the costs of decommissioning EDF NGL's nuclear power stations and the discharge of certain nuclear liabilities not covered under contract with third parties, to the extent that there might be any shortfall in the Nuclear Liabilities Fund.

11.20 The funding ceased in January 2009 following the sale of British Energy to EDF NGL. However, the commitments relating to annual payments and the Sizewell B contribution remain and fall to EDF NGL.

11.21 The arrangements for decommissioning EDF NGL's nuclear power stations and discharging its uncontracted liabilities are contained within the Nuclear Liabilities Funding Agreement. Under this agreement, EDF NGL is required to produce plans that look forward on both a three year ahead 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 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 approve from a liabilities funding sufficiency viewpoint, station life extensions, noting that increases in life will increase the waste which is classed as a liability.

11.22 EDF NGL, as a private company and site licensee, is solely responsible for decommissioning its plants. However, the restructuring agreements provide the (relevant) Secretary of State (for Energy and Climate Change) 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 NDA's portfolio of sites.

11.23 Financial details of EDF NGL's liabilities and the Nuclear Liabilities Fund are set out in the respective companies' annual accounts.

Management of human resources for safety related activities

Regulatory background and approach

11.24 Several licence conditions set goals on management of human resources and training. LC 36 was amended in 2011 to include a specific reference for the licensee to provide and maintain adequate human resources to ensure safe operation.

11.25 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.

11.26 In addition, HSWA74 (Ref. 9) places responsibility for health and safety on every employer on the licensed site. This responsibility includes the competence and training of staff with safety related roles. Specific requirements are included in the MHSWR99 (Ref. 6), in particular Regulation 13 on capabilities and training.

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

11.28 Human resource and training issues are addressed by nuclear inspectors when they are reviewing safety documentation against ONR's SAPs (Ref. 29). The SAPs give inspectors guidance on whether the legal requirement of the licence conditions is being met. In particular, that the organisation has the capacity and capability to secure and maintain the safety of its operations.

Regulatory approach to organisational capability

11.29 ONR has produced guidance to set out its expectations with regard to a 'capable licensee' in its TAGs (Ref. 33). It has also worked with the nuclear industry to develop a good practice guide entitled 'Nuclear Baseline and the Management of Organisational Change' (Ref. 109).

11.30 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.

11.31 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 or roles and 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, length of time in post etc. Workforce planning is conducted at a local level and aggregated into company-wide plans.

11.32 EDF 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. The licensee should adopt an 'intelligent customer' approach. This means that the licensee should have sufficient in-house expertise to specify, set up contracts, manage, monitor and accept work undertaken on its behalf and, if necessary, challenge the work of contractors.

11.33 ONR expects that changes to the 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. Management of change is one of EDF 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.

11.34 ONR's inspection activities under LC 36 include review of nuclear baseline and management of change processes at site level and monitoring development of corporate HR processes. EDF NGL's LC 36 arrangements have been formally approved by ONR and include the provision for ONR to formally 'agree' organisational changes proposed by the licensee where these have the potential for a significant impact on nuclear safety.

Regulatory approach to training and qualification

11.35 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 LC 10.

11.36 ONR's expectations are set out in ONR TAG 'Training and Assuring Personnel competence' (Ref. 33). LC 10 requires the licensee to make arrangements to ensure their staffs are trained. LC 12 requires that any posts on site that may affect operational safety, or that implement any actions connected with the site licence conditions, must be performed only by suitably qualified and experienced persons. LC 12 also requires the appointment of duly authorised persons.

11.37 ONR looks for clear links between an individual's post and roles and the training required. For example, within EDF 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 LC 10 and 12. ONR inspectors routinely assess training outcomes during SBIs which assess whether systems will perform the safety functions claimed in the safety case. SBIs are explained in Article 14.

11.38 LC 7 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.

Development of training programmes

11.39 ONR will judge whether the licensee can demonstrate how it applies a systematic approach to training and assessment of personnel with safety roles. Within EDF NGL, the training and qualification process is one of EDF 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.

11.40 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.

Delivery of training programmes

11.41 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.

11.42 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. ONR will also look for evidence of cross-functional training to ensure mutual understanding of roles and to improve communications.

11.43 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.

Qualification

11.44 Procedures for assessing competence prior to undertaking a safety related role are part of the arrangements made under LC 10. For operations and maintenance personnel for example, training programmes within EDF NGL also include on-the-job training and training performance evaluation as part of the qualification process.

11.45 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. Assessment should not be regarded as a one-off activity and ONR looks for evidence of periodic re-assessment to ensure personnel are aware of any changes and remain competent to carry out their duties.

11.46 ONR does not have any specific role in the selection, training and authorisation of staff to perform safety related duties as is the case in some regulatory regimes. It does, however, have powers to intervene if, in its opinion, any person is unfit to perform the duties of a duly authorised person.

Training of external personnel

11.47 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

11.48 Within EDF NGL, a series of training review committees (at operational, tactical and strategic levels) ensures that training programmes are kept up to date for example, taking into account changes to plant configuration arising from plant modifications. Plant modification proposals, made under the arrangements under LC 22 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.

11.49 Training provision within EDF 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 training manager who meets regularly with a peer group comprising station and corporate training managers.

11.50 Since the Sixth UK Convention Report, EDF NGL has established a leadership academy to provide a focus for leadership training. Particular emphasis has been given to leadership behaviours; setting standards and expectations and continuous improvement. Over 900 managers have attended leadership academy training.

Training programme accreditation

11.51 ONR considers the use of a robust accreditation process to be good practice. EDF 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:

- Training for performance improvement;
- Management of the training processes and resources;
- Initial training and qualification;
- Continuing training;
- Conduct of training and trainee evaluation; and

- Training effectiveness evaluation.

11.52 Since 2011, all eight of EDF 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 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.

Maintaining and enhancing the national nuclear skill base

11.53 Existing operations, decommissioning and clean-up, together with a potential 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. Skill gaps are projected for the nuclear industry. A 2015 report produced by the Nuclear Energy Skills Alliance summarises the best labour market intelligence currently available for the nuclear industry which is being kept under review. Its key findings are:

- A peak in workforce demand (including construction to 2021);
- Total workforce demand is expected to grow from 78,000 in 2015 to 111,000 in 2021; and
- Demand for the existing estate will also increase (~ 4%).

11.54 Occupations with potential demand/supply pinch points include: mechanical engineering; electrical engineering; construction and decommissioning; control and engineering; project and programme management and core construction skills. Other potential resource vulnerabilities include safety case specialists; commissioning engineers and heavy electrical engineering.

11.55 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. In 2013, the government, in partnership with industry published its Nuclear Industrial Strategy. This set the strategic direction and initiated work of the Nuclear Industry Council.

11.56 In 2015, the government published a key document 'Sustaining Our Nuclear Skills' which sets out the government's ambitions including clear goals for delivering a sufficient, high-quality and diverse nuclear workforce. This approach emphasises the continued partnership between government and the wider nuclear sector including industry, national regulators, the research community and skills bodies and providers. The common goals are;

- Aspire to meet 90% of the sector's skill demands from the UK workforce by developing the right profile and pipeline of skills to meet future demands of the sector;
- Ensure the nuclear workforce's expertise is unsurpassed globally by developing training, development and certification programmes of the highest quality; and
- Cultivate a more diverse nuclear workforce including increasing the proportion of the sector's workforce who are women to 40% and the proportion of women in senior management to 25% by 2030.

11.57 Employers have sought a skills partnership with government, that is strategic, that is across the UK, that covers all parts of the sector and that represents views on the skills needs and solutions. Most importantly, this partnership needed to be led and driven by employers themselves and in late 2015; the Nuclear Skills Strategy Group (NSSG) was successfully formed.

11.58 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. The group will report to the Nuclear Industry Council, taking responsibility for its skills work-stream.

11.59 EDF 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’ for example, through apprenticeship and graduate recruitment programmes.

11.60 The NDA has a statutory duty as set out in The Energy Act 2004 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.

11.61 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.

11.62 At university level there has been a very positive response to the shortage of graduates entering the industry. A number of new postgraduate nuclear courses have been set up, and there has been an increase in the number of students taking up places on these courses. The nuclear content of some undergraduate courses is being enhanced, and for the first time for many years, there will be the chance to obtain a degree in nuclear engineering. The number of students undertaking postgraduate research is also increasing.

Article 12 - Human factors

Each Contracting Party shall take the appropriate steps to ensure that the capabilities and limitations of human performance are taken into account throughout the life of a nuclear installation.

12.1. Under this Article, compliance with the Convention is demonstrated in a way that has not substantially changed since the Sixth UK Convention Report (Ref.3) (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 the safety of a nuclear installation. Human factors are concerned with all aspects of human performance, and the factors affecting this performance, which can impact on the safe operation of a nuclear installation.

12.3. ONR's SAPs (Ref. 29), TAGs (Ref. 33) and TIGs (Ref. 110) set out ONR's expectations for licensees' treatment of human factors. It is also noted that many of the licence conditions 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, as well as the regulator, employ human factors specialists who carry out human factors assessments themselves, or who oversee work carried out by external consultancies on their behalf. EDF NGL employs a number of human factors specialists and is also supported by specialist contractor support. ONR currently has seven human factors specialists and sixteen organisational factors specialists.

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 Articles 6 and 14), 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.29).

Human error identification and reduction

12.7. The approach is outlined in ONR's SAPs and supporting TAGs and covers 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 also 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 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 take into account 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. In response to recommendations raised in CNI's report on the Fukushima accident, licensees are continuing work 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. The

probabilities reflect influences on performance arising from psychological factors (for example, stress, personal experience and knowledge) and with other task-specific factors (for example, the physical environment, training, working practices, time constraints, adequacy of procedures and user interface etc.). 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.

Organisational factors issues – ONR regulatory approach

Safety Assessment Principles - Leadership and Management for Safety

12.12. ONR SAPs have explicit focus on leadership and management for safety. The principles provide guidance to inspectors on ONR's expectations of licensees regarding the foundation for the effective delivery of nuclear safety, including the development and maintenance of a positive safety culture.

12.13. The SAPs on leadership and management for safety comprise four high-level interrelated principles: leadership, capable organisation, decision making and learning. More detailed attributes are set out for each principle. The attributes are expressed as outcomes to be achieved for effective leadership and management for safety rather than prescribing specific systems, processes and procedures required to achieve safety. Because of the interrelated nature of the principles, there is some overlap between them and they should be considered as a whole for effective delivery. The leadership and management for safety principles reflect the:

- emphasis ONR's strategy gives to leadership and management for safety, the role of directors and the involvement of workers;
- necessary emphasis on leadership and managing people and processes as well as on engineering; and
- the need to consider the management of safety throughout the whole organisation in building and sustaining a positive safety culture.

Leadership and management for safety strategy

12.14. ONR has a regulatory strategy to place more consistent and structured focus on leadership and management for safety, in particular on the maturity of licensees' self-regulation. ONR assesses licensee performance through the leadership and management for safety review process. This summarises and rates licensee performance for the purpose of intervention planning and to facilitate feedback to the licensees. ONR's current process is set out in TAG 93 (Ref. 33). ONR has found that it is possible to make a good assessment of a licensee's performance against the leadership and management for safety SAPs, based upon the experience of all of its interactions with the licensee. The leadership and management for safety review is carried out by inspection teams and makes reference to ONR's interventions. The results are shared with the licensees and used during discussion with licensee working groups such as the Safety Directors' Forum. The intention this year is to refocus this more on nuclear safety outcomes, in particular the self-regulation of licensees.

12.15. Another important aspect of ONR's strategy on leadership and management for safety is the corporate inspection function. The purpose of corporate inspection is to look at licensees', in this instance EDF NGL's organisation as a whole, 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. Corporate inspectors are in place for all power reactor licensees. EDF-NGL has a corporate inspector who influences corporate management of the operating fleet.

12.16. ONR's corporate discipline group on leadership and management for safety is well established. The group is responsible for oversight and coordination of ONR's plans and activities on leadership and management for safety. 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:

- nuclear safety governance (taking into account the lessons from the financial sector on failure of governance processes);
- organisational learning (to influence improvements in the licensees' ability to identify underlying causes of events and apply the lessons effectively);
- internal regulation and challenge (to support and strengthen these functions in licensees); and
- human performance (to emphasise the importance of organisational factors that affect individual performance).

Organisational development and change

12.17. ONR recognises that a licensee's organisational capability makes a considerable contribution to assuring nuclear safety. 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. 41) which was revised in January 2015. This document is instrumental in informing ONR's interactions with prospective new power station licensees. ONR has also published a suite of TAGs which state ONR's expectations of a prospective licensee's organisational capability and the arrangements that it develops to lead and manage for safety. The guides address areas such as managing organisational change; use of contractors and intelligent customer capability; the role of licensees' own internal advice and challenge functions; procurement; training and competence; and design authority. ONR acknowledges that licensees need to evolve their organisations over time as the plant life cycle moves on, and in response to different drivers.

12.18. ONR's SAPs identify the requirement for the safety analysis of proposed modifications, either technical or organisational, to consider specifically the impact on required staffing levels via a process of task and workload analysis. As well as a review of the adequacy of staffing levels associated with individual modifications, ONR requires that adequacy of staffing and organisation are considered as part of the PSR process for each nuclear installation. ONR seeks assurance that organisational change is managed effectively in accordance with LC 36 and underpinning technical assessment guidance.

12.19. Under modification to LC 36 since the last report, ONR now requires licensees to demonstrate that sufficient and resilient human and financial resources are in place. This is normally demonstrated by what ONR refers to as the nuclear baseline; ONR TAGs provide guidance in this area. The nuclear industry has also developed a code of practice in this area.

12.20. The strategy also includes engagement with the industry on safety culture through the Safety Directors' Forum and ONR carries out its own interventions on safety culture where appropriate.

12.21. Where appropriate, ONR carries out direct interventions to assess safety culture, this is often done in conjunction with the licensee. The approach taken is to carry out interviews and focus groups and to undertake thematic analysis of the output. ONR is developing guidance in this area and has formed an industry group to share experience and good practice. EDF NGL undertakes similar reviews of leadership and management at their operating stations and also carries out safety culture surveys and supporting workshops.

Self-assessment of human and organisational factors by the licensee

12.22. Specific examples of human factors initiatives run by EDF NGL include:

- The implementation of initiatives to improve procedure quality use and adherence with a view to optimising operational performance and minimising the number of events in this area. The focus was on key procedures through a review of the each station's top twenty activities where there is a risk of reactor trip.
- A benchmarking study of how human factors are applied in relation to safety cases within EDF NGL. A range of initiatives came out of this work to address the findings, including human factors training for safety case officers and authors.
- Development and extension of EDF 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.
- 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.
- A revised approach to consideration of human factors as part of PSRs, with a focus on optimisation of processes and ongoing assessment.
- Extension and development of the leadership academy to provide exemplary training and development for future leaders.
- Re-invigorated human performance programmes including error avoidance training for knowledge workers. More recently, refinement of human performance programmes to link and align with complimentary training provided as part of the leadership academy.
- 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.
- The introduction of the EDF 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 NGL PSAs.

- The establishment of a core organisational function to drive continuous improvements through benchmarking and self-assessment. Many of the elements of the continuous improvement programme have been drawn from best practice in the USA.
- An increased focus on human performance through the use of error reduction tools, enhancement of leadership skills, task observation and coaching and leaders spending time in the field to reinforce desired behaviours.
- The use of an externally benchmarked and formally-accredited systematic approach to training has been adopted.
- Safety culture assessment and improvement programmes.
- 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 CNI's report on the Fukushima accident.
- The training of significant numbers of staff in the use of common human error avoidance tools to support human error reduction initiatives.
- Benchmarking, including feedback from WANO and INPO visits and comparisons with high performing nuclear sites and other types of organisation.
- Learning from other organisations via routes such as intra and inter-industry groups. Experience from such events is fed into PSRs.
- Carrying out leadership and management reviews.
- Use of external organisations to assess its safety culture.

12.23. 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, the IAEA and INPO, 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

12.24. ONR's regulatory activities fall broadly into two main intervention categories: the assessment of licensee submissions and direct inspection on licensee sites. Both these activities are supported by a process of continuous improvement, which includes: the periodic review of internal policies, process, and procedures; the collection and analysis of licensee operating experience; and contributing to international activities / working groups / cross-regulatory groups in the human factors discipline to obtain up to date knowledge and influence the establishment of internationally recognised good practice.

12.25. As previously stated, the ONR SAPs 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.

12.26. 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 that is 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. A set of human factors TAGs are in place to support the consistent assessment of licensees' treatment of human factors issues. 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.

12.27. Some aspects of human factors are specifically addressed by the nuclear site licence conditions, for example, LC 10, LC 12 and LC 24. Compliance with these 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 with ONR's specialist human factors inspectors.

12.28. ONR's human factors inspectors proactively identify areas of the licensees' operations for examination based on their awareness of issues raised from a variety of sources. These include national and international operating experience, developments in human factors techniques and research, and 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.

12.29. In addition, ONR has recently published a new research strategy (Ref. 110) 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, demonstrating ONR's recognition of the importance of Article 12.

12.30. Current human factors research topics include:

- Research into board performance, corporate governance relevant good practice and impact on nuclear safety.
- Human reliability data for modern control room environments to seek a better 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.

12.31. In addition to this, EDF NGL operates its own independent research programme, which again recognises the importance of Article 12 commitments.

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 Under this Article, compliance with the Convention is demonstrated in a way that has not substantially changed since the Sixth UK Convention Report (Ref. 3) (i.e. in a way that has implications for the Convention obligations), but has been updated to improve clarity, and include changes such as the variation of LC 17 (Ref. 19).

13.2 This Article has been addressed by considering the requirements in the IAEA Safety Standard GS-R-3, 'The Management System for Facilities and Activities'. (Ref. 94). The scope of GS-R-3 covers management system requirements for nuclear facilities, activities using sources of ionising radiation, radioactive waste management, the transport of radioactive material and radiation protection. GS-R-3 is supported by 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 most recent document provides guidance on implementing requirements for nuclear facilities, including ONR's SAPs (Ref. 29).

13.3 The SAPs broadly reflect the IAEA requirements. The SAPs supported by TAGs (Ref. 33) provide a framework to guide regulatory decision-making in the nuclear permissioning process. In addition, the SAPs recognise the importance of leadership and management for safety and expect quality management systems to be an integral part of this.

Regulatory requirements and review and control activities for quality management systems

13.4 LC 17 places a duty on licensees to establish and implement management systems which give due priority to safety. In addition LC 17(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. The MHSWR99 regulations are integral to management arrangements (Ref. 69).

Regulatory review and control activities

13.5 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 GS-R-3 and is encouraged by ONR as it ensures safety is considered in the licensee activities and is not confined to the quality / safety management systems.

13.6 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 ONR inspectors on procurement and contract management. Details are given in ONR TAG 'Supply chain management arrangements for the procurement of nuclear safety related items or services' (Ref. 33).

Status of integrated management systems

13.7 As discussed above, the licensee 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.

13.8 EDF NGL has a mature integrated management system which continues to develop and improve as required and as opportunities are identified. The management system is based on recognised international standards and 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 NNB GenCo integrated management system.

Main elements of quality management systems

Graded application of management system requirements

13.9 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

13.10 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, post profiles, instructions, drawings, technical procedures and training material.

Planning

13.11 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

13.12 The management systems are authorised for use by 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

13.13 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.

13.14 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.

Performance monitoring by the licence holders

13.15 Monitoring and measurement are a fundamental element in the licensee management systems. The licensee 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. In addition to the audits and reviews carried out by, or on behalf of, the licensee, ONR, as part of its regulatory activities, carries out inspections of the licensee's arrangements.

Self-audit of procedures

13.16 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 using reporting mechanisms of the organisation.

Independent assessment

13.17 The licensee deploys diverse means of independent assessment of its management system arrangements, including the procurement of nuclear safety related items and services. The following are some of the activities undertaken by EDF NGL internal organisation and external independent bodies:

1. An overall oversight programme which includes quality system compliance auditing and regulatory oversight by the internal regulator;
2. Inspector General Annual Report (An EDF group corporate requirement)
3. Internal control self-assessments of their processes;
4. A fleet-wide third party certification from Lloyds Register Quality Assurance including regular visits for ISO 9001:2008 (quality); ISO 14001:2004 (environment); OHSAS 18001:2007 (occupational health and safety); and ISO 55001:2014 (asset management);
5. WANO peer reviews.

Records

13.18 The importance of identification and retention of design, procurement, manufacturing, fabrication and inspection records are key to support the safety case. These provide the evidence of assurance activities for compliance to the licensee and ONR.

13.19 The identification, generation, timely completion, handover and retention of records associated with the supply of items or services should form part of the contractual arrangements between purchaser and supplier at all levels of the supply chain. Particular attention should be given to material traceability and inspection, test and surveillance activities.

Management system review

13.20 The licensee carries out reviews of its management systems to ensure its continued effectiveness of its arrangements and to provide a basis for continued improvement. Information from a number of 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

13.21 The licensee uses a number of processes to support continual improvement of the management system. Once the need for improvement is identified, it 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. This approach is compatible with ONR SAPs (Ref. 29), demonstrating commitment to safety and system improvement.

13.22 The licensee considers the identification of opportunities for improvement as an ongoing responsibility and activity.

13.23 A number of 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 by the licence holders

13.24 The licensee 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.

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;

14.1 Under this Article, compliance with the Convention is demonstrated in a way that has not substantially changed since the Sixth UK Convention Report (Ref.3) (i.e. in a way that has implications for the Convention obligations). This section of the report addresses dutyholders' and regulator's work to deliver their duties in relation to safety assessment and verification of safety. The legal requirements for safety assessment and verification of safety are discussed first, followed by discussion of assessment of safety and verification of safety. The Article has been updated to address the relevant aspects of the Vienna Declaration on Nuclear Safety.

Legal requirements for safety assessment and safety verification

14.2 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 verification that the installation is operated and maintained within the limits and conditions of the safety case. In particular, the licence conditions most relevant to safety assessment and/or safety verification are (see Annex 1 for further description of these conditions):

- 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)
- LC30 (Periodic shutdown)

14.3 In addition, LC 10, LC 12, LC 26 and LC 36 deal with competency, capability and control and supervision of personnel who are involved in safety assessment and/or safety verification.

14.4 The licensee must also have arrangements for compliance with relevant statutory provisions of the HSWA74 (Ref. 9). Examples include the MHSWR (Ref. 69) (which require the licensees to make assessments of the health and safety risks of their activities) and the IRR99 (which provide for the protection of all workers and

members of the public from ionising radiations) (Ref. 61), as well as other appropriate legislation (see Article 7 for further details).

Assessment of safety

14.5 In terms of assessment of safety, dutyholders include:

- organisations or requesting parties seeking a GDA DAC;
- organisations intending to apply for a nuclear site licence 'prospective licence applicant';
- organisations that have applied for a nuclear site licence 'licence applicant'; and
- organisations that have been granted a nuclear site licence 'licensee'.

Safety assessment by the dutyholder: the safety case

14.6 To comply with LC 23, each nuclear power plant in the UK 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 to ALARP. The safety case therefore confirms that:

- all credible faults / hazards have been identified;
- appropriate standards have been set and met;
- adequate safety features are in place;
- all significant assumptions have been identified, verified and validated; and
- all instructions, limits and conditions required to maintain operations within specified margins for safety have been identified. All operating modes, including low power and shutdown states, are required to be covered by the safety case.

14.7 LC 14 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. 29) and TAG "The Purpose, Scope, and Content of Safety Cases' (Ref. 33) set out what a safety case should demonstrate.

14.9 The safety case demonstrates in writing that the plant, its processes, activities and any modifications:

- 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).

14.10 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 and the outcome of PSRs. The purpose and process of PSRs are discussed later in this Article.

14.11 EDF 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 Acceptance Principles. Horizon Nuclear Power (currently a prospective licence applicant) has also developed Nuclear Safety and Environmental Principles. These principles constitute Horizon's top level expectations on the standards to be achieved on the management of nuclear safety and environmental protection and form part of its LC 14 arrangements for the production and assessment of safety cases. In addition to their nuclear safety principles, the dutyholders conduct its assessment in line with a range of British, European and International standards.

14.12 The magnitude, complexity, and development of the safety case through the life of each plant has required 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 LC 17 (discussed in Article 13), and any changes to the safety case are regulated as modifications under LC 22.

14.13 Some UK nuclear power plants have undertaken major projects to significantly enhance visibility, traceability and user-friendliness of their safety cases, thus, enhancing the safety case's ability to effectively support decision-making, and easing the effort required to keep it up-to-date.

Safety assessment by the dutyholder: safety case for a new reactor

14.14 ONR's publication 'Licensing Nuclear Installations' (Ref. 41) provides information to potential licensees preparing to embark on a programme of constructing a new nuclear power plant. The latest version of this report retains the need to develop pre-construction and pre-operation safety reports, but the process now recognises the international nature of possible suppliers and potential licensees, and a generic approach to early assessment of the design. The guidance considers that the design of the nuclear power plant may have undergone, or be in the process of undergoing, a voluntary GDA, based on a generic pre-construction safety report and a generic site envelope. If ONR is content with the safety case and security aspects of the generic design, it will provide the GDA requesting party with a DAC. (The status of the ongoing GDAs is discussed in Section A).

14.15 'Licensing Nuclear Installations' makes it clear that although a site specific pre-construction safety case is not necessary at the time of licensing a new nuclear power plant. ONR needs to be satisfied that the site will be suitable for the proposed activities if the plant is adequately designed, constructed and operated.

14.16 The granting of a nuclear site licence is not itself permission to start nuclear-related construction. That requires a regulatory permission which is based on a site specific 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 enable the nuclear power plant to operate safely. GDA does not replace any stage of the licensing process but will make a significant contribution to ONR's assessment of the site-specific pre-construction safety case. At the site-specific stage of the project, ONR does not anticipate the need for any further assessment of aspects of the safety and security case already assessed and accepted in GDA (subject to no significant new information arising which might call into question the basis of ONR's original assessment of the design).

Safety assessment by the dutyholder: safety analysis

14.17 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).

14.18 The accident analyses use the complementary approaches of design basis analysis (DBA), 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.

14.19 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 of 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 in Article 18.

14.20 The dutyholder is also required to carry out an assessment of internal hazards. It is a 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. That is, 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.

14.21 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 respond to mitigate the radiological consequences of fault sequences. Assessment of internal hazards is also discussed in Article 18.

14.22 The safety assessments for the nuclear power plants in the UK demonstrate that threats from external hazards are removed, minimised or mitigated. For each type of external hazard identified that is not screened out for a particular site, a design basis event is determined with consideration of the site hazard curves. 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.

14.23 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. Further and extensive information regarding the assessment of external hazards can be found in Article 18.

14.24 The PSA provides a comprehensive, systematic analysis of the plant response to a fault condition and the numerical analysis of the risk from the plant to 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. PSAs for the earlier AGRs were developed as part of the first PSRs. For the later AGRs at Heysham 2 and Torness and the PWR at Sizewell B, PSA was used from the design stage; the Sizewell B PSA is a full scope level 1, 2 and 3. As a result of the UK response to the Fukushima accident, EDF NGL has also developed a representative level 2 PSA for the AGRs.

