

Essential Guide.



Nuclear Industry Association

THE ESSENTIAL GUIDE
FOR THE NUCLEAR NEW
BUILD SUPPLY CHAIN

STAGE THREE
JUNE 2019

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Introduction

The UK nuclear renaissance has been a subject of significant interest to a broad spectrum of UK organisations including the UK Government, developers and suppliers, with each having a significant influence on making the renaissance possible.

The Government has been very active in supporting a number of initiatives to make nuclear new build possible through the establishment of the Infrastructure Planning Commission, the facilitation of the Generic Design Assessment (GDA) process and the reform of the Electricity Trading Act. In the early years of the Nuclear New build programme the Department of Energy and Climate Change (DECC), in conjunction with UK business, recognised significant business opportunities for UK industry would emerge. It promoted the new build opportunities through various initiatives including:

- ▶ Formation of the SC@nuclear supply chain support programme which was operated by the Nuclear Industry Association (NIA)
- ▶ Development of the Nuclear Advanced Manufacturing Research Centre (Nuclear AMRC)
- ▶ Support of the National Skills Academy for Nuclear (NSAN) in skills development, qualifications and skill set standardisation across the industry

As part of the enabling works for the development of new nuclear power plant, Government has completed a Strategic Siting Assessment. This reviewed the appropriateness of potential sites in the UK and how they complied with the requirements detailed in the National Policy Statement (NPS).

The following sites have been nominated as suitable for the development of new nuclear power plant in the UK. Most locations are or have been sites for operational nuclear plant. The exception is Moorside in Cumbria which is on land adjacent to the existing Sellafield nuclear site:





Courtesy of EDF Energy

The Strategic Siting Assessment is valid until 2025, but Government is working on a successor NPS to facilitate nuclear power stations at sites capable of deployment between 2026 and 2035.

The responsibility for the development of the nuclear programme and maximising the opportunity for UK Industry now sits with the Department for Business, Energy and Industrial Strategy (BEIS). It is leading the Government's Industrial Strategy which includes a Nuclear Sector Deal agreed with the nuclear industry. BEIS is currently working with the developers to facilitate new nuclear build projects in the UK and to enable the GDA of technologies which developers hope to build in the future. BEIS also understands the need to maximise the involvement of UK industry in the current programmes, generating business for UK companies in the short to medium term and ensure the new build programme leaves lasting legacies in terms of competencies and capability of UK industry. This will enable UK companies to maximise their exports to other nuclear programmes worldwide.

One of the key enablers in achieving these goals was the development of the Nuclear Industrial Strategy in 2013.¹ This document stated that the Government expected nuclear to play a significant role in the UK energy mix in the future and contained the vision that:

“Together, Government and Industry have a clear and ambitious vision to ensure the development of a vibrant UK nuclear industry that is an area of economic and strategic national strength, providing the UK with safe, reliable and affordable supply of low carbon electricity.”

Large companies with experience of the nuclear industry in the UK quickly understood the magnitude of the UK nuclear new build opportunity. They have been supporting the developers in the formulation of their plans and been producing prices for packages of work to assist the developers in compiling costs for the various projects. Many companies are aware of the development activities they need to undertake to maximise their market share and have already put such plans in place. They can implement these plans once there is sufficient market certainty to ensure an adequate return on investment is achieved. However, to maximise UK contribution to the new build programme, the involvement of smaller UK companies is also required, many of whom have had little or no nuclear history. It was recognised that additional steps needed to be taken to ensure their involvement in the new build programme.

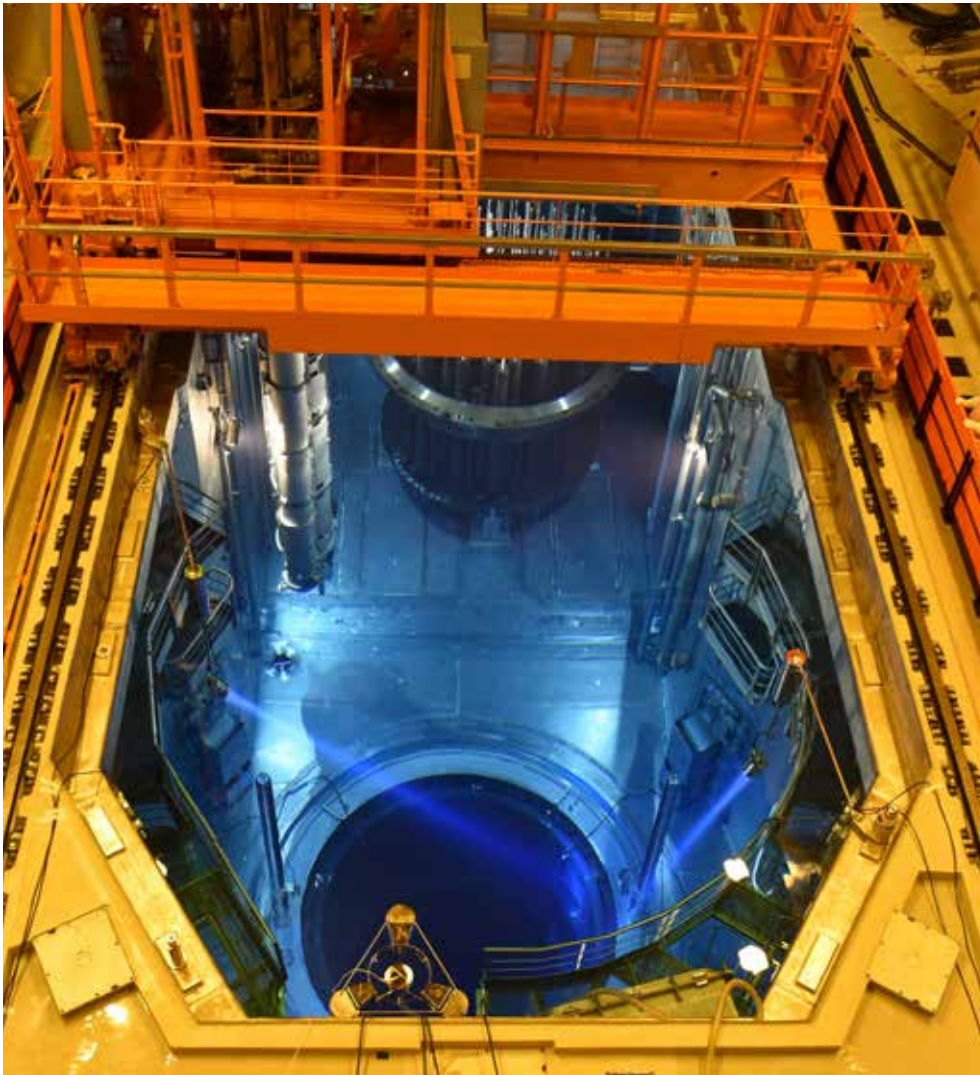
¹ Department for Business, Innovation & Skills and Department of Energy & Climate Change, Nuclear industrial strategy: the UK's nuclear future (26 March 2013) www.gov.uk/government/publications/nuclear-industrial-strategy-the-uks-nuclear-future

Initially, the NIA's SC@nuclear programme ran several events throughout the UK and published 'The Essential Guide for the Nuclear New Build Supply Chain' in February 2011. This document set out the scale of opportunities and the key issues for UK industry. This document was updated in 2013 to provide more in-depth information on market opportunities and on a range of technical and cultural subjects relevant to the nuclear new build programme. The 2013 document has now been superseded by this 2019 revision which includes the latest market position and nuclear industry requirements.

The current document been developed with the input of developers, technology vendors and a number of Tier 1 companies who have a major involvement in the nuclear industry. Input has also been provided by BEIS and the Office for Nuclear Regulation (ONR) to ensure it has the widest possible cross-industry support.

The primary aim of this document is to provide smaller companies with an introduction to the processes, procedures and working arrangements required to design, manufacture, construct and commission new nuclear power plant in the UK. Companies should not be concerned if they lack familiarity with the topics described in the document as it is the responsibility of the higher tier contractors to ensure that their subcontractors have a knowledge of the industry requirements and to provide any necessary training or inductions before work commences. However, disseminating the information contained in the document through their workforce will assist personnel in the smaller companies to understand the requirement of the UK nuclear industry.

Courtesy of CGN UK



Project Certainty and Timeline



1.1 The role of Government in facilitating the development of new nuclear projects in the UK has included the development of the Nuclear Industrial Strategy. A key objective of the Strategy was realised in 2018 with the development by Government and industry of the Nuclear Sector Deal (NSD).² The 'Deal' demonstrates how Government and industry can work together to maximise the UK contribution to current and future nuclear projects, while leaving a lasting legacy in terms of export potential, infrastructure improvement and nuclear skills development in the UK. A summary of the Nuclear Sector Deal is included below.

1.2 At present only the EDF Energy/CGN Strategic Partnership has made a final investment decision to proceed with two reactors at Hinkley Point C. They are also developing other projects at Sizewell C and Bradwell B sites with the Final Investment Decisions (FID) to be made some time in the future. Hitachi Ltd, through its UK subsidiary Horizon Nuclear Power, had been developing plans to construct new reactors at Wylfa and Oldbury.

However, this development has been suspended pending resolution of funding and the development of a robust business case for the plant. It is hoped that discussions with Government and the involvement of new investors will result in this project being continued at some time in the future. Toshiba, through its UK subsidiary NuGeneration Ltd, had been developing proposals for reactors at Moorside in Cumbria. This development has been terminated and NuGeneration Ltd has been wound-up. The site at Moorside still remains a candidate for future development by others.

1.3 Apart from the Hinkley Point C project, the final decision to proceed with development at the other sites will be subject to acceptable economic conditions, achieving the relevant consents and permits, the UK demand for electricity and the development of suitable funding models which provide certainty of return on investment. The current stated position of each development is detailed below. As more certainty develops on the FID's and the project timescales, the position of each of the projects will be updated on the NIA website.³

Nuclear Sector Deal

1.4 In June 2018 the Government published the NSD, which has been agreed between Industry and Government through the Nuclear Industry Council. This was the latest in a suite of Sector Deals with some of the key UK industrial sectors such as Automotive, Aerospace, Construction and Life Sciences among others.

The NSD recognises that through Government/Industry collaboration, the nuclear industry can make a significant contribution to meeting the UK Clean Growth Grand Challenge.

1.5 The NSD builds on the five Foundations of Productivity outlined in the Governments' Industrial Strategy⁴ to improve wellbeing, productivity and business in the UK.

2] Department for Business, Energy & Industrial Strategy (BEIS), Nuclear Sector Deal (27 June 2018) www.gov.uk/government/publications/nuclear-sector-deal/nuclear-sector-deal

3] www.niauk.org

4] Department for Business, Energy & Industrial Strategy, Industrial Strategy (27 November 2018) www.gov.uk/government/publications/industrial-strategy-building-a-britain-fit-for-the-future

1.6 These five foundations are:

- ▶ **Ideas** – to be the world’s most innovative economy
- ▶ **People** – to have good jobs and greater earning power for all
- ▶ **Infrastructure** – to create a major upgrade to the UK’s infrastructure
- ▶ **Business Environment** – to make the UK the best place to start and grow a business
- ▶ **Places** – to develop prosperous communities across the UK

1.7 Each of the above have key policies to achieve the goals which are set out in more detail in the Industrial Strategy document. The NSD takes these high-level policies and translates them into a set of nuclear sector-specific of goals, actions and investment plans as described below.

Ideas

1.8 The NSD recognises that the UK has consistently been at the forefront of the development of nuclear power. To maintain this lead Government and industry have been generating proposals to support the design, manufacture and construction of advanced modular reactors in the UK and to maintain the UK’s position in nuclear research and development. This goal is supported by the £44 million investment by Government announced in December 2017, to develop modular reactor technology and to develop advanced manufacturing processes to reduce power plant costs.

1.9 An Expert Finance Working Group was set up to assess the commercial viability of modular reactor projects and concluded the UK was well placed to develop a ‘First of a Kind’ small modular reactor project. It also concluded that the UK was well positioned to attract private finance, provided Government helped to de-risk projects by creating the right market framework. The Working Group concluded that the goal of the NSD to enable the development of advanced nuclear technologies and to develop a technically/commercially viable propositions for their development in the UK was well founded.

1.10 Over the longer term, the NSD commits to support the UK world leading Fusion research at the UKAEA site at Culham in Oxfordshire as well as supporting the UK involvement in the international collaboration ITER Fusion project located in France.

People

1.11 The NSD recognises the need for over 100,000 workers in the UK nuclear sector. The skills required range from craft workers to world recognised subject matter experts in nuclear technology. A key target in this area is to increase the percentage of female representation in the industry from the present level of 22% to 40% by 2030.

1.12 The role of schools and higher educational establishments is recognised with the aim to increase participation in STEM subjects through to the support for PhDs to ensure the development of subject matter experts. The Nuclear Skills Strategy Group will play a leading role with industry and education establishments in achieving the NSD goals in this area, and have set out a Strategic Skills Plan.⁵

Infrastructure

1.13 The Government recognises the benefits to the economy and to the UK’s carbon targets from the growth of nuclear power. The deal recognises the importance of reducing future new nuclear power plant costs with a target of a 30% reduction by 2030. Steps to achieve this target include the development of a number of new

5] Nuclear Skills Strategy Group, Delivering the NSSG Strategic Skills Plan (1 December 2016) www.nssguk.com/media/1621/nssg-strategic-plan-a4-summary-v2.pdf





Courtesy of Balfour Beatty

financial models including the Regulated Asset Base Model. Cost reductions can also be achieved through deployment of advanced manufacturing and construction techniques, with digital modelling playing a major role.

- 1.14 The Sector Deal aims to increase opportunities for the UK supply chain which result from new nuclear power plant projects, both domestically and in export markets. BEIS is currently producing guidance for developers to produce their supply chain plans. This requirement highlights the importance of supply chain development and the sector will contribute towards fulfilling a commitment in the NSD to maximise the potential for UK content in projects.

Although nuclear projects going forward are likely to be based on technology originating overseas, with certain key components being supplied by Original Equipment Manufacturers (OEM) in the country of origin, there should be extensive opportunities and benefits for the UK Supply Chain to supply and install a significant proportion of the plant and equipment for the various projects; there is a mutuality of interest and a balance to be struck.

- 1.15 The future decommissioning spend in the UK is projected to be just under £150 billion, covering the legacy liabilities managed by the Nuclear Decommissioning Authority (NDA), the current nuclear generating fleet and the defence sector. It is recognised that this is an important market for UK companies and the work in this sector can lead to a valuable export business. To deliver best value to the UK tax payer, the Government and the sector will conduct a joint review into the decommissioning pipeline and waste management arrangements to target savings of 20% in the cost of decommissioning compared with current estimates.

The review will look at improving the way we do decommissioning in the UK to minimise cost and drive best value, whilst also exploring opportunities to support UK businesses to leverage our world-leading expertise in decommissioning and waste management to increase exports.

Business Environment

- 1.16 To improve the capability and competitiveness of UK industry, Government and industry will work together to develop advanced manufacture and construction demonstration programmes. These will focus on an advanced manufacturing and assurance processes, including for example, plant modularisation, advanced joining techniques and high efficiency construction techniques. The Government will make available up to £20 million, subject to robust business case and industry support, to develop a range of projects to demonstrate the benefits of the above processes to meet the goal of cost reduction. This programme will contribute to achieving the cost reduction targets for new build and decommissioning projects. It will ensure UK companies can offer high technology components for future projects and increase the opportunity for export orders. The potential value in new orders is estimated to be £2 billion by 2030.

Places

- 1.17 The NSD recognises the regional spread in capability and business generated by the existing nuclear business. The high value, high capability clusters round the UK add significant value to local communities and can be further developed by the actions arising from the NSD. Key Targets within the Deal which build on local infrastructure and organisations are:
 - ▶ Boosting capability and regional expertise
 - ▶ Creating world leading research centres
 - ▶ Delivering high-value jobs for local people
 - ▶ Sharing lessons to unlock the benefits of infrastructure investment
 - ▶ Creating clusters of nuclear expertise

Governance

- 1.18 The Nuclear Industry Council will oversee the future development and implementation of the NSD. Implementation of actions arising from the deal will be directed by industry-led working groups covering each of the main elements of the deal, with support from Government. The activities will be co-ordinated via a Programme Office managed by the NIA.
- 1.19 Achieving the goals of the NSD will greatly enhance the prospects for the nuclear industry in the UK, and increase the potential for export led business.

New Build Projects Being Developed by EDF Energy and CGN

- 1.20 EDF Energy has entered into a strategic partnership with the Chinese company CGN to construct new nuclear power plant at Hinkley Point in Somerset, at Sizewell in Suffolk, and at Bradwell in Essex. They have formed three companies, NNB GenCo (HPC), NNB GenCo (SZC) and BRB GenCo, who will be responsible for the design, development, construction, testing, commissioning, operation, maintenance and the eventual decommissioning of the new nuclear power plant at Hinkley Point C, Sizewell C and Bradwell B sites respectively. These companies will be the Site License holders or Licensees for each of the respective plant and subsequent operators of the new nuclear plant. A FID has been made for the Hinkley Point C project and work is progressing well. In the case of the other sites, the projects are being developed with the aim of achieving FID in the coming years.

The ownership of the three companies is shown below but EDF Energy and CGN will have joint control of decisions and operation of the companies.

Company	Site	EDF % Ownership	CGN % Ownership	Technology
NNB GenCo (HPC)	Hinkley Point C	66.5	33.5	EPR™
NNB GenCo (SZC)	Sizewell C	80.0	20.0	EPR™
BRB GenCO	Bradwell B	33.5	66.5	UK HPR1000
GNS Ltd*	N/A	33.5	66.5	UK HPR1000

*responsibility for completion of the Generic Design Assessment (GDA) works

- 1.21 As can be seen from the table above, the EPR™ reactor technology will be built at the Hinkley and Sizewell sites, and this design has been approved for use in the UK through the GDA process. The EPR technology is a Pressurised Water Reactor (PWR) with a central reactor vessel containing the nuclear fuel which is connected to four steam generators, known as a four-loop system.⁶ Each reactor can generate

⁶] EDF Energy, EPR Reactor design www.edfenergy.com/energy/nuclear-new-build-projects/hinkley-point-c/about/reactor

◀ Fig. 4 EDF Energy and CGN new build companies

1,600MW of electricity giving an output for each of the Hinkley and Sizewell sites of 3.2GW. This type of reactor is currently being built by CGN and EDF Energy at Taishan in China (2 units) and by EDF Energy at Flamanville in France (1 unit). One unit is also being built by Areva at Olkiluoto in Finland. The first EPR reactor to become operational in December 2018 was Unit 1 at Taishan.

- 1.22 The design of the EPR which will be built at Hinkley Point C, represents a major development on all previous PWR designs, making it amongst the safest and most efficient civil nuclear power generation plant ever designed. An assessment of the EPR design by the Office for Nuclear Regulation and the Environment Agency has been completed and a Design Acceptance Confirmation (DAC) and a Statement of Design Acceptability (SoDA) has been issued by the respective organisations in 2012 certifying the EPR design is suitable for construction and operation in the UK.
- 1.23 The UK HPR1000 is currently undergoing the GDA process, and in December 2018 completed the second phase of the GDA process.



Hinkley Point C Project

- 1.24 As part of the development phase of this project, EDF Energy negotiated a Strike Price with the Government for the sale of electricity from the Hinkley Point C project known as 'Contract for Difference'. The agreed rate for the supply of electricity is subject to an inflation model, active from the date of signature of the Agreement. Should the price of electricity in the UK exceed the Strike Price, EDF Energy will be paid the strike price plus the difference. Should the price of electricity be lower than the Strike Price, EDF Energy will refund the Government the difference.
- 1.25 The model will remain in force for 35 years and its agreement helped ensure the development of the Hinkley Point C project. It should be noted that the Strike Price is not dependent on the outturn cost of the project and EDF Energy (with its partner CGN) hold all the construction risk. The model only applies to the Hinkley Point C project and it is likely that a different model for financing new nuclear build will be considered in the forthcoming Energy White Paper.

- 1.26 Initially EDF Energy formed a UK subsidiary called NNB GenCo. This company carried out the project developments and liaised with the UK supply chain at many events to explain the project and their supply chain engagement model. Preparatory works on the Hinkley Point C site commenced in February 2012 and a Nuclear Site License was granted in November 2012. Approval of the Development Consent Order (DCO) to allow construction to commence was given by the Secretary of State for Energy in March 2013 and a FID to allow the project to commence was taken by the EDF Energy board in July 2016.
- 1.27 Approval for pouring the first nuclear base concrete at the Hinkley Point C site was given by the ONR in 2017. This was a major milestone for the project and reflected the confidence of the regulators in the ability of EDF Energy and its supply chain to deliver a major nuclear plant to the quality and safety levels required in the UK. The history of the process to arrive at the point of pouring first concrete demonstrates both the complexity and the thoroughness of the assessment and approvals process for new nuclear plant in UK.⁷
- 1.28 While many of the early contracts for the Hinkley Point C project were awarded by NNB GenCo, the Hinkley Point C project is now being run by HPC GenCo(HPC). Work is proceeding on the site and progress is continuously updated on the Hinkley Point C project website.⁸ Under the ‘Local Community’ section of the website, the activities undertaken by the project to support the local community are detailed. This demonstrates the considerable efforts by EDF Energy, CGN and the Hinkley Point C project to be a good and considerate neighbour. Construction is expected to last nine years and first power from the first reactor at Hinkley Point C is projected to come online in 2025.



Courtesy of EDF Energy

7] Stephen J Walls and Olivier Bard, Design Assessment and Site Licensing of the EPR for the Hinkley Point C Project (October 2016) www.nnr.co.za/wp-content/uploads/2016/10/06-Pres-EDF-Design-Assessment.pdf

8] EDF Energy/CGN UK, Hinkley Point C Project www.edfenergy.com/energy/nuclear-new-build-projects/hinkley-point-c



Courtesy of EDF Energy

Sizewell C Project

1.29 The Sizewell C project is now being managed by NNB GenCo(SZC). A summary of the progress on the Sizewell C site is shown in the table below.

Fig. 3 Sizewell C progress

Task	Complete	Ongoing	In Preparation
Stage 1 Public Consultation	Complete		
Stage 2 Public Consultation	Complete		
Land Ownership	Complete		
Site Surveys		Ongoing	
Stage 3 Public Consultation	Complete		
Nuclear Site Licence			In Preparation
Submission of Application for a Development Consent Order			In Preparation

1.30 The Stage 2 Consultation process involved significant effort by EDF Energy and its partner CGN including:

- ▶ Attendance at over 70 public exhibitions, meetings and presentations
- ▶ Review of the 1,059 responses from the public
- ▶ Analysis of statutory and non-statutory responses to assist in the formulation of forward plans for the project.

1.31 Stage 3 of the public consultation took place between 4 January and 29 March 2019.

1.32 Work is currently ongoing to complete the site investigations and the site-specific licensing activities for the project. Site specific approvals (Nuclear Site Licence and DCO) are expected in 2020. This would allow construction to commence around 2021 with first power around 2030. Further details of the progress of the project can be found on the Sizewell C website.⁹



Courtesy of CGN UK



Bradwell B Project

- 1.33 CGN and EDF Energy proposed to construct a version of the Chinese HPR1000 reactor technology at the Bradwell B site in Essex. This reactor design, to be known as the UK HPR1000, will be subjected to the UK GDA process to ensure it meets all the UK regulatory design and safety requirements.
- 1.34 China has developed several different nuclear power plant technologies over recent years and the HPR1000 has become the preferred reactor technology for China's Nuclear Power Export Strategy. It was developed jointly by CGN and China National Nuclear Corporation and is based on China's 30 years' experience of design, construction, and operation of nuclear power plants. The HPR1000 reactor design complies with China's latest safety standard, HAF102, the requirements of the United States Utility Requirements Document and the European Utility Requirement (EUR). The design also incorporates changes to the original reactor design to accommodate the lessons from the Fukushima incident.
- 1.35 The HPR1000 reactor is a three-loop system comprising the reactor pressure vessel and three steam generators, delivering 1,100 MW electrical output. The reactor design incorporates both active and passive safety systems.¹⁰

Safety features include:

- ▶ An outer shell containment to withstand the impact of large commercial airplanes
- ▶ A double containment arrangement which allows an annular space ventilation system to minimise the risk of radioactive releases into the environment
- ▶ A Passive Residual Heat Removal System to remove the residual heat from the reactor core should the active feed water system fail
- ▶ A Passive Reactor Pit Injection System (IVR) to maintain the integrity of the pressure vessel and prevent reactor core meltdown
- ▶ A large internal volume which improves safety in case of a beyond-design incident

¹⁰ CGN UK, Technical detail of HPR 1000 Reactor www.ukhpr1000.co.uk/the-uk-hpr1000-technology/hpr1000-design

1.36 Two units of the HPR1000 reactor design are being built at Fangchenggang plant in Guangxi province in China and these will be the reference plant for the Bradwell B plant. Importantly this means that by the time Bradwell B starts construction, there will be extensive construction and operational experience of the HPR1000 design which will significantly reduce the risk for the Bradwell B project.

1.37 EDF Energy and CGN have created a joint venture company, called General Nuclear System Limited (GNS), to undertake the GDA process for the UK HPR1000 design. In October 2016, it wrote to the BEIS requesting entry to the GDA process. The request was accompanied by a report providing evidence of their readiness to enter the process and, in January 2017, the UK HPR1000 formally entered Step 1 of the GDA process.

In November 2017, the Regulators concluded the information submitted by GNS during Step 1 was sufficient to allow the start of Step 2. This formally commenced on 16 November 2017. On 13 November 2018, the regulators confirmed in writing that sufficient information had been submitted to allow the start of Step 3. The targeted timescale for the UK HPR1000 GDA process is approximately five years from the start of Step 1.

1.38 While GNS will be responsible for the GDA, the company called BRB GenCo will be responsible for the design, construction and operation of the nuclear plant at Bradwell.

1.39 In parallel with the GDA process, BRB GenCo are progressing with work on the Bradwell site. This will involve several years of investigative works and public consultations before detailed proposals are produced to allow a full planning



application to be made. BRB GenCo commenced early site investigations at the Bradwell B site in December 2017. A planning application for more intrusive works, including the drilling of boreholes has been approved by Maldon District Council. These investigative activities will carry on throughout 2018 and into 2019.

- 1.40 Details of the UK HPR1000 design, its progress through the GDA process and the progress at the Bradwell site can be found on the Bradwell B website.¹¹ In the future, this website will also give details of the supply chain development process to be undertaken by BRB GenCo as it procures and constructs the UK HPR1000 plant.