14.25 Sizewell B 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. PSA has also been used during the assessment of flooding risk at coastal nuclear power plants. ONR is continuing its engagement with the licensee regarding the adequacy of its current approaches to external hazards PSA 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.

14.26 In order to assess a reactor against ONR's numerical targets in the SAPs, some form of level 3 PSA is required. These targets include individual risk of death, targets for single accident frequency versus dose, and societal risk measured as the frequency of 100 or more fatalities. Thus, all the AGR PSAs have some components of a level 3 PSA. For new build reactors, level 1, 2 and 3 PSA are / will be carried out consistent with international expectations. ONR's expectations for level 3 PSA can be found in its PSA TAG (Ref. 33).

14.27 Sizewell B and the AGRs have established "Living PSA programmes". UK regulation is not prescriptive; however, there is an expectation that licensees will follow good international practice when developing their safety documentation and their processes. In this regard, the living PSA programmes established by EDF NGL have been developed based on IAEA-TECDOC-1106 (Ref. 112), the PSAs for Sizewell B and the AGRs are updated approximately every three years, unless there are significant changes to the plant / operation that require a more frequent update.

Safety assessment by the dutyholder: safety reviews

14.28 Major PSRs are carried out by licensees, no later than every ten years (or more frequently, if necessary, for example following a major event). The current status of PSRs is described in Article 6. PSRs are also briefly discussed in Article 18.

14.29 As discussed in Article 6, the legal basis for PSRs in the UK is embodied in the conditions that are attached to the nuclear site licence. LC 15 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 TAG (Ref. 33) sets out what ONR expects to see in the PSR.

14.30 As an installation matures, modifications are made to the plant, ageing effects take place, some components may become obsolete and need replacing and plant operating instructions may be changed as a result of experience. At all times, the safety case must remain valid and must therefore be updated and revalidated as appropriate. Complementary to this ongoing process, the PSR process is designed to ensure that a thorough and comprehensive review of the totality of the safety case is made at regular intervals throughout the power plant's life.

14.31 A key objective of a PSR is to compare against current standards for new plant, identify and evaluate gaps, and implement reasonably practicable improvements. Therefore the review addresses relevant advances in safety standards, practices and scientific and engineering knowledge. Any significant shortcomings should be identified and any improvements which are reasonably practicable should be introduced, taking the expected future life of the plant into account.

14.32 Another essential element of the review is for all systems, structures and components susceptible to ageing or degradation to be reviewed, and failure mechanisms, together with any life-limiting features, identified. These various factors then have to be evaluated, particularly for aspects that may eventually result in unacceptably reduced levels of safety, and ultimately dictate the safe working life of the nuclear installation.

14.33 Finally, the PSRs 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; this will be dependent upon continuing satisfactory results from routine inspections. Should any 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.

14.34 Following the Fukushima accident, ONR revised its guidance on production of PSRs. The new guidance emphasises that the safety case should not be limited to design basis events, but should also consider the resilience of the plant, staff and processes to events beyond the design basis and cliff-edge conditions.

14.35 In addition to PSRs, major safety reviews are undertaken every one-and-a-half, two or three years to coincide with reactor periodic shutdowns, carried out in accordance with LC 30 for the purpose of enabling examination, inspection maintenance and testing (LC 28). The review findings are used to update the nuclear power plant safety case and provide a justification for a further period of operation (until the next periodic shutdown). The focus is on plant inspection results and any modifications completed during the outage, to demonstrate that adequate safety margins will continue to exist throughout the subsequent operating period. This is further discussed later in this Article, under 'Verification of Safety'.

14.36 The periodic reviews of safety conducted for the nuclear power plants in the UK meet the second principle of the Vienna Declaration, which requires that comprehensive and systematic safety assessments be carried out periodically and regularly for existing installations throughout their lifetime. This is in order to identify (and implement in a timely manner) safety improvements orientated to meet the Convention objective to prevent accidents with radiological consequences and mitigate such consequences should they occur.

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

14.37 The results of the PSRs have produced, and continue to produce, worthwhile improvements to safety. Since the Sixth 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 NGL power stations. Examples include:

- A series of fire-related improvements in the gas circulator and boiler houses at Dungeness B. These include:
  - additional fire barriers to prevent potential oil spray fires affecting sensitive plant;

  - reduction in potential ignition sources;
  - changes to oil systems to reduce the amount of oil available in potential fires;
  - re-engineering and re-optimisation of water deluge systems including modifications to introduce a film forming agent to water sprayed onto a horizontal surface.
- Completion of a work programme to provide an enhanced nitrogen secondary hold-down system for Hinkley Point B and Hunterston B arising from PSR2 commitments.
- A project is underway to renew, replace and reposition the CO2 storage tanks and distribution system at Hunterston B, initiated from a company review of the hazards from missiles in the event of tank failure.
- Completion of a programme of work of fire improvements instituted after the second PSR for Hinkley Point B and Hunterston B against a potential oil spray fire in the gas circulator house, covering improvements in prevention, protection and mitigation. The work includes reducing potential ignition sources, intercepting oil sprays by flange guarding, protecting sensitive areas of the plant such as penetrations, and a new foam fire system as a defence-in-depth mitigation against oil fires outside bunded areas.
- On a number of AGR stations, increased awareness of the potential for steam leaks either from weld failures or from corrosion mechanisms has led to improvements in plant surveillance procedures to detect early failures before these grow to pipe failures.

Safety assessments prompted by the Fukushima accident

14.38 Since the Sixth UK Convention Report, a significant programme of work has been undertaken by EDF NGL to address the recommendations in ONR's CNI Fukushima Report (Ref. 26) and issues identified following reviews of the risks from external hazards as a result of the Fukushima accident (discussed in detail in Section A).

14.39 The following items are listed as examples of the EDF NGL enhancements post-Fukushima:

- Provision of off-site back up emergency equipment to be stored in three regional AGR depots and a new Sizewell B emergency response centre, for example, off-road and debris removal vehicles, diesel-driven electricity generators and treated water pumps for reactor and fuel cooling (as shown in Figure 11).
- Enhanced external flood protection at Dungeness B nuclear power plant through the construction of a concrete flood wall around the entire site (shown earlier in Article 6, Figure 6).
- Undertaking a number of modifications at the Sizewell B power plant as detailed in the UK's report to the Second Extraordinary Meeting of the Convention in 2012 (Ref. 31).
- Review and updating of reactor symptom-based emergency response guidelines and severe accident guides.
- Review of claims falling under the heading of human capabilities and capacities.

Figure 9 – Emergency equipment

14.40 Post-Fukushima work by EDF NGL to address ONR recommendations has now largely been completed and a closure report published (Ref. 36). The remaining enhancements are due to be completed by 2017.

14.41 In relation to the new reactors currently undergoing GDA (Westinghouse's AP1000® and Hitachi-GE's UK ABWR), substantial work is being done by the requesting parties to demonstrate that lessons learnt from the Fukushima accident are implemented in the designs as appropriate.

14.42 Additional relevant work is conducted in the framework of the MDEP, of which ONR is a member. MDEP's design-specific working groups have been requested by the MDEP Steering Technical Committee to consider the lessons learnt from the Fukushima accident and establish common positions. These papers establish common positions, among the international regulators, for key issues relevant to the Fukushima accident related to the safety of the specific designs. These include evolutionary improvement in safety, external hazards, reliability of safety functions, accidents with core melt, emergency preparedness in design, spent fuel pools, and safety analysis. ONR has been an active contributor to the UK EPR™ common position paper already published (Ref. 114), is currently contributing to the development of the AP1000® paper, and is leading the development of the ABWR paper. MDEP's efforts in this regard contribute to addressing the first challenge identified by the Special Rapporteur from the Sixth Convention Review Meeting. It requested that Contracting Parties consider how to minimise gaps between parties in relation to lessons learnt from Fukushima.

Regulatory review of dutyholders' safety submissions

14.43 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.

14.44 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. GDA is a successful example of joint working between the nuclear regulators.

14.45 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. 29) and TAGs (Ref. 33).

14.46 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, Ref. 29).

14.47 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. 115).

14.48 Assessment of a safety case is undertaken by first understanding the key aspects of a safety case using ONR's SAPs, TAG's and other national and international standards when appropriate, and then sampling them. The technical expertise of ONR staff is used to select the issues to be pursued in depth.

14.49 Extensive discussion between the different technical specialist inspectors and the project and site inspectors, together with face-to-face discussions and written exchanges with the dutyholder, are used to clarify and test the information used, background analyses performed and assumptions made in the safety case. The overall judgement of acceptability is based on the full range of assessment advice. The specialist inspectors make recommendations on where safety can be improved. These recommendations are discussed with the dutyholder and a programme to implement improvements is agreed. ONR monitors progress with implementation of these recommendations and other issues that may be raised and require regulatory follow-up. ONR utilises a system for recording and monitoring progress made by the licensee in addressing regulatory issues and recommendations. Appropriate regulatory action is taken if the issues remain unresolved or inadequate progress is made.

14.50 In its appraisal of a nuclear power plant safety case, ONR's inspectors seek certain attributes in the licensees' safety submissions. These are:

- **Intelligible:** The safety case should be intelligible and structured logically to meet the needs of those who will use it.
- **Valid:** a safety case should accurately represent the current status of the facility in all physical, operational and managerial aspects. It should reflect changes that have arisen from previous modifications, revised operating methods, operating experience, examination and test results, different analytical methods and periodic reviews. For

new facilities or modifications, the safety case should accurately represent the design intent.

- **Complete:** a safety case should comprehensively analyse the activities associated with normal operation, identify and analyse the faults of potential safety concern and demonstrate that risks are ALARP. It should contain the information necessary to show that the facility is adequately safe and explain what will be needed for it to remain so over the period of validity. Important supporting work, such as engineering substantiation should be referenced in the safety case.
- **Evidential**: the arguments developed in the safety case should be supported with verifiable and relevant evidence.
- **Robust:** a safety case should demonstrate that the nuclear facility will or does conform to good nuclear engineering practice and sound safety principles, including defence-in-depth and adequate safety margins.
- **Integrated:** hazards from and dependencies on other facilities or external services (for example grid supplies) should be identified and related claims or assumptions should be substantiated; and the safety case should be integrated with and reference the safety cases and documents for such dependencies.
- **Balanced:** a safety case should present a balanced account, taking into consideration the level of knowledge and understanding; areas of uncertainty should be identified, not just strengths and claimed conservatism; and potential weaknesses or areas for improvement in the facility design or the safety argument should be explained clearly and openly (for example, in the summary or main conclusions of the safety case).
- **Forward looking:** the safety case should demonstrate that the facility will remain safe throughout a defined lifetime.

14.51 If a safety issue is judged to be of sufficient importance, ONR may commission confirmatory analyses and research to allow additional input into the regulatory judgement process. In addition, if insufficient in-house resource or expertise is available to undertake the assessment effectively and timely, or if additional views are required, ONR may use external, recognised, independent experts in the appropriate technical field to help to inform its regulatory judgement. Such external resources do not make regulatory judgements but provide expert authoritative advice to ONR inspectors.

14.52 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 PARs. To ensure openness and transparency of regulatory decisions, PARs are published on the ONR website (Ref. 116).

14.53 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 assessment reports. The regulators also publish quarterly updates describing the status of the assessment (Ref. 117).

14.54 An illustration of the rigour of ONR's approach to assessment is the importance it attaches to the analysis of nuclear power plant fault conditions using the complementary approaches of DBA, PSA and SAA. ONR sees these analysis techniques as vital to showing that the control of hazards has been adequately addressed and that residual risks during the progression of an accident are addressed to satisfactory standards and the risk has been reduced ALARP. For example, the regulatory assessment of the severe accident aspects of the safety submission seeks to verify that the licensee's / requesting party's justification of the design features to limit the consequences of the accident, during its progression, are appropriate for design basis and severe accident. ONR's assessment of safety submissions for new reactors looks for a demonstration that the following aspects in relation of severe accidents have been thoroughly addressed:

- severe accident phenomena relevant to the design in question;
- progression of the severe accident sequences, including timings and uncertainties;
- aspects of validation of the computer codes employed to support the analyses;
- engineered features and strategies and procedures to deal with severe accident sequences;
- qualification of the equipment expected to operate in severe accident environment;
- performance of dedicated severe accident mitigation measures (such as in-vessel retention of molten material, ex-vessel core melt stabilisation system, etc.);
- challenges to the containment during accident progression; and
- challenges posed by the hydrogen released during accident progression.

14.55 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 of the SAPs numerical targets are used as benchmarks that reflect modern standards and expectations, thus, ONR refers to the objectives when judging whether analyses are demonstrating adequate results for new reactors. Of particular relevance in this regard is the objectives for target 9 "societal risk" ($1x10^{-7}$ per year representing the total risk of 100 or more fatalities, either immediate or eventual from accidents at the site). In line with wider international guidance, ONR expects the SAA 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. Ultimately, ONR seeks confirmation that the level of risk is ALARP and would not be reasonably practicable to reduce the risk further by implementing further improvements. The approach described meets the first principle of the Vienna Declaration which requires that new nuclear power plants are designed consistent with the objectives of preventing accidents. If an accident should occur, the Vienna Declaration requires mitigation of releases of radionuclides causing long-term off site contamination, and avoidance of large or early radioactive releases.

Verification of safety

Examination, inspection, maintenance and testing

14.56 LC 28 requires licensees to ensure that all plant that may affect safety receive regular and systematic examination, inspection, maintenance and testing.

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 examination, inspection, maintenance and testing that indicate that the safe operation or safe condition of the plant may be affected.

14.57 Whilst a significant number of these activities may be carried out while a reactor is in operation, some work will inevitably necessitate a reactor shutdown. AGRs were designed to refuel on load and not to have specific refuelling outages during which essential maintenance can be carried out. In practice only four of the seven AGR stations refuel on load and they must reduce power to do so. LC 30 requires licensees to shutdown plant or processes periodically 'periodic shutdown'. Periodic shutdowns are used to enable examination, inspection, maintenance and testing of plant that may affect safety. Periods between periodic shutdowns are 18 months for Sizewell B and up to three years for AGRs. These periods must be explicitly defined in the plant maintenance schedule. Before the re-start of operation after a periodic shutdown, the safety case is reviewed in the light of any findings arising during the previous operational period and during the periodic shutdown. The licensee must demonstrate that the plant is safe to operate until the next periodic shutdown. Operation cannot restart without permission from ONR. Periodic shutdowns are also used to make modifications to improve plant safety and reliability.

14.58 In order to justify operation until the next periodic shutdown, the licensee may 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 and sample testing monitoring are used widely to support these analyses.

14.59 The licensees' overall examination, inspection, maintenance and testing 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:

- the integrity of all safety-related plant to meet 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.

14.60 In the design phase, diverse and redundant systems and plant are provided to ensure that safety-related systems meet the safety performance criteria, making due allowance 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.

14.61 It is ONR's expectation that PSA should be used as an input to preparing the Maintenance Schedule. ONR's SAP FA.14 states: PSA should be used to inform the design process and help ensure the safe operation of the site and its facilities. This includes activities related to planning examination, inspection, maintenance and testing. 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 examination, inspection, maintenance and testing intervals. PSA continues to be used to inform modifications to the maintenance schedule. ONR also expect licensees to use PSA to support plant configuration control, including maintenance planning. This is further discussed under Article 19.

14.62 Licence conditions require licensees to maintain records of examination, inspection, maintenance and testing. The results are reviewed by the licensees' staff, who are aware of the safety functions of the plant and the safety case requirements that need to be met. This data enables reviews of the appropriateness of the intervals and activities to be undertaken to optimise maintenance work so as to minimise plant interference, operator radiation dose, and cost. ONR site inspectors routinely review the availability and content of the examination, inspection, maintenance and testing records.

Surveillance of compliance with operational limits and conditions & configuration management

14.63 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 detail under Article 19 - Operation.

14.64 EDF 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 to self-check that they are complying with their Technical Specifications include plant surveillance, maintenance and administrative checks. EDF 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 LC 7 (incidents on the site).

14.65 Heysham 2 and Torness use special (risk monitoring) tools to assist operators in addressing compliance with the Technical Specifications. These assist the operators by indicating whether or not the current plant configurations are compliant with the pre-determined permissible plant configurations and, in parallel, carry out a risk evaluation. They have user-friendly interfaces and present risks in a way that can be appreciated by the operators. Logs are maintained of all changes in plant configuration and the results of relevant Technical Specification compliance. These are periodically reviewed to verify that the plant has been operated in accordance with the safety case.

14.66 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 managed at all times.

Elements of ageing management programmes: Structural Integrity

14.67 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. 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.

14.68 Ageing of structures, systems and components in this context is considered to be degradation of the material from which the structures, systems and components are constructed due to the environment it is operated in. The propensity to degrade, and the rate it degrades are influenced by many factors. Some aspects of ageing are addressed through routine maintenance work on the plant, for example the refurbishment of valves, pumps and bearings at defined intervals. Other aspects of degradation cannot be addressed through routine maintenance. It is these aspects which cause concern for ONR in terms of ageing management strategies and programmes and ensuring that the licensees have adequate arrangements. Examples of degradation mechanisms on mechanical and civil components include corrosion, erosion, environmentally assisted cracking, irradiation embrittlement, mechanical fatigue, thermal fatigue, oxidation, and creep. Examples on electrical components include insulation embrittlement and degradation.

14.69 Some aspects of ageing are an inevitable part of the operation of the reactor and are allowed for at the design stage and then monitored through life, for example irradiation damage to steel reactor pressure vessels. In other cases the degradation was not anticipated at the design stage, but has been subsequently identified either by the licensee themselves through routine inspection or through the sharing of operational experience between operators. In these cases, the amount of degradation accrued is established, a rate of degradation predicted, and through life monitoring put in place. In both situations, the licensee must ensure that the degradation does not reach a level where the plant is outside the safety envelope for operation.

14.70 There are many structures, systems and components which are subject to ageing and 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.

14.71 As an example 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 the reactor. At periodic shutdowns required under LC 30, 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. ONR reviews this information prior to granting consent to restart the reactor to ensure that the core will remain within the limits defined within the safety case for the next period of operation.

14.72 Another example 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.

14.73 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 LC 30 periodic shutdowns. ONR reviews this information prior to granting consent to restart the reactor to ensure that the

components will remain within the limits defined within the safety case for the next period of operation.

14.74 In the PWR reactor, an example is the surveillance programme in place to confirm the rate of irradiation embrittlement in the RPV. This uses surveillance capsules 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 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 next capsule will be removed from the Sizewell B reactor in 2016, with a further number of surveillance capsules added to the RPV at that stage to underpin long term operation and any possible life extension.

Elements of ageing management programmes: Electrical

14.75 An electrical example that applies to both the AGR fleet and the PWR reactor is the cable condition monitoring programme implemented to identify onset of cable ageing at an early stage. It is recognised as not practical or necessary to monitor the ageing factors of all cables/routes on a continuous basis. However by targeting specific cables according to their importance, utilisation and environment for each generic type, it is possible to make judgements on the condition of the remaining inventory of that type. For each of the AGRs and the PWR, a cable inspection schedule covering a representative sample of each of the cable types and routes has been produced with emphasis placed on causes of cable ageing such as heat, radiation, manipulation. For each of the cable types and routes identified on the schedule, a regular and systematic inspection programme has been implemented, which includes the appropriate inspection and testing method. ONR routinely inspects a sample of the cable condition monitoring activities and cable condition reports against LC 28 requirements to maintain confidence in the licensee's arrangements for ensuring adequate cable condition.

Elements of ageing management programmes: Control and Instrumentation

14.76 Mis-management of C&I systems and equipment ageing and obsolescence can produce a significant risk to nuclear safety across nuclear plants. There are requirements for licensees to have robust arrangements to identify common and emerging ageing mechanisms for electronic components used in nuclear C&I systems and equipment obsolescence issues. These arrangements require pragmatic techniques for non-destructive ageing detection, management and mitigation of obsolescence through active engagement with the supply chain. The issues with ageing and obsolescence apply to a range of C&I systems and equipment including the following:

- ageing mechanisms within neutron flux detectors and challenges within the supply chain;
- ageing and obsolescence of computer-based data processing and control systems;
- ageing and obsolescence of key equipment within reactor protection systems; and
- degradation and insulation breakdown of neoprene sleeves and markers.

14.77 ONR has worked extensively with licensees to influence their development of robust arrangements for ageing and obsolescence management. This has included work undertaken by licensees to identify key vulnerabilities within stations

and across the nuclear fleet. This has resulted in the identification of key vulnerable equipment and the development of strategies for common solutions to obsolescence whilst maintaining diversity where necessary.

14.78 In addition, licensees have developed guidance aimed at sharing good practice (for example, management of whiskers and dendrite growth, replacement of aged tantalum capacitors and degraded neoprene insulation) and developed approaches for reinforcement and re-engineering of vulnerable equipment to ensure that it remains fit for its intended purpose.

14.79 ONR recognises the importance of C&I ageing and obsolescence in maintaining nuclear safety and these aspects form an integral part of ONR's C&I inspections. In addition, ONR hold quarterly meetings with the licensee to discuss ageing and obsolescence issues and their management.

Internal and external review and verification activities by licensees

14.80 EDF NGL operates in accordance with a single unified management system that integrates safety, health, environmental, security, quality and economic objectives. The management system defines the responsibilities of key post holders, the line management organisation and the main interfaces between the company and other organisations.

14.81 EDF NGL's management system draws on best practice, as defined within the IAEA Safety Requirements No. GS-R-3, The Management System for Facilities and Activities, together with BS EN ISO9001, Quality Management System – Requirements, BS EN ISO14001, Environmental Management Systems – Requirements With Guidance For Use, BS OHSAS18001, Occupational Health And Safety Management Systems – Requirements and BS ISO ISO55001, Asset Management. Management System – Requirements. It has also been designed to ensure that the requirements of our nuclear site licences are fulfilled.

14.82 EDF NGL's management system comprises a defined organisational structure and 36 interlocking processes. For each process there is an identified champion in the business who owns the process definition and documentation and is charged with its continuous improvement. The whole system is underpinned by the values, standards and expectations that should inform and permeate all activities throughout the company.

14.83 Based on the standards, the processes include all the elements necessary to manage and control nuclear power stations safely and efficiently. Alongside the processes for specific technical activities there are processes for securing sufficient suitably qualified and experienced personnel. These processes include training, for implementing and monitoring governance procedures, for ensuring adherence to regulations, for securing independent assessment of our activities, for investigating departures from expected plant and personnel behaviour and preventing their recurrence and for driving improvement in all aspects of performance.

14.84 EDF NGL operates a "defence-in-depth" approach towards oversight to monitor performance and conformity to both its internal standards and external regulations. EDF NGL operates a multi-layer model with increasingly independent oversight being exercised through:

- management accountability – the exercise of leadership; 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 identify opportunities for improvement.
- independent internal oversight from the INA function which reports to the Board independently of the operating arm of the company and also have 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 and a central team providing independent assessment of significant plant and safety case changes and support for fleet-wide and corporate audits and inspections.
- external oversight is sought from and provided by many bodies:
    - Each station has a NSC that advises on safety matters and 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 to the Nuclear Safety Council, and provides high level oversight of nuclear activities across EDF group, including EDF NGL.
    - WANO peer reviews are periodically performed on each of the EDF 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. During this reporting period Heysham 2 and Hartlepool were reviewed in 2013, Sizewell B and Hinkley Point B in 2014 and Hunterston B in 2015. A review of Heysham 1 started in December 2015 but was suspended after a week because of extreme weather conditions and will be completed during 2016. A follow up to the 2012 corporate review took place in 2015.
    - An OSART mission took place at Sizewell B in October 2015. There will be an OSART follow-up review at Sizewell B in the first half of 2017.
    - EDF NGL maintains fleet-wide third party certification to international management system standards for quality (ISO 9001:2008), environment (ISO 14001:2004), occupational health and safety (OHSAS 18001:2007) and asset management (ISO 55001:2014). This is externally assessed by Lloyd's Register Quality Assurance which completes annual assessments across stations and central support functions to confirm that the integrated management system is adequate and effective.

Verification of safety: regulatory review and control activities

14.85 ONR carries out planned inspections of nuclear licensed sites to monitor compliance with the licence conditions, compliance with the site safety case, the requirements of HSWA74 and other regulations. 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.

14.86 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.

14.87 Once the reactor is operational, the nuclear site inspector(s) allocated to the site spend about 30% of their working time on their site. In particular, 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; instead, there is a periodic change, normally after a few years, for a number of reasons (changing regulatory priorities, career development etc.) which also serves to ensure the continued independence of ONR inspectors.

14.88 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 recent operational experience feedback. Before the start of each year, the plan is modified, as necessary, to take into 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.

14.89 Site Intervention Plans are produced to monitored and reviewed within an 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 (see also Article 12).

14.90 The IIS embraces the site and corporate inspection processes together with the assessment processes to help provide a consistent and integrated framework for all regulatory activities. ONR's programme working fosters consistency in regulation of similar sites and enables ONR to have better oversight of regulatory issues within the operating fleet, defueling and decommissioning plants and hence more effectively target its regulatory efforts effectively.

14.91 The elements included in the site intervention plan will be subject to regular inspection visits against the appropriate licence condition by the nominated site inspector. Further inspections may be included in the IIS to verify compliance with other licence conditions. Inspections by site inspectors provide regular updates of current site performance and operational issues, which are obtained through activities such as examination of event and operational records.

14.92 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.

14.93 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 the enforcement policy statement and the regulatory strategy for the site. Occasionally, ONR inspectors also undertake unannounced inspections and out of hours inspections.

14.94 LC 29 requires licensees to carry out and report the results of tests, inspections and examinations specified by ONR, after consultation with the licensee. This condition may therefore be regarded as a verification activity by the nuclear regulator or as a means to intervene to improve knowledge or secure a safety improvement.

14.95 A general example of the role of site inspection is the granting of consent to re-start a reactor following each periodic shutdown. These consents are based in part on ONR site inspections during the periodic shutdown involving a wide range of technical disciplines (for example, civil engineering, structural integrity, mechanical engineering).

14.96 In April 2013, ONR introduced a new proactive programme of 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. The SBI programme forms part of the site intervention plan and is integrated with programmes of inspections to monitor compliance with licence conditions and other legal requirements. The SBI programme has become an essential element of ONR's overall intervention on a nuclear site.

14.97 ONR has identified around 30 safety systems and structures for the EDF NGL fleet of AGRs and the PWR at Sizewell B. The safety systems for AGRs and PWRs are different and reflect the two reactor technologies. However, the SBIs have been grouped against broad safety functions such as reactor cooling, essential power supplies, gaseous / liquid radioactive waste system. The groupings assist in the planning of inspections in that six SBIs are undertaken on an annual basis. A five year SBI programme is in place to ensure that each of the identified safety systems and structures on every site is inspected at least once during this period.

14.98 The SBIs are mandatory and are an ONR Key Performance Indicator (KPI) which requires 100% of planned inspections to be completed each year.

14.99 Each SBI is undertaken by a small team of inspectors from appropriate disciplines. Preparatory work is undertaken to identify relevant matters from the safety case that will determine whether the relevant safety systems and structures will adequately meet the safety functional requirements claimed in the safety case. Inspection work on site typically takes place over a two day period and includes document review, discussions with licensee staff and plant walk-downs. SBI inspections are structured around compliance with six licence conditions (LC 10, LC 23, LC 24, LC 27, LC 28 and LC 34) which are outlined in more detail in Annex 1.