New Build Projects Developed by Horizon Nuclear Power Ltd

HORIZON

NUCLEAR POWER

- 1.41 Horizon Nuclear Power Ltd is a UK energy company which had planned to develop new nuclear power plants on Anglesey (Wylfa Newydd), and at Oldbury on Severn in South Gloucestershire. In January 2019 Horizon issued a press release¹² suspending work on the two projects.
- 1.42 An exception is activities to support the examination and determination of the submitted DCO for Wylfa Newydd, which comprises two 1350MW reactors and associated infrastructures. Completion of this work will increase the chances of a timely restart of the project should the funding conditions allow.
- 1.43 Horizon continues to retain a team of people to manage its sites and continue discussions with Government, site communities and other key stakeholders.

New Build Project by NuGeneration Ltd

NU'GEN

- 1.44 NuGeneration Ltd had been planning to develop three AP1000 reactors at Moorside in Cumbria. However the decision by Toshiba to exit the nuclear market and its sale of its Technology provider, Westinghouse, meant NuGeneration was also put up for sale. As no buyer has been found Toshiba has now wound-up NuGeneration Ltd.
- 1.45 The Moorside site remains one of the potential sites in the UK for the construction of new nuclear power plant and may be developed by others in the future.

^{11]} CGN UK/EDF Energy, Bradwell B Project www.bradwellb.co.uk

^{12]} Hitachi Ltd, Press release by Horizon Nuclear Power suspending Wylfa Newydd Project www.hitachi-hgne-uk-abwr.co.uk

Routes to Market

- 2.1 The aim of this Chapter is to help companies understand the procurement process used by the project developers. Within the UK supply chain, the terminology of 'Tier or Tiers' within the supply chain is used extensively, from Tier 1 through to Tier 4.

It should be noted that these are not rigid definitions and largely depend on the position of a company within the supply chain hierarchy on each particular contract. A company acting as a Tier 2 contractor on one contract could have a lesser role on another contract and hence operate as a Tier 3 contractor. Nevertheless, the following broad definitions apply.

2.2 **Tier 1 Contractors**

Major companies who have considerable experience in the global nuclear market and have the financial strength to accept the risks and liabilities associated with multi-million pound/euro contracts. Tier 1 contractors are likely to subcontract significant parts of their contracts to Tier 2 and Tier 3 companies and will have extensive experience of supply chain management. They will have nuclear safety culture firmly embedded in their organisation and have robust management, safety and quality systems in place.

2.3 **Tier 2 Contractors**

Large companies who have considerable experience of the UK nuclear market and can accept the risks and liabilities associated with significant sized contracts. They are likely to subcontract some of their activities to Tier 3 and Tier 4 contractors. Like Tier 1 contractors they will fully understand the workings of the UK nuclear industry including Nuclear Safety culture and will have robust management, safety and quality systems in place.

2.4 **Tier 3 Contractors**

These could be larger companies with limited experience of working in the nuclear industry or smaller companies who have had some experience of the industry. They are unlikely to be able to accept the larger contracts directly and will usually work for the Tier 1 or Tier 2 contractors. They are likely to have accreditation to the national and international standards for the management of their business and operate proven quality, health and safety systems.

2.5 **Tier 4 Contractors**

These are likely to be smaller companies with little experience of the nuclear industry. They will need the support of the higher tier contractors to deliver to the required quality and safety arrangements.

They are unlikely to understand many of the 'flow down' requirements and their staff may need training as to what it means to work in the nuclear industry in the UK.

- 2.6 The procurement process used by project developers and their approach to supply chain engagement, will vary between projects. In addition, developers may change their delivery strategy and the associated procurement routes for their projects over time.

It is therefore necessary for the supply chain to continually update their intelligence on the intent of the developers and how they are structuring their supply chain. It will also be necessary to understand how both commercial and regulatory requirements are being interpreted by the developers and how they will flow down these requirements into the supply chain.

Routes to Market for Hinkley Point C and Sizewell C Projects

Background

2.7 EDF Energy is the largest producer of low carbon energy in the UK. It has a generation mix of wind farms, gas plant and combined heat and power plant. It also operates 15 nuclear reactors in the UK which meet approximately 20% of the UK power demand. As a result, it has a well-established UK supply chain and has formed a Strategic Partnership for Lifetime to support the operation of its existing nuclear fleet through to the end of their operational lives.

Strategic Partnership for Lifetime



- ▶ Working together to maximise generation
- ▶ Shared objectives and common incentivisation

2.8 The main companies involved in this arrangement are shown above and are supported by many Tier 2, 3 and 4 companies in the UK to provide the range of services required. While these relationships only exist to service the EDF Energy existing power generation business in the UK, the relationships already developed are likely to be beneficial to all parties in the nuclear new build programme. EDF Energy understand the capabilities of the UK supply chain and its robust application of a nuclear safety culture. In turn, the supply chain understands EDF Energy's values and the importance it places on nuclear safety, human performance, quality and delivery to programme.

2.9 Prior to the formation of the two current Joint Venture companies NNB GenCo(HPC) and NNBSGenCo(SZC), their predecessor, NNB GenCo, had been engaging with the UK and French supply chains for many years. It had presented its procurement strategies at many conferences and had arranged many supplier days to inform industry about its procurement and construction plans. It had established an online national supplier database so companies could register for the type of product or services they wished to supply.

2.10 To assist the supply chain in understanding the procurement process, NNB GenCo produced a guidance document entitled 'Building our industrial future-Hinkley Point C Supply Chain'.¹³ This is an excellent document and details how EDF Energy and the supply chain can work together to deliver new nuclear power

¹³ EDF Energy, Building our industrial future: Hinkley Point C Supply Chain - be part of it (2014) www.hinkleysupplychain.co.uk/wp-content/uploads/2014/05/HPC_Supplier_Booklet.pdf



Courtesy of Wood

plant projects. The document provides details on the procurement processes to be employed and their requirements in areas such as quality, component classification, expected behaviours and the inspection and surveillance process which will occur during the contract phase. It also documents the engagement with local communities and suppliers including the local Chambers of Commerce.

NNB GenCo(HPC) engagement with the Supply Chain

- 2.11 As the Site License company, NNB GenCo(HPC) will be responsible for the delivery of the project at Hinkley Point C. It has to demonstrate it can act as an intelligent customer for the procurement, installation, construction and commissioning of the plant. It must also ensure its values of nuclear safety culture and quality requirements flow down through all levels of the supply chain and demonstrate that it is operating in accordance with world best practice, taking on board lessons from the construction of nuclear plant worldwide.
- 2.12 A part of this learning process NNB GenCo(HPC), has assessed the lessons learned from the construction of the EPR at Flamanville in France. To ensure these lessons are transferred to the UK, it has encouraged UK and French companies to co-operate and jointly tender for the major work-packages for the Hinkley Point C project. This approach is viable because of the proximity of the two countries and brings many advantages such as:
- ▶ French companies bring a knowledge of the RCCM and RCCE nuclear codes which are used for the design manufacture and installation of parts of the Nuclear Island
 - ▶ French and UK companies are experience in the manufacture of components to ASME, EN and British Codes as well as the PED and PER99 regulations
 - ▶ UK companies bring a knowledge of UK regulatory processes and the application of the UK nuclear safety culture including the application of human performance requirements
 - ▶ French companies bring an understanding of the construction techniques and scheduling used on Flamanville and by working with UK partners, can optimise the construction schedules on the Hinkley Point C site
 - ▶ UK companies bring an understanding of UK construction practices including the application of CDM regulations and working with the UK unions and construction workforce

- 2.13 Several French/UK partnerships and Joint Ventures have been formed and have been successful in being awarded contracts or being selected as a preferred bidder.
- 2.14 In addition, NNB GenCo(HPC) has assessed the lessons learned from bringing the EPR reactor at Taishan in China successfully into operation. CGN is now bringing expertise derived from that project to bear on the Hinkley Point C project.

Procurement Processes

- 2.15 NNB GenCo(HPC) has developed a stepped procurement process involving the following, each of which are discussed further below:
- ▶ Pre-qualification
 - ▶ Tender submission and Assessment
 - ▶ Preferred Bidder/Contract award
 - ▶ Contract Delivery

Prequalification Stage

- 2.16 At the Prequalification Stage, contractors are assessed to ensure they have the competencies, capabilities and experience to deliver the required works. Checks are made to ensure that companies are financially stable and have the culture to work safely in the nuclear industry. Successful companies are included on the tender list for the relevant work-package.

Tender Submission and Assessment

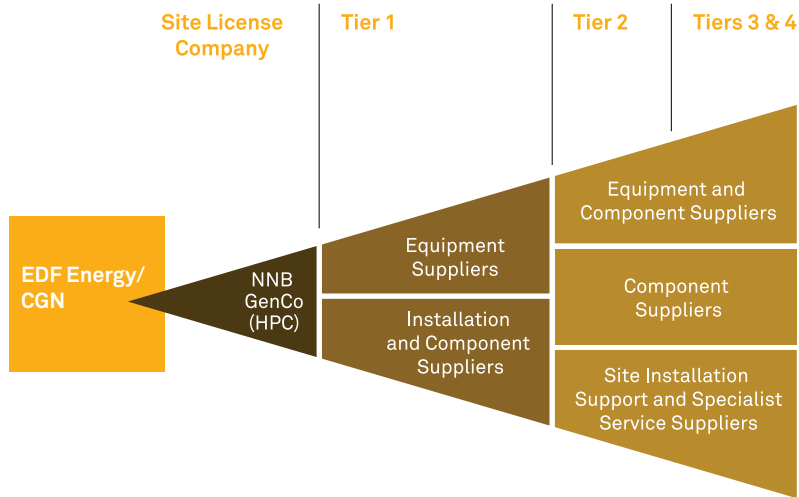
- 2.17 On larger work packages the tender requirements are extensive. Detailed tender submissions must be submitted by the contractors on their technical capability, quality systems and delivery strategy, including the nomination of key suppliers or subcontractors.
- 2.18 Demonstration is required that companies have robust and effective Health and Safety management processes, understand the significance of working in the nuclear industry and have a nuclear safety culture embedded in their organisation. Detailed cost models and cost breakdowns for the work must be accompanied by a Level 2 or Level 3 programme for the contract activities. Following the tender submission, an extensive technical evaluation will be carried out by NNB GenCo(HPC). This can last for several months for larger work-packages or where site installation works are involved.
- 2.19 Key subcontractors at Tier 2 and Tier 3 level are often included in the assessment process. EDF Energy recognise the high costs incurred by parties involved in the tendering process, and where several companies are involved in tendering for a contract, early shortlisting is often undertaken to avoid unnecessary supply chain expense. At the end of this process a single preferred bidder is usually nominated.

Preferred Bidder/Contract Award

- 2.20 During the preferred bidder stage, elements of the design finalisation may be required so that the contract price can be frozen. Early Contractor Involvement (ECI) contracts or Early Works Contracts (EWC) may be used at this stage to allow the works to progress in parallel with contract finalisation. Final commercial negotiations take place during this phase to agree terms and conditions of contract and form of payment. These are usually based on standard forms of contract such as FIDIC or NEC3 with modifications to reflect the NNB GenCo(HPC) contract drivers. Regulatory flow down requirements such as license conditions are often incorporated into the standard forms of contract. The agreement of the frozen design, a detailed programme for the works and the commercial arrangements usually results in formal contract award.

2.21 NNB GenCo(HPC) expect to directly award approximately 200 contracts at Tier 1 level. These contracts vary in value from several billion pounds for some of the large site installation contracts to several million pounds for the manufacture only contracts. On the larger contracts, the Tier 1 contractors will have their own Tier 2, 3 and 4 contractors. Some niche contracts may also be awarded directly by EDF Energy to Tier 2 contractors. A typical supply chain map is shown below, and the list of work packages is available on the EDF Energy website.¹⁴

Fig. 4 Typical supply chain map



2.22 At present the approximately 180 main Tier 1 contracts for Hinkley Point C project are at different stages in the procurement process. At the end of 2018, contracts signed with the Tier 1 contractors account for 84% of the total contract value for Hinkley Point C with a further 9% at preferred bidder status. Only 7% of the total contract value was in the early procurement process. Some of the main contracts awarded are listed below.

Fig. 5 Examples of contracts awarded for Hinkley Point C

Work Package	Discipline	Contractor appointed
Earth Works	Civil	Kier Bam Joint Venture (JV)
Main Civil Works	Civil	BYLOR - JV between Laing O'Rourke and Bouygues TP
Marine Works	Civil	Balfour Beatty
Nuclear Steam Supply System	Mechanical	Framatome
Balance of Nuclear Island	Mechanical	CBN - JV between Cavendish Nuclear and Bocard
Nuclear Island Ventilation	Mechanical	ACTAN - JV between Axima Concept Tanzini Nucleaire and Doosan Babcock
Electrical Equipment and Cabling Works	Electrical	Balfour Beatty Bailey - JV between Balfour Beatty and NG Bailey

^{14]} EDF Energy/CGN UK, Description of work packages and contract award status on Hinkley Point C Project www.edfenergy.com/energy/nuclear-new-build-projects/hinkley-point-c/for-suppliers-and-local-businesses/work-packages



- 2.23 Reflecting on lessons learned from Taishan and elsewhere, NNB GenCo(HPC) has reviewed its procurement route for the Mechanical, Electrical and HVAC contracts and is in advanced discussions with a number of companies to form a MEH (Mechanical Electrical and HVAC) Alliance. The aim is to form a more integrated delivery vehicle for the works and agreements are in place with several contractors with whom PSC contracts have been signed.
- 2.24 When the MEH Alliance is fully operational, the Balance of Nuclear Island, Nuclear Island Ventilation and Electrical Equipment and Cabling contracts in the table above will be encompassed into one MEH Alliance Contract. Some of the companies involved in the MEH Alliance discussions are Altrad, Balfour Beatty Bailey, Cavendish Nuclear and Doosan Babcock. Progress on the formation of the Alliance will be reported on the Hinkley Point Supply Chain website.¹⁵

Working with Local Stakeholders and Local Suppliers

- 2.25 NNB GenCo(HPC) has recognised the importance of working with local suppliers and of developing the skill sets of local people. Some of the ways in which NNB GenCo(HPC) is achieving local involvement are described below:

1. Skill Development

A Construction Skills and Innovation Centre¹⁶ is operated in conjunction with Bridgwater & Taunton College to help local people develop the construction skill sets necessary for the Hinkley Point C project. At present this is focused on civil skill sets such as rebar placement, but this will quickly develop to incorporate mechanical and electrical construction skill sets. In addition to the craft skills, a separate Energy Skills Centre has been developed to enhance the availability of the technical and engineering skills which will be required by the energy industry in the UK.