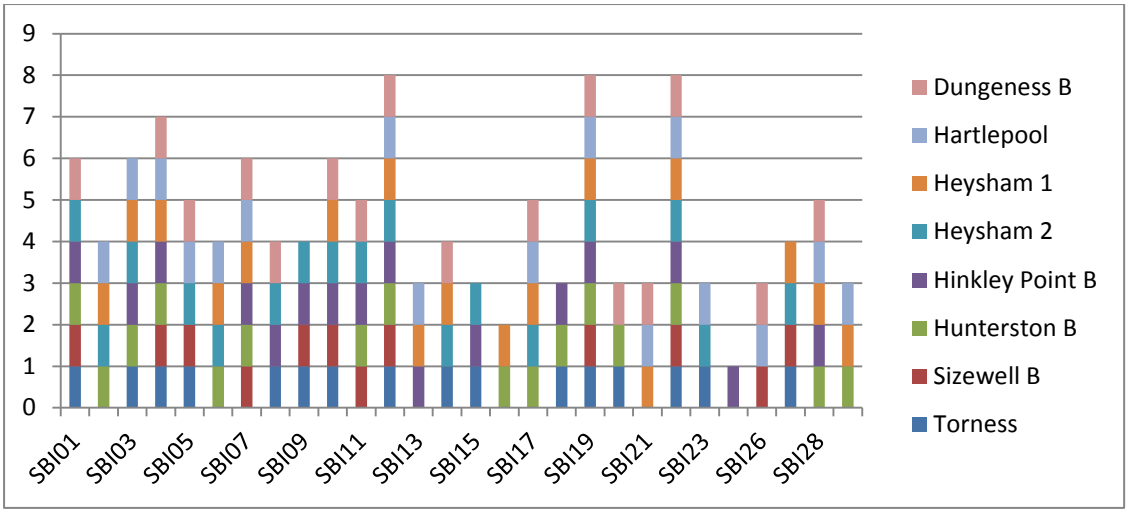


Figure 12 – Overview of system based inspections carried out against licence condition across the EDF NGL fleet

14.100 At the time of writing, ONR is three years into its five year programme of undertaking SBIs across the reactor fleet and has completed 126 SBIs. Whilst all 30 SBIs have yet to be carried out at each site, ONR has planned and undertaken its interventions over the last three years to ensure that all SBIs have been covered at least once (across the fleet) as shown in Figure 12.

14.101 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 three SBIs completed to date have concluded that the relevant structures, systems and components have fully met the requirements of the safety case. For the three SBIs that were not judged to have met the safety case, ONR identified shortfalls in the maintenance arrangements. The licensee was formally notified of the identified shortcomings and these were fully addressed on a timely basis.

14.102 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.

14.103 Following review by the ONR inspector, the findings of the inspection are discussed with the licensee and, where appropriate, the corrective actions required from the licensee are agreed. Subsequently, an intervention record is prepared by the inspector to record appropriate details of the objectives of the visit, matters considered, conclusions drawn and any follow-up actions identified. Significant issues are recorded in ONR's regulatory issues database so that their resolution can be monitored. Executive summaries of all intervention reports for operating reactors are published on the ONR website (Ref. 118).

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

15.1 Under this Article, compliance with the Convention is demonstrated in a way that has not substantially changed since the Sixth UK Convention Report (Ref.3) (i.e. in a way that has implications for the Convention obligations), but has been updated to reflect current procedures.

15.2 A summary of the laws and regulations relevant to nuclear safety, environmental and radiation protection can be found in Article 7.

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). However, in the UK the ALARP principle is used and is fundamental to all health and safety legislation. The principle requires all nuclear site operators to follow relevant good practice and also adopt practices that could further reduce the risk if it is reasonably practicable to do so. Where relevant good practice in particular cases is not clearly established, the operator has to assess the significance of the risks (both their extent and likelihood) to determine what action needs to be taken. 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 cost to reduce them further. The licensee must take measures, to reduce risk unless the costs in terms of time, trouble and money of taking particular actions are clearly excessive (in gross disproportion) compared with the benefit of the risk reduction. The widely used International Commission on Radiological Protection concept, ALARA (economic and social factors being taken into consideration), is equivalent to ALARP, but unlike ALARP, does not have a legal basis in UK law (see Annex 3 for a more detailed discussion of these concepts). 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 The IRR99 (Ref. 61) implement the European Basic Safety Standards Directive 96/29/Euratom (Ref. 67) and European Outside Workers Directive 90/641/Euratom (Ref. 63) under the auspices of the HSWA74, as amended (Ref. 9) and implement the recommendations of the International Commission on Radiological Protection (Ref. 119).

15.5 To meet the IRR99 regulation 8 and nuclear site licensing requirements, licensees must optimise protection to provide the highest level of safety that is reasonably practicable. This optimisation includes, but is not limited to, criteria reflecting aspects of the fundamental principles of the SAPs In addition, optimisation would include the radiation protection principles of the SAPs encompassing a hierarchy of control measures, normal operation (planned exposure situations), fault and accident conditions (emergency exposure situations), designated areas, contaminated areas, decontamination and shielding.

15.6 Licensees are required by IRR99 to restrict exposure by means of engineering controls, such as 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. At nuclear installations,

whether or not licensees' employees undertake the work, the licensees are responsible for controlling work and ensuring doses to individuals are ALARP.

15.7 A dose constraint is a prospective restriction on the individual dose delivered by a source of ionising radiation, which serves as an upper bound on the dose in optimising the protection and safety of persons who may be affected by the source. IRR99 regulation 8 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 SFAIRP. In general, the licensees have considerable experience in developing dose databases which provide accurate dose forecasts for planned tasks.

15.8 IRR99 does not specify a level of dose below which optimisation is always regarded as satisfied. The duty on the radiation employer (for nuclear sites this is generally the licensee, but may also include other employers with staff working at the site) given in regulation 8(1) is to restrict, SFAIRP, the extent to which employees and other persons are exposed to ionising radiation. This requirement has no lower dose boundary and is satisfied when the radiation exposures are ALARP. ONR has published SAPs which include some lower numerical dose targets for normal operation called Basic Safety Objectives of 1 mSv/year for employees working with ionising radiation, 0.1 mSv/year for other employees on the site, and 0.02 mSv/year for any person off the site. The Basic Safety Objective is that dose value below which the regulator will not seek further improvements, provided that it is satisfied by the licensee's arguments. The objective does not represent a notional value of optimisation and a radiation employer at a nuclear licensed site would still have to seek further dose reductions below the Basic Safety Objective 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 IRR99. There are levels of 20 mSv/year for employees working with ionising radiation (which is also the dose limit for employees in IRR99), 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 IRR99.

Dose limitation

15.9 IRR99 regulation 11 specifies dose limits for persons engaged in work with ionising radiation that comply with the limits in the Euratom Basic Safety Standards Directive (Ref. 67) and the International Commission on Radiation Protection recommendations of 1990 (Ref. 119). For example, for adult employees, the normal limit on effective dose for whole body exposure is 20 mSv/year. 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. IRR99 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, with 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.

15.10 Where designated classified persons receive exposure from a number of sites operated by different employers, the "outside worker" provisions of IRR99 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 to control the cumulative dose of the worker, which may have been accrued on a number of different sites. The Approved Code of Practice (ACoP) and guidance (Ref. 120) supporting IRR99 give practical advice on the most appropriate methods of complying with the regulatory requirements and how to ensure that exposures do not exceed any dose limit and are also ALARP. This guidance covers matters such

as: restriction of exposure; information instruction and training; co-operation between employers; designation of controlled and supervised areas; personal protective equipment and its maintenance; and monitoring of designated areas.

Licensee responsibility

15.11 For the assessment of compliance with dose limits relating to members of the public (IRR99 regulation 11, ACoP and guidance (Ref. 120), the licensee is required to derive realistic estimates of the average effective dose (and where relevant, equivalent dose) to representative members of the appropriate reference group (now replaced by the appropriate representative person) for the expected pathways of exposure. Through IRR99 regulation 8 covering ALARP, licensees are also required to keep their activities under review to establish whether doses from direct radiation could be reduced.

15.12 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.

15.13 The EPR10 (Ref. 54) have introduced the concept of best available techniques which, for all practical purposes, 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. 53) in Scotland; and
- Best available techniques applied to permits granted under EPR10 (Ref. 54) in England and Wales.

15.14 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 so as to achieve a high standard of protection for the public and the environment taken as a whole. 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. 121). The Environment Agency has also published Radioactive Substances Regulation – Environmental Principles which are modelled on the SAPs (Ref. 122). In setting limits, the environment agencies use monitoring and discharge and plant performance data with suitable modelling to ensure that the radiation exposure of 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.

15.15 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 2015 which contains 2014 monitoring data (Ref. 123). 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.

Qualified experts

15.16 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 IRR99, to provide expert advice on compliance with those Regulations. In particular, the employer must consult the RPA on those matters set out in Schedule 5 of IRR99. HSE has published a statement (Ref. 124) on RPAs, setting out criteria for core competences of individuals and bodies intending to give advice as RPAs. The licensee should select RPAs whose experience is appropriate to the advice required. The licensee will usually operate with an independent health, safety and environment department. This will be separate from the main production departments and will be available to give advice on health and safety issues. The RPA will usually be a member of this department, but may, alternatively, be employed as a consultant to the operating organisation, thus giving the necessary independence from the production departments. In addition, in the UK, the qualified expert in relation to radioactive waste is the

Radioactive Waste Adviser (RWA) with respect to advising on protection of the public from radiation arising from radioactive waste (RWAs are not appointed under IRR99).

Local rules and procedures

15.17 IRR99 regulation 17 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. The guidance to IRR99 (Ref. 120 - paragraphs 278 - 281) contains advice on the essential and optional contents for local rules. To meet the requirements of IRR99 regulation 17 covering local rules licensees have to put in place arrangements to ensure compliance. The Radiation Protection Supervisor 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 IRR99, in particular, in supervising the arrangements set out in the local rules. The Radiation Protection Supervisor does not need to have the same depth of knowledge of IRR99 as a RPA, but must be suitably trained and appointed in writing.

15.18 Under IRR99 regulation 8, 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, usually in conjunction with the RPA. The purpose of this investigation is to establish whether or not sufficient action is being taken to restrict exposure to ionising radiation, SFAIRP.

15.19 IRR99 regulation 25 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 radiation must carry out a thorough investigation. To meet the requirements of regulation 25 covering investigation and notification of over exposure, licensees have to put in place arrangements to ensure compliance.

15.20 Similarly, IRR99 regulation 30 requires incidents, like the release (unless in accordance with a discharge authorisation or permit) or spillage of radioactive substances in excess of certain quantities, to be investigated. LC 34 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 LC 7 arrangements (See Annex 1).

Individual monitoring

15.21 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), IRR99 regulation 20 requires the employer to designate that employee as a classified person. For non-classified employees, the ACoP and guidance to IRR99 (Ref. 120) provides guidance on the arrangements that licensees should put in place to restrict exposure. Guidance for licensees is also provided on the arrangements for entry into controlled areas by members of the public or employees who do not normally work with ionising radiation. In particular, licensees must be satisfied that the relevant numerical dose limits for non-classified employees or other persons are being complied with and that doses are being kept ALARP, and this may be achieved by a number of means.

15.22 For classified persons, the employer has to arrange for any significant doses (internal or external) they receive to be assessed by a dosimetry service approved by HSE for the assessment of doses for the relevant type of radiation. Such services are referred to as Approved Dosimetry Services (ADS) (assessment). HSE also approves dosimetry services to co-ordinate individual doses received from different ADSs (assessment) and to produce and maintain dose records for classified

persons. These services are referred to as ADS (records). Although there is no online sharing register for the transfer of dose information between ADSs; an ADS (assessment) will send dose information direct to the relevant ADS (records), who then send all dose summaries to HSE annually. Dose records are kept until the person has or would have attained the aged of 75 years but in any event for at least 50 years from the date from when they were made.

Exposure records

15.23 To help the employer assess the effectiveness of its dose control measures, the ADS (records) provides a written summary of the doses recorded for each classified person at least once every three months. Many ADS (records) provide monthly dose summaries. By the end of March each year, the ADS must also provide HSE with summaries of all recorded doses relating to classified persons for the previous calendar year.

Control of exposure

15.24 HSE has a computerised Central Index of Dose Information that receives and processes the annual dose summaries for classified persons. All dose summaries and individual personal data provided to HSE by ADS (records) under IRR99 (or previously under the Ionising Radiations Regulations 1985) (Ref. 125) are treated as confidential. Various safeguards protect computer files in order to maintain that confidentiality. The data in the Central Index of Dose Information are periodically analysed to identify any trends in dose uptake.

15.25 Designation of controlled or supervised areas is required by IRR99 regulation 16. 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 radiation. Regulations 18 and 19 specify requirements for designated areas to ensure that, inter alia, there are appropriate arrangements for control and monitoring of radioactive contamination, including contamination of workers. Such arrangements typically include monitoring of contamination where work is being carried out, and of workers at the points of egress from the local work area and at the exits from designated areas.

15.26 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. IRR99 includes a number of regulations to ensure that appropriate steps are taken for the assessment of internal exposure. Regulations 20 and 21 require that relevant workers are classified, and that for these workers all significant doses are assessed and recorded. A comprehensive system exists to ensure that the assessment and recording of doses for classified persons is done accurately and reliably.

15.27 IRR99 regulation 23 states that, where any accident or other occurrence takes place which is likely to result in a person receiving an effective dose exceeding 6mSv, or equivalent dose greater than three tenths of any dose limit, the employer shall arrange a dose assessment by an ADS. This is for a classified person who is an employee who has been issued with a dosimeter or other device in accordance with contingency plan requirements (IRR99 regulation 12 refers), and any other case having regard to the advice of the RPA. This should include in-vivo and biological monitoring as necessary to determine the extent of any exposure to internal contamination. The employer is expected to inform those affected as soon as possible, and to keep records for the durations required in IRR99 regulation 23 (namely, until the person has or would have attained the aged of 75 years but in any event for at least 50 years from the date of the relevant accident).

Outside workers

15.28 UK employees who are designated as classified persons and who work in designated controlled areas (other than controlled areas of their own employers) are called outside workers. Outside workers possess Radiation Passbooks issued by ADS and outside workers must present these to the licensees prior to being given permission to enter controlled areas on their sites. The purpose of Radiation Passbooks is to provide employers who are employing outside workers with up-to-date dose information so that they can ensure that relevant dose limits are not exceeded during that period of employment. IRR99 regulation 21 requires employers to make suitable arrangements to ensure that particulars entered in passbooks are kept up-to-date, and it is an offence under regulation 34 for an employee to misuse a Radiation Passbook or falsify entries. Outside workers should wear their own employers' dosimeters issued by HSE ADS for all entries into controlled areas to comply with their own employers' arrangements for assessing doses, as well as any dosimetry provided by licensees. Licensees would need to have appropriate equivalent sets of arrangements for foreign contractors (especially workers from within Europe) working on nuclear licensed sites.

15.29 IRR99 regulation 18(4) requires the employer who has designated a controlled area (for nuclear licensed sites this is usually the licensee) to make arrangements for estimating the dose of ionising radiation received by the outside worker whilst in the controlled area. This employer (licensee) must enter the estimated dose into the outside worker's Radiation Passbook as soon as is reasonably practicable after the outside worker has completed his/her work on site. Usually, the licensee obtains an estimate of the dose of external radiation to the outside worker by issuing him/her with an electronic personal dosimeter. Generally, internal dose uptake estimates are obtained using the ADS arrangements used for the employer's (licensee's) own workers. Under these circumstances, the estimated dose may not be available before the outside worker leaves the site. In which case the employer (licensee) would need to make arrangements to forward the estimated internal dose to the outside worker's employer. The outside worker's employer must arrange for the estimated dose to be entered into their Radiation Passbook.

Public doses

15.30 Arrangements to control exposures to the public from a nuclear licensed site are partly regulated through IRR99 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 EPR10, respectively.

Employer co-operation

15.31 IRR99 regulation 15 requires employers to co-operate with each other. The aim of the co-operation should be to co-ordinate the measures they take to comply with legal requirements and inform each other of the risks to employees arising from their work. The information shared would include matters relating to controlled areas, contingency arrangements, and sharing information on the doses incurred whilst working under each employer's control.

Controlled areas

15.32 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.

15.33 Under IRR99 regulation 16, the responsibility for designating a controlled or supervised area rests with the employer in control of that area. In the case of a nuclear licensed site, this duty is also on the licensee. An assessment undertaken by the licensee will establish whether special procedures are necessary to restrict exposure. The designation of a supervised area will depend on the assessment of doses, and whether conditions may change. The licensee is required under IRR99 regulation 13(1) to consult an RPA on the implementation of the requirements as to controlled and supervised areas. IRR99 regulation 19 also requires licensees who designate controlled or supervised areas to ensure that levels of ionising radiation are adequately monitored, and that those areas are kept under review. Advice is provided in the ACoP and guidance to IRR99 (Ref. 120) on issues for consideration and dose levels appropriate to designate a controlled or supervised area. Licensees have therefore developed arrangements to ensure the appropriate legal requirements are met and relevant good practice is adopted for controlled and supervised areas on nuclear licensed sites.

15.34 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 at the boundary between controlled and other areas.

Protective equipment

15.35 IRR99 regulations 9 and 10 require licensees to ensure that any personal protective equipment provided pursuant to regulation 8 is appropriate and that it is subject to routine examination and maintenance. Licensees are also required, under regulation 14, 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 IRR99, 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. 126).

Licensing requirements

15.36 In addition to the application of IRR99, the regulation of radiological hazards on nuclear licensed sites is also achieved through the licensing regime. Under LC 14 on safety documentation, the licensee is required to submit to HSE written safety cases demonstrating that safety will be maintained through all phases of an installation's life, from design and construction through to its decommissioning.

15.37 The adequacy of the licensee's safety submissions is assessed by ONR against its SAPs (Ref. 29). The principles relating to radiation protection are consistent with the latest recommendations in 'The 2007 Recommendations of the International Commission on Radiological Protection (Ref. 127) and ensure that the licensee makes a strenuous pursuit of the objective to keep exposures ALARP. The ONR considers that the principles in the SAPs relating to radiation protection are consistent with the recommendations of International Commission on Radiological Protection published in 2007.

15.38 Owing to the nature of the radiological hazard presented by large nuclear installations, there is, in addition to the provisions of IRR99, the requirement for licensees to make and implement adequate arrangements for the assessment of the average effective dose equivalent (including any committed effective dose equivalent) to specified classes of person (LC 18 on radiological protection). Again, enforcement of this requirement is carried out by ONR.

Forthcoming legislative changes

15.39 The UK is currently implementing the latest European Basic Safety Standards Directive 2013/59/Euratom (Ref. 128) into UK legislation. This may lead to some changes to the legislation described in this Article by February 2018. This Directive is broadly consistent with the latest version of the International Basic Safety Standards published by the IAEA in 2014 (Ref. 129).

Regulatory review of control of radiation exposure

15.40 ONR satisfies itself that licensees have adequate arrangements in place to restrict exposures to ionising radiation SFAIRP in a number of ways. To take a view at a particular site, ONR undertakes assessments of safety cases and carries out inspections on site, including compliance against IRR99. To take a view on occupational exposure across the industry, ONR periodically undertakes reviews across all GB nuclear sites, and is currently undertaking 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 such exposures from licensees on an annual basis, and using our 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.

Radiation doses at nuclear power plants

15.41 All EDF NGL policy, procedures, standards and requirements are identical for employees and contractors who work on EDF NGL sites. The majority of the doses on site relate to vessel entry work which is largely undertaken by contract staff. For EDF NGL sites (which are all operational sites) data for all employee and contractor doses for 2011-2015 is given in Table 15.1.

15.42 The total collective dose to all persons working on EDF NGL sites during calendar year 2015 was 0.98 manSv with 0.31 manSv to employees and 0.67 manSv to contractors.

15.43 No person exceeded the statutory annual dose limit of 20 mSv specified in IRR99, nor the EDF NGL dose restriction level of 10 mSv. No worker has exceeded the company dose restriction level of 10 mSv per annum since 2006.

15.44 The maximum individual dose received by an EDF NGL employee in 2015 was 6.83 mSv. The maximum individual dose received by a contractor in 2015 was 7.78 mSv. In 2015, the average dose received by EDF NGL employees was 0.06 mSv and by contractors was 0.07 mSv.

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

Table 4 - Doses at EDF NGL sites

Year	**2011**	**2012**	**2013**	**2014**	**2015**
Collective dose - employees (man-mSv)	354.23	293.31	304.47	347.76	308.64
Collective dose – Contractors (man-mSv)	1358.14	567.94	557.70	1058.64	674.44

Total	1712.37	861.25	862.17	1406.4	983.08

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

16.1 Under this Article, compliance with the Convention is demonstrated in a way that has not substantially changed since the Sixth UK Convention Report (Ref.3) (i.e. in a way that has implications for the Convention obligations). The Article has been updated to demonstrate the UK's capability with respect to emergency preparedness and response to address the relevant aspects of the Vienna Declaration on Nuclear Safety.

Emergency preparedness for a radiological emergency at a UK nuclear installation

National programme

16.2 DECC co-ordinates emergency preparedness policy at national level, as the lead government department for the UK's arrangements for response to any emergency with off-site implications from a civil nuclear site in England and Wales. In the event of an emergency at a civil nuclear site in Scotland, the lead government department responsibility and the main national coordinating role would fall to the Scottish Government. DECC would still be responsible for briefing the Westminster Parliament and the UK's international partners.

16.3 The precautions taken in the design and construction of nuclear installations in the UK, together with the high safety standards in their operation and maintenance, reduce to a low level the risk of accidents that might affect the public. However, all nuclear licensees are required to prepare, in consultation with local authorities, the police 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 and their workforce, including those for dealing with an accidental release of radioactivity. These off-site emergency plans are regularly observed by ONR. Due to its role as lead government department for the planning and response phase for an off-site nuclear emergency at a civil site in England and Wales, DECC chairs the Nuclear Emergency Planning Programme Board (NEPPB). This board brings together organisations with responsibilities in off-site civil nuclear emergency planning;

including representatives of the nuclear operators, regulatory bodies, police, fire service, local authority emergency planning officers, government departments, and agencies that would be involved in the response. The NEPPB provides an oversight for the UK Nuclear Emergency Planning and Response Programme (NEPRP). The NEPRP provides a number of forums, through project and working groups, for discussing common issues, exchanging information and experience, and agreeing improvements in planning, procedures and organisation. Figure 13 shows the NEPRP Governance Map.

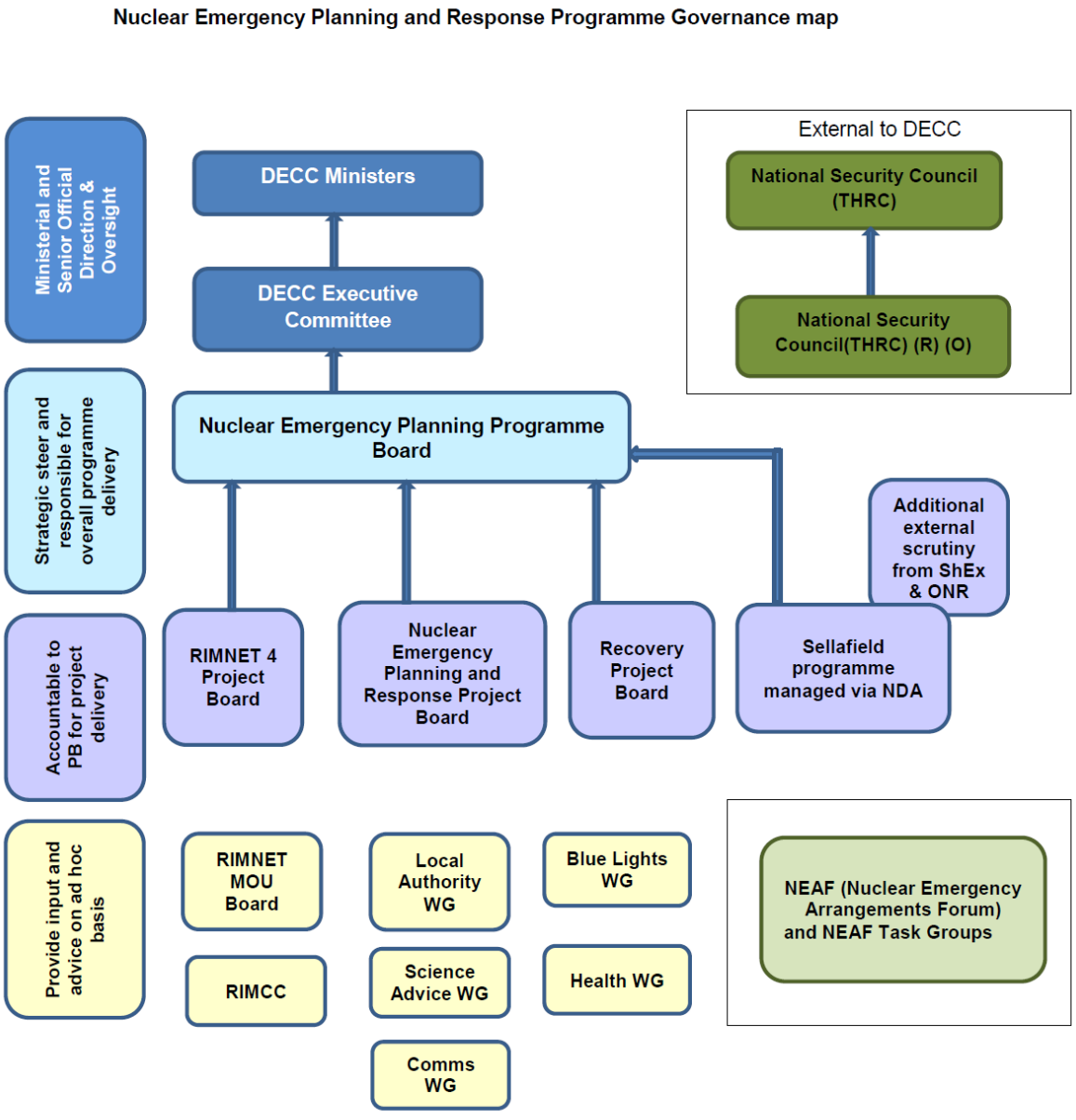


Figure 13 – DECC Nuclear Emergency Planning and Response Programme Governance Map

16.4 The NEPRP vision is for the UK's planning and response to nuclear emergencies at home and overseas to be effective, proportionate and sustainable.

16.5 The NEPRP strategy is to identify areas for improvement and strengthen the UK's capability, at national and local level, to respond to a nuclear emergency at home and overseas, and to transition from response to recovery from the incident. In doing this, the NEPRP will be based on generic civil contingency arrangements as far as possible with the approach to ensure that the response is seamless at each level and across the UK.

16.6 The NEPRP strategy is delivered through the following set of objectives:

- Overarching guidance setting out clear roles and responsibilities at all levels to improve the UK's ability to respond to an incident.
- Improved science products so that advice is underpinned on best possible evidence and data.
- Monitoring capability is adequate and up to date so that responders can make decisions using consistent data that is quick and easy to access.
- On-site arrangements and infrastructure are improved so that sites are safe and secure and processes are updated in the light of lessons learnt from real life incidents.
- Off-site arrangements are fit for purpose for more severe incidents.
- Programme is evidence-based, evaluated and reviewed.

16.7 DECC also issues National Nuclear Emergency Planning and Response Guidance (Ref. 130), in consultation with NEPRP, to all organisations that may be involved in planning for a civil nuclear emergency. The guidance describes the arrangements that have been developed for responding to an emergency in the UK over a number of years and aim to harmonise the UK response to a nuclear emergency.

16.8 The NEPRP working groups review the results of regional and national level nuclear emergency exercises, which are designed specifically to test the capability of the off-site agencies and to ensure that important lessons learned from those exercises are put into practice.

16.9 The Nuclear Emergency Arrangements Forum (NEAF) provides operators of nuclear licensed sites and ONR with a forum to discuss best practice in relation to, primarily, the operators' on-site emergency response planning. The forum also covers the operators' role in connection with the local authorities' off-site response. NEAF is chaired by a nuclear operator representative nominated by the licensee's Safety Directors' Forum.

16.10 The NEPRP Local Authority Working Group, which ONR attends, provides a forum for local authority planning officers, representatives of industry and other appropriate bodies to discuss emergency planning issues relating to the nuclear industry.

16.11 ONR also attends various NEPRP meetings, working groups and NEAF as part of its regulatory function for enforcing REPPIR (Ref. 66) to monitor the overall planning position for both on-site and off-site aspects. As a result of involvement in these forums, ONR advises DECC in respect of nuclear emergency preparedness and response.

16.12 The NEPRP is developing an assurance framework, for implementation through 2016/17, for assessing the effectiveness of preparedness and response at all levels. The focus is on assessing the following elements:

- Response plans and guidance are adequate: Plans in place to respond to an emergency and guidance to inform on the preparation of the plans.
- Information provision: Adequate flow of scientific information for decision making and effective public warning and informing.
- Infrastructure: Adequate emergency management response co-ordination capability is constantly available.
- Legislation: There is a robust regulatory and safety regime to reduce the risk from radiation to ALARP.
- Equipment and Supplies: Adequate and effective radiation monitoring and decontamination arrangements.
- Personnel: Key responders are sufficiently trained and capable of carrying out their required role during an emergency.
- Exercising: Review of the UK emergency test arrangements and application of continuous improvement to response capability.

International harmonisation of UK emergency plans and response measures

16.13 The UK takes a cross stakeholder approach to European and International emergency preparedness and response activities to ensure that all UK competent authorities with emergency preparedness and response responsibilities are appropriately represented. UK's international strategic objectives are:

- To continue to identify and enable improvements in the UK's emergency preparedness and response capability.
- To use our expertise and international credibility to influence and shape improvements and identify best practice in global nuclear safety and security.
- Engage with European radiation protection authorities, IAEA, and other competent agencies on key radiation issues affecting UK nuclear regulation.
- Share information and participate in work that will support the UK implementation of the EC (and IAEA) Basic Safety Standards Directive.
- Through effective governance and administration, enable standards, guidance, position statements, and good practices' developed internationally on emergency arrangements, to be implemented which optimise the UK approach to nuclear emergency planning.

16.14 The key European and International bodies that ONR contributes to include:

- IAEA Commission on Safety Standards and IAEA Emergency Planning and Response Standards Committee (EPReSC): This group first met in November 2015 to agree the scope of work in relation to input to all IAEA standards containing a component of emergency preparedness and response. EPReSC is currently considering issues such as implementation of IAEA guidance GSR Part 7 (2015), reviewing IAEA GS.G.2.1 guidance, and termination of an emergency. Any EPReSC proposals require approval by the IAEA Commission on Safety Standards. The UK also participates in the IAEA National Competent Authorities Coordinating Group, the Inter-Agency Committee on Radiological and Nuclear Emergencies, the Response and Assistance Network, and Modelling and Data for Radiological Impact Assessments.

- HERCA Board of Heads and Working Group on radiation emergencies. This Working Group meets twice per year and is currently developing a common approach to off-site and cross-border emergency arrangements and communications with WENRA, known as the HERCA-WENRA approach.
- ONR also provides representatives to WENRA (who recently developed the HERCA-WENRA approach), ENSREG, 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 , European Radiological Data Exchange Platform , EU platform on preparedness for nuclear and radiological emergency response and recovery , and the OECD Working Party on Nuclear Energy Matters .

16.15 The UK undertook benchmarking by inviting IAEA IRRS missions in 2006, 2009 and a follow-up mission in 2013 that included review of UK arrangements for emergency planning and response. In the 2013 follow-up mission, all related recommendations from the previous missions were closed out and areas within the UK were identified as examples of international good practice.

On-site emergency arrangements

16.16 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, LC 11 requires the licensee to make and implement adequate arrangements for dealing with any accident or emergency arising on the site and its effects. Licensees must submit to ONR for approval its emergency arrangements for each site, usually known as the Emergency Plan which includes:

- A description of the organisation that is set up on the site to manage the emergency;
- Responsibilities of personnel in the emergency organisation;
- Training requirements for personnel;
- Equipment for use in an emergency;
- Arrangements for liaison with emergency services on the site;
- Radiological monitoring of the environment on and around the site; and
- Communications with organisations off the site.

16.17 LC 11 also requires rehearsal of the arrangements to ensure their effectiveness. This is achieved by the licensee holding training exercises and ONR agreeing to a programme of demonstration emergency exercises that ONR inspectors observe. ONR can specify that exercises cover all or part of the arrangements. Encouraged by the UK Government and ONR, each year across the industry at least two sites hold joint safety and security exercises, for example the response to a terrorist attack simultaneous with a nuclear emergency. These can increase the complexity to the sites and expose the arrangements to a set of different and valid challenges.

16.18 In 2015, ONR introduced additional assurance to the LC 11 arrangements through the application of on-site emergency planning and response capability maps. These capability maps assess both the security and safety aspects of each site's emergency response and provide a transparent, proportionate and consistent regulatory approach across the UK nuclear industry.

16.19 Incorporating security in the capability map process, and encouraging joint safety and security exercises, demonstrates an ability to deal with an event

regardless of the initiating event. ONR's assessment of emergency arrangements takes account of this approach and considers the coherence of the arrangements prepared under LC 11 and those prepared under security legislation.

16.20 Over the complete life of the nuclear installation, the emergency arrangements are subject to review and, with ONR's approval as described above, revision as appropriate. As part of the licensee's training arrangements, all staff participate in a regular programme of emergency exercises, which requires each shift at each nuclear site to exercise the arrangements at least once a year.

Off-site emergency arrangements

16.21 REPPIR (Ref. 66) implements the Articles on intervention in cases of radiation emergency in Council Directive 96/29/Euratom (Ref. 67) and 89/618/Euratom (known as the Public Information Directive) (Ref. 68) on informing the general public about health protection measures to be applied. Steps required to be taken in the event of an emergency are covered in the UK by REPPIR. REPPIR is the principal regulation regulated by ONR for the off-site elements of the emergency plan. The regulation requires off-site plans to be produced by the local authority in consultation with emergency responders, for those sites where a radiation emergency is considered to be reasonably foreseeable. Responsibilities for preparation, reviewing and testing off-site emergency plans are also covered by REPPIR.

16.22 In 2015, ONR provided assurance of the off-site arrangements through the application of off-site emergency planning and response assessment matrices. These assessment matrices assess the local authorities off-site emergency plans against the requirements set within REPPIR and provide a transparent, proportionate and consistent regulatory approach.

16.23 Where there is the potential for radiation emergency that would result in a radiation dose to a member of the public above levels set in REPPIR, detailed emergency planning areas are provided around nuclear installations. These areas as a minimum, under REPPIR, will include members of the public who could be exposed to 5 mSv in the twelve months after a reasonably foreseeable radiation emergency. Whilst REPPIR does not prescribe a specific probability to what is reasonably foreseeable, events with a frequency of $1x10^{-5}$ to 10^{-6} per year are considered, with any cliff edge effects from events of lesser probability also being considered.

16.24 The extent of these zones is assessed by the operator, as part of a hazard identification and risk evaluation, and is based on the most significant radiation doses arising from an accident that can be reasonably foreseen. ONR determines the adequacy of the technical argument supporting the operators assessed zone, then considers how this zone might be modified to secure confidence in protection of the public by consideration of other relevant practical and strategic factors (based on guidance from IAEA GS.G.2.1) such as:

- Local geographic, demographic and practical implementation factors;
- Avoidance of bisecting local communities;
- Inclusion of immediately adjacent vulnerable groups;
- International standards and guidance;
- Credibility and confidence in the extent of the off-site emergency planning area;
- Benefits and dis-benefits of countermeasures; and
- Other site specific factors of which ONR is aware.

16.25 In the event of an accident going beyond a reasonably foreseeable event, the Statutory Guidance (Ref. 131) to the Civil Contingencies Act 2004, Emergency Preparedness, defines the requirements for preparing general emergency response

plans for use when extending the off-site response to include a much larger geographical area. DECC continues to support research and development into extendibility arrangements with support from the local authorities. In late 2015, the local authorities started a programme of extendibility workshops based on principles and guidance provided by DECC. The aim of these extendibility workshops is to strengthen outline planning for more severe nuclear emergencies at a local level and identify any improvements at national level that would support extendibility.

16.26 The declaration of an off-site nuclear emergency at a site is the responsibility of the operator in accordance with previously approved arrangements. This would be followed immediately by notification of the emergency services and local and national authorities. A cascade notification mechanism is in place so the operator can focus on dealing with the nuclear emergency itself.

16.27 The agencies that provide a local response are located at the off-site Strategic Coordination Centre (SCC). At this facility the Strategic Co-ordinating Group's (SCG) prime function is to decide on and action the appropriate protection measures and mitigatory actions to be taken off-site to protect the public. The SCG ensures that those actions are implemented effectively and ensures that authoritative information and advice on these issues is passed to the public (the facility includes media briefing centres). Decisions would generally be made through regular coordinating group meetings. These are chaired by the police, who are responsible for taking decisions to protect the public, and would involve all the principal organisations represented at the facility.

16.28 Each organisation with responsibilities for dealing with the emergency would be 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. In addition, government departments and agencies would also be represented. These would include DECC (or Scottish or Welsh equivalents), Public Health England (or Health Protection Scotland), the relevant FSA, the relevant environmental protection agencies and ONR.

16.29 The Scientific and Technical Advice Cell (STAC), located within the SCC, brings together technical experts from those agencies involved in the response and provides authoritative and independent scientific and technical radiological and health protection advice to the SCG. 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.

16.30 To assist communications between the SCC and central government, the lead government department would also appoint a government liaison officer to support the off-site facility. The officer would be a senior departmental official and would support the SCC by providing a direct link with Ministers and government departments. The relevant environmental protection agencies are represented because of their role in radioactive waste disposal and other environment protection roles, as are the FSA to issue advice and restrictions (if required) to ensure that food contaminated to unacceptable levels does not enter the food chain. Representatives at the SCC would be in communication with their organisations and be responsible for ensuring that adequate information and advice was available, both at the SCC and at the emergency control centres of their respective organisations. The representatives would liaise closely to ensure that a proper assessment was being made of the situation, that appropriate actions were being taken, and that the public was being kept informed.

16.31 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 as a consequence of radiological effects, for example, sheltering, taking of potassium iodate tablets or evacuation.

16.32 The SCC will receive this information from the licensee's organisation. The licensee's representatives at the SCC will have a prime function in ensuring that adequate information is available to those at the facility and to ensure that their own organisations are aware of what assistance the facility requires.

16.33 In the event of an off-site nuclear emergency, the central Government Emergency Operation Centre (EOC) and the Cabinet Office Briefing Rooms (COBR) would be activated in order to coordinate the response and decision-making at the national level. The lead for the response will remain at local level under the control of a senior police officer at the SCG, except for all but the most severe events. The COBR Committee would consist of representatives (Ministers or senior officials) from relevant departments and agencies. Decision-making within COBR would be supported by a number of bodies and advisory groups, including a Scientific Advisory Group for Emergencies.

16.34 DECC is the lead government department for off-site civil nuclear emergency response in England and Wales (the lead is devolved in Scotland). During an emergency other departments would have lead responsibility for specific elements of the off-site response, such as Department of Health for health countermeasures, Department for Communities and Local Government for sheltering and evacuation etc. The Home Office would lead on the counter terrorism response element of any nuclear emergency caused by sabotage. Figure 14 shows the arrangements for responding to off-site nuclear emergencies (accidents) at civil sites schematically for England and Wales.

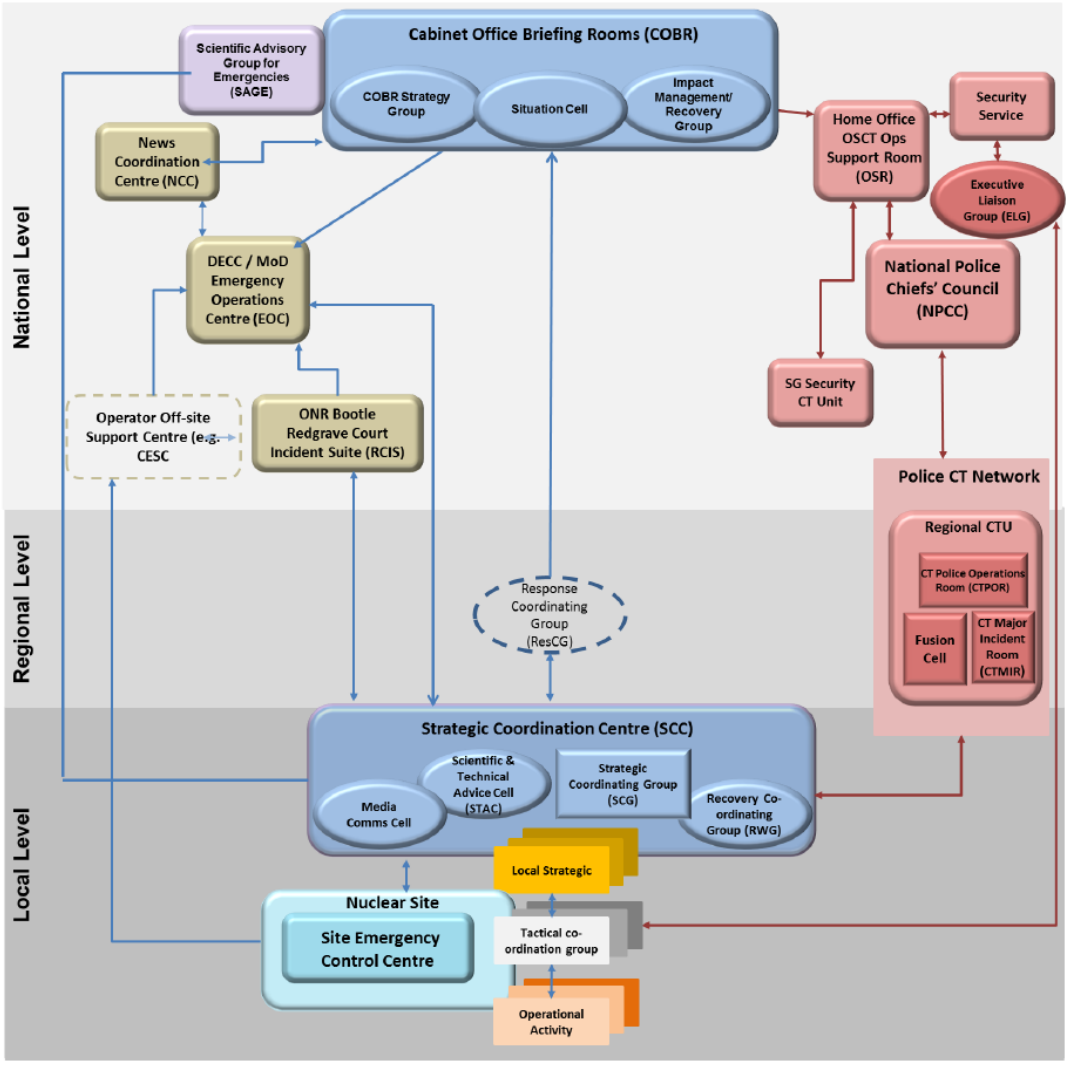


Figure 14 – Emergency arrangements structure for England & Wales

16.35 The Scottish Government Response is consistent with the England and Wales response shown in figure 16.2 with the exception that the central government response would be through the Scottish Government Resilience Room (SGoRR).

16.36 The Department of Environment, Food and Rural Affairs is the lead government department for recovery from nuclear emergencies and would work closely with government agencies to coordinate longer-term remedial action, including decontamination.

Testing of emergency arrangements

16.37 On and off-site emergency arrangements are tested regularly under three categories known as levels 1, 2 and 3.

16.38 Level 1 exercises are held at each nuclear site once a year and concentrate primarily on the licensee's actions on and off the site. ONR observes, make judgements and provide feedback on the adequacy of level 1 exercises. In addition, each site has a programme of training and exercises for all staff involved in the emergency scheme and each role has a training profile which defines the type and frequency of training. 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. In light of 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.

16.39 Level 2 exercises are aimed primarily at demonstrating the adequacy of the arrangements that have been made by the local authority to deal with the off-site aspects of the emergency, particularly the functioning of the SCC where organisations with responsibilities or duties during a nuclear emergency also exercise their functions. Level 2 exercises are performed at each nuclear site 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 provide a variety of scenarios at a national level for example, extended periods of time, real time activation or concurrent emergencies.

16.40 From the annual programme of level 2 exercises, one is chosen as a level 3 exercise to 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/COBR (for England and Wales) in London, or the SGoRR (for Scotland) in Edinburgh. Aspects of DECC's international liaison arrangements, including the process on notification, are routinely tested during the level 3 exercises. The decision on which exercise should be selected as the level 3 is made jointly between the licensees, the lead government departments (DECC or the Scottish Government) and the NEPPB, in consultation with ONR. The level 3 exercises for 2015 and 2016 were both based on nuclear emergencies at civil nuclear sites.

16.41 On occasion, level 1 and level 2 exercises are carried out concurrently in order to test the integration of the on-site and off-site arrangements.

Provision of prior information to the public

16.42 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 requirements are placed on the operator in cooperation with the relevant local authorities.

16.43 REPPIR requires that members of the public within an off-site emergency planning area, who would be at risk from a reasonably foreseeable radiation emergency, should receive certain prescribed information to explain what to do in the event of a radiation emergency being declared. Such information must be distributed in advance of any emergency occurring. Site operators provide this information in a variety of forms, updated at regular intervals not exceeding three years. The licensee also makes the information available to the wider public, usually by providing information on request or by placing copies in public buildings such as libraries and civic centres. 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 an emergency

16.44 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. 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.

16.45 In addition, the various information services of the local agencies 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 of the course of the nuclear emergency.

Recovery

16.46 The duration and extent of an emergency would primarily depend on the scale and nature of the radioactive release. Once the release had been 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.

International notifications

16.47 For an emergency at a nuclear installation in the UK, DECC would take the responsibility for notifying other countries and initiate requests for international assistance. Under existing early notification conventions, DECC would inform the European Community, the IAEA, and countries with which the UK has bilateral agreements and arrangements, about the accident and its likely course and effects.

16.48 The UK uses the IAEA INES as the classification and notification system for safety significant events involving sources of radiation. DECC 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.

16.49 The UK regularly 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.

Measures to enhance emergency preparedness programmes

16.50 The UK has a programme of site, regional and national exercises of emergency plans. Lessons learned from this programme are reviewed and any actions requiring improvement to emergency facilities, equipment, procedures, training, etc. are identified and completed. The NEPRP provides a framework for reviewing the UK Emergency Exercise Programme to ensure that a balanced programme of exercises takes place covering all types of nuclear facilities.

16.51 ONR produces a 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 and is submitted to the NEPRP Lessons Learned Working Group for consideration and action.

16.52 Lessons learned from nuclear exercises are shared with the appropriate Working Groups of the NEPRP through the Lessons Learned Working Group.

Implications of the Fukushima accident

16.53 Since the Fukushima accident the UK has produced a number of reports on the lessons it has learned and Section 2 of this report records this work. DECC as lead Government department has designed a National Nuclear Emergency Planning and Response Programme to co-ordinate a national programme of work to address the recommendations with a focus on response to severe or prolonged emergencies. The following provides an updated summary in the context of emergency preparedness and response.

National level

16.54 The UK Government continues to work with its partners internationally to progress work on the dissemination of information under the Convention on Early Notification of a Nuclear Accident and is a member of IAEA's global Response and Assistance Network, RANET.

16.55 The DECC NEPRP is undertaking a project to update the UK's radiation monitoring system, Radiation Incident Monitoring Network (RIMNET). The project will merge RIMNET and the Ministry of Defence's Nuclear Emergency Response Information Management System. The project aims to replace the current DECC and Ministry of Defence nuclear emergency IT system (including hardware and software) and service provision by 2019. The purpose of the project is to provide a combined system with better functionality and usability for the UK.

16.56 The DECC NEPRP is undertaking a joint agency modelling project that is reviewing how, particularly in the early phases, information on the potential consequences of a nuclear emergency is gained, transmitted and considered by the various stakeholders. The project is working to improve the characterisation of potential source terms associated with a wider variety of nuclear accidents with the objective of allowing more rapid assessment of the likely dispersion of radioactive materials and the potential impact on the UK or overseas.

Site level

16.57 There were a significant number of recommendations and stress test findings placed on the nuclear industry, which ONR's implementation report refers (Ref. 27). In 2016, ONR reported on the 'Progress in implementing the lessons learnt from the Fukushima accident' (Ref. 34) for the licenced sites. The overall conclusion of the report is the most significant of the CNI's recommendations and stress test outcomes for licensees have been satisfactorily addressed.

16.58 The main outcomes of this work in the context of emergency preparedness and response is summarised for EDF NGL sites in the following two sections.

Summary for EDF NGL Sites

16.59 EDF NGL is the licence holder for all eight operating civil nuclear power plants in the UK. Since 2011, EDF NGL has been further enhancing its existing arrangements to respond to a severe 'beyond design basis' accident and implementing the post-Fukushima recommendations and stress test findings (discussed in more detail in Section A). This work has been overseen by ONR.

16.60 The enhanced response capability will enable EDF NGL's reactor sites to withstand and recover from an extreme natural event.

16.61 EDF NGL's initial response included a number of prudent improvements that were straightforward measures which provided genuine safety benefit. Examples of early safety improvements implemented included:

- Increased CO_2 and diesel fuel stocks on sites, well above those required by operating rules existing at the time;
- Flood prevention measures to critical plant buildings by the installation of dam boards;
- Provision of back-up feedwater/fire pumps on sites to provide further defence in-depth;
- Development and implementation of improved training in respect of the symptom-based emergency response guidelines and severe accident guidelines; and
- Additional stocks of essential equipment (for example, basic tools, flash lights etc.) stored in diverse locations;

16.62 Further longer term work has taken place, including:

- Improving the extent of resilience enhancements to C&I systems and equipment associated with plant condition monitoring, and secondary control capabilities in emergency facilities. This included capability as part of the back-up equipment deployed to sites.

- Additional site enhancements and modifications against seismic, flood and fire hazards.
- Increased resilience of fuel storage ponds to extreme events. This included pond coolers along with associated equipment to supply water and power to the units.
- Review of guidance in beyond design basis operating instructions as well as the adequacy of training and exercise arrangements together with implementation of improvements to enhance human performance during extreme conditions.
- Procurement of a range of containerised remotely stored back-up equipment to support sites in the management of a beyond design basis accident, or an event. The back-up equipment includes various vehicles for transport and debris removal, mobile diesel generators, transformers, various pumps, water purification equipment, remote data recording/transmitting equipment and general tools. This equipment is designed to supply existing systems and equipment at sites. The primary plan for deployment of these containers is by road, however, they are designed and weighted to be capable of being airlifted to the desired locations.

Response to emergencies outside the UK

16.63 DECC 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, RANET. RIMNET is the contact point for inward notifications under these arrangements.

16.64 The national response plan, implemented by DECC with support from other agencies, provides arrangements for dealing with an overseas nuclear emergency. This includes DECC maintaining contact arrangements and duty officers that ensure the UK can be notified of an emergency at any time. The RIMNET network comprises 91 gamma dose rate monitors located throughout the UK and provides a secondary alert mechanism in the event of non-notification. RIMNET provides the UK's national radiological database. DECC 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 EOC and Technical Co-ordination Centre containing the equipment required for management of the response.

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

17.1 Under this Article, compliance with the Convention is demonstrated in a way that has not substantially changed since the Sixth UK report (Ref.3) (i.e. in a way that has implications for the Convention obligations). The Article has been updated to align with IAEA guidance (Ref. 17) and to address the relevant aspects of the Vienna Declaration on Nuclear Safety.

17.2 Proposed nuclear power stations generating more than 50 MWe are required to obtain a development consent order from the Secretary of State, under the Planning Act 2008 (Ref. 132) and a consent under Section 36 of the Electricity Act 1989 (Ref. 133). 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 under the Town and Country Planning Act 1990 (Ref. 134). Site-related factors relevant to the safety of the proposed nuclear installation will be considered as material considerations within the planning process. In addition, the government undertook strategic siting assessment between 2008 and 2011, to identify suitable sites for new nuclear power stations. This is recorded in the National Policy Statement for Nuclear Power Generation (EN-6) (Ref. 135).

Procedures for evaluating all relevant site-related factors likely to affect the safety of a nuclear installation for its projected lifetime

17.3 The 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.

17.4 The policy statement (Ref. 135) 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 demographic criteria. The demographic criteria defining semi-urban areas are set out in a paper, entitled 'The Siting of Nuclear Installations in the United Kingdom' (Ref. 136) prepared by ONR.

17.5 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 (Ref. 29) and as low as reasonably practicable.

17.6 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 (see Article 14), ONR uses its SAPs for nuclear facilities (Ref. 29) and associated TAGs (Ref. 33) as a framework for assessing the adequacy of the licensee's application. The SAPs are not mandatory standards, but they provide ONR inspectors with a framework for making regulatory judgements. The development of the SAPs included benchmarking against IAEA Safety Standards. The SAPs were updated in 2014 to reflect both published and proposed changes in these standards.

17.7 The IAEA safety requirements for siting, set out in 'Site Evaluation for Nuclear Installations' (NS-R-3 Rev 1) (Ref. 137) 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.

17.8 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.

17.9 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 siting. 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 under LC 22.

17.10 The siting of future installations will consider external hazards and relevant good practice current at that time.

17.11 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 & 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. Man-made 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 tested against the SAPS and subordinate ONR guidance to confirm they meet relevant good practice or otherwise support a demonstration that site risk is ALARP.

17.12 Licensees often monitor natural phenomena at their sites; typically this would include tide height (for coastal heights), 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.

17.13 The COMAH Regulations 2015 (Ref. 138) 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 (see Article 7 and 16) and COMAH, the relevant local authority is required to prepare a written off-site emergency plan that brings together the emergency arrangements of all hazardous installations in the area. These emergency plans are publicly available and so the existence of hazardous materials which could affect a nuclear site can be used by the licensees in their hazard analyses.