^{15]} EDF Energy/CGN UK, Hinkley Point C Supply Chain www.hinkleysupplychain.co.uk

^{16]} Bridgwater and Taunton College, Construction, Skills & Innovation Centre (CSIC) www.btc.ac.uk

2. Industrial Partner Supply Steering Group

Membership of this Steering group¹⁷ include the client's Hinkley Point C Supply Chain Team, the Somerset Chamber of Commerce and the major Hinkley Point C Tier 1 construction partners. Its role is to oversee and maximise the involvement of local business in the supply of manufactured goods and services to the project, via the Tier 1 contractors.

3. South West Hinkley Supply Chain Team

This Supply Chain Team¹⁸ is managed jointly by Somerset Chamber of Commerce, Business West, SWMAS and NNB GenCo(HPC). The team are the single point of contact between the local and regional supply chains seeking to win work and the Tier 1 or 2 contractors on the project. The supply chain team has its own supply chain portal with over 3,000 local and regional suppliers registered. The capabilities of these suppliers are mapped against each of the work packages to be awarded to Tier 1 and 2 contractors and introductions between the various parties are facilitated.

4. Site Operation and Supplier Steering Group

This group is chaired by NNB GenCo(HPC) and Somerset Chamber of Commerce. It is focused on providing local solutions for the provision of services needed by the on-site construction teams including catering, provision of accommodation, transport and other site services. This group has been very successful in facilitating the formation of local consortia to enable the local groupings to tender for larger packages work than would otherwise have been possible.

2.26 The work of the above groups will maximise the value of work won, and services provided by local companies. There have already been some significant successes and further positive results are expected as more contracts are awarded locally. The work of the groups will leave a lasting legacy for the future in the area round the plant.

NNB GenCo(SZC) engagement with the Supply Chain

2.27 As indicated in Chapter 1, the Sizewell C project is still in its early stages. Activities are limited to obtaining the Site License and the engagement with the supply chain is limited to the local site investigations works. As the project develops it is expected that NNB GenCo(SZC) will follow a similar procurement strategy to that adopted by NNB GenCo(HPC). Engagement with local bodies such as the Suffolk Chamber of Commerce has commenced and it is expected a similar, high level of local engagement will follow the Hinkley Point C model. As further clarity develops, the NIA website and the Sizewell C Project website will be updated with the relevant information.

Routes to Market for the Bradwell B Project

2.28 As described in Chapter 1 the UK HPR1000 reactor design will be developed for the Bradwell B site. These reactors are already being built in China, and by

¹⁷ Industrial Partner Supply Group www.hinkleysupplychain.co.uk/the-industrial-partners-supplier-steering-group

¹⁸ South West Hinkley Supply Chain Team www.hinkleysupplychain.co.uk/the-south-west-hinkley-supply-chain-team

the time Bradwell B procurement commences, a number of HPR1000 units will be operational. Existing supply chains will be in place and will have built up considerable expertise supplying and constructing these reactors.

- 2.29 The principal developer, CGN, has already started working with EDF Energy to understand the UK supply chain and it has stated that it wants to engage with the UK supply chain in a meaningful way. To this end it has already organised visits with NNB GenCo(HPC) and some of their main UK suppliers to meet Chinese supply chain companies engaged in the Fangchenggang project.
- 2.30 As CGN has stressed its intent to ensure the involvement of the UK supply chain in the Bradwell B project, further exchange visits and potentially the formation of UK/Chinese partnerships could be expected. These partnerships might provide many of the components and construction services required for the Bradwell B plant. As more details of the proposed UK supply chain engagement emerge, information will be placed on the NIA website and the Bradwell B Project website will be updated.

Routes to Market for the Wylfa Newydd Project

Early engagement with the UK Supply Chain

- 2.31 Horizon Nuclear Power and Hitachi Nuclear Energy Europe had been working together to develop the two reactors at the Wylfa Newydd site. They had been interacting with the UK supply chain for several years and a common supply chain website, using the CompeteFor platform had been established where suppliers could register the services they wish to supply. With the suspension of the project all supply chain development activities have been put on hold.

Working with local stakeholders and organisations

- 2.32 Welsh Government and the Isle of Anglesey County Council (IOACC) had been actively supporting the local supply chain development. They had, with the support of Horizon, set up a Business Readiness Programme¹⁹ to help local companies develop the special skills necessary to work in the nuclear industry. This includes funding from the Welsh Government for Welsh companies to participate in the Nuclear AMRC Fit 4 nuclear programme. The continuation of these programmes will depend on the future development of the Wylfa Newydd site.

^{19]} Welsh Government/Isle of Anglesey County Council, Business Readiness Programme www.anglesey.gov.uk

Legal Framework and Regulatory Bodies

Overview of Legalisation and Regulatory Authorities

- 3.1 A main piece of legislation regulating the nuclear industry in the UK is the Energy Act 2013. This legislation covers most of the energy industries in the UK with Chapter 3 of the Act specifically setting out the legislation as it applies to the UK nuclear industry.
- 3.2 The Act established the ONR and defined its structure, accountability and responsibilities within Great Britain. It describes the ONR's principal function as 'doing whatever it considers appropriate to ensure nuclear safety.' The Act tasks the ONR with ensuring nuclear safety, conventional health and safety at nuclear sites, nuclear security, overseeing nuclear safeguarding activities on behalf of Government, and regulating the transport of radioactive material in the UK.
- 3.3 The Health and Safety at Work etc. Act 1974 applies to nuclear sites in Great Britain. Under this Act the ONR ensures arrangements are in place to secure the health and safety of people working at nuclear sites and the health and safety others out-with the site who may be affected by such undertakings.
- 3.4 The Nuclear Installation Act 1965 requires the licensing of sites which are to be used for the operation of nuclear facilities via a nuclear site license. Attached to the site license are a number of site license conditions which influence how the site is managed, operated, maintained and finally decommissioned. The latter are used by ONR to operate a permissioning regime at nuclear sites and failure to comply with the conditions of the nuclear site license or license conditions is an offence under the Act.

Legal Frameworks

- 3.5 The Legal Framework which regulates and controls the Nuclear Industry in the UK is primarily based around three Acts noted above and their relevant statutory provisions. A summary of the Acts is presented below:

Energy Act 2013

- 3.6 The Energy Act²⁰ is a very diverse document dealing with legislation for much of the energy industry in the UK. Part 3 of the Act entitled 'Nuclear Regulation' covers the activities of the nuclear energy industry and comprises of five chapters:
 - ▶ **Chapter 1** The ONR's Purposes
 - ▶ **Chapter 2** Nuclear Regulations
 - ▶ **Chapter 2A** Nuclear Safeguards
 - ▶ **Chapter 3** The ONR
 - ▶ **Chapter 4** Function of the ONR
 - ▶ **Chapter 5** Supplementary
- 3.7 Most of the chapter titles are self-explanatory except for Chapter 5 which deals with General Duties of Employers and Employees – replicating duties found in the Health and Safety at Work etc. Act 1974. It also includes some offences under the Energy Act, and issues associated with civil nuclear liabilities.

²⁰ Energy Act 2013 www.legislation.gov.uk/ukpga/2013/32/pdfs/ukpga_20130032_en.pdf

- 3.8 There are a number of schedules attached to the Act which provide additional information about the formation and responsibilities of the ONR. These are:
- ▶ **Schedule 6:** Provisions for Nuclear Regulations
 - ▶ **Schedule 7:** Structure of the ONR
 - ▶ **Schedule 8:** Appointment and Powers of ONR Inspectors
 - ▶ **Schedule 9:** Disclosure of Protected Information
 - ▶ **Schedule 10:** Provisions Relating to Offences
 - ▶ **Schedule 11:** Transfer to ONR of People and Property
 - ▶ **Schedule 12:** Minor and Consequential Amendments in relation to Part 3.
- 3.9 The Act establishes the ONR as an independent statutory legal entity, empowered to enforce the statutory provisions of the Energy Act and the Health and Safety at Work Act. It should be noted that the responsibility for delivering a safe secure nuclear industry rests with the industry itself and the role of the ONR is to provide efficient, effective regulation with respect to:
- i. Nuclear Safety
 - ii. Nuclear Site Health and Safety
 - iii. Nuclear Security
 - iv. Nuclear Safeguards
 - v. Transport (civil transport of nuclear material)

The structure of the ONR and the way in which it discharges its responsibilities is discussed later in this Chapter.

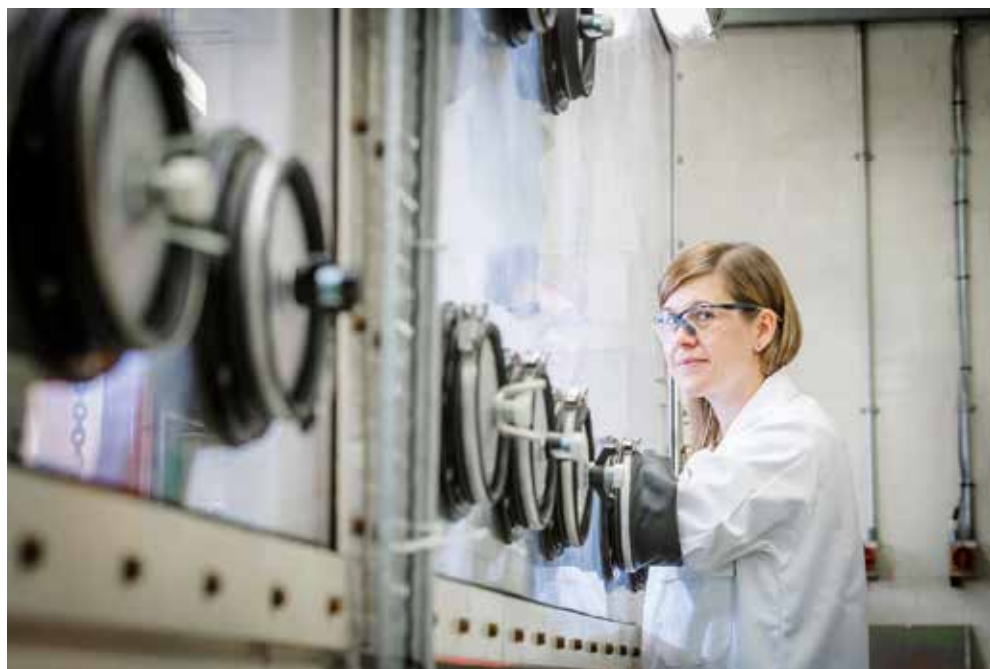
The Health and Safety at Work Act 1974

- 3.10 Health and Safety at Work Act 1974 (HSWA)²¹ is the primary piece of legislation covering occupational health and safety in Great Britain. It covers all work activities in all industries, including the nuclear industry. In Part 1 of the Act the main objectives are defined as:
- ▶ Ensuring the health and safety of all persons at work
 - ▶ Protecting persons, other than persons at work, against risks to health and safety arising from activities of persons in work
 - ▶ Controlling the keeping and use of explosive, flammable and other dangerous substances
- 3.11 The Act places duties on both employers and employees with respect to health and safety including:
- ▶ Provision of systems of work which are safe and without risk to health or safety
 - ▶ Maintenance of plant to ensure safety
 - ▶ Ensuring safety in connection with storage and transportation of substances
 - ▶ Provision of a safe work environment including adequate means of safe access and egress to the working area
 - ▶ Conducting all undertakings such that there is no exposure of the public to risk or danger
- 3.12 Compliance with the above duties must be the primary aim of both the employer and employees and all parties are tasked with achieving compliance with the above 'in so far as it is reasonably practicable'.
- 3.13 Under the Act, employers have a duty to protect the health, safety and welfare of their employees at work. They must also ensure that persons not in their

²¹ Health and Safety at Work Act 1974 www.legislation.gov.uk/ukpga/1974/37/pdfs/ukpga_19740037_en.pdf

employment (the public and others) are not exposed to risks to their health and safety arising from employers' activities, or in some cases, by inactivity on the part of the employer. As part of achieving the above goals, employers must develop written statements of health and safety policy and must ensure all employees are both aware of the policy and act accordingly. Employees also have a duty to co-operate with their employer to maximise health and safety, to take care of their own and their colleagues' health and safety and to do all they can to avoid incident and injuries, as far as is possible.