17.14 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.

17.15 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.

17.16 EIADR99 (Ref. 64) require the submission of an EIA for new nuclear power stations, during the application for development consent. The EIA must include:

- an estimate, by type and quantity, of expected residues and emissions (water, air and soil pollution, noise, vibration, light, heat, radiation, etc.) resulting from the operation of the proposed development.
- a description of the aspects of the environment likely to be significantly affected by the development, including, in particular, population, fauna, flora, soil, water, air, climatic factors, material assets, including the architectural and archaeological heritage, landscape and the inter-relationship between the above factors.
- a description of the likely significant effects of the development on the environment, which should cover the direct effects and any indirect, secondary, cumulative, short, medium and long-term, permanent and temporary, positive and negative effects of the development
- a description of the measures envisaged to prevent, reduce and where possible offset any significant adverse effects on the environment.

17.17 The EIA is subject to 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 may have significant effects on the environment in those States

17.18 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

17.19 The initial design of a nuclear power plant will minimise, so far as is reasonably practicable, the radiation exposure to the workers and general public. This will 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 PSRs required by LC 15.

17.20 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).

17.21 SAPs targets 4, 6 and 8 set out targets for radiation exposure in design base fault sequences for people on and off the site.

17.22 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 making an ALARP demonstration, 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.

17.23 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.

17.24 REPPIR (Ref. 66) requires operators of nuclear installations to produce a Hazard Identification & Risk Evaluation report (HIRE), and to review the HIRE every three years and also following any material change to operations that have the potential to increase their radiological impact. Nuclear operators are required to submit a report of their assessment (RoA) to ONR. ONR will then carry out an assessment of the RoA/HIRE, and may require further assessment to be carried out. This further assessment would address uncertainties in the methodologies used and the impact of those uncertainties on the effectiveness of measures taken to prevent and control any potential radiation emergency.

17.25 The operator's safety case for a nuclear facility is normally the source of most of the information needed to inform the contents of a HIRE report, and for such facilities the provisions of REPPIR and the relevant site licence conditions are equivalent. The SAPs are therefore utilised in the assessment of the adequacy of the emergency control arrangements that provide the final level of defence-in-depth

to ensure that all reasonably practicable measures have been taken to safeguard individuals and society from nuclear accidents.

17.26 In particular, assessment by ONR would consider:

- 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 & 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, & FA.25) and the assurance of (the) validity of data and models (AV.1 – AV.8).

17.27 Relevant TAGs (Ref 33) that inform such assessment include the technical assessment of REPPIR submissions, PSA, validation of computer codes and calculation methods and radiological analysis – fault conditions.

17.28 The technical assessment of REPPIR submissions TAG reflects IAEA Safety Standards in describing how a proportionate approach is applied, addresses ONR's interpretation of reasonably foreseeable, and presents ONR's expectations for the comprehensiveness of the hazard review relevant to RoA and HIRE assessments.

17.29 ONR's determination of the area affected within REPPIR may conclude that the area affected should differ from the range of distances outlined in the IAEA guidance (Ref. 137). This is because the technical basis for REPPIR differs from that used by the IAEA, for the following reasons:

- The IAEA approach is based on restricting severe deterministic effects from high radiation doses incurred off the site, typically doses in excess of 1 Gy. Whereas REPPIR is based on restricting off-site effective doses in excess of 5 mSv.
- The IAEA approach addresses very unlikely high consequence events, whereas REPPIR is based on the concept of reasonably foreseeable radiation emergencies.
- The concept of extendibility within the UK framework for nuclear emergency planning provides the basis for dealing with the very unlikely high consequence events which affect a large area.
- The IAEA approach (Ref. 139) contains the provisions for use of alternative distances if substantiated by a detailed safety analysis. REPPIR requires such detailed analysis for UK nuclear facilities.

17.30 The IAEA IRRS acknowledged in 2009 (Ref. 140) that "the UK's planning zones achieve an equivalent capability to those of IAEA, but the terminology used is different."

17.31 PSRs required by LC 15 include consideration of the extent to which the licensing basis remains valid (including demographic considerations and their potential impact on SAP targets relevant to the potential exposure of persons off site). It also includes and any changes to the nature and significance of any internal or external hazards that may impact on the adequacy of the arrangements in place to maintain safety until the next PSR. This ensures that the plant design still meets its original intent and that all reasonably practicable safety improvements are implemented (see Article 6).

Planning and demographic controls

17.32 The UK Government maintains a policy relating to the control of population around nuclear sites. The National Policy Statement for Nuclear Power Generation (EN-6 Vol II page 266, July 2011) (Ref.135) states:

> *"The Government has a longstanding policy regarding local demographics which would limit the radiological consequences to the public in the unlikely event of an accident involving the spread of radioactive materials beyond the site boundary. This policy is a measure of prudence over and above the stringent regulatory requirements imposed on nuclear operators in order to prevent such accidents.*
>
> *The Office for Nuclear Regulation administers the Government's policy on the control of population around licensed nuclear sites. The Office for Nuclear Regulation fulfils this function throughout the entire life cycle of the installation through consultation with local authorities. This ensures that until the installation is delicensed, the basis for site licensing is preserved through constraints placed on the surrounding population by controls on future development*."

17.33 Local planning authorities consult the ONR with regard to 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.

17.34 The National Planning Policy Framework and Planning Policy Guidance on Hazardous Substances (in England & Wales) (Ref. 141) & Planning Circular 3/2015 Planning Controls for Hazardous Substances (in Scotland) (Ref. 142) provide guidance on the exercise of planning control over hazardous development and over development in the vicinity of hazardous installations (including nuclear installations).

17.35 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 & Scotland) (Ref. 143) 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.

17.36 ONR's inspectors assess such planning applications to determine:

- whether the external hazards from a proposed nearby hazardous installation could affect nuclear safety, or otherwise ensure that the existing safety case is not compromised, or alternatively whether the nuclear safety case can be modified and justification provided to incorporate the new hazard. The ONR inspector would normally rely on the licensee of the affected site to demonstrate whether its safety case(s) remain valid or not;
- whether, for a proposed development within the nuclear licensed site, the licensee has made a satisfactory safety case for the proposed development and for any existing licensable activities on the site that it would impinge upon, and whether the proposed activity is suitable for the nuclear licensed site; and

- for a proposed development within the off-site emergency planning area (where applicable), ONR refers the application to the licensee, who must in turn liaise with those bodies having responsibilities under the off-site emergency plan. This is to find out whether the development can be incorporated into the emergency plan, or failing that, whether the emergency plan could be modified to incorporate the development into the emergency plan.

17.37 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.

17.38 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.

17.39 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 6 include requirements that the radiological risk from the nuclear installation under review will remain acceptable during the period covered by the reviews. This is done as part of the normal regulatory process and during the PSRs. In addition, ONR maintains a database of the estimated population around nuclear installations, based upon the most recent ten-yearly population census, updated to take account of subsequent planning applications for residential developments.

Procedures 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

17.40 Operating experience and changes in technology, relevant good practice and safety standards are addressed during the PSR. Operating experience feedback (UK and International) is also continually reviewed by the operational experience team within ONR, who generate targeted briefings that then inform regulatory intervention strategies. The scope and timescales associated with any additional regulatory intervention would be proportionate to the safety significance of the event.

17.41 ONR publishes the assessment findings relating to PSRs (Ref. 144).

17.42 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. ONR would request that relevant nuclear site operators 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 operator 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.

17.43 ONR would monitor and assess the adequacy of progress made by the UK nuclear industry until satisfied that the significant lessons learnt from the event have

been adequately discharged. It will, if necessary, use its regulatory powers to ensure that all reasonably practicable improvements are implemented.

17.44 Reports relating to the re-evaluation of nuclear safety in the UK following the nuclear accident at Fukushima and the progress in implementing the lessons learnt are published by ONR (Ref. 34).

Procedures for consulting Contracting Parties in the vicinity of a proposed nuclear installation

17.45 In accordance with Article 37 of the Euratom Treaty (Ref. 145), the UK Government provides the European Commission with general information relating to a proposed nuclear installation (including details of the site and its surroundings, the nature of the installation, radioactive waste discharges from normal operations & 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.

17.46 EIA regulations (Ref. 139) transpose the requirements of EU Directive 85/337/EEC (as amended) into UK law and requires consultation with other EEA States regarding developments that may have significant effects on the environment in those States (discussed above).

17.47 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 agencies safety work streams. ONR is also a member of MDEP, collaborating with other foreign national regulators looking at new reactor designs. In the European context we co-operate with both our fellow members of the EU through groups such as ENSREG and throughout the continent via groups such as WENRA.

17.48 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.

17.49 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 - we are supportive of the continuing efforts of the Convention President and secretariat to achieve greater engagement by all Contracting Parties.

17.50 In the event of a nuclear emergency within the UK, the RIMNET, operated by DECC, 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 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).

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;

18.1 Arrangements for compliance with this Article of the Convention have not substantially changed since the Sixth UK Convention Report (Ref.3) (i.e. in a way that has implications for the Convention obligations). However, the structure of the report has been updated to reflect the template for drafting of national reports (Ref. 17) and additional content has been added to address the Vienna Declaration on Nuclear Safety. The content has also been updated to reflect the current status of the GDA programme, and actions arising following the Fukushima accident.

18.2 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 ONR Safety Principles with IAEA Standards

18.3 ONR's inspectors use SAPs (Ref. 29), together with supporting TAGs (Ref. 33), 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. 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. 146). 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 acknowledge that these SAPs cannot reflect the breadth and depth of the entire suite

of IAEA publications and so, as guidance is updated, we explicitly identify those documents as relevant good practices within the TAGs.

Implementation of defence-in-depth

Contracting Party's arrangements and regulatory requirements

18.4 As discussed earlier in this report (for example, Article 14), 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, 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.

18.5 ONR's SAPs provide numerical targets to judge whether radiological hazards are being adequately controlled and risks reduced to ALARP. The targets quantify ONR's risk policy. More specifically, the targets are guides to inspectors to indicate where additional safety measures may need to be considered and, in the case of permissioning decisions, to help judge whether risks are tolerable. In assessing the safety of nuclear facilities, inspectors examine the safety case to judge the extent to which the targets are achieved. Some of the targets are in the form of dose levels; others are expressed as frequencies or risks. Each is set in terms of a basic safety level and a basic safety objective. It is ONR's policy that a new facility or activity should at least meet the basic safety levels, however, even if the levels are met, the risks may not be ALARP. In such cases, the designer/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

18.6 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 in Article 14) 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.

18.7 DBA should be carried out to provide a robust demonstration of the fault tolerance of the engineering design and the effectiveness of the safety measures. Relevant good practice in the UK is that the design basis should include internal faults in the facility that have an initiating frequency down to 1×10^{-5} per year and natural hazards that conservatively have a predicted frequency of down to 1×10^{-4} per year.

18.8 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.

18.9 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.

18.10 The 2014 SAPs do not vary significantly with regard to 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' (also discussed in Article 14).

Consideration of external and internal hazards

18.11 External hazards are defined for use in plant design and DBA in terms of design bases, as described in SAPs EHA.3 & EHA.4. Design bases are defined by characterising the site and identifying all credible external hazards events that could affect the site. 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' to which the plant has to appropriately withstand. ONR inspectors test the plant design against the body of world-wide relevant good practice (including from IAEA and WENRA) and using the engineering and fault analysis SAPs generally.

18.12 There are some special features of external hazards that set them apart from internal hazards or internal plant faults, and require special consideration. 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.

18.13 Natural hazards, for example, earthquake, extreme weather, external flood, etc. are characterised by hazard curves describing a range of frequency/hazard severity possibilities. The design bases defined conservatively at 1×10^{-4} per year are therefore only a partial description of the hazard – essentially a surrogate description solely for the purposes of feeding into the design process. The plant will respond to more severe hazard events at frequencies below 1×10^{-4} per year, so an additional analysis activity called Beyond Design Basis Analysis (BDBA) is needed. Again there is substantial relevant good practice world-wide 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.

18.14 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).

18.15 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.

18.16 As part of ONR's commitment to continuous improvement in nuclear safety, it has applied the lessons from the Fukushima event in the latest update to the SAPs. Those relevant to external hazards have been improved in the following ways:

- SAP EHA.18 has been added to bring more clarity to regulatory expectations on external hazards beyond design basis analysis. The text supporting this principle specifically refers to the need for licensees to identify the point at which loss of safety function occurs.
- SAP EHA.7 is an existing principle referring to beyond design basis cliff-edge failures. The supporting text has been improved so that together with principle EHA.18, the SAPs provide comprehensive guidance on beyond design basis analysis, in line with learning from the Fukushima accident.
- SAP EHA.19 has been added to bring more clarity to the regulatory expectations on hazard screening, so that all hazards that could credibly provide a significant contribution to nuclear risk are effectively captured and form part of the safety analysis of the site.
- External hazards have now been classified as 'discrete' hazards if they can be described by one or more discrete severity/frequency of occurrence data pairs. They are classified as 'non-discrete' hazards if they are defined by a hazard curve, which is the case for earthquake hazard. This important distinction has enabled improved guidance to be provided on what is meant when non-discrete hazards are defined in terms of exceedance frequencies, rather than discrete point frequencies. This in turn has enabled better guidance to be provided on the importance of BDBA for non-discrete hazards, when the design basis itself is formulated as a single hazard severity value at a specified frequency of exceedance. The limitations of defining non-discrete hazard design bases in this way are noted and the importance of BDBA highlighted as a result.
- Improvements have been made to the text supporting SAP EHA.12 on extreme flooding, including positive reference to the IAEA concept of achieving a design based on the 'dry site' concept.
- The SAPs generally, and especially those referring to external and internal hazards, now provide a much stronger connection between the engineering design principles and those relating to fault analysis, including the need for PSA. This again is a response to the learning form Fukushima.

18.17 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).

18.18 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.

18.19 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.

Consideration of defence-in-depth

18.20 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. 1) 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.

18.21 Defence-in-depth is generally applied in five levels, which should be, as far as practicable, independent from one another (SAPs, Ref 29, para 152). 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 5 below.

Table 5 – 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,	Additional measures and procedures to protect against or mitigate fault progression and for

	including protecting against further fault escalation and mitigation of the consequences of severe accidents.	accident management.
Level 5	Mitigation of radiological consequences of significant releases of radioactive material.	Emergency control and on and offsite emergency response.

18.22 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.

18.23 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).

18.24 In some cases, relevant good practice established in the SAPs exceeds international guidance, for example, it is expected that all nuclear power plants, whether operating or new, have two diverse means of delivering key nuclear safety functions for all frequent design basis faults (defined by ONR to have an initiating frequency > 1×10^{-3} per year). Both of these means need to be formally identified, claimed and substantiated in the safety case, and then maintained and tested appropriately for a Level 3 measure.

18.25 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.

18.26 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 LC 11 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

18.27 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.

18.28 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.

18.29 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 sea-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.

18.30 Further details on the application of defence-in-depth for the operating reactors are provided in Annex 4 (part 1).

18.31 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. An overview of key aspects of the design in relation to defence-in-depth is given in Annex 4 (part 2).

External hazards

18.32 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.

18.33 As already discussed in Article 14, all the stations have undertaken substantial 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.

18.34 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.

18.35 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, BDBA 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.

18.36 Sizewell B has modern standards seismic PSA, but otherwise there has been very little quantitative risk analysis of plant response to external hazards for the operating reactors.

18.37 Following the Fukushima accident, and under the auspices of ENSREG, licensees were directed by ONR to apply ‘stress tests’ at each licensed site as a one-off application of site LC 15. The results from these stress tests at each site were reported to ONR in the form of safety case type submissions. These were assessed by ONR and a number of regulatory findings made. Those related specifically to external hazards are listed below (Ref. 6):

- STF-2: The nuclear industry should establish a research programme to review the seismic hazard working party methodology against the latest approaches. This should include a gap analysis comparing the methodology with more recent approaches such as those developed by the senior seismic hazard analysis committee.

- STF-3: Licensees should undertake a further review of the totality of the required actions from operators when they are claimed in mitigation within external hazards safety cases. This should also extend into beyond design basis events as appropriate.
- STF-4: Licensees should undertake a further systematic review of the potential for seismically-induced fire which may disrupt the availability of safety-significant structures, systems and components in the seismic safety case and access to plant areas.
- STF-5: Licensees should further review the margins for all safety-significant structures, systems and components, including cooling ponds, in a structured systematic and comprehensive manner to understand the beyond design basis sequence of failure and any cliff-edges that apply for all external hazards.
- STF-6: Licensees should review further the margin to failure of the containment boundary and the point at which containment pressure boundary integrity is lost should be clearly established for the AGRs and Magnox stations.
- STF-7: Licensees should undertake a more structured and systematic study of the potential for floodwater entry to buildings containing safety-significant SSCs from extreme rainfall and / or overtopping of sea defences.

18.38 The state of operating reactor design basis safety cases, when tested against the stress tests, was largely sound. There were a large number of minor issues identified either by the licensees themselves or by ONR. A major review of extreme flooding by the licensees revealed concerns at a small number of sites and a significant concern at Dungeness B. Following identification of this significant issue, a substantial modification was made to the site to add a flood protection wall around the whole site, to augment the existing coastal flood protection to the seaward facing site frontage. ONR monitored the implementation of this modification and is content that the protection afforded now meets relevant good practice.

18.39 Several other findings were also relevant to external hazards, especially those relating to severe accident progression and emergency arrangements. Across all reactor sites, there have been major improvements in the licensee's emergency arrangements and severe accident guidelines. All sites have now implemented removable 'damboards' to protect sensitive buildings from flooding. Also, substantial additional back-up equipment is now available (so called resilience enhancement equipment). This provides additional capability to respond to any external hazard-driven severe events should they occur.

18.40 The progress of operating reactor licensees in addressing these findings has been reported annually since 2011, with the most recent update in 2016 (Ref. 34). The work required is mostly complete but residual work is still ongoing to fully address all of the findings.

18.41 The UK licensee's guidance for hazard identification has included combined and consequential hazards for some time. This guidance has been used in recent PSRs and other hazard safety case reviews. The guidance was itself reviewed following Fukushima to ensure that the combinations of related external and internal hazards reflected lessons learned. As part of improvements to the licensee's periodic review process, the licensee has initiated a continuous improvement model, which includes regular reviews of the health of their safety cases and regular zonal walk-downs to challenge or confirm their hazards safety cases, based upon the current guidance.

18.42 Paragraph 773 of the SAPs sets the expectation that the scope of the accident management and emergency preparedness strategies and plans should include accidents affecting multiple facilities. The licensee of the Heysham 1 and 2 sites (two adjacent AGR stations with a total of four reactors) has carried out a demonstration exercise to test the response arrangements to a beyond design basis event that simulated the loss of cooling function to all four reactors. The multi-reactor exercise demonstrated that:

- the Heysham 1 and 2 sites can work together effectively to plan the deployment of off-site deployable back-up equipment to restore critical cooling function;
- the central emergency support centre has the ability to support two stations simultaneously; and
- the human performance arrangements can maintain the response capability over a prolonged period.

Use of design principles

Introduction

18.43 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 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

18.44 ONR's SAPs set out engineering principles that have been benchmarked against IAEA and other international guidance, examples are summarised in Table 6 below. 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.

Table 6 – 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	Safety should be secured by characteristics as near as possible to the top of the list below: (a) Passive safety

(EKP.5)	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	When designing systems, dependence on human action to maintain and recover a stable, safe state should be

actions (EHF.2)	minimised. The allocation of safety actions between humans and engineered structures, systems or components should be substantiated.

Examples of the application of design principles

18.45 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 CO_2 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 located in pairs in two separate buildings.

18.46 The designs for the proposed new reactors have been / are being assessed by the regulator against the latest SAPs and relevant international good practice. Further details of key design features can be found in Annex 4 (part 2)

Implementation of beyond design basis design measures

18.47 As a result of a renewed consideration of modern safety case practice, a number of areas for further safety improvements were identified and implemented by the operator. 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.
- 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
- Robust means for transportation of equipment and personnel to the site post-event.
- The resilience measures have been reviewed to allow the plant operators to recover cooling / containment. The resilience provisions specifically for the AGRs include; primary circuit cooling support, secondary circuit cooling support, buffer store fuel management and ponds fuel management.
- As part of this, consideration has been given to how the plant operators can recover electrical supplies in the event of a station blackout. In such an extreme event, the strategy is to use off-site located back-up generators to cover a period of 72 hours (after which higher-capacity generators may be deployed). The aim is to recover critical plant operations or to assist in the accident management activities (emergency lighting, battery charging, operation of selected pumps / valves and operation of certain indications / control logic).
- The above set of improvements include additional guidance to the operators, on-site / off-site personal in order to manage a beyond design basis event, including the use of the newly procured beyond design basis equipment. These arrangements are exercised by the licensee.
- At Sizewell B, a new emergency response centre has been built, two new battery charging diesel generators have been installed along with various connection points for back-up equipment, and passive autocatalytic recombiners have been fitted. Connection points include, for example, installation of a borated containment water injection tie-in to mitigate sequences where the core has exited the RPV.

18.48 There have been improvements to beyond design basis measures for new reactor designs considered under the GDA process and also through the site licensing process for the UK EPR™. There has been a requirement for each of the designs to be reviewed in light of the lessons learnt from Fukushima. Further details of the improvements are given in Annex 4 (part 3).

Implementation of measures to maintain containment integrity

AGRs

18.49 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.

18.50 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.

18.51 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.

18.52 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

18.53 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 recovery of a 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.

18.54 In light water reactors, generation of hydrogen occurs during severe accidents due to oxidation of Zircaloy fuel cladding by steam, oxidation of other metals in the corium and molten core concrete interaction. Sizewell B has ignitors strategically placed within the containment structures to allow controlled burning of hydrogen. Following the events at Fukushima, PARs have been fitted to Sizewell B.

Design improvements as a result of deterministic and probabilistic safety assessments

Changes since last report

18.55 Key focus since the last report has been on completion of the post-Fukushima modifications. Additionally, a number of key improvements have been completed, or are in progress, at a number of operating plants as detailed in Article 6. The improvements take into account the specific circumstances at each of the stations and include:

- Installation of super-articulated control rods and seismically qualified nitrogen injection systems at Hinkley Point B and Hunterston B.
- Large-scale flooding improvements have been implemented at Dungeness B to re-establish the design intent with additional beyond design basis margin.

- Modifications at Dungeness B to automatically initiate boiler depressurisation and feedwater isolation to the affected boiler following tube rupture, thereby minimising water ingress into the reactor. This brings the station into line with the other AGRs.
- Passive Autocatalytic Recombiners have been installed in the Sizewell B containment to mitigate hydrogen generation under accident conditions.

Overview of main improvements since commissioning

18.56 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).

18.57 Subsequent PSRs have focused more on ageing issues, although this has also resulted in additional defence-in-depth measures being identified, particularly in relation to boiler tube aging and protection against water ingress to the reactor:

- Vessel overpressure protection equipment systems.
- Busting discs on safety relief valves.
- Moisture monitoring systems.
- Quadrant feed trip (Heysham 1 and Hartlepool).
- Gas circulator protection system.

Regulatory review and control activities

GDA and new reactor build

18.58 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 particular site. GDA ensures technical assessments are conducted before reactor construction starts. This means that regulatory questions and challenges can be addressed while the designs are still ‘on paper’. It also provides a greater opportunity to identify those improvements that will result in the best safety outcome. The GDA process was described in detail in the fifth UK report to the Convention and is mentioned in several other places in this report (eg, Article 14). In addition, substantial amount of information is available on ONR’s website (Ref. 117). Progress with the GDAs for the AP1000® and UK ABWR is discussed in Section A.

Licenced sites

18.59 The granting of a nuclear site licence (refer to Articles 7 and 14) is a significant step but is not itself permission to start nuclear-related construction. That requires a regulatory permission under a licence condition, 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.

18.60 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 for further discussion on nuclear power plant safety cases.

18.61 Subsequent design and construction changes are controlled by LC 19 and LC 20. LC 19 requires the licensee to make and implement adequate arrangements to control the construction or installation of a new plant. If safety-related modifications to the design arise during the construction phase, their implementation is controlled by arrangements made under LC 20.

18.62 ONR set up a special regulatory oversight group to monitor the licensee's response to the Fukushima accident. The licensee's response resulted in a number of the modifications to the plants and arrangements, as described above. This group maintained regulatory oversight to ensure that the measures proposed by the licensee met ONR's expectations, informed by worldwide activities. Where the licensee had to make physical modifications which directly affected a plant, these modification were monitored as part of the normal regulatory framework. LC 22 requires the licensee to inform ONR of any modifications to plant and where appropriate, ONR will assess these modifications and grants permission to the modification.

Compliance with the Vienna Declaration on Nuclear Safety

18.63 The information and evidence provided in the above sub-sections of Article 18 contribute to demonstrating that the UK meets the aims of the three principles of the Vienna Declaration on Nuclear Safety, all related to the objective of the Convention on Nuclear Safety, to prevent accidents with radiological consequences and mitigate consequences should those accidents occur.

18.64 The first principle of the Vienna Declaration requires that new nuclear power plants be designed consistent with the objectives of preventing accidents. In the unlikely event of an accident, the licensee must mitigate any release of radionuclides causing long-term off-site contamination, and avoid large or early radioactive releases. The previous sub-sections have stressed the importance placed in the UK on defence-in-depth. Information has been provided on how fault and accident

conditions, including internal and external hazards, beyond design basis and severe accident scenarios, are considered in the analyses underpinning the design.

18.65 The second principle of the Vienna Declaration requires that comprehensive and systematic safety assessments be carried out periodically and regularly for existing installations throughout their lifetime. This is to identify (and implement in a timely manner) reasonably practicable safety improvements. This was discussed in detail in Article 14 and its importance is once again highlighted in Article 18 (see also text below on incorporation of proven technologies).

18.66 The third principle of the Vienna Declaration calls for national requirements and regulations to take IAEA Safety Standards and other good practices into account. This Article has explained how ONR's SAPs have been benchmarked against the IAEA standards twice in the last decade. The most up-to-date WENRA reference levels were also used to update the SAPs. IAEA standards, WENRA reference levels and other relevant good practice are explicitly referenced in the ONR TAGs that support the SAPs. The use of relevant good practice is at the core of UK nuclear regulation. The first and most important way for a UK dutyholder to show that the nuclear power plant risk is ALARP is demonstrating that relevant good practice has been used in the design and safety analysis.

Incorporation of proven technologies

Contracting Party's arrangements and regulatory requirements

18.67 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 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. 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).

18.68 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 with regard to 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 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;
- ensure that codes and standards are evaluated to determine if they are suitable and sufficient. Where necessary these standards and codes should be supplemented as necessary to a level commensurate with the importance of the safety function being performed;
- ensure that the amalgamation of different codes and standards for a single aspect of a safety system or safety-related system is either avoided or appropriately justified to demonstrate compatibility;

- ensure that 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
- ensure that 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).

18.69 With regard to 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).

18.70 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.

18.71 ONR's SAPs (Ref. 29) 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 & 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.

18.72 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.

18.73 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.