- 3.14 The Act places duties on legal entities who design, manufacture or supply articles or substances for use at work. The design and construction of these items must be such that, in so far as is reasonably practicable, they are safe and without risks to health or safety when being installed, commissioned, used, cleaned or maintained by persons at work. Appropriate testing and inspection must be carried out to ensure operational safety, and sufficient documentation must be provided to aid the safe use of the equipment or material. As well as the HSWA there is a wealth of other legislation which details the duties placed on designers, manufacturers, and suppliers of articles and substances for use at work such as the Construction Design Management requirements under CDM2015 regulations.
- 3.15 Under the Act, the Secretary of State is given powers to make modify or repeal Health and Safety Regulations. The Act created the Health and Safety Executive, but also allows for other authorities to regulate health and safety within the fields in which they have responsibility. In the case of the nuclear industry, responsibility for Health and Safety on nuclear sites in Great Britain lies with the ONR who become the enforcing authority under the Act.
- 3.16 The enforcing authority can appoint Inspectors to regulate the provisions of the Act that fall within the responsibility of that authority. The powers provided to inspectors must be granted by the enforcing authority through a written instrument and include:
- ▶ Entering any premises to make any examinations or inspections considered necessary to enforce the provisions of the Act
 - ▶ Suspension of work and quarantine of premises or any portion thereof as is deemed necessary
 - ▶ Taking samples of any substance on the premises, in the atmosphere or in the vicinity of the premises as required
 - ▶ Taking possession of plant, equipment or documentation in relation to any investigation or incident



Courtesy of Wood

- 3.17 Inspectors are appointed by the ONR to carry into effect the relevant statutory provisions of the Energy Act 2013, including the relevant provisions of the Health and Safety Act 1974 and the Nuclear Installations Act 1965.

Nuclear Installations Act 1965

- 3.18 The Nuclear Installations Act 1965 (NIA65)²² describes the permissioning regime that applies to nuclear installations in the United Kingdom. The Act has three main purposes in that it:
- ▶ Requires the licensing of sites which are to be used for the installation or operation of nuclear reactors and attaches conditions about how they can be built, operated, and decommissioned through a Nuclear Site License and a number of License Conditions;
 - ▶ Requires nuclear installations which are prescribed in legislation to be licenced and managed in accordance with relevant licence conditions, and;
 - ▶ Provides a special legal regime to govern the liability of the nuclear site Licensee towards third parties for damage caused by nuclear matter or ionising radiations on, or coming from, nuclear sites.
- 3.19 NIA65 requires that a nuclear site licence²³ can only be granted to a corporate body. It is granted by the appropriate national authority, which in England, Wales and Scotland is the ONR; in Northern Ireland it is the Secretary of State. The appropriate national authority attaches conditions to the site licence which are necessary or desirable in the interest of safety through a number of license conditions. The site licence requires measures are introduced for:
- ▶ Provision of an effective system for detecting and recording radioactive emissions or discharges
 - ▶ Controlling the design, operation, maintenance and modification of the plant or other installation on the site
 - ▶ Preparing measures to be taken in the event of any accident or other emergency on the site
- 3.20 The licence conditions²⁴ provide the basis for regulation of nuclear safety by ONR on nuclear sites in Great Britain. They are generally non-prescriptive and set goals which the Licensee is responsible for meeting. The site licence and relevant licence conditions apply at all times throughout the life of a licensed installation and cover design, construction, commissioning, operation, maintenance, modifications and decommissioning. NIA65 empowers the ONR to add, vary or revoke a site licence at any time during the Licensee's period of responsibility. This allows ONR the flexibility to change the licence conditions to reflect specific circumstances and the phases of the plant life. However, the granting of a site licence by the ONR do not relieve the Licensee of the responsibility for ensuring the safety of the plant, the public and the environment at all times.
- 3.21 There are 36 standard licence conditions used by the ONR and these are described in more detail later in this Chapter.

²² Nuclear Installations Act 1965 www.legislation.gov.uk/ukpga/1965/57/pdfs/ukpga_19650057_en.pdf

²³ Office for Nuclear Regulation (ONR), Licensing Nuclear Installations (January 2015) www.onr.org.uk/licensing.htm

²⁴ ONR, License Condition Handbook (February 2017) www.onr.org.uk/documents/licence-condition-handbook.pdf

The Structure and Operation of Regulatory Organisations

Office for Nuclear Regulation

3.22 The Office for Nuclear Regulation (ONR) was established by the Energy Act 2013 as an independent statutory legal entity to regulate the nuclear industry in the Great Britain. Its mission is:

“...to provide efficient and effective regulation of the nuclear industry, holding it to account on behalf of the public.”

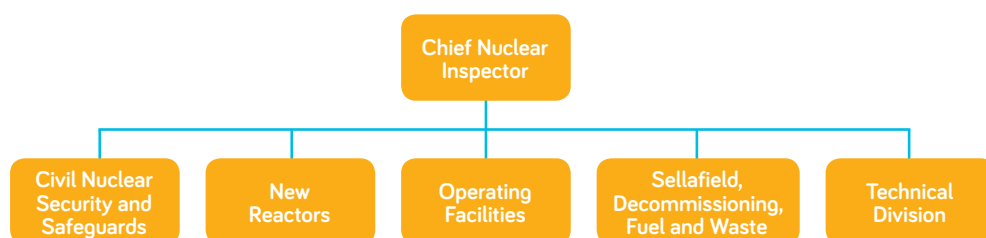
3.23 The statutory purposes of the ONR brings together under one body, responsibility for:

- ▶ Nuclear safety
- ▶ Nuclear site health and safety
- ▶ Civil nuclear security
- ▶ Nuclear safeguards
- ▶ Transport of radioactive material by road, rail or inland waterway

3.24 As a public corporation, ONR is accountable to the UK Parliament through the Secretary of State for Work and Pensions in relation to governance, finance and conventional health and safety. It works closely with the BEIS, whose Secretary of State is accountable for the UK civil nuclear regulatory framework and policies. These include civil nuclear safety and security, construction of new nuclear facilities, decommissioning programmes, emergency planning and response, nuclear material safeguards and regulation of the transport of nuclear materials. The ONR also works closely with the Ministry of Defence in relation to the nuclear licenced sites which contribute to its defence nuclear programme.

3.25 The ONR is governed by an eleven-strong unitary Board of Directors including a Chair, Chief Executive, Chief Nuclear Inspector, Finance Director and HR Director. There are also six independent non-executive directors. Reporting to the Board is a Senior Leadership Team (SLT), led by the Chief Executive. It is the primary executive decision-making body providing overall strategic leadership, supporting the Board to carry out legislative, policy, operational and administrative functions. The SLT is supported by the Regulatory Leadership Team, led by the Chief Nuclear Inspector, which provides oversight, governance and decision making on all regulatory matters.

Regulatory Directorate Structure



A summary of the duties of each Division²⁵ is outlined on the following pages.

Fig. 6 Divisions of the Office for Nuclear Regulation

- 3.26 The **Civil Nuclear Security and Safeguards Division** is responsible for approving the security arrangements within the civil nuclear industry. It regulates the security of nuclear material when it is on licenced nuclear sites, being transported by road, rail or by sea when on UK flagged vessels. It also sets rules for the control of sensitive nuclear material and regulates the movement of prescribed (nuclear) goods into the UK through the issuing of import licences. In order to comply with international obligations on the control of nuclear material (safeguarding against unauthorised use in weapons programmes), the Division monitors the use and movement of nuclear material in Great Britain. It also contributes to international programmes to safeguard against the unauthorised use of nuclear material in global weapons programmes.
- 3.27 The **New Reactor Division** is responsible for assessing, licensing and controlling the development of new reactors in Great Britain. Along with the Environment Agency, it has developed the Generic Design Assessment process to systematically assess the safety of new reactor designs. The Division also has the responsibility for assessing companies who wish to build and operate new nuclear power plant in GB. The Division needs to be satisfied that the choice of site is suitable, and that the developer understands the risks and hazards of the proposed activities. It also ensures that the developer has the organisational structure, personnel and capability to lead and safely manage the construction and operation of new nuclear plant. The Division will only assess those reactor designs requested by BEIS.
- 3.28 **Sellafield, Decommissioning Fuel and Waste Division** is responsible for the regulation of 20 nuclear licenced sites under the four sectors of decommissioning, land management, radioactive waste management and geological disposal. Because of its size and the complexity of its waste material, the Sellafield site has a dedicated Manager within the Division. For this site, the focus is on the monitoring of hazard reduction being achieved while ensuring that the projects on the site are being implemented in a manner which complies with all the required regulatory standards.



- 3.29 The **Operating Facilities Division** regulates the safety and security of operational nuclear power plant as well as the facilities which support the UK's fleet of nuclear submarines. It also regulates the activities of the atomic weapons sites where the UK nuclear weapons are maintained and stored. In the regulation of the 15 operational civil nuclear reactors, it promotes fleet wide improvements in all aspects of nuclear safety, gives permissions for key activities on the sites and undertakes periodic safety reviews at each site every 10 years.
- 3.30 The **Technical Division** is tasked with ensuring that the ONR has the skills and information to allow its people to effectively and efficiently regulate the health, safety and security of nuclear facilities. It disseminates best international practice across the other divisions as well as being responsible for establishing and monitoring research programmes developed by ONR. It operates a knowledge management strategy across the divisions to ensure harmonisation of approach as well as resolving any technical difference which may arise between the divisions or between ONR and nuclear operators.
- 3.31 The ONR co-operates with a number of other bodies and Government agencies through a series of Memoranda of Understanding (MoUs) and Agency Agreements. The MoUs are administrative agreement between ONR and other parties to ensure that the parties involved understand their own responsibilities and the responsibilities of others. These MOUs are not legally binding documents and do not transfer responsibilities or powers but are used to govern the relationships between the organisations. A good example is the co-operation between ONR and the relevant environment agencies to complete the GDA of new nuclear plant, where the bodies jointly assess the suitability of new nuclear plant designs for construction and operation in GB.
- 3.32 Agency agreements are formal, legal documents which are used to transfer statutory responsibilities between bodies. Under such agreements the ONR can take responsibilities or functions from other statutory bodies but requires ministerial approval to do so.

Environment Agency

- 3.33 The Environment Agency (EA) works with Natural Resources Wales (NRW) and Scottish Environment Protection Agency (SEPA) to improve the environment in Great Britain. The EA is an executive public body sponsored by the Department of Environment, Food and Rural Affairs. It was formed in 1996 with responsibilities to regulate the impact of major industries on the environment, to manage the treatment of contaminated land and to ensure water quality.
- 3.34 Through cooperation with local flood authorities, the bodies are responsible for all aspects of flood management and flood prevention. Under the management of a Chair Person and a Chief Executive, the EA has three operational groups; Flood & Coastal Erosion, Environment & Business, and Operations, as well as two support groups.
- 3.35 The EA, via its Environment & Business Group, and in conjunction with NRW, regulate the emissions and discharges from nuclear sites in England and Wales against the Nuclear Sector Environment Plan Issue 3. It is involved jointly with ONR in the GDA of the proposed new nuclear plant, issuing its own GDA statements and interim or final SoDA for the new nuclear plant.

Regulatory Processes

The Nuclear Site Licence

- 3.36 The safety of nuclear installations in Great Britain is secured through a nuclear site licence and the conditions attached to it. NIA65 provides for a nuclear site licence to be granted to a named corporate body to install or operate specified nuclear installations in a defined location. Each nuclear site licence is unique to its site and is not transferable. A nuclear site licence is granted by the ONR for an indefinite period provided there are no material changes to the basis on which the licence was granted. It can cover the entire lifecycle of a site from installation and commissioning through operation and decommissioning to site clearance and remediation. All new nuclear power plant designs which have obtained a DAC from the ONR and a SoDA from the EA also need a nuclear site licence before nuclear safety critical construction can start and before operation of the plant can commence.
- 3.37 NIA65 requires ONR to attach to each nuclear site licence, such licence conditions as it considers necessary or desirable in the interests of safety. The nuclear site licence and attached licence conditions apply at all times throughout the life of a nuclear licenced site and therefore cover design, construction, commissioning, operation, maintenance, modifications and decommissioning. NIA65 empowers ONR to add, vary or revoke conditions at any time, allowing ONR the flexibility to tailor requirements to the specific circumstances or phases of the plant's life.
- 3.38 While the licence conditions provide the basis for regulation by ONR, they do not relieve the Licensee of their responsibility for the safety of the plant. The ONR reviews the Licensee's compliance arrangements to ensure they are clear and unambiguous and address the main safety issues adequately.

Licence Conditions

- 3.39 There are 36 standard licence conditions which apply to nuclear plant under construction, in operation or in the decommissioning phase as set out in the License Condition Handbook. The duty to comply with these licence conditions rests with the Licensee (the organisation constructing, operating or decommissioning the plant). When contracting out work, the Licensee will find it necessary to flow down some of the obligations under the licence conditions into their supply chain. In many cases these obligations end at the Tier 2 level, but can, in cases, flow down to the Tier 3 and Tier 4 companies. Some of the licence conditions and how they may affect the supply chain are summarised in Appendix 1.
- 3.40 The common feature of the licence conditions is about control of works. Some ensure people are Suitably Qualified and Experienced (SQEP) to carry out the work with which they are tasked (LC12) or they have sufficient knowledge and training to understand the rules, regulations and risks associated with working on operational nuclear sites (LC9). Others relate to the production of documentation to justify the safety of plant (LC14), or that documentation is produced to define what works has been done in the design, manufacture of components or in the modification of plant (LC6). Specific licence conditions exist to control the construction operation or modification of nuclear plant (LC 19 and LC20), while the controls for the commissioning of nuclear plant or facilities is specified by LC21.

Approach to Regulation on Nuclear Plant

- 3.41 The ONR regulates all activities associated with nuclear plant whether it is design activities in offices, work in factories or work on licenced nuclear sites. It does so by:
- ▶ **Permissioning Inspection** – before ONR permissions key activities, it assesses the safety cases produced by the Licensee according to potential consequences, to ensure that the hazards have been understood and are properly controlled
 - ▶ **Compliance Inspection** – ONR checks that Licensees comply with their licence conditions through planned inspections on a sample basis, according to information derived from safety cases and other operational intelligence
 - ▶ **Enforcement** – ONR undertakes a full spectrum of enforcement activities, from the provision of advice through to prosecution, in accordance with their Enforcement Policy Statement and the Regulators' Compliance Code
 - ▶ **Influence** – ONR seeks to use its influence to gain improvements in areas which are difficult to regulate such as safety culture, leadership and vision. It does this at the Licensee level but also in the supply chain when appropriate
- 3.42 ONR is made up of site inspectors and specialist inspectors, drawn from various professional fields including civil engineering, radiological protection, human factors, chemical engineering, mechanical engineering and nuclear physics. The inspectors are supported by a business support team, which ensures the necessary administration and legal considerations are in order and handles enquiries from members of the public and other parties.
- 3.43 The ONR has established Safety Assessment Principles (SAPs)²⁶ which guide the ONR specialist inspectors in the assessment of safety cases for nuclear plant and facilities. In addition, the Security Assessment Principles (SyAPs)²⁷ guide the Inspectors in the assessment of security plans which include site security plans and transport security statements. The principles presented in the SAPs and SyAPs are supported by a suite of guides known as Technical Assessment Guides (TAGs) to further assist ONR's inspectors in their technical assessment work and in making regulatory judgements. The TAGs of interest to supply chain companies are detailed in Appendix 1. Companies wishing to work in the nuclear sector might benefit from reading ONR's recently published guide entitled 'Licensing Nuclear Installations.'²⁸
- 3.44 All inspection and assessment by the ONR are carried out on a sample basis. The size and scope of the sample is determined by factors such as the potential hazard of the activity, the findings from initial examinations, the novelty and complexity of proposed works, the maturity of the organisation and ONR's knowledge of the Licensee's safety performance history.
- 3.45 Every licenced site has a nominated site inspector who is ONR's primary point of contact for that site. The inspector typically spends around one week in four at the site, conducts routine site inspection for compliance with licence conditions and follows up incidents and events at the site. The inspector liaises with the Licensee's personnel giving advice on how to comply with legal requirements, assessing the adequacy of safety cases and most importantly ensuring that risks to workers and members of the public are reduced so far as is reasonably practicable. In special circumstances the inspector may also visit and inspect works being carried out by supply chain companies.

26] ONR, Safety Assessment Principles (2014) www.onr.org.uk/saps/index.htm

27] ONR, Security Assessment Principles (2017) www.onr.org.uk/syaps/index.htm

28] ONR, Licensing Nuclear Installations 4th edition (January 2015) www.onr.org.uk/licensing-nuclear-installations.pdf

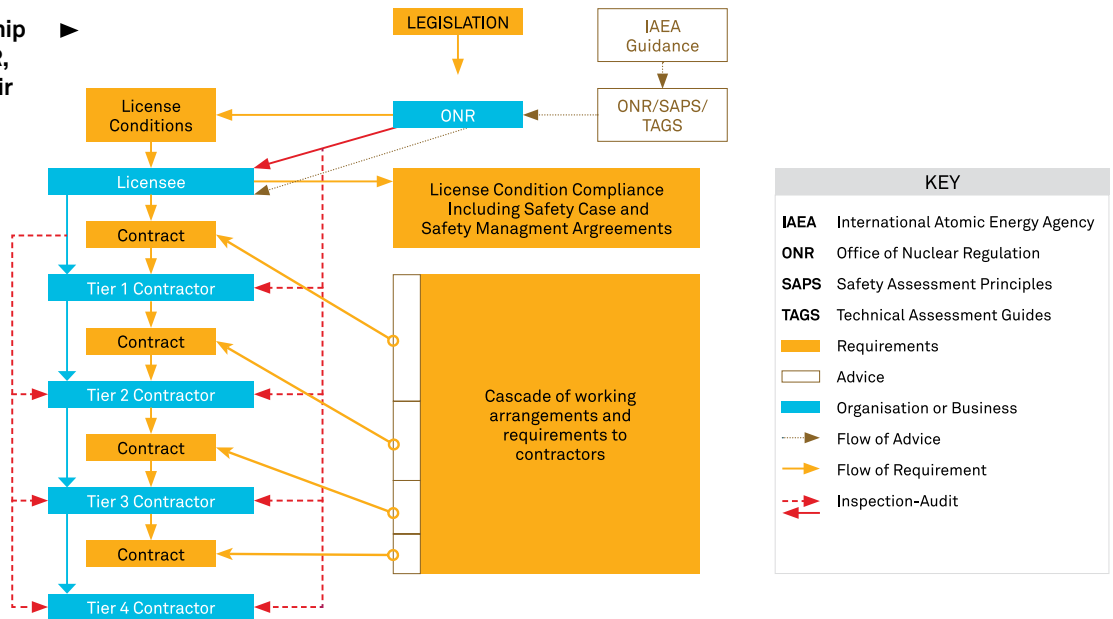
- 3.46 Other regulators that may be relevant to supply chain activities include the EA for England, NRW for Wales, and SEPA for Scotland.

Regulation of the Supply Chain for New Build

- 3.47 There are some broad principles contained in the License Condition Handbook which underpin ONR's expectations of a Licensee's arrangements for the use of the supply chain and for retaining control of nuclear safety. These are summarised below and then interpreted in the sections that follow:
- ▶ The Licensee shall retain overall responsibility for, and control of, the nuclear and radiological safety and security of all its business, including work carried out on its behalf by contractors
 - ▶ Licensee's choices between sourcing work in-house or from contractors should be informed by a clear 'make or buy' policy that takes due account of the nuclear safety implications of the work to be delivered
 - ▶ The Licensee should maintain an 'intelligent customer' capability such that it can fully understand the nuclear safety significance of any purchased expertise or equipment and be able to adequately specify the works, monitor the delivery and technically review the works before its implementation on site
 - ▶ The Licensee should ensure it only lets contracts for work with nuclear safety significance to contractors with suitable competence, safety standards and resources
 - ▶ The Licensee should ensure all contractor staff are familiar with the nuclear safety implications of their work and interact in a well-coordinated manner with its own staff
 - ▶ The Licensee should ensure that contractors' work is carried out to the required level of safety and quality
- 3.48 The Licensee is directly responsible for managing its contractors, and this requirement should be reflected in contractual arrangements between the parties. 'Relevant Arrangements' between the Licensee and Tier 1 contractors must also cascade down into contracts throughout the lower Tiers of the supply chain in an appropriate manner.
- 3.49 Contractors within the Supply Chain should have an 'intelligent contractor' capability to understand the technical and quality requirements of their customer. They should be aware that failure to meet safety significant requirements could have severe consequences for their customer, other organisations further up the supply chain (up to and including the Licensee) and, in the event of a major failure, to members of the public. A company in the supply chain may need to act as both intelligent contractor and intelligent customer e.g. a Tier 2 contractor may use its own supply chain to meet the needs of its Tier 1 customer and will need to procure goods or services in an 'intelligent' manner.
- 3.50 It is the responsibility of Licensee and higher tier contractors to fully interpret the nuclear codes, regulations and licence conditions which are applicable to the contract which they are seeking to place. The contracting entity should document all relevant requirements clearly and precisely without over reliance on referencing out to other documents. Tier 1 companies should fully brief their sub-contractors on the nuclear safety significance of the products or services they are supplying. This should include expectations set out in relevant ONR SAPs, TAGs and SyAPs. These briefings should be formal, and attendance should be mandatory. Signed attendance records should form part of the contract quality pack. It is the responsibility of the contractors to ensure any new staff joining the project are similarly and adequately briefed.

- 3.51 The aim of this approach is to ensure that each tier within the supply chain is aware of, and understands, the nuclear safety significance of the work they are doing and is able to demonstrate that they have arrangements to comply with the contract specifications. Each link in the supply chain should therefore ensure that its staff, and any sub-contractors, are suitably trained and briefed on their responsibilities under the relevant licence conditions, and that suitable measures are implemented to assure compliance with contract specifications.
- 3.52 An outline schematic representation of the relationship between ONR, the Licensee and the Licensee's supply chain are given below. It indicates the major information flows to and from the organisations, where Licensee and Tier 1 contractor audits may occur and where ONR interventions may take place.

Fig. 7 Relationship between the ONR, Licensee and their supply chain



Security of Information, Plant and People in the Nuclear Industry

Security Framework and Regulation

- 3.53 The Government has produced a Security Policy Framework (SPF)²⁹ which describes how Government organisations and third parties must manage the security of Government information and other assets.
- 3.54 The framework states that the Prime Minister, supported by the Cabinet Secretary and the Committee on Security, is responsible for the overall security of the Government and the country. The Policy Framework sets out a range of mandatory security outcomes and, while it does not define how these are to be achieved, it does describe what good security looks like in a number of areas.
- 3.55 These include aspects such as good governance and leadership within organisations and the importance of an awareness of the need for security including the policy of involving all staff through personal accountability to

^{29]} UK Government, Security Policy Framework (May 2018) www.gov.uk/government/publications/security-policy-framework

manage and minimise security risks. The need for cyber security is recognised, especially to protect citizens data through having modern and functional systems which are resistant to cyber-attack. Such systems should be supported by well tested plans, policies and procedures to ensure organisations can respond appropriately to cyber threats and that reporting routes for cyber-attacks are defined. The way in which Government and its partners use security classification of information is described and the requirements of physical barriers and the way in which technology can be used to protect information is discussed. This is coupled with requirements for national security vetting of personnel to ensure that people only gain access to information aligned with their security clearance. While this is a high-level document many of the requirements and topics are expanded in other lower level documents as is described below.

Security Classification of Information

3.56 To assist with the management of the security of documents, Government has introduced a Security Classification System (SCS)³⁰ Information is separated into three security classifications and all Government documents must be marked with one of the three classifications below. This applies to information used or generated by Government, their partners or contractors.



◀ Fig. 8 Government security classifications

3.57 The key principles in the security classification document are developed from the security policy framework and are:

- ▶ All information which Government generates collects, processes, shares or stores has intrinsic value and hence needs to be protected
- ▶ Everyone who works for Government, including contractors has a duty of confidentiality to safeguard Government information irrespective of whether it is marked or not and they must have appropriate security training
- ▶ Access to sensitive information must only be granted on a need to know basis and to people with appropriate security clearances
- ▶ Information received from external partners must be protected in accordance with any relevant legislative or regulatory requirements, including any international agreements and obligations

3.58 In addition to the classification of information into the three categories above, organisations may protectively mark sensitive documents with additional descriptors which control or restrict the extent to which distribution is allowed. These must be used in conjunction with the Security Classification term such as OFFICIAL-SENSITIVE - [DESCRIPTOR].

30] UK Government, Government Security Classifications Version 1.1 (May 2018) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/715778/May-2018_Government-Security-Classifications-2.pdf



Courtesy of URENCO

- 3.59 Government uses the following descriptors, but organisations/industries can add their own as appropriate to their industry:
- ▶ **COMMERCIAL** – This relates to commercial or market sensitive information which could be damaging to Government or business if lost
 - ▶ **LOCSEN** – This relates to sensitive information that locally engaged overseas staff cannot have access
 - ▶ **PERSONAL** – This relates to sensitive information relating to an identifiable individual, where inappropriate access could have damaging consequences
- 3.60 Descriptors must not be applied to information that is sent to overseas partners (unless formally agreed in advance) as they are not recognised under any international agreements and are likely to cause confusion.

Security of Information in the Nuclear Industry

3.61 The Nuclear Industries Security Regulations 2003 (NISR 2003)³¹ set out the security requirements that must be applied at nuclear premises, for the transportation of nuclear material and for the security of sensitive nuclear information. Under the terms of NISR 2003, arrangements for the security of nuclear information comes under the control and regulation of the security division of the ONR. Based on the Government security policy framework and the requirements of NISR 2003, ONR has developed a Security Purpose Statement to summarise requirements as:

“Civil Nuclear Industry Dutyholders (hereafter ‘Dutyholders’) are responsible for the leadership, design, implementation, operation and maintenance of security arrangements to protect the public from the risks arising from a radiological event caused by the theft or sabotage of nuclear material (NM) /other Radioactive Material (ONM) and supporting systems or through the compromise of Sensitive Nuclear Information (SNI).”

- 3.62 Under this purpose statement the Dutyholder can be the operator of a nuclear facility, a Licensee or a Site Licence Company. In the case of new nuclear power plant projects, the Dutyholder will most likely be the Developer or the proposed Licensee of the facility but may also be a Requesting Party (for GDA application).
- 3.63 In support of the Statement, the ONR have defined SyAPs, which guide regulatory judgements when undertaking assessments of Dutyholders’ security submissions. These are fully compliant with Government Security Policy Framework and the requirements of NISR 2003.