18.74 SAPs EAD.3 – EAD.5 require that arrangements should be in place for the recording and retrieval of lifetime data. This is supported by LC 28 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.

18.75 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.

18.76 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 addresses operational feedback and nuclear safety research.

Measures taken by the licence holders to implement proven technologies

18.77 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.

18.78 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 also Articles 6 and 14 for further details on PSRs.

18.79 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.

18.80 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.

18.81 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.

18.82 The AP1000® being considered in GDA is an example of where novel features have been proposed in a design for the first time in the UK. As a result, Westinghouse has provided a large amount of analytical and test data to support its claims and this evidence has received significant regulatory attention. This attention will continue throughout the assessment, licensing, construction and commissioning phases.

Methods for qualification of new technologies, such as digital C&I

18.83 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.

18.84 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.

18.85 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

18.86 Article 14 explains regulatory assessment of safety submissions and verification by ONR. Taken together, these activities describe in general terms how ONR implement 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.

18.87 Once in service, the processes described in Article 14 under verification by ONR, identify activities which ensure that the basis for the safety submissions are not challenged and the design remains within the envelope defined by the safety case. Important work is also undertaken during the LC 30 periodic shutdowns where the reactors are shut down to enable the necessary inspection and testing to be undertaken. This includes inspection work on, for example, confirming that the AGR graphite core, boilers, and steam and feed pipework remain within the limits of the current safety cases. Formal permission to re-start the reactor is only given if ONR is satisfied that the reactor is within the envelope defined by the current safety case.

Design for reliable, stable and manageable operation

Contracting Party's arrangements and regulatory requirements for human factors and human-machine interface

18.88 The specific arrangements by which ONR enforces, and UK licensees consider human factors and human machine interfaces is described in detail within Article 12 and Article 11 (in relation to training). To avoid repetition it is only summarised here.

18.89 Reliable, stable and easily manageable nuclear power plant operation in UK is assured by, inter alia, consideration of all aspects of human factors by both ONR and licensees in all design and operation phases, plant states and accident conditions.

18.90 ONR recognises the importance of this and has long-established and regularly updated SAPs, TAGs, and licence conditions, which reflect internationally recognised relevant good practice, which includes IAEA standards. These ensure that human factors are considered throughout the nuclear lifecycle.

18.91 Two of ONR's human factors SAPs EHF.6 and EHF.7 set the design expectations that:

- Workspaces in which plant operations and maintenance are conducted should support reliable task performance by taking account of human perceptual and physical characteristics and the impact of environmental factors.
- User interfaces, comprising controls, indications, recording instrumentation and alarms, should be provided at appropriate locations, and should be suitable and sufficient to support effective monitoring and control of the plant during all plant states.

18.92 Reliable, stable and easily manageable operation is also achieved organisationally via the careful selection (SAPs EHF.11 and EHF.12), training (SAP EHF.8), control and supervision, of sufficient operators (SAP EHF. 8), who are, in turn, supported by procedures (SAP EHF.9) and a task design (SAPs EHF.2, EHF.3 and EHF 5), which takes into account the limitations of human performance during all operational states. Further, for licensees, it is a legal requirement under LC 36 to provide evidence that the organisation has sufficient human resources to maintain the nuclear safety function.

18.93 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

18.94 UK licensees recognise the importance of human factors and their internal arrangements reflect this. For example, EDF NGL has continuously developed its suite of proprietary human factors design guidance safety case guidance, human reliability methods (the Nuclear Action Reliability Assessment tool), administrative control guidance and organisational learning guidance.

18.95 New designs currently being assessed for suitability for deployment within GB 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.
- 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

18.96 In developing its intervention strategies, ONR specifically targets human factors themes to inspect and assess licensee arrangements. Further detail on ONR's regulatory assessment and permissioning of safety submissions and verification can be found within Article 14.

18.97 For new nuclear build projects, ONR follows a similar staged permissioning process (described in more detail in Article 14) 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.

18.98 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.

18.99 Review and control is 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 in Article 12.

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;

19.1 Under this Article, compliance with the Convention has not substantially changed since the Sixth UK Convention Report (Ref.3) (i.e. in a way that has implications for the Convention obligations), but has been updated to reflect changes made in the UK to the reporting of incidents and operating experience feedback.

19(1) – Initial authorisation

19.2 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 and Annex 1). ONR, through its inspection and assessment activities (see Article 14) judges compliance with the licence conditions throughout all of the lifecycle phases. EDF NGL has produced a set of principles to demonstrate compliance with the nuclear site licence. These principles are supported by compliance statements for each of the nuclear site licence conditions. The compliance statements make reference to the specific company procedures that detail the arrangements by which EDF NGL ensure compliance with the relevant nuclear site licence condition.

19.3 During each licence compliance inspection, ONR judges the adequacy of the associated company arrangements using its inspection guidance and other relevant good practice such as IAEA Safety Standards.

19.4 EDF NGL's arrangements for the control of a new plant is referenced in the compliance statements for LC 19, LC 20 and LC 21 specifically apply to the construction, installation and commissioning of a new plant. 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 LC 14 – safety documentation.

19.5 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.

19.6 Each of the safety cases are categorised by their safety significance and are authorised by appointed persons. These are then subject to the appropriate internal peer review and, for the most safety significant, ONR may need to assess and agree. In addition, EDF NGL has a number of scrutiny panels to continually assess the adequacy of the project. These include a project safety review group and a test and commissioning panel. Each of these groups includes a number of suitably qualified and experienced people covering all aspects of the project.

19.7 Articles 14 and 18 of this report address the safety analysis undertaken during the design and prior to the initial authorisation to operate a nuclear installation. The GDA process was established by the nuclear regulators for new nuclear reactor designs, to determine if they would in principle be acceptable to build in the UK.

19.8 The commissioning of a nuclear installation is regulated by ONR in accordance with the requirements of LC 21. 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.

19.9 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.

19.10 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 LC 21 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. LC 21 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. LC 23 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 LC 21.

19.11 Where appropriate, the licence requires commissioning to be undertaken in stages and ONR's formal agreement must be sought before the commencement of each stage. A typical programme will comprise stages of inactive commissioning followed by stages of active commissioning. ONR will not give its formal agreement to the commencement of routine operations until the inactive and active commissioning tests are available to wholly substantiate the safety case. Furthermore all the necessary documents, including commissioning records, are required to be in place to support the future safe operation and maintenance of the plant. 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.

19(2) - Operational limits and conditions

19.12 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.

19.13 EDF NGL, through its safety cases, defines a safe operating envelope via a set of operational parameters, within which the power station is required to operate. This envelope represents a bounding condition from which fault transients can be assumed to start.

19.14 The acceptable safe operating envelope was originally defined in operating safety rules. These were originally operating rules and identified operating instructions but were fully replaced by technical specifications.

19.15 Technical specifications are used to ensure that the station is always operated within the safe operating envelope, defined by the Nuclear Safety Requirements and supported by the limiting conditions for normal operation. 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.

19.16 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.

19.17 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.

19.18 The plant operators undergo regular training in the requirements and application of the technical specifications, especially following amendments, through classroom based, directed reading and training on the reactor simulator. The technical specifications are written jointly by safety case engineers and operators and tested and refined through reactor simulator training sessions. ONR reviews the adequacy of the technical specifications through its LC 23 and LC 24 compliance inspections and assessment of safety cases. This often involves observation of the operator training and attendance at some of the training courses. In recognition of

their specific duties, reactor desk engineers are appointed duly authorised person status, as required under the nuclear site licence. This has been previously covered under Articles 11 and 12. Changes to the technical specifications are subject to a similar process to the production and revision of safety cases in that they are subject to rigorous change control procedures, dependant on the safety significance of the change.

19(3) - Procedures for operation, maintenance, inspection and testing

19.19 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.

19.20 As stated above, EDF NGL has company procedures to ensure compliance with all the nuclear site licence conditions. These include 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.

19.21 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 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.

19.22 EDF 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.

19.23 EDF NGL's arrangements ensure that all relevant staff at the power stations are fully involved in the development of all procedures required for safe operation, maintenance, inspection and testing. Through the actual 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.

19.24 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 NGL has defined for modifications to plant and safety cases, as required under LC 22.

19.25 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.

19.26 All UK operating nuclear reactors are required to shut down at specified intervals for inspection and testing. These periodic shutdowns (required under LC 30) occur every 18 months to three years, depending on the reactor type. Once shutdown, the reactor cannot be restarted without the formal consent of ONR. Prior to issuing a consent, ONR needs to be satisfied that all necessary maintenance, inspection and testing has been completed, that the licensee has fully evaluated its findings and that the safety case remains valid. This evaluation may identify any necessary changes to the type and frequency of maintenance, inspection and testing.

19(4) - Procedures for responding to operational occurrences and accidents

19.27 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 LC 24 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.

19.28 All the EDF 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).

19.29 For the AGRs, if the reactor does not respond to the expectations of 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.

19.30 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.

19.31 ONR's SAPs (Ref. 29) 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.

19.32 Following Fukushima, EDF NGL has undertaken an extensive work programme leading to a revision of both the severe accident guidelines and symptom-based emergency response guidelines. This has been 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.

19.33 The arrangements for dealing with accidents and emergencies are set out under Article 16. There is a site emergency plan together with a site emergency handbook at each reactor site which together forms the 'operators plan' as defined in REPPIR 2001. Although these documents primarily describe the arrangements for dealing with accidents involving the release of radioactivity, they outline the principles to be adopted in dealing with any accident or emergency on the site.

19.34 The emergency organisation is assigned activities and responsibilities to achieve the following objectives:

- To activate the site emergency arrangements.
- To issue appropriate warnings at the correct time and ensure the safe withdrawal of all persons on site to pre-arranged assembly points.
- To rapidly notify all persons and external organisations concerned with implementing remedial actions.
- To assemble and deploy, when necessary, emergency teams to assess and take appropriate action to minimise the consequences of the accident.
- To assess the risk and extent of any potentially hazardous situation and ensure timely advice is given on appropriate measures to safeguard the public and that appropriate measures are taken to safeguard station personnel.
- To minimise and then terminate any release of radioactivity and make the affected plant safe.
- To provide authoritative specialist advice to the police, local authorities and other organisations responsible for taking the necessary action to protect the public and the environment.

19.35 There is a multi-agency off-site plan for each reactor site. The plan is prepared by the emergency planning department of the relevant council authority local to each reactor site. Each off-site plan sets out the multi-agency strategic and tactical management arrangements for dealing with an off-site nuclear emergency. The document provides instruction, information and guidance on the initial strategic actions to be taken to prevent or restrict public and environmental exposure from the effects of a radiation incident. Furthermore, the document describes other emergency plans that may be invoked at the time of an incident, for example, EDF NGL's on-site emergency plan (identified above).

19.36 The nuclear site licence requires the site emergency plan for each reactor site to be formally approved by ONR. Any proposed changes to the site emergency plan must be submitted to ONR for re-approval. ONR observes the demonstration of the emergency plan at every reactor site on an annual basis which allows for any opportunities for learning and improvements to be made.

19.37 There is a legal requirement for the multi-agency off-site plan to be demonstrated at every reactor site every three years.

19(5) - Engineering and technical support

19.38 EDF 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. The nuclear site licence requires that the licensees have access to sufficient technical expertise for all stages of a plant's life.

19.39 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's view is that this is acceptable, providing that EDF NGL retains sufficient expertise to be an 'intelligent customer' of such work.

19.40 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.

19.41 EDF 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.

19.42 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 NGL to bring focus to critical issues affecting the nuclear stations and, by the application of increased focus and priority, return the issues to normal business as safely, as quickly and as efficiently as it is possible to do so.

Research and development – regulatory focus

19.43 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.

19.44 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.

19.45 Nuclear site licensees are responsible for managing the risks of their operations, and the designers and manufacturers of nuclear plant are responsible under the HSWA74 for undertaking the research necessary to identify and reduce these risks. The licensees are required by Licence Condition 23 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).

19.46 ONR's objectives for research are consequently:

- to test claims made in licensees' safety cases where the state of the art recognises there may be significant uncertainties;
- to ensure ONR has continuing access to independent scientific and technical expertise in areas where this is scarce;
- to identify emerging technologies with the potential to provide licensees with new ways of managing and reducing existing risks;
- to identify new information and understanding that might undermine existing safety cases;

- to improve ONR's understanding of potential safety issues associated with technologies proposed for future deployment in the UK, where government has informed ONR that it has sufficient confidence that these may proceed; and
- to enhance the efficiency and effectiveness of the nuclear regulatory system.

19.47 ONR's strategy for meeting these objectives is:

- its Technical Specialisms identify topics that need further research to meet these objectives
- ONR liaises with other public bodies for example, the Environment Agency and UK nuclear industry research boards, to coordinate its research needs with theirs
- The research topics are reviewed, collated and published
- If appropriate, the nuclear industry is invited to commission research to address these topics and share the results with ONR
- If not, ONR commissions the research itself and publishes the results
- ONR does not commission research either to support the commercial development of nuclear technologies or in areas for which other public bodies have regulatory responsibilities or are responsible for providing authoritative advice.

19.48 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.

19(6) - Reporting of events significant to safety

Overview of Contracting Party's arrangements and regulatory requirements

19.49 There are legal requirements outlined in various regulations and in some of the licence conditions (notably LC 7) for notifying ONR of significant events occurring on nuclear sites.

19.50 EDF 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.

19.51 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;

- confirmation of the factual details in the preliminary information;
- conclusions from the licensee's investigation of the event including the cause of the event;
- summary of the mitigation and corrective actions taken or to be taken;
- an outline of learning from the event with any implications for related plant; and
- confirmed INES level ascribed to the incident.

Overview of established reporting criteria and reporting procedures

19.52 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. 147).

19.53 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

19.54 An important part of ONR's role is to investigate incidents, and where warranted take proportionate enforcement action. As an example, ONR served a legal Improvement Notice on EDF NGL following notification of an incident at Heysham 1 power station on 16 March 2015. The incident led to the release of around 30 tonnes of non-radioactive clean CO_2 from a failed pipe in the carbon dioxide storage and distribution plant on site. There was no release of radioactive material, no persons were injured and the two reactors remained operational during the event.

19.55 As stated previously, LC 28 requires the licensee to make and implement adequate arrangements for the regular and systematic examination, inspection, maintenance and testing of its facilities. Following a preliminary investigation, ONR inspectors judged that EDF NGL did not meet this condition of its nuclear site licence and required improvements to be introduced.

19.56 The Improvement Notice required the licensee to address the deficiencies in its LC 28 arrangements with respect to the carbon dioxide storage and distribution plant. In response to the Improvement Notice, EDF NGL carried out a systematic review of the condition of the east carbon dioxide storage and distribution plant and carried out remedial work where necessary. In addition the maintenance policy for the plant was reviewed and revised.

19.57 ONR reviewed the work undertaken and considered that suitable and sufficient work has been undertaken to satisfy the requirements of the notice. EDF NGL is currently applying the lessons learnt from this event to other plants at Heysham 1 and the rest of its fleet.

Policy for use of the International Nuclear and Radiological Event Scale

19.58 The UK complies with the requirements of the IAEA's INES reporting arrangements. For most incidents reported to ONR (those of lesser significance and where the applicable INES level is clear), the INES level is determined by the originator of the report. In other cases, advice is sought from the UK INES national officer, who is the final arbiter in determining the INES rating for any incident. For relevant incidents the dutyholder is expected to assign a provisional INES rating, this is so that any onward international reporting commitments can be made should the rating be at Level 2 or higher on INES. International reporting is made through the IAEA online reporting database by the national officer. There have been no notifications made to IAEA by the UK since the Sixth UK Convention Report.

19.59 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.

Statistics of reported incidents significant to safety for the past three years

19.60 This report includes events that have occurred over a reporting period, from June 2013 to December 2015. Since the Sixth UK Convention Report, there have been a total of 19 incidents rated at Level 1 on INES, which are summarised in Table 7 below.

Table 7 – Summay of incidents and INES ratings

Year	Number	NS Rating						RS Rating	INES Level	
		03	05	07	08	11	12	07	1	2+
2013	**7**	**0**	**6**	**1**	**0**	**0**	**0**	**0**	**7**	**0**
2014	**5**	**1**	**1**	**0**	**1**	**1**	**0**	**1**	**5**	**0**
2015	**7**	**0**	**1**	**0**	**5**	**0**	**1**	**0**	**7**	**0**
Total	**19**	**1**	**8**	**1**	**6**	**1**	**1**	**1**	**19**	**0**

19.61 Of these incidents notified to ONR:

- Eight were categorised as NS05 - Any operation or condition of plant that is prohibited by operational limits and conditions or operating rules.
- Six were categorised as NS08 - Any examination, inspection, maintenance, test, surveillance, alarm, alert, indication or notice that a system, structure or component reveals any matter indicating that the safe condition, including degradation of design safety barriers providing defence-in-depth or safe operation of that plant, may be affected.

19.62 One incident occurred in each of the following categories:

- NS03 - Examination, inspection, maintenance, test or operation of any part of the plant revealing that the safe operation or condition of the plant may be significantly affected.
- NS07 - Any automatic or manual reactor, chemical processing plant or other nuclear facility shutdown as required by the operational limits and conditions, or as a result of other significant safety related considerations.
- NS11 - Significant inadequacy in or significant failure to comply with the arrangements made under a condition attached to the Nuclear Site Licence or permission granted under a Licence Instrument.
- NS12 - Any problem or defect in the design, fabrication, construction, commissioning or operation of the installation that results in, or could result in, a condition that had not previously been analysed or that

could significantly challenge design basis assumptions or the safety case for operation.

- RS07 - Discovery outside a controlled area boundary of radiation or contamination, including contamination on equipment, clothing or skin, significantly above that permitted by the local arrangements.

19.63 Examples of incidents are outlined below:

- NS 7 incident - on an operating AGR station, a fire system operated during the test run of a gas turbine resulted in water ingress into alternator ducts on two gas turbines. The immediate response by the licensee was to initiate a site incident, which was closed following shut down of the reactors. An event recovery organisation was established to manage the recovery and work on the affected gas turbines. The licensee proceeded to implement a number of modifications to ensure that in the event of the accidental activation of the fire system, the gas turbines would not be disabled by the release of firefighting water and station back-up power capability would remain available.
- NS12 incident - the potential for failure of air receivers at an AGR station. The steam release reactor trip system comprises of a number of air compressors and receivers to initiate closing of the boiler's main feed, isolating valves in response to a steam release fault. The boiler arrangement in question incorporates two vertical cylinders secured to the floor in the quadrant of the boiler house. It was determined that in the event of a boiler house fire in the vicinity of these air receivers, they could fail catastrophically , noting that the safety relief valves are not sufficiently sized to release the internal air pressure in the event of such a boiler house fire. The licensee's response to this anomaly was to raise an interim justification for continued operation and to raise an action on the asset management system on nuclear safety group to track the engineering change to resolve the safety case shortfall. Physical protection is also being installed onto the air receivers to protect them from the effects of a fire as an interim measure. It has been confirmed that this issue only affects certain boilers which have the vertically mounted receivers.

19.64 The two examples above illustrate 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

19.65 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.

19.66 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". DECC 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.

19.67 To further enhance its openness and transparency arrangements, ONR published a report on 4 February 2016 – 'Events reported to the Nuclear Safety Regulator in the period of 1 April 2001 to 31 March 2015' (Ref. 21). This report provided information on all of the safety related incidents, reported to it between 1 April 2001 and 31 March 2015 by all nuclear licensed sites in the UK, including those outside the scope of the operating reactors covered by the Convention. This report provides supplementary information to that in the 'Chief Nuclear Inspector's Annual Statement – 2015/16' contained in ONR's Annual Report and Accounts 2015/16 (Ref.93), and to that already placed into the public domain.

19.68 The report notes that ONR's regulatory focus remains on ensuring that dutyholders achieve and maintain high standards of safety and security. However, it recognises that the occurrence of safety related incidents and events (even if predominantly minor in nature) provides opportunities for dutyholders to improve safety, and that ONR actively holds dutyholders to account, on behalf of workers and the public, to ensure that this is done.

19.69 The report notes data limitations prior to 2012 that prevent detailed event analysis, but also sets out the improvements made from 2012 onwards that will allow more meaningful reporting and analysis of the data in the future. This will further support continuous improvement by dutyholders and inform ONR's future regulatory focus.

19.70 The data, as published, suggests a small number of high level conclusions as follows:

- There has been an increase, over recent years, in the rate of reporting of incidents of no or very low nuclear safety significance, which is consistent with a positive, proactive and developing safety culture amongst dutyholders. This is welcomed, as a mature and open reporting culture is important in order to achieve the highest standards of safety. This increase in reporting of very minor incidents, in part, reflects an increased focus on reporting by dutyholders, even if the incident did not result in any adverse safety outcome. It is also a reflection of the broadening of the scope of ONR's regulatory activities to areas other than nuclear safety (for example, conventional health and safety, radioactive materials transport safety).
- Of the 3866 incidents reported to ONR during the period covered by this report, the nuclear safety significance of 3857 (more than 99.7%) was very low (rated at or below level 1 – anomaly on INES).
- Eight events, only one of which has occurred since 2009, were rated at the next significance level of the scale (INES level 2 – incident).
- One event - that occurred ten years ago - was of sufficient significance to be rated at Level 3 on INES (serious incident); this event was not associated with any of the operating nuclear reactors, i.e. was outside the scope of the Convention.
- None of the more significant events reported had any detrimental effect on public safety or the environment.

19.71 In addition to the list of events contained in the report, a small number of case studies were also included to provide examples of the sorts of responses to a range of events by the dutyholder, and by ONR.

19.72 These exemplify ONR's approach to regulatory enforcement and the influencing of dutyholders in accordance with its EPS, and of ONR's commitment to ensuring that necessary improvements are delivered.

19.73 The report notes that ONR uses the intelligence gained from incident reports, in conjunction with information gained through its other regulatory activities, to inform its future regulatory focus and priorities. In this way, ONR is able to secure effective oversight of the delivery of safety improvements and to maintain a focus on addressing themes and any identified adverse trends. It is ONR's intention to publish future reports of events reported to it, and to continue to review the nature of information reported in order to further increase its transparency and usefulness.

19(7) – Operational experience feedback

19.74 Recognising that effective organisational learning is an important element of a strong nuclear safety culture, ONR's SAPs set out specific regulatory expectations for nuclear licenses' operating experience feedback programmes. One of the SAPs requires that organisations have effective processes for seeking out, analysing and acting upon lessons from a wide range of sources within the licensee's organisation. 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.

19.75 EDF 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. 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.

19.76 Functional units within the licensee organisation carry out self-assessments to evaluate the performance of work and identify areas for improvement. The process is supported by benchmarking which seeks to identify opportunities for improvement from interactions with other power stations and 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.

19.77 EDF 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 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.

19.78 EDF 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.

19.79 As part of its international operational experience feedback processes, ONR liaises routinely with EDF 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 for operating experience.

Regulatory review of licence holder

19.80 In determining its response to incidents notified to ONR, it applies the key principles underpinning its EPS 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, SFAIRP.

19.81 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).

19.82 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 EPS.

19.83 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.

19.84 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.

19.85 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 in Article 16.

19(8) Management of spent fuel and radioactive waste on the site

19.86 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.

19.87 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 LC 7. Each site has a discharge authorisation issued by the appropriate environment agency. The licensee must demonstrate how it complies with such authorisations.

19.88 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 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.

19.89 LC 33 requires the disposal of radioactive waste to be in accordance with an authorisation granted under RSA93 in Scotland and EPR10 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 EPR10. These authorisations or permits also require that operators use best practicable means or best available techniques, respectively, to minimise the creation of radioactive waste.

19.90 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. 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.

19.91 The management of spent fuel at the Sizewell B PWR has been covered previously in Article 6.

19.92 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.

19.93 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.
- 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 is made up of material such as clothing, packaging and paper which has been lightly contaminated during operations in the radiologically controlled area. These wastes are transferred via a number of means to low level waste facilities on each station. Active, compactable waste is reduced in volume by the use of techniques such as shredding and compaction, prior to disposal. Non-compactable waste is, where reasonably practicable, reduced in volume prior to disposal.

Section C

Annex 1 - Extracts from legislation relevant to the Convention

Extracts from Part 3 and Schedule 8 of The Energy Act 13 relevant to the convention.

A1.1. The Energy Act 13 (Ref. 7) commenced on 1st April 2014. Part 3 of that Act (and the associated Schedules 6-12) established ONR as a Statutory Body and enforcing authority, separate and distinct from the Health and Safety Executive. Schedule 8 is of particular relevance as it details the powers of inspectors and the key elements of the enforcement regime.

A1.2. The Energy Act 2013, coupled with consequential amendments to the wider family of Nuclear Law in GB, established ONR's purposes, routes to enforcement and regulatory vires. Of key importance to the convention, Sections 1, 3-6, 22 and 24A of the Nuclear Installations Act 1965 (Ref. 8) which were formerly relevant statutory provisions of HSWA 74 (Ref. 9), but since 1st April 2014, are now relevant statutory provisions of the Energy Act 2013.

Part 3

A1.3. **67 The ONR's purposes**

In this Part, "the ONR's purposes" means:

(a) the nuclear safety purposes (see section 68),
(b) the nuclear site health and safety purposes (see section 69),
(c) the nuclear security purposes (see section 70),
(d) the nuclear safeguards purposes (see section 72), and
(e) the transport purposes (see section 73).

A1.4. **Section 74 allows ONR to propose the creation of new nuclear regulations**

A1.5. **74 Nuclear regulations**

(1) The Secretary of State may make regulations (to be known as "nuclear regulations") for any of the following purposes—
(a) the nuclear safety purposes;….
(2) Schedule 6 (which gives examples of particular kinds of provision that may be made by nuclear regulations) has effect.
(3) Nuclear regulations may—
(a) confer functions on the ONR;
(b) create powers which inspectors may be authorised to exercise by their instruments of appointment under paragraph 2 of Schedule 8;
(c) create offences (as to which see section 75);
(d) modify—
(i) any of the provisions of the Nuclear Installations Act 1965 that are relevant statutory provisions;
(ii) any provision of the Nuclear Safeguards Act 2000;
(e) provide for exemptions (including conditional exemptions) from any prohibition or requirement imposed by or under any of the relevant statutory provisions;
(f) provide for defences in relation to offences under any of the relevant statutory provisions;
(g) provide for references in the regulations to any specified document to operate as references to that document as revised or re-issued from time to time.

A1.6. **Section 77 – Creates the Office for Nuclear Regulation**

A1.7. **77 The Office for Nuclear Regulation**

(1) There is to be a body corporate known as the Office for Nuclear Regulation.
(2) In this Part that body is referred to as “the ONR”.
(3) Schedule 7 makes further provision about the ONR

A1.8. **79 Codes of practice**

(1) The ONR may, in accordance with section 80—
(a) issue codes of practice giving practical guidance as to the requirements of any provision of the relevant statutory provisions;
(b) revise or withdraw a code of practice issued under this section

(Note - ONR may issue codes of Practice for the relevant statutory provisions of the Energy Act 2013 (note codes of practice for HSWA RSPs remain the responsibility of HSE))

A1.9. **81 Proposals about orders and regulations**

(1) The ONR may from time to time—
(a) submit proposals to the Secretary of State for—
(i) nuclear regulations,
(ii) regulations under section 85,
(iii) regulations under section 101,
(iv) health and safety fees regulations, or
(v) orders or regulations under a relevant enactment;
(b) submit proposals to the Health and Safety Executive for relevant health and safety regulations.

A1.10. **82 Enforcement of relevant statutory provisions**

(1) The ONR must make adequate arrangements for the enforcement of the relevant statutory provisions.

A1.11. **83 Inspectors**

Schedule 8 (appointment and powers of inspectors) has effect. (Note – these powers are broadly equivalent to those power granted to ONR Inspectors under HSWA Sections 20, 21, 22, 38, 39)

A1.12. **96 Co-operation between ONR and Health and Safety Executive**

(1) The Health and Safety Executive and the ONR must enter into and maintain arrangements with each other for securing co-operation and the exchange of information in connection with the carrying out of any of their functions.

A1.13. **102 General duty of employees at work in relation to requirements imposed on others**

(1) Every employee, while at work, must co-operate with any person (whether or not the employer) on whom a requirement is imposed by or under any relevant provision so far as necessary to enable the requirement to be complied with.
(2) Failure to comply with the duty in subsection (1) is an offence.

A1.14. **111 Crown application: Part 3**

(1) Subject as follows, this Part, and regulations made under it, bind the Crown.
(2) Part 2 of Schedule 8 (inspectors: improvement and prohibition notices) does not bind the Crown.
(3) Any other provision of, or of regulations under, this Part under which a person may be prosecuted for an offence—
(a) does not bind the Crown, but
(b) applies to persons in the public service of the Crown as it applies to other persons.

A1.15. **Section 118 concerns sets out that the Secretary of State must review the elements of this act pertaining to nuclear regulation after five years.**

A1.16. **118 Review of Part 3**

(1) As soon as reasonably practicable after the end of the period of 5 years beginning with the day on which section 77 comes into force, the Secretary of State must carry out a review of the provisions of this Part.

(2) The Secretary of State must set out the conclusions of the review in a report.

(3) The report must, in particular—

(a) set out the objectives of the provisions of this Part,

(b) assess the extent to which those objectives have been achieved, and

(c) assess whether those objectives remain appropriate and, if so, the extent to which those objectives could be achieved in a way that imposes less regulation.

(4) The Secretary of State must lay the report before Parliament.

A1.17. **Schedule 6, Part 2 provides more detail on the making of nuclear regulations.**

A1.18. **Examples of Provisions that may be made by nuclear regulations:**

A1.19. **4 Nuclear installations etc**

(1) Imposing requirements with respect to the following, in relation to any nuclear installation or its site—

(a) design and construction;

(b) siting, installation and commissioning;

(c) operation;

(d) testing, maintenance and repair;

(e) inspection;

(f) alteration or adjustment;

(g) dismantling and decommissioning.

A1.20. **Schedule 7 establishes ONR as a statutory body and defines certain roles and responsibilities:**

A1.21. **2 Membership**

(1) The ONR is to consist of—

(a) not more than 4 executive members, who are employees of the ONR, and

(b) not more than 7 non-executive members, who are not members of the ONR's staff.

(2) References in this Part of this Act to members of the ONR's staff are to persons who—

(a) are employees of the ONR, or

(b) have been seconded to it.

(3) The executive members consist of—

(a) the Chief Nuclear Inspector,

(b) the Chief Executive Officer, and

(c) not more than 2 other members (or not more than 3 other members, if the Chief Nuclear Inspector and the Chief Executive Officer are the same person) appointed by the ONR.

A1.22. **Schedule 8 establishes the powers of Inspectors:**

A1.23. **Part 1 – Appointment and Powers of Inspectors**

A1.24. **1 Appointment of inspectors**

(1) The ONR may appoint persons (referred to in this Part of this Act as "inspectors") to carry into effect the relevant statutory provisions.

(2) A person appointed as an inspector must be someone who appears to the ONR to be suitably qualified to carry out the functions that the ONR authorises the person to carry out……

A1.25. **2 Powers of inspectors**

(1) An inspector's instrument of appointment may authorise the inspector to exercise any relevant power.

(2) Authority to exercise a relevant power may be given—

(a) without restriction, or

(b) only to a limited extent or for limited purposes….

A1.26. **Part 2 – Powers exercisable by inspectors authorised by instrument of appointment: Improvement Notices and Prohibition Notices**

A1.27. **3 Improvement notices**

(1) This paragraph applies where an inspector is of the opinion that a person—

(a) is contravening one or more applicable provisions, or

(b) has contravened one or more of those provisions in circumstances that make it likely that the contravention will continue or be repeated.

(2) The inspector may, if authorised, give the person a notice (an "improvement notice") requiring the person to remedy—

(a) the contravention, or

(b) as the case may be, the matters giving rise to the notice, within the period specified in the notice…….

A1.28. **4 Prohibition notices**

(1) This paragraph applies where an inspector is of the opinion that—

(a) relevant activities, as they are being carried on by or under the control of a person, involve a risk of serious personal injury, or

(b) relevant activities which are likely to be carried on by or under the control of a person will, as so carried on, involve a risk of serious personal injury.

(2) The inspector may, if authorised, give the person a notice ("a prohibition notice") directing that the activities to which the notice relates must not be carried on by or under the control of the person……

A1.29. **7 Improvement and prohibition notices: offences**

(1) It is an offence to contravene any requirement or prohibition imposed by an improvement notice or a prohibition notice.

A1.30. **Part 3 – Other powers exercisable by Inspector if authorised by instrument of appointment**

A1.31. **8 Power of entry**

(1) An inspector may, if authorised, enter any premises which the inspector has reason to believe it is necessary for the inspector to enter for the relevant purpose—

(a) at any reasonable time, or

(b) at any time, in a situation—

(i) which in the inspector's opinion is or may be dangerous, ……

A1.32. **9 Power to take persons and equipment etc onto premises**

In exercising the power of entry mentioned in paragraph 8, an inspector may—

(a) be accompanied—

(i) by any person approved by the ONR for the purpose, and

(ii) if the inspector has reasonable cause to expect any serious obstruction in the exercise of any of the inspector's powers, by a constable, and

(b) take along any equipment and materials required for any purpose for which the inspector is exercising the power of entry.

A1.33. **10 Power to deal with cause of imminent danger**

(1) Sub-paragraph (2) applies where an inspector finds any article or substance in relevant premises in circumstances in which the inspector has reasonable cause to believe it is a cause of imminent danger of serious personal injury.

(2) The inspector may, if authorised, do any of the following—

(a) seize the article or substance;

(b) cause it to be made harmless or the risk of harm from it to be reduced (in either case, by destruction or otherwise);

(c) for the purpose mentioned in paragraph (b), seize any other article or substance…….

A1.34. **11 Powers exercisable in relation to particular articles or substances or in particular circumstances**

(1) An authorised inspector may cause any article or substance in relevant premises—

(a) to be dismantled;

(b) to be tested;

(c) to have any other process applied to it….

A1.35. **12**

(1) An authorised inspector may take possession of any article or substance found on relevant premises and retain it for as long as necessary—

(a) for it to be examined;

(b) for anything to be done to it which the inspector may cause to be done under paragraph 11;

(c) to ensure that it is not tampered with before any examination or other procedure mentioned in paragraph (a) or (b) is complete;

(d) to ensure that it is available for use in—

(i) any proceedings for an offence under any of the relevant statutory provisions, or

(ii) any proceedings relating to an improvement notice or a prohibition notice…

A1.36. **13 Powers of inspection and examination and to take samples**

(1) An authorised inspector may carry out any examination or investigation necessary for the relevant purpose and, in doing so, may—

(a) take measurements and photographs, and

(b) make recordings.

(2) An authorised inspector may take and deal with samples of—

(a) any article or substance found in relevant premises, or

(b) the atmosphere in or in the vicinity of relevant premises.

(3) The Secretary of State may by regulations make provision about—

(a) the procedure to be followed in taking any such samples, and

(b) the way in which any such samples are to be dealt with.

A1.37. **14**

(1) An authorised inspector may direct that any relevant premises, or any article or substance in them, must be left undisturbed for as long as reasonably necessary for the purposes of any examination or investigation necessary for the purpose of any of the relevant statutory provisions.

(2) A direction under sub-paragraph (1)—

(a) may relate to part of any relevant premises;
(b) may relate to particular aspects of any premises or article or substance.

A1.38. **15 Powers to require information and documents**

(1) An authorised inspector may require any person who the inspector has reasonable cause to believe is able to give any information relevant to any examination or investigation under paragraph 13—
(a) to answer any question the inspector thinks fit, and
(b) to sign a declaration of the truth of the person's answers…...

A1.39. **16**

(1) An authorised inspector may—
(a) require any relevant documents to be produced, and
(b) inspect and take copies of (or of any information in) any relevant documents…..

Extracts from the Nuclear Installations Act 65 (NIA65) relevant to the convention

A1.40. Sections 1, 3 to 6, 22 and 24A of NIA65, were previously relevant statutory provisions of HSWA74. On the formation the Office for Nuclear Regulation as a Statutory Body, via the Energy Act 2013 these parts of NIA65, whilst substantively still making the same legal provisions, have been redrafted and on 1st April 2014 became relevant statutory provisions of the Energy Act 2013. The parts of each of these sections relevant to this Convention are:

A1.41. **Section 1 restricts certain nuclear installations to licensed sites:**

(1) No person may use a site for the purpose of installing or operating—
(a) any nuclear reactor (other than a nuclear reactor comprised in a means of transport, whether by land, water or air), or
(b) any other installation of a prescribed kind, unless a licence to do so has been granted in respect of the site by the appropriate national authority and is in force (where ONR is that authority for GB nuclear sites)

A1.42. **Section 3 concerns the granting and variations to nuclear site licences:**

(1) A nuclear site licence—
(a) may be granted only to a body corporate;
(b) is not transferable.

(3) Two or more installations in the vicinity of one another may, if the appropriate national authority consider appropriate, be treated for the purposes of the grant of a nuclear site licence as being on the same site.

(12) The appropriate national authority may from time to time vary a nuclear site licence by excluding from it any part of the licensed site—
(a) which the licensee no longer needs for any use requiring such a licence, and
(b) with respect to which the appropriate national authority is satisfied that there is no danger from ionising radiations from anything on that part of the site.

A1.43. **Section 4 allows ONR to attach conditions to licences:**

(1) The appropriate national authority—
(a) must, when it grants a nuclear site licence, attach to it such conditions as the authority considers necessary or desirable in the interests of safety, and
(b) may attach such conditions to it at any other time.

(2) For the purposes of subsection (1), "safety" in relation to a nuclear site includes—
  (a) safety in normal circumstances, and
  (b) safety in the event of any accident or other emergency on the site.
(3) Conditions that may be attached to a licence by virtue of subsection (1) may in particular include provision—
  (a) for securing that an efficient system is maintained for detecting and recording the presence and intensity of any ionising radiations from time to time emitted from anything on the site or from anything discharged on or from the site;
  (b) with respect to the design, siting, construction, installation, operation, modification and maintenance of any plant or other installation on, or to be installed on, the site;
  (c) with respect to preparations for dealing with, and measures to be taken on the happening of, any accident or other emergency on the site;
  (d) without prejudice to sections 13 and 16 of the Radioactive Substances Act 1993 or to the Environmental Permitting (England and Wales) Regulations 2010 (S.I. 2010/675), with respect to the discharge of any substance on or from the site.
(4) The appropriate national authority may at any time attach to a nuclear site licence such conditions as the appropriate national authority may consider appropriate with respect to the handling, treatment and disposal of nuclear matter.
(5) The appropriate national authority may at any time vary or revoke any condition for the time being attached to a nuclear site licence by virtue of this section.
(10) Where a condition attached to a nuclear site licence by virtue of this section is contravened, each of the following is guilty of an offence—
  (a) the licensee, and
  (b) any person having duties upon the site in question who committed the contravention.
(11) A person convicted of an offence under subsection (10) in England and Wales or Scotland is liable—
  (a) on conviction on indictment to imprisonment for a term not exceeding 2 years, or a fine, or both;
  (b) on summary conviction to imprisonment for a term not exceeding 12 months, or a fine (in England and Wales) or a fine not exceeding £20,000 (in Scotland), or both.
(12) A person convicted of an offence under subsection (10) in Northern Ireland is liable—
  (a) on conviction on indictment to imprisonment for a term not exceeding 5 years, or a fine, or both;
  (b) on summary conviction to imprisonment for a term not exceeding 3 months, or a fine not exceeding the prescribed sum, or both.

A1.44. **Section 5 deals with the revocation and surrender of licences:**

(1) A nuclear site licence may at any time be—
  (a) revoked by the appropriate national authority, or
  (b) surrendered by the licensee.
(3) Subsections (4) to (6) apply where a nuclear site licence has been revoked or surrendered.
(4) If the appropriate national authority requires it to do so, the licensee must deliver up or account for the licence to such person as the appropriate national authority may direct.

(5) During the remainder of the period of the licensee's responsibility the appropriate national authority may give the licensee such directions as the authority may consider appropriate for preventing, or giving warning of, any risk of—
  (a) injury to any person, or
  (b) damage to any property,
by ionising radiations from anything remaining on the site.

(6) A nuclear safety inspector may direct the licensee to ensure that, during the remainder of the period of responsibility, notices indicating the limits of the site are kept posted on the site in the positions specified in the direction.

(7) For this purpose, "nuclear safety inspector" means an inspector appointed—
  (a) by the ONR under Schedule 8 to the Energy Act 2013, in the case of a site in England, Wales or Scotland, or
  (b) under section 24, in the case of a site in Northern Ireland.

(8) A licensee who contravenes any direction for the time being in force under subsection (5) or (6) is guilty of an offence.

(9) A person who without reasonable cause pulls down, injures or defaces any notice posted under subsection (6) is guilty of an offence.

(14) In this Act, "period of responsibility" in relation to the licensee under a nuclear site licence means, as respects the site in question or any part of it, the period—
  (a) beginning with the grant of the licence, and
  (b) ending with whichever of the dates in subsection (15) is the earliest, except that it does not include any period during which section 19(1) does not apply in relation to the site.

A1.45. **Section 6 refers to the maintenance of a list of licensed sites by the relevant Secretary of State (or Scottish Ministers in Scotland).**

A1.46. **Section 22 refers to reporting of and inquiries into dangerous occurrences:**

(1) The provisions of this section shall have effect on the happening of any occurrence of any description as may be prescribed, being an occurrence -
  (a) on a licensed site

(2) The licensee or other person mentioned in subsection (1) must ensure that the occurrence is reported without delay in the prescribed manner—
  (a) to the appropriate national authority, and
  (b) to such other persons, if any, as may be prescribed in relation to occurrences of that kind.

A1.47. **Section 24A covers the recovery of expenses by the ONR.**

Extracts from the Health and Safety at Work etc. Act 74 (HSWA74) relevant to the Convention

A1.48. **Section 2 places the following 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.

A1.49. **Under Section 3 employers and the self-employed have the following duties 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 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.

A1.50. **Section 6 places general duties on manufacturers of articles and substances for use at work:**

(1) It shall be the duty of any person who designs, manufactures, imports or supplies any article for use at work or any article of fairground equipment-
(a) to ensure, so far as is reasonably practicable, that the article is so designed and constructed that it will be safe and without risks to health at all times when it is being set, used, cleaned or maintained by a person at work;
(b) to carry out or arrange for the carrying out of such testing and examination as may be necessary for the performance of the duty imposed on him by the preceding paragraph;

A1.51. **Section 7 places general duties on employees at work:**

It shall be the duty of every employee while at work -

(a) to take reasonable care of the health and safety of himself and of other persons who may be affected by his acts or omissions at work; and
(b) as regards any duty or requirement imposed on his employer or any other person by or under any of the relevant statutory provisions, to

co-operate with him so far as is necessary to enable that duty or requirement to be performed or complied with.

A1.52. **Section 8 places a duty on persons not to interfere with or misuse things provided pursuant to certain provisions:**

No person shall intentionally or recklessly interfere with or misuse anything provided in the interests of health, safety or welfare in pursuance of any of the relevant statutory provisions.

A1.53. **Section 16:** allows, for the purpose of providing practical guidance on meeting the HSWA74 Regulations made under the Act and of the relevant statutory provisions, the issuing of codes of practice.

A1.54. **Section 18(1A):** makes the Office for Nuclear Regulation responsible for the enforcement of the relevant statutory provisions [of the Health and Safety at Work etc. Act 1974] as they apply in relation to GB nuclear sites.

A1.55. **Section 19:** allows the enforcing authority to appoint as inspectors such persons having suitable qualifications as it thinks necessary for carrying into effect the relevant statutory provisions within its field of responsibility. Every appointment of a person as an inspector must be made by an instrument in writing specifying which of the powers conferred on inspectors by the relevant statutory provisions are to be exercisable by the person appointed.

A1.56. **Section 20:** gives an inspector the following powers:

(1) ……for the purpose of carrying into effect any of the relevant statutory provisions within the field of responsibility of the enforcing authority which appoints him, exercise the powers set out in subsection (2) below.

(2) ….., namely –

(a) at any reasonable time (or, in a situation which in his opinion is or may be dangerous, at any time) to enter any premises which he has reason to believe it is necessary for him to enter for the purpose mentioned in subsection (1) above;

(b) to take with him a constable if he has reasonable cause to apprehend any serious obstruction in the execution of his duty;

(c) without prejudice to the preceding paragraph, on entering any premises by virtue of (a) above to take with him –

(i) any other person duly authorised by his (the inspector's) enforcing authority; and

(ii) any equipment or materials required for any purpose for which the power of entry is being exercised;

(d) to make such examination and investigation as may in any circumstances be necessary for the purpose mentioned in subsection (1) above;

(e) as regards any premises which he has power to enter, to direct that those premises or any part of them, or anything therein, shall be left undisturbed (whether generally or in particular respects) for so long as is reasonably necessary for the purpose of any examination or investigation under paragraph (d) above;

(f) to take such measurements and photographs and make such recordings as he considers necessary for the purpose of any examination or investigation under paragraph (d) above;

(g) to take samples of any articles or substances found in any premises which he has power to enter, and of the atmosphere in or in the vicinity of any such premises;

(h) in the case of any article or substance found in any premises which he has power to enter, being an article or substance which appears to him to have caused or to be likely to cause danger to health or safety, to cause it to be dismantled or subjected to any process or

test (but not so as to damage or destroy it unless this is in the circumstances necessary for the purpose mentioned in subsection (1) above);

(i) in the case of any such article or substance as is mentioned in the preceding paragraph, to take possession of it and detain it for so long as is necessary for all or any of the following purposes, namely -

(ii) to examine it and do to it anything which he has power to do under that paragraph;

(iii) to ensure that it is not tampered with before his examination of it is completed;

(iv) to ensure that it is available for use as evidence in any proceedings for an offence under any of the relevant statutory provisions or any proceedings relating to a notice under section 21 or 22;

(i) to require any person whom he has reasonable cause to believe to be able to give any information relevant to any examination or investigation under paragraph (d) above to answer (in the absence of persons other than a person nominated by him to be present and any persons whom the inspector may allow to be present) such questions as the inspector thinks fit to ask and to sign a declaration of the truth of his answers;

(j) to require the production of, inspect, and take copies of or any entry in –

(i) any books or documents which by virtue of any of the relevant statutory provisions are required to be kept; and

(ii) any other books or documents which it is necessary for him to see for the purposes of any examination or investigation under paragraph (d) above;

(k) to require any person to afford him such facilities and assistance with respect to any matter or things within that person's control or in relation to which that person has responsibilities as are necessary to enable the inspector to exercise any of the powers conferred on him by this section;

(l) any other power which is necessary for the purpose mentioned in subsection (1) above."

A1.57. **Section 21:** gives an inspector the power to serve improvement notices.

A1.58. **Section 22:** gives an inspector the power to serve prohibition notices.

A1.59. **Section 25:** gives an inspector the power to deal with cause of an imminent danger.

A1.60. **Section 28:** places restrictions on the disclosure of information.

A1.61. **Section 39:** gives an inspector the power in England and Wales to prosecute before a magistrates' court proceedings for an offence under any of the relevant statutory provisions.

Table A1 - Table of Licence Conditions

	Title	Description
LC1	Interpretation	Defines expressions used in the conditions.
LC2	Marking of the site boundary	The licensee shall make and implement adequate arrangements to prevent unauthorised persons from entering the site or, if so directed by ONR, from entering such part or parts thereof as ONR may specify.
LC3	Control of property transactions	The licensee shall make and implement adequate arrangements to control all property transactions affecting the site or any part of the site to ensure that the licensee remains in overall control of the site. The arrangements shall include provision for the classification of property transactions according to their safety significance and their impact on the licensee's control of the site.
LC4	Restrictions on nuclear matter on the site	The licensee shall ensure that no nuclear matter is brought onto the site except in accordance with adequate arrangements made by the licensee for this purpose. The licensee shall ensure that no nuclear matter is stored on the site except in accordance with adequate arrangements made by the licensee for this purpose.
LC5	Consignment of nuclear matter	The licensee shall not consign nuclear matter (other than excepted matter and radioactive waste) to any place in the United Kingdom other than a relevant site except with the consent of ONR.
LC6	Documents, records, authorities and certificates	The licensee shall make adequate records to demonstrate compliance with any of the conditions attached to this license.
LC7	Incidents on the site	The licensee shall make and implement adequate arrangements for the notification, recording, investigation and reporting of such

		incidents occurring on the site.
LC8	Warning notices	The licensee shall ensure that suitable and sufficient notices are kept on site for the purposes of informing persons thereon of each of the following matters, that is to say; warning signals, the location of emergency exits, and the measures to be taken by such persons in the event of an emergency.
LC9	Instructions to persons on the site	The licensee shall ensure that every person authorised to be on the site receives adequate instructions as regards to risks and hazards associated with the plant and its operation, the precautions to be observed, and the action to be taken in the event of an accident or emergency on site.
LC10	Training	The licensee shall make and implement adequate arrangements for suitable training for all those on site who have responsibility for any operations which may affect safety.
LC11	Emergency arrangements	The licensee shall make and implement adequate arrangements for dealing with any accident or emergency arising on the site and their effects.
LC12	Duly authorised and other suitably qualified and experienced persons	The licensee shall make and implement adequate arrangements to ensure that only suitably qualified and experienced persons perform any duties which may affect the safety of operations on the site or any other duties assigned by or under these conditions or any arrangements required under these conditions. The aforesaid arrangements shall also provide for the appointment, in appropriate cases, of duly authorised persons to control and supervise operations that may affect plant safety.
LC13	Nuclear safety committee	The licensee shall establish a nuclear safety committee or committees to which it shall refer for consideration and advice the following: all

		matters required by or under these conditions to be referred to a nuclear safety committee; such arrangements or documents required by these conditions as ONR may specify; any matters on the site affecting safety or off the site which ONR may specify; any other matters that the licensee considers should be referred to the nuclear safety committee.
LC14	Safety documentation	The licensee shall make and implement adequate arrangements for the production and assessment of safety cases consisting of documentation to justify safety during the design, construction, manufacture, commissioning, operation and decommissioning phases of the installation.
LC15	Periodic review	The licensee shall make and implement adequate arrangements for the periodic and systematic review and reassessment of safety cases.
LC16	Site plans, designs and specifications	The licensee shall submit to ONR an adequate plan of the site showing the location of the boundary of the licensed site and every building or plant on the site which might affect safety.
LC17	Management systems	The licensee shall establish and implement management systems which give due priority to safety.
LC18	Radiological protection	The licensee shall make and implement adequate arrangements for the assessment of the average effective dose to such class or classes of persons specified in the aforesaid arrangements and the licensee shall notify ONR if the average effective dose to such class or classes of persons exceeds such level as ONR may specify.
LC19	Construction or installation of new plant	Where the licensee proposes to construct or install any new plant which may affect the safety the licensee shall make and implement adequate arrangements to control the

		construction or installation.
LC20	Modification to design of plant under construction	The licensee shall ensure that no modification of the design which may affect safety is made to any plant during the period of construction except in accordance with adequate arrangements made and implemented by the licensee for that purpose.
LC21	Commissioning	The licensee shall make and implement adequate arrangements for the commissioning of any plant or process which may affect safety.
LC22	Modification or experiment on existing plant	The licensee shall make and implement adequate arrangements to control any modification or experiment carried out on any part of the existing plant or processes which may affect safety.
LC23	Operating rules	The licensee shall, in respect of any operation that may affect safety, produce an adequate safety case to demonstrate the safety of that operation and to identify the conditions and limits necessary in the interests of safety. Such conditions and limits shall hereinafter be referred to as operating rules.
LC24	Operating instructions	The licensee shall ensure that all operations which may affect safety are carried out in accordance with written instructions hereinafter referred to as operating instructions.
LC25	Operational records	The licensee shall ensure that adequate records are made of the operation, inspection and maintenance of any plant which may affect safety. The aforesaid records shall include records of the amount and location of all radioactive material, including nuclear fuel and radioactive waste, used, processed, stored or accumulated upon the site at any time.
LC26	Control and supervision of	The licensee shall ensure that no operations are carried out which may affect safety except under the control and supervision of suitably qualified

	operations	and experienced persons appointed for that purpose by the licensee.
LC27	Safety mechanisms, devices and circuits	The licensee shall ensure that a plant is not operated, inspected, maintained or tested unless suitable and sufficient safety mechanisms, devices and circuits are properly connected and in good working order.
LC28	Examination, inspection, maintenance and testing	The licensee shall make and implement adequate arrangements for the regular and systematic examination, inspection, maintenance and testing of all plant which may affect safety.
LC29	Duty to carry out tests, inspections and examinations	The licensee shall carry out such tests, inspections and examinations in connection with any plant as ONR may, after consultation with the licensee, specify.
LC30	Periodic shutdown	Where necessary for the purpose of enabling any examination, inspection, maintenance or testing of any plant or process to take place, the licensee shall ensure that any such plant or process shall be shut down in accordance with the requirements of its plant maintenance schedule referred to in Condition 28.
LC31	Shutdown of specified operations	The licensee shall, if so directed by ONR, shut down any plant, operation or process on the site within such a period as ONR may specify.
LC32	Accumulation of radioactive waste	The licensee shall make and implement adequate arrangements for minimising SFAIRP the rate of production and total quantity of radioactive waste accumulated on the site at any time and for recording the waste so accumulated.
LC33	Disposal of radioactive waste	The licensee shall, if so directed by ONR, ensure that radioactive waste accumulated or stored on the site is disposed of as ONR may specify and in accordance with an environmental permit granted under the

		Environmental Permitting (England and Wales) Regulations 2010, or the Radioactive Substances Act 1993 (for licensed sites in Scotland).
LC34	Leakage and escape of radioactive material and radioactive waste	The licensee shall ensure, SFAIRP, that radioactive material and radioactive waste on site is at all times adequately controlled and contained, so that it cannot leak or otherwise escape from such control or containment. The licensee shall ensure, SFAIRP, that no such leak or escape of radioactive material or radioactive waste shall occur without being detected, and that such leak or escape is then notified, recorded, investigated and reported in accordance with arrangements made under Condition 7.
LC35	Decommissioning	The licensee shall make and implement adequate arrangements for the decommissioning of any plant or process which may affect safety.
LC36	Organisational capability	The licensee shall provide and maintain adequate financial and human resources to ensure the safe operation of the licensed site. The licensee shall make and implement adequate arrangements to control any change to its organisational structure or resources which may affect safety.