^{31]} UK Government, Nuclear Industry Security Regulations (February 2013), www.legislation.gov.uk/ukxi/2013/190/pdfs/ukxi_20130190_en.pdf

3.64 The SyAPs are prefaced by a Unifying Purpose Statement containing 10 fundamental security principles as below:

Unifying Purpose Statement		UPS
Civil Nuclear Industry dutyholders (hereafter ‘dutyholders’) are responsible for the leadership, design, implementation, operation and maintenance of security arrangements to protect the public from the risks arising from a radiological event caused by the theft or sabotage of Nuclear Material (NM)/Other Radioactive Material (ORM) and supporting systems or through the compromise of Sensitive Nuclear Information (SNI).		
Fundamental Security Principles	Leadership and Management for Security	FSyP 1
Dutyholders must implement and maintain organisational security capability underpinned by strong leadership, robust governance, an adequate management and accountability of security arrangements incorporating internal and independent evidence-based assurance processes.		
Fundamental Security Principles	Organisational Culture	FSyP 2
Dutyholders must encourage and embed an organisational culture that recognises and promotes the importance of security.		
Fundamental Security Principles	Competence Management	FSyP 3
Dutyholders must implement and maintain effective arrangements to manage the competence of those with assigned security roles and responsibilities.		
Fundamental Security Principles	Nuclear Supply Chain Management	FSyP 4
Dutyholders must implement and maintain effective supply chain management arrangements for the procurement of products or services related to nuclear security.		
Fundamental Security Principles	Reliability, Resilience and Sustainability	FSyP 5
Dutyholders must design and support their nuclear security regime to ensure it is reliable, resilient and sustained throughout the entire lifecycle.		
Fundamental Security Principles	Physical Protection Systems	FSyP 6
Dutyholders must implement and maintain a proportional physical protection system that integrates technical and procedural controls to form layers of security that build defence-in-depth and are graded according to the potential consequence of a successful attack.		
Fundamental Security Principles	Cyber Security & Information Assurance	FSyP 7
Dutyholders must implement and maintain effective cyber security and information assurance arrangements that integrate technical and procedural controls to protect the confidentiality, integrity and availability of SNI and technology.		
Fundamental Security Principles	Workforce Trustworthiness	FSyP 8
Dutyholders must implement and maintain a regime of workforce trustworthiness to reduce the risks posed by insider activity.		
Fundamental Security Principles	Policing and Guarding	FSyP 9
Dutyholders must demonstrate effective guarding and policing arrangements, integrating the operations of relevant police forces (e.g. CNC, BTP) and security guard services.		
Fundamental Security Principles	Emergency Preparedness and Response	FSyP 10
Dutyholders must implement and maintain effective security Emergency Preparedness and Response arrangements which are integrated with the wider safety arrangements.		

◀ Fig.9 Fundamental security principles

- 3.65 The system of classification of the security of documents in the nuclear industry follows that used by Government and the rest of UK industry using OFFICIAL, SECRET and TOP SECRET. A security DESIGNATOR which is specific to the Nuclear industry is **Sensitive Nuclear Information** or SNI. The requirement of this categorisation is similar to that of OFFICIAL- SENSITIVE -[DESIGNATOR] and it applies where it is necessary to protect nuclear information in the interest of National Security. The SNI designator is placed in the centre top and bottom of each page in capital letters so that there can be no doubt as to the importance of safeguarding the information in the document.
- 3.66 If a company is required to handle documents designated as SNI, it must demonstrate that it has all the controls in place to safeguard the information as required by NISR 2003 and the ONR Security Assessment Principles. A Dutyholder must ensure that its supply chain is also compliant before sharing SNI; further information on security of documents and information in the supply chain is given in the following section.
- 3.67 Before transmitting any information to the supply chain, the Licensee, Developer or plant operator has a duty to ensure that their contractors have the appropriate security arrangements and controls in place.
- 3.68 For documents classed as OFFICIAL, this can be achieved by completion of a questionnaire where the contractor must describe their security arrangements and demonstrate that information will only be shared within their organisation on a 'need to know' basis. For higher classified information including SNI, a full audit of the organisation is required to demonstrate that access to buildings is controlled, that the availability of the information is restricted to those with the appropriate level of security clearances and that information is shared on a 'need to know' basis only.
- 3.69 To further support the security of nuclear installations the Government has introduced the Nuclear Security Regulations 2018.³² These regulations enable the Secretary of State to issue directions directly to industry in the case of an immediate security threat to the civil nuclear sector. Additional guidance to support these regulations is being produced.

Security of plant and people

- 3.70 **Building Security**
Organisations must layer their security, including perimeter controls, building design features such as screening or controlled access areas and secure office furniture for storing documents. For OFFICIAL information, it will be required to implement and demonstrate the effectiveness of arrangements which support the need-to-know principle with appropriate level of segregation.

For OFFICIAL-SENSITIVE such as SNI, full compliance with the Government Security Policy Framework and the ONR SyAPs is required. This will be audited to ensure adherence to security policies and that the building/offices are properly managed from a security view point, prior to receipt of information.

^{32]} UK Government, Nuclear Security Regulation 2018 (October 2018) www.legislation.gov.uk/uksi/2018/408/pdfs/uksi_20180408_en.pdf

3.71 Personnel Security

For the UK nuclear industry, a programme of pre-employment screening and national security vetting operates³³ to ensure personnel hold a level of clearance appropriate to their level of access to nuclear material or information on the operation of nuclear facilities. The various level of security vetting which apply are summarised below and described in more detail in Appendix 1.

▶ Baseline Personnel Security Standard (BPSS)

This applies to all individuals employed in the civil service, armed forces, private sector employees working on Government contracts and those with access to nuclear facilities or nuclear information.

▶ Higher National Security Vetting Clearances

There are three levels of national security vetting clearance: A Counter Terrorist Check (CTC), Security Check (SC) and Developed Vetting (DV). Before any such clearance is undertaken the requirements of the Baseline Personnel Security Standard must be successfully completed. Of these the CTC is the lowest and DV is the highest level of security clearance. Is required by those who have unsupervised access to the sensitive parts of nuclear plant and systems.

3.72 Active, ongoing personnel security management by companies is required to ensure that a security clearance of their workforce is maintained. Any changes in terms of convictions, unusual travel or security concerns regarding individuals must be reported to the authorities. For higher levels of security clearances, checks must be repeated at regular intervals.

3.73 When planning for contracts at any of the new build nuclear projects, companies must consider the impact of security clearance timescales on the availability of staff. Timescales associated with the various vetting levels can typically be:

- ▶ Baseline Personnel Security Standard – 1 month
- ▶ Counter Terrorist Check – 6 to 8 weeks
- ▶ Security Check – 3 to 4 Months
- ▶ Developed Vetting – 4 to 6 Months

Security of Documents and Information in the Supply Chain

3.74 Nuclear plant operators, Licensees or Developers (Dutyholders) will define their security policy and procedures to comply with the NISR 2003, and other appropriate legislation. They have a duty to ensure their security procedures flow down throughout the supply chain. It is the responsibility of all companies to protect any information provided to them as part of a tender or contract.

The requirements on the Dutyholder are to:

- ▶ Ensure the supply chain is aware of the need for security of information
- ▶ Provide the supply chain with guidance on the security classification of information
- ▶ Only supply OFFICIAL – SENSITIVE information on a 'need to know' basis.
- ▶ Only supply OFFICIAL – SENSITIVE information and above, following a successful audit of physical and IT security arrangements used by contractors
- ▶ Help suppliers reach the required levels of physical and electronic protection for different types of information

33] UK Government, HMG Personnel Security Controls Version 4.0 (May 2018) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/714017/HMG_Personnel_Security_Controls_-_May_2018.pdf

The requirements on the supply chain are to:

- ▶ Ensure the security of information provided to them
- ▶ Understand the need for security in their supply chain
- ▶ Understand why certain types of information are protected and how to identify this information
- ▶ Have policies and procedures to underpin security and implement them

3.75 Before any OFFICIAL-SENSITIVE or more highly classified SNI is sent to a supplier, the supplier will receive a Security Aspects Letter (SAL) from the Dutyholder. The SAL will instruct the supplier on the measures they will need to have in place to protect that information and how to avoid including protectively marked information in their tender submission.

3.76 Documents issued by the Dutyholder will be classified and protectively marked to help users protect them correctly. Where classified documents are produced by the supply chain, care must be taken to classify them correctly in accordance with the security policy of the Dutyholder. Details of the requirements for documentation classification and protection will be contained within the contract.

Cyber Security

3.77 The Government recently published the National Cyber Security Strategy 2016-2021³⁴ stating:

“...much of our prosperity depends on our ability to secure our technology, data and networks from the many threats we face.”

3.78 A key element of this strategy is an initiative known as the Cyber Essentials Scheme is now found in many supply chain procurement requirements, especially in the nuclear sector. It is supported by the Government National Cyber Security Centre³⁵ which is a Government-backed, industry supported, initiative that defines a set of controls to provide organisations with a basic level of protection from the most common threats emanating from the internet.

It focuses on five basic control themes of Boundary Firewalls, Secure Configuration, Access Control, Malware Protection and Patching.

3.79 In line with the National Cyber Security Strategy, site license companies and developers are taking steps to reduce the levels of cyber security risk in their supply chain and they are demanding that suppliers meet the requirements of the Cyber Essentials scheme and become certified. This is achieved by completing a questionnaire³⁶ issued by a registered certification body who then verifies the submission. There are two levels of verification:

1. **Cyber Essentials Basic Certification** is self-assessed and externally verified by approved assessors. The assessor may contact the company with clarifications to some of the responses given. This certification is typically required for suppliers that:
 - Process a low amount of personal information
 - Process some OFFICIAL information

^{34]} UK Government, National Cyber Security Strategy 2016-2021 (July 2016) https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/567242/national_cyber_security_strategy_2016.pdf

^{35]} UK Government, Government National Security Centre www.ncsc.gov.uk

^{36]} Indelible Data, Cyber Security Questionnaire <http://indelibledata.co.uk>

2. **Cyber Essentials Plus Certification** requires that an assessor conducts a technical assessment of the company to confirm the responses given in the questionnaire. Currently, this level of certification is required for suppliers that:
- Process any amount of OFFICIAL-SENSITIVE information
 - Process significant volumes of personal information
 - Process significant volumes of OFFICIAL information

3.80 Companies that are certified to ISO 27001 Information Security Management System standard should be aware that compliance of the ISO standard does not provide an equivalent level of assurance as cyber essentials certification unless the controls contained within the Cyber Essentials Scheme have been included in the scope of ISO 27001, and verified as such.

3.81 It should be noted the Cyber Essentials Scheme only covers the minimum requirements to defeat internet-based threats. To achieve a broader cyber resilience regime the '10 steps to cyber security'³⁷ outlined below can be applied:

1. **Risk Management Regime** – Assess the risks to the organisation's information and systems. Embed regime across organisation, supported by the Board and senior managers
2. **Network Security** – Protect networks from attack. Defend the network perimeter, filter out unauthorised access and malicious content. Monitor and test security controls
3. **User education and awareness** - Produce user security policies covering acceptable and secure use of systems. Include in staff training. Maintain awareness of cyber risks
4. **Malware prevention** - Produce relevant policies and establish anti-malware defences across the organisation
5. **Removable media controls** - Produce a policy to control all access to removable media. Limit media types and use. Scan all media for malware before importing onto the corporate system
6. **Secure configuration** - Apply security patches and ensure the secure configuration of all systems is maintained. Create a system inventory and define a baseline build for all devices
7. **Managing user privileges** - Establish effective management processes and limit the number of privileged accounts. Limit user privileges and monitor user activity. Control access to activity and audit logs
8. **Incident management** - Establish an incident response and disaster recovery capability. Test incident management plans. Provide specialist training. Report criminal incidents to law enforcement authorities
9. **Monitoring** - Establish a monitoring strategy and produce supporting policies. Continuously monitor all systems and networks. Analyse logs for unusual activity that could indicate an attack
10. **Home and mobile working** - Develop a working policy and train staff to adhere to it. Apply the secure baseline and build to all devices. Protect data both in transit and at rest

3.82 The NIA has produced a Cyber Security Guide³⁸ for the UK nuclear supply chain. Written in collaboration with BEIS, NCSC, the ONR and the NDA, the guide allows supply chain companies to raise awareness of basic cyber threats and protections, whilst also highlighting the key points of contact in the event of a breach.

³⁷ National Cyber Security Centre, 10 Steps to Cyber Security (17 November 2018) www.ncsc.gov.uk/guidance/10-steps-cyber-security

³⁸ Nuclear Industry Association (NIA), Cyber Security Guide for the Nuclear Supply Chain (12 October 2018) www.niauk.org/media-centre/press-releases/cyber-security-guide-nuclear-supply-chain





EU Directive on Security of Networks

- 3.83 At the time of writing, the UK is implementing the EU Directive on the security of Networks and Information Systems, known as the NIS Directive.³⁹ This began to be transposed into UK law in May 2018 and is the first piece of EU-wide legislation on cybersecurity. It is intended to provide legal measures to increase the overall level of cybersecurity in the EU.
- 3.84 Amongst other things, NIS applies to Operators of Essential Services (OESs) which includes energy and power, transport, telecommunications, health providers, water suppliers and food suppliers amongst others.
- 3.85 An OES company must take appropriate security measures to manage their network and information system risks. Moreover, they must notify the appropriate national authority of any serious incidents which have occurred. Achieving cyber resilience requires a cyber security programme tailored to meet the needs of the organisation.
- 3.86 It is expected that those parts of the EU directive already in law will be maintained in force, but it is not clear if further EU requirements will be incorporated in UK law in the future. Companies should maintain a watching brief in this area.

Generic Design Assessment

- 3.87 Before any new nuclear power plant can be built or operated in the United Kingdom, the Nuclear Installations Act 1965 requires that a number of permissions must be obtained. These include:
- ▶ A nuclear site licence and other relevant consents from the ONR
 - ▶ Environment permits from the EA/NRW
 - ▶ Planning permission from the BEIS and local authorities
- 3.88 In 2006 the Government requested a review of the licensing process for new nuclear plant. This concluded that there were significant advantages in developing the design and safety case for the new plant as early as possible to reduce the risks associated with meeting the UK regulatory requirements and to increase the likelihood of achieving the site licence in a shorter timescale. As a result, the Government requested the ONR and the EA to develop a 'pre-licensing assessment process'.
- 3.89 This process has become known as the GDA process.⁴⁰ While it is not mandatory that developers adopt this process, the inherent advantages of it are such that it is being instigated for all the new nuclear power plant currently being proposed for the UK. The benefits of the process include:
- ▶ Early involvement in the design assessment of the plant means that the regulators can influence aspects of the design solutions.
 - ▶ Employing a step-wise approach with the assessment becoming more detailed with each step of the process. This means issues can be identified early and resolved in later steps in the process. Separating out generic design and safety case issue from site related issues which may not be available at the time of the assessment.
 - ▶ Having an open and transparent process where the public has full access to the decisions being made and the progress of the assessment being achieved.

^{39]} UK Government, Guidance on EU NIS Directive version 11 (15 November 2015) www.ncsc.gov.uk/guidance/nis-guidance-collection

^{40]} ONR, New Nuclear Power Plants: ONR-GDA-GD-006 Revision 0 Generic Design Assessment Guidance to Requesting Parties (2019) - to be confirmed

The GDA process has been operational since 2013 and has worked well for mature designs. It has been successfully used to approve three reactor technologies for use in the UK: the EDF Energy EPR, the Westinghouse AP1000 and the Hitachi ABWR. One reactor is currently being assessed using the existing process, the UK HPR 1000.

Revision to GDA Process

- 3.90 In 2018 BEIS and the regulators reviewed the existing GDA processes to be ascertain if it could be modernised to:
- ▶ Improve the flexibility of the process so that it could accommodate applications with different levels of maturity
 - ▶ Capture lessons from previous and ongoing GDAs
 - ▶ Ensure a level of consistency with already completed GDA applications
- 3.91 Under the revision to the GDA process, the entry assessment process operated by BEIS for mature reactor technologies will remain unchanged, but a new entry process is being devised for technologies under development including SMRs and AMRs to reflect the more limited information available for these new reactor technologies. The new entry guidelines are expected to be published by BEIS in 2019.
- 3.92 A revised GDA process has been developed by the ONR and the EA, to accommodate both mature designs and developing technologies. Under this new process the ONR will move to a three-step process to better align with the arrangements used by the EA. There will also be a greater emphasis on early engagement with the Requesting Party (RP) submitting the reactor design to the GDA process. This is to ensure the RP fully understands the process and the submissions which are required at the different stages in the GDA process.
- 3.93 The revised process will allow use of previous submissions to other regulators, though many of these will have to be supplemented to meet UK requirements. A major development will be the ability of the regulators to issue different levels of output to better reflect the maturity of the design being considered rather than the almost pass/fail output in previous process. For plant with a high level of maturity the revised process will still allow the completion of the assessment to a final DAC or SoDA.
- 3.94 Where the plant design is not finalised, but large parts of the major systems are defined or where the full concept design of the plant is available, a meaningful GDA assessment can now be made resulting in Statement of Findings at the end of Step 2 and Step 3 of the process. These statements give the RPs valuable insight as to how the design might fare in the full GDA process and allows them to see where the design needs change to meet the regulatory requirements. It also allows the regulator to influence the development of the final design which will in turn will facilitate the successful completion of the GDA process.

Entry to the GDA Process

- 3.95 The first step in the application process to develop new nuclear plant in the UK is for the developer or the technology vendor to issue a Registration of Interest to BEIS, requesting entry to the GDA process. BEIS and the regulators engage with the RP to issue guidance on the process and to agree timescales for the application process. Having achieved agreement, BEIS then conducts a formal assessment of the application against set criteria.
- 3.96 Some of these, such as compliance with national security, non-proliferation policies of the RP and the financial solvency of the applicant are hard pass/fail criteria. Others, such as alignment with UK industrial policy and the likelihood of

the development creating a value proposition for UK are softer more subjective assessments. If the assessment by BEIS is positive they will advise Ministers and request the regulators to accept the application into the GDA process.

- 3.97 In the pre-GDA or enabling phase, the regulators work with the RP to develop a cost recovery model whereby the RP pays for all the cost incurred by the regulators in carrying out the GDA process. All parties must agree funds are in place to complete the full GDA process before Step 1 can start.

The GDA Process

3.98 Overview of GDA Process

The GDA process is a stepped step process in which the RP supplies progressively more detailed information to the regulators on the arrangements for delivery of the plant, the safety cases used to demonstrate the safety of the plant, the emissions and discharges and waste produced by the plant and the security arrangements to protect both the plant and the nuclear material. As the title states the assessment only considers the generic design of the plant on a generic site in the UK. Detailed site-specific issues are considered in a separate exercise once the GDA process has been successfully completed. The ONR and the EA work together through the GDA process with each organisation having its own areas of responsibility for the assessment work.

- 3.99 The ONR focuses on the design of the plant, the adequacy of the safety cases developed, the management and quality arrangements being proposed and the security arrangements for the technical information as well as the physical security of the plant. The EA focuses on the environmental impact assessment of the plant and the levels of wastes which will be produced including proposed discharge limits. If the plant is to be built in Wales, the EA works with NRW to produce a joint assessment. Although the ONR and EA have different areas of responsibility there is a significant alignment in the way they conduct the process and the timescales involved in the various steps of the GDA process.

- 3.100 At the end of a successful GDA process, the ONR will issue a DAC and the EA/NRW will issue a SoDA. Because of the highly related nature of the information being assessed by the regulators and commonality of many of the submissions, it is very unlikely that the ONR would issue a DAC if the EA felt unable to issue a SoDA and vice versa.

3.101 Steps in the GDA Process

Step 1 or Initiation Step is a preparatory phase where the RP establishes its project management and technical teams. Meetings between the regulators and the RP are held to ensure that the RP has a full understanding of the entire GDA process. The RP is also made aware of the regulators' expectation in terms of the content, timing and quality of the various submissions required by the process. In Step 1 the submissions prepared by the RP include generic safety, security and environment cases for the proposed plant. Having reviewed these generic submissions the regulators will issue a Step 1 GDA statement confirming that the scope of the GDA process has been agreed and documenting the status of the design, safety, security and environmental information which has been made available.

- 3.102 The Step 1 statement reports on the assessment by the regulators of the information provided and identifies any gaps against their expectations. These gaps are then taken forward into subsequent steps of the process for resolution. Depending on the adequacy of the information and the robustness of the arguments presented in Step 1, the statement will conclude whether or not the application can proceed to the next step. It is expected that Step 1 would last approximately 12 months.



- 3.103 Step 2 or Fundamental Assessment Step involves a substantial technical assessment of the proposed plant by the regulators. They will assess the fundamental aspects of the safety, security and environmental claims for the plant as well as reviewing the proposed codes, standards and quality arrangements. It is expected that the activities in this step will allow the RP to develop its understanding of the regulatory process in the UK and modify its submissions so they meet the regulatory expectations of both the ONR and the EA.

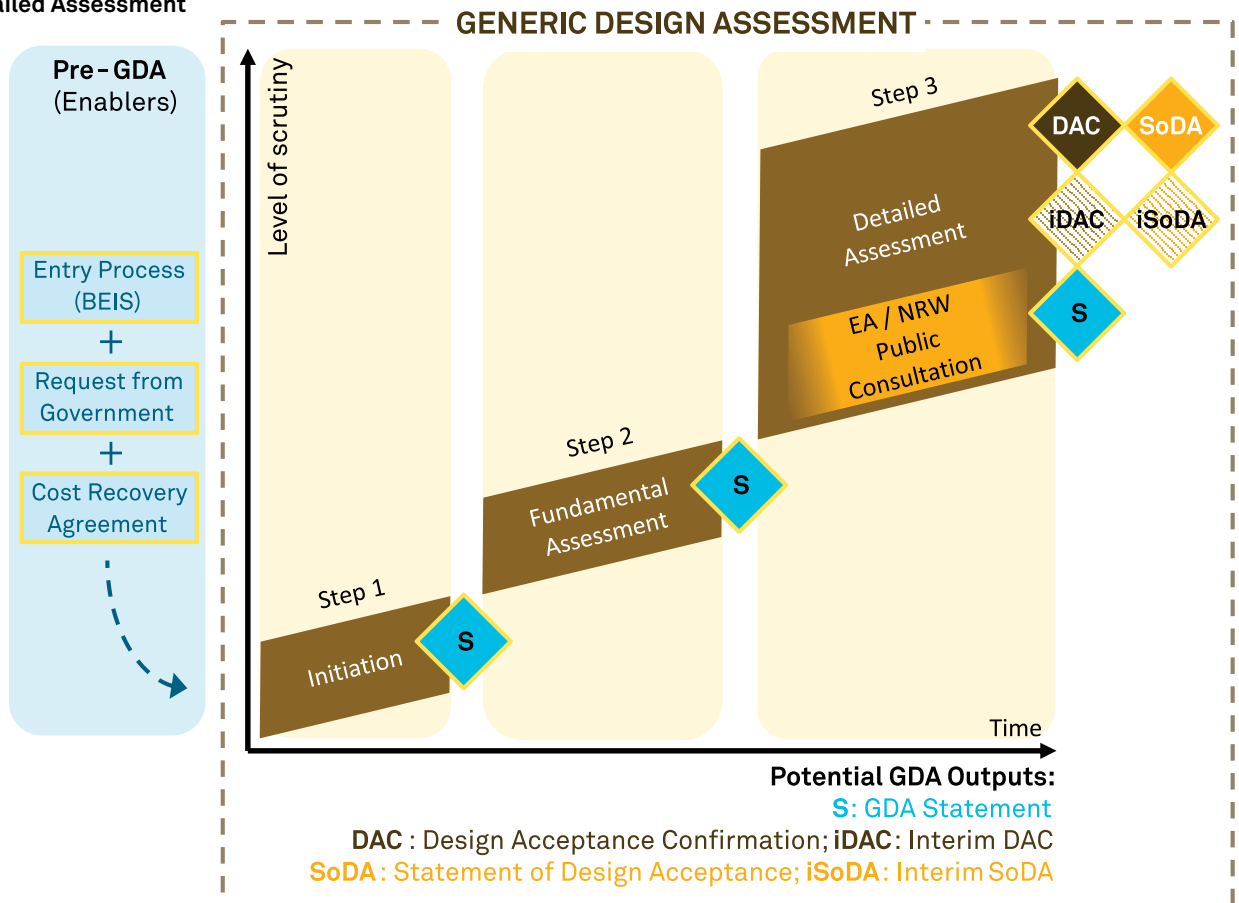
At the end of Step 2 the regulators will issue a Step 2 GDA statement which identifies any fundamental shortfalls in the proposals for the safety and security of the plant or any shortfalls in the environment protection measures which could prevent the permitting of the plant. It is expected that Step 2 would last approximately 12 months and by the end of this step the RP should have submitted all of the safety cases and supporting information to the regulators.

- 3.104 Step 3 or Detailed Assessment Step is where the regulators carry out a detailed assessment of the safety, security and environment claims made by the RP plus the supporting information. Because of the volume of the latter, a risk-based sampling approach is used to select the supporting documents for review.
- 3.105 The ONR assessment in this step will consider if the risks associated with the plant have been reduced to **As Low as Reasonably Possible (ALARP)** and if the principles of **Defence in Depth** have been applied in the design of the safety critical systems. Analysis of key documents such as the **Probabilistic Safety Analysis** and the **Severe Accident Analysis** reports will be undertaken.
- 3.106 The EA will assess the environment impact assessment of the plant over its entire lifetime including its decommissioning phase and will assess if **Best Available Techniques (BAT)** have been deployed to ensure protection of the environment. Towards the end of this step the EA will undertake a consultation process, seeking the views of the Government, key stakeholders, relevant national and local bodies and the public.

- 3.107 At the end of Step 3 the Regulators issue a Step 3 GDA Statement. If they are content the plant meets UK regulatory requirements and could be safely built and operated in the UK, the ONR will issue a DAC and the EA will issue a SoDA. If the regulators are broadly happy that the design of the plant is acceptable but there are some outstanding issues, they can issue interim certificates in the form of an IDAC and iSoDA. The issue of these is conditional on the RP having a clear strategy and agreed timeframe for resolving the outstanding issues.
- 3.108 For plant where the design is not totally finalised or where a full concept design is available, the regulators can still issue a Step 3 GDA Statement but cannot issue any form of DAC or SoDA. There are still advantages to the RP from this type of feedback in that it gives strong indicators as to where the design must be modified to meet UK regulatory requirements. It also allows the regulator to influence the design and safety cases being produced by the RP and thus maximise the chances of a successful completion of the GDA process in the future.
- 3.109 Prior to the end of Step 3 the RP must consolidate all GDA submissions in a manner whereby they could be accessed by any future Licensee of the plant to produce the site-specific safety, security and environment permitting submissions.

It is expected that Step 3 would last about 24 months with the EA consultation period starting around month 15 from the beginning of Step 3.

Fig. 10 Step 3 of GDA ▶
- Detailed Assessment



3.110 **Post GDA Authorisations**

The issuing of a DAC, iDAC or any GDA statements by the ONR does not guarantee that future permissions will be given for the construction or operation of the nuclear plant in the UK. The future Licensee of the plant will need to apply for, and be granted, a nuclear site license before construction of the plant can commence.

They will also need other permissions which can be obtained through the completion of a pre-construction safety report and a site security plan. These must build on the documentation