Annex 2 - The Environmental Regulatory Bodies

A2.1 This Annex provides further information to that supplied in Article 8 on the regulators that enforce environmental regulation in the UK.

Environment Agency

(i) Mandate and duties

A2.2 The Environment Agency was created by the Environment Act 1995 (EA95) (Ref. 52) 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. 148):

- 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 our planning
- Regulations must be practicable

(ii) 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 2014.

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).

(iii) 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.

(iv) 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.

(v) 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.

(vi) 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

(i) 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 license 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. 53) 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. 123).

(ii) 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.

(iii) 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.

(iv) Human resources

A2.29 SEPA has approximately 1250 staff, around 17 of whom are involved in nuclear site regulation.

(v) Inspectors' qualifications

A2.30 Nuclear regulatory staff recruited by the Agency are required to have a degree in a relevant discipline.

(vi) 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

(i) 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 2010 (EPR10) in Wales. The provisions of EPR10 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 our agent, 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.

(ii) 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.

(iii) 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.

(iv) 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.

(v) 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.

(vi) Inspectors' training

A2.51 As above.

Annex 3 - ONR's Safety Assessment Principles

Background

A3.1 ONR's inspectors use the SAPs (Ref. 29), together with supporting TAGs (Ref. 33), to guide their regulatory judgements and recommendations when undertaking technical assessments of nuclear site licensees' safety submissions. Underpinning these is the legal duty on licensees to reduce risks so far as is reasonably practicable, and this informs the use of these SAPs. In addition, the SAPs are used to guide our assessments of proposed new nuclear facilities designs that may come forward for eventual construction at sites in the UK.

A3.2 The 2006 version of the SAPs built upon earlier publications (1979, 1983, 1988 and 1992) taking account of developments in nuclear safety and its regulation, both internationally and in the UK.

A3.3 The 2014 revision of the SAPs was prompted by publication in 2011 of the Chief Nuclear Inspector's report on the implications of the Fukushima accident for the UK nuclear industry. That report concluded that there were no significant gaps in the 2006 safety assessment principles, but recommended a review to ensure that lessons learned were incorporated.

A3.4 In addition to the lessons from Fukushima, we have also taken account of recent work by the International Atomic Energy Agency (IAEA), in particular the development of IAEA's design standard on the safety of nuclear power plants (Ref. 146 - SSR 2/1). As with the previous version of the SAPs, we believe that they are fully in line with IAEA guidance and standards. We acknowledge that these SAPs cannot reflect the breadth and depth of the entire suite of IAEA publications and so we explicitly identify those documents as relevant good practices within our TAGs

A3.5 IAEA guidance recommends that regulatory bodies subject their principles, regulations and guidance to periodic review, and take account of internationally endorsed standards and guidance. Although the SAPs have been reviewed and revised a number of times over the years, we acknowledge the importance of regular reviews and will formalise arrangements to carry out future reviews of the SAPs at least every five years.

A3.6 ONR is an active member of the Western European Nuclear Regulators' Association (WENRA), which is dedicated to ensuring that all European Union countries and candidate countries with civil nuclear power stations as well as Switzerland have harmonised levels of nuclear safety. To this end, WENRA has developed reference levels that represent good practices for existing civil nuclear power plants, radioactive waste management and decommissioning. ONR has previously acknowledged the reference levels as relevant good practice. It has now reviewed the most recent version of the reference levels, themselves recently revised to take account of learning from Fukushima, to ensure compatibility with the SAPs. These reference levels are also explicitly referenced in the ONR TAGs that support these SAPs.

The purpose of the Safety Assessment Principles (SAPs)

A3.7 The SAPs apply to assessments of safety at existing or proposed nuclear facilities. This is usually through our assessment of safety cases in support of regulatory decisions. The term 'safety case' is used throughout this document to encompass the totality of the documentation developed by a designer, licensee or dutyholder to demonstrate high standards of nuclear safety and radioactive waste management, and any subset of this documentation that is submitted to the ONR.

A3.8 The principles presented in the SAPs relate only to nuclear safety and radioactive waste management. Other conventional hazards are excluded, except where they have a direct effect on nuclear safety or radioactive waste management.

The use of the word ‘safety’ within the document should therefore be interpreted accordingly.

A3.9 The primary purpose of the SAPs is to provide inspectors with a framework for making consistent regulatory judgements on the safety of activities. The principles are supported by TAGs to assist the decision making within the nuclear safety regulatory process. Although it is not their prime purpose, the SAPs may also provide guidance to designers and dutyholders on the appropriate content of safety cases, clarifying our expectations in this regard. However, they are not sufficient on their own to be used as design or operational standards. Although in most cases the SAPs provide guidance, in those places where they refer to legal requirements they may be mandatory depending on the circumstances.

SFAIRP, ALARP and ALARA

A3.10 The SAPs are consistent with ‘Reducing Risks, Protecting People: HSE’s Decision- Making Process’ (R2P2, Ref. 149), 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. 150). 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.

A3.11 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.

A3.12 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.

A3.13 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 radiation exposure by other bodies nationally and internationally.

A3.14 The SAPs assist inspectors in the judgement of whether, in their opinion, the designers or duty holder’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.

A3.15 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.

A3.16 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.

A3.17 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 (eg in relation to legal limits) that detailed consideration of off-site effects and/or worker risks is unnecessary.

A3.18 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.

Application of the SAPs

General

A3.19 The SAPs contain principles and guidance. The principles form the underlying basis for regulatory judgements made by inspectors, and the guidance associated with the principles provides either further explanation of a principle, or their interpretation in actual applications and the measures against which judgements can be made.

Structure of the principles

A3.20 The SAPs are structured in separate sections, as follows:

- Fundamental principles. These principles are founded in UK health and safety law and international good practice, and underpin all activities that contribute to sustained high standards of nuclear safety.
- Leadership and management for safety. This section sets out principles that form the foundation for the effective delivery of nuclear safety.
- The regulatory assessment of safety cases. This section sets out principles applicable to assessments of the content of safety cases and the processes governing their production.
- Siting aspects. This section sets out principles relating to ONR's role in siting decisions and to how the physical location of a facility can affect safety.
- Engineering principles. This section comprises the major part of this document and covers many aspects of the design and operation of nuclear facilities.

- Radiation protection. This section links to Basic Safety Standards (BSS) and IRR99 and sets out principles for assessing whether exposures to ionising radiation are as low as reasonably practicable.
- Fault analysis. This section describes the principles to be applied when assessing the adequacy of measures to prevent, protect against and/or mitigate the consequences of faults and accidents.
- Numerical targets and legal limits. This section is based predominantly on Tolerability of Risk (TOR) and sets out targets to assist in making regulatory judgements, on the acceptability of the estimated numerical risks.
- Accident management and emergency preparedness. This section provides principles for assessing arrangements for the control and mitigation of radiological consequences following a significant release of radioactivity.
- Radioactive waste management.
- Decommissioning.
- Control and remediation of radioactively contaminated land.

A3.21 Not all of the principles in the SAPs apply to all assessments or every facility; clearly, principles specific to reactors do not apply to fuel-cycle facilities. Less obviously, not all of the reactor principles apply to all reactors: research reactors have significant differences from power reactors. Additionally, the assessment of a modification to a facility will only require the relevant principles to be applied. In short, the principles are a reference set from which the inspector needs to choose those to be used for the particular nuclear safety situation.

Proportionality

A3.22 There is a wide range of hazards associated with different facilities and activities on nuclear licensed sites so the depth and rigour of the analysis required for nuclear facilities will vary considerably. This is consistent with ONR's Enforcement Policy Statement (Ref. 87) that the requirements of safety should be applied in a manner that is commensurate with the magnitude of the hazard. Therefore, the extent and detail of assessments undertaken by dutyholders as part of a safety case, including their independent assessment and verification, need to be commensurate with the magnitude of the hazard. Similarly, subject to other legal duties or public policy requirements, ONR regulatory attention should likewise be commensurate with the magnitude of the hazard, although issues such as novelty and uncertainty will also be factors.

A3.23 Safety cases, and the analyses and assessments contained within them, must be fit for purpose, in accordance with nuclear site licence condition requirements and with Regulation 3 of the Management Regulations (Ref 69), and IRR 1999 Regulation 7. They must, among other things, be suitable and sufficient for the purpose of identifying all measures to control the risk.

A3.24 Inspectors must be proportionate in what they require from duty holders. The higher the hazard, the more rigorous and comprehensive the analysis which would be expected to lead to greater defence–in-depth to protect people. Therefore a low hazard facility may only require a much more limited analysis to ensure adequacy. This may well be expected to result in fewer or less extensive safety provisions.

A3.25 In some cases, the magnitude of the radiological hazard may be uncertain. In these cases a precautionary approach should be applied (R2P2) by erring on the side of safety. Where the absence of a radiological hazard cannot be shown, an

appropriate radiological hazard and magnitude should be assumed and the justification given.

Life-cycle

A3.26 The SAPs are designed to support regulatory assessments throughout the lifecycle of nuclear facilities. Specific sections are, however, devoted to individual stages, eg siting and decommissioning. In general, not every principle in every section will apply to every lifecycle stage. Instead the principles are a reference set from which the inspector should select those relevant to the particular stage in the lifecycle. For instance, the sections on Leadership and Management for Safety and the Regulatory Assessment of Safety Cases include aspects covering the entire lifecycle of the facility. The Engineering Principles are relevant to design, construction, manufacture and installation, but will also apply to later operational stages. Commissioning is a key stage in providing the necessary assurance of safety and a number of the principles include aspects of commissioning. Decommissioning should also be considered at all lifecycle stages.

New facilities

A3.27 One of the aims of the SAPs is the safety assessment of new (proposed) nuclear facilities. They represent ONR's view of good practice and we would expect modern facilities to have no difficulty in satisfying their overall intent.

Facilities built to earlier standards

A3.28 Inspectors should 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. For facilities designed and constructed to earlier standards, the issue of whether suitable and sufficient measures are available to satisfy ALARP will need to be judged case by case.

A3.29 For certain activities, such as decommissioning, it is recognised that some principles may not be met transiently, and this is allowable provided the result is to achieve a safer end-state. However, during this period, the requirement to reduce risks ALARP remains.

Ageing

A3.30 As a facility ages, safety margins may be eroded and a dutyholder may argue that making improvements is not worthwhile. The short remaining lifetime of the facility may be invoked as part of the ALARP demonstration. However, this factor should not be accepted to justify the facility operating outside legal requirements, or at levels of risk that are unacceptably high (see SAPs Numerical Targets). A safety case which argues for not making an improvement based predominantly on limited future lifetime should only be accepted where the maximum extent of the future operational life is irrevocably fixed and provides a suitable margin of safety. In cases where the planned lifetime is not irrevocably fixed, a minimum period of ten years (or the unavoidable necessary life of the facility, if longer) should be considered for the purposes of judging whether the ALARP demonstration is acceptable.

Multi-facility sites

A3.31 When assessing the hazards and risks posed by a nuclear site, all the facilities, services and activities on it need to be considered. In most cases, the SAPs are applied in relation to single facilities and so the control of risks is also generally considered on a facility basis. However, there is sometimes also a need to consider the totality of risks from a site and how these are controlled, for example when a single initiating event can affect multiple facilities. The licensee has a duty to manage all the risks within its control so that total risks are ALARP, including risks from multi-facility events. In some locations there are multiple sites, governed by different

licensees, ie there are neighbouring sites. In this circumstance, ONR expects licensees and others in control of major nuclear hazards to co-operate with one another so that the overall risks in the location, taking into account all neighbouring sites, are kept ALARP.

A3.32 Individual sites with multiple facilities often produce individual safety cases for each facility. Shared services are also generally dealt with by separate cases. The division of a site's safety case in this way requires the definition of boundaries and interfaces between facilities, facilities and services, and services. It also requires an appropriate combination of the individual assessments to provide an overall site safety case which accounts for the interactions and interdependencies between facilities and services.

Alternative approaches

A3.33 The SAPs express ONR's expectations for the content of safety cases submitted to us. However, designers and/or dutyholders may wish to put forward safety cases that differ from these expectations. As in the past, ONR inspectors should consider such submissions on their individual merits. However, where the approach being followed differs substantially from the expectations set out here, inspectors should advise designers and/or dutyholders to discuss the method of demonstration with ONR beforehand. ONR will need to be assured that such cases demonstrate equivalence to the outcomes associated with the use of the principles here, and such a demonstration may need to be examined in greater depth to gain that assurance.

ANNEX 4 – Additional Information to Support Article 18

APPENDIX 1 (Part 1)

Diversity in front-line safety functions for existing reactor designs

AGRs

A4.1 For all of the AGRs, the primary means of shutting the nuclear reaction down is the fall under gravity of control rods into the reactor core. There is a high level of redundancy in the control rod primary shutdown system. The nuclear reaction would be stopped by insertion of a small number of control rods, provided they were fairly uniformly distributed radially about the core.

A4.2 All AGRs have an automatically initiated diverse shutdown system, in order to ensure shutdown, even if for any reason insufficient rods in the primary shutdown system are inserted into the core. At some stations, the (fully) diverse system is based on rapid injection of nitrogen into the reactor core: nitrogen absorbs neutrons and hence stops the chain reaction. At other stations, the (partially) diverse system is based on an adaptation to the control rod system so that the rods are actively lowered into the core rather than falling under gravity and is then backed up by nitrogen injection manually initiated from the reactor control desk.

A4.3 A tertiary shutdown is provided to maintain the reactor in its shutdown state in the longer term if an insufficient number of control rods have dropped into the core and it is not possible to maintain a sufficient pressure of nitrogen. The principle of a hold-down system is that neutron-absorbing material is injected into the reactor circuit. Such a measure would only be adopted as a last resort and is achieved by injection of boron beads or water, which is irrevocable and would mean the permanent shutdown of the reactor.

A4.4 The AGRs are provided with a post-trip cooling system for removing decay heat. Providing the pressure vessel is intact, the fuel is cooled by the gas circulators pumping the CO_2 coolant through the reactor core and boilers. The heat is removed from the boilers by post-trip feedwater systems which pump water through the boiler tubes. If the gas circulators fail, the fuel can be cooled by natural circulation providing boilers continue to be cooled by feedwater systems. All AGRs have at least two diverse post-trip feedwater systems with redundancy and diversity in their electrical supplies. If a breach has occurred in the pressure vessel then natural circulation will be insufficient and the fuel will need to be cooled by forced gas circulation with feed water supplied to the boilers.

Sizewell B PWR

A4.5 Sizewell B also demonstrates the application of the defence in depth principle for the key nuclear safety functions for controlling reactivity and post-trip cooling to ensure the integrity of the fuel in the reactor core. Core reactivity control during normal operation and shutdown in the event of a reactor trip is provided by the RCCAs. In a reactor trip the RCCA fall under gravity into the core to shut the primary nuclear reaction down. In addition to the RCCA, the Emergency Boration System provides a diverse means of shutting the reactor down. The operator can also add boron using the Chemical and Volume Control System.

A4.6 Assuming the primary circuit is intact, post-trip cooling can be provided by the following systems:

- Main feedwater system (not backed by emergency diesels).
- Motor-driven auxiliary feedwater system consisting of two redundant trains, supplied by AC power backed by the Emergency Diesel Generators.

- Turbine-driven auxiliary feedwater system that comprises two redundant trains. The system is supplied by steam from the steam generators and therefore has self-sustaining motive power derived from core decay heat.

A4.7 If the primary circuit is not intact, i.e. there is a coolant leak, make-up water and the Emergency Core Cooling System provides decay heat removal. This consists of high head safety injection pumps, low head safety injection pumps and pressurised accumulators (although the routine makeup systems can also be used). Heat is mostly rejected to the containment atmosphere via the leak, and the containment would in turn be cooled using fan coolers.

A4.8 The heat sink for the post-trip cooling systems at Sizewell B is provided by the sea-cooled essential service water system or the air-cooled reserve ultimate heat sink. These systems are backed by the essential diesel generators.

A4.9 The Sizewell B reactor is housed within a containment building which limits the release of radioactivity should a beyond design basis fault occur. This is a large structure made of pre-stressed concrete able to withstand substantial overpressure. In the containment, heat is removed and pressure reduced by fan coolers and reactor building spray systems.

APPENDIX 2 (Part 2)

Diversity in front-line safety functions for new reactor designs

A4.10 The Westinghouse AP1000® and Hitachi-GE's UK ABWR are currently being considered through the GDA process. The EDF/AREVA UK EPR™ has completed the GDA process and an operator has been granted a nuclear site licence to build a two-unit plant at Hinkley Point C.

A4.11 All three of the new reactor designs currently being considered apply the principles of redundancy, diversity and defence-in-depth to key safety functions. The designs have been required to demonstrate the robustness of their safety systems to single failures. Relevant good practice is to not just consider active failures, but also passive failures (including the failure of non-return/check valves).

A4.12 As a result of the GDA process, to demonstrate compliance with relevant good practice, all three designs have had their secondary C&I protection system modified to provide much greater diversity to the primary protection systems.

A4.13 The PWRs (UK EPR™ and AP1000®) use RCCAs for core reactivity control during normal operation and shutdown in the event of a reactor trip. These are fail safe and fall under gravity to trip the reactor. They both have diverse C&I systems for initiating a reactor trip, and also have capabilities to flood the core with boronated water if there is a problem with the RCCAs. Their safety case contain arguments for so called "anticipated transients without scram" (ATWS) events as part of their design basis.

A4.14 The UK ABWR uses control rods driven by a fail-safe hydraulic system to shut down the reactor, initiated either by the primary C&I protection system or a partially diverse Alternative Rod Insertion system. The ATWS safety case considers the effectiveness of tripping recirculation pumps, stopping feedwater, inhibiting the automatic depressurisation function and mechanically driving the control rods into the core. It also has a boron injection system (the Standby Liquid Control System) if other means are not effective in shutting down the reactor.

A4.15 The UK EPR™ has four redundant and independent primary circuit loops for decay heat removal from the reactor core. Each loop has electrically driven medium

and low pressure injection pumps and passively initiated accumulators which inject water into the core. In these were to fail, dedicated severe accident features are provided which are designed to minimise the consequences of the core melt accidents and confine the resulting radioactivity within the containment. These features include a severe accident depressurisation system and an ex-vessel 'core catcher'.

A4.16 The AP1000® design utilises passive features instead of the multiple redundant active safety systems deployed on other designs. The tolerance of the passive systems to single failures and potential merits/dis-benefits of adding additional systems has been thoroughly reviewed by both the designer and regulator. Makeup water to the core can be provided passively by two heavily borated Core Makeup Tanks and a Passive Heat Removal Heat Exchanger is provided which uses natural circulation to reject heat from the core to the large in-containment water storage tank. The AP1000® does retain two trains of active makeup/cooling capability comparable to those used in 'traditional' PWR designs, providing additional defence in depth to the passive systems. If all these measures fail and core melt occurs, the AP1000® strategy is to cool/confine the material within the reactor pressure vessel by flooding the lower portions of the containment building.

A4.17 Both the UK EPR™ and AP1000® have large containment buildings to manage the consequences of design basis and severe accident events. The UK EPR™ incorporates a containment heat removal system using a dedicated spray, heat exchanger and heat slink system to manage the pressure and temperature within the containment (and therefore protecting its integrity and ability to confine radioactivity). The AP1000® uses a combination of gravity-fed water being poured over the outside of the containment structure and air being drawn over the containment structure by natural circulation.

A4.18 The UK ABWR is designed with a three division emergency core cooling system with both a high and low pressure injection pump and heat removal capability in each division. For diversity, one of the divisions includes a steam driven, high pressure pump (the other pumps being electrically driven). Each division is supported by an emergency diesel generator in case off-site power is lost. In the UK ABWR, this capability has been supplemented by a separate Backup Building with its own power generating capability, water sources and pumps to inject water into the reactor core, containment and spent fuel pool. Providing even further defence in depth, a further diverse additional generator is provided on the site, along with mobile power sources, pumps and heat exchangers. If all these measures fail and core melt occurs, the 'dry well' beneath the core is designed to spread the molten corium to facilitate cooling and the area is flooded.

A4.19 The UK ABWR design uses a Reinforced Concrete Containment Vessel (RCCV) with steel liner. The RCCV forms an integral part of the Reactor Building, which also provides a secondary containment function. The RCCV is not as large as the equivalent structures on the UK EPR™ and AP1000®. In the event of a severe accident and the active heat removal systems are unavailable, it may be necessary to vent the RCCV to maintain its integrity (and therefore its confinement of radioactivity function). The UK ABWR is provided with both a hardened venting route (which utilises the large volume of water in the suppression pool to scrub the radioactivity from any atmospheric discharges) and also a filtered containment venting route (which utilises a water scrubber and metal fibre filter to minimise radiological releases, in addition to the suppression pool).

APPENDIX 3 (Part 3)

Design changes arising out of the GDA assessment of new reactor designs

A4.20 For the new reactor designs under consideration within the UK, beyond design basis measures have been/are being considered as part of the overall safe design concept. The GDA and initial site licensing reviews have identified further measures beyond the standard design basis of the reactor plant to ensure that beyond design basis events will not progress or to minimise the consequences of a severe accident.

A4.21 As modern designs, the designers and potential operators of all three reactor technologies have stated (and ONR accepts) that they already include numerous redundant and diverse accident measures for both design basis and severe accidents events incorporated in the standard design. The nature of the GDA process, considering a generic design and site, means that detailed determination of some severe accident measures or emergency procedures are inevitably postponed until site-specific licensing commences. However, some improvements to the original designs have been identified (compared to what has been built elsewhere on similar plants or from the original proposal for the UK).

UK EPR™

A4.22 The UK EPR™ design planned to be built at Hinkley Point C is a modern and robust design with a number of diverse and severe accident measures incorporated in the standard design. These measures include, for example, the primary depressurisation system, core melt stabilisation system, combustible gas control system and containment heat removal system, which significantly reduce the likelihood of large or early releases following a severe accident. In the context of extreme external hazards conditions, in addition to permanently installed structures, systems and components, some mobile components, stored on-site or brought from off-site may be deployed, especially for the medium to long term period.

A4.23 A number of resilience enhancements have been added to the UK EPR™ design:

- Modifications have been made to increase the robustness of the plant to external hazard levels beyond the design basis. This has included implementation of measures to protect the ultimate diesel generators and severe accident batteries against flooding, and enhanced water tightness of some buildings and structures against beyond design basis flooding events.
- Modifications have been made to enhance the emergency electrical supplies. This has included the provision to allow connection for one or more large-scale mobile diesel generators (stored off-site) within 72 hours, an increase in the capacity of the severe accident batteries from 12 to 24 hours, and the provision of a small scale mobile generator to be deployed within 24 to provide the uninterruptible power supply to the severe accident C&I system.
- Modifications have been made to enhance the emergency water supplies. This has included an additional means to replenish the emergency feedwater tanks from the raw water storage tanks, increased capacity of some pumps and increased water storage volume.
- Provision has been made for injecting water into the reactor building through the containment spray nozzles to reduce pressure in the containment. This is to be initiated by 48 hours to allow time for re-

supply of electrical power and reinstatement of the containment heat removal system.

- A diverse means, using diesel driven pumps, of providing emergency feedwater to the steam generators in the event of a total loss of AC power situation is being developed.

A4.24 As part of containment overpressure protection, a filtered containment venting system has been considered for the UK EPR™ at Hinkley Point C, but given the standard design features and enhancements described above it is currently demonstrated as not required. However, the option to fit a filtered containment venting system at a later date (throughout design, construction or operation), if required, has not been foreclosed, as a penetration has been allocated in the reactor building and space has been allowed for such a system.

A4.25 A number of safety enhancements have also been made to the spent fuel pool:

- Upgrading the spent fuel pool cooling system to class 1 safety classification; this will be seismically qualified to meet the relevant classification requirements.
- Upgrading of the spent fuel pool water makeup system to class 1 safety classification. This system is seismically qualified to meet the relevant classification requirements.
- Provision of a secondary containment to envelope the fuel transfer tube to prevent significant leakages upon gross failure of the tube.
- Provision of an external connection to the fuel building to allow re-supply of the spent fuel cooling pools via the raw water storage facility. This additional water is supplied to make-up the water level of the spent fuel pool to offset that lost through evaporation and boiling in the event of a prolonged loss of the spent fuel pool cooling system.
- Establishment of passive or automatic opening of the spent fuel pool hall to the nuclear auxiliary building to improve protection against over-pressurisation of the spent fuel pool hall.

AP1000®

A4.26 The standard design already included passive features which allow the reactor core and spent fuel pool to be adequately cooled for 72 hours without AC power or additional water supplies. Only small quantities of power and water are needed after 72 hours to maintain the reactor core and spent fuel pools in a safe stable state. These requirements can be provided by either permanently engineered or flexible (i.e. mobile) systems. In a change from the standard design, passive filters have been added to the blowout panels of the UK AP1000® which open to vent the steam generated from the spent fuel pool in the event of a loss of active cooling. Post-Fukushima, it has been proposed to improve the beyond design basis flood protection of safety significant batteries, enhance the power supply for communication equipment, enhancements to the provisions for connecting power cabling after 72 hours, and additional connection points to on-site water storage tanks.

UK ABWR

A4.27 The original design has been supplemented by a number of features for beyond design basis events:

- A diverse backup building has been added, located away from the main reactor building with its own air-cooled diesel generators, water sources and pumps for providing cooling water to the reactor and Reinforced Concrete Containment Vessel (RCCV).

- A diverse hard-wired severe accident C&I system available from the backup building.
- A diverse additional generator in addition to the three Emergency Diesel Generators of the original ABWR design and the two air-cooled diesel generators of the backup building.
- Provision of mobile equipment to manage a beyond design basis event, including power and water with appropriate connection plant points.
- The ability to provide core and containment cooling via mobile heat exchangers.
- The provision of all these diverse and redundant features to supply cooling to the reactor core, notably the backup building, reduces the likelihood of severe core damage.
- If there is ultimately a need to vent the RCCV to protect its integrity, the UK ABWR is provided with hardened venting system (to be used if there is no significant core damage) and a Filtered Containment Venting System to ensure major radiological releases are minimised, even in severe accidents.
- Passive Auto-catalytic Recombiners in the wet and dry compartments of the RCCV (i.e. within containment) and in the reactor building (i.e. outside of primary containment).
- Additional segregated cooling chain for the spent fuel pool.
- Multiple ways of providing makeup water to the spent fuel pool, including from the backup building and mobile sources.
- A spray capability to cool the spent fuel in the event of a catastrophic failure and drain down of the spent fuel pool.

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
DECC	Department for Energy and Climate Change
DWP	Department for Work and Pensions
EA95	The Environment Act 1995
EC	European Council
EDF NGL	Electricite de France Energy Nuclear Generation Ltd
EIA	Environmental Impact Assessment
EIADR99	The Nuclear Reactors (Environmental Impact Assessment for Decommissioning) Regulations 1999
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

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 Radiation 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 2001
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
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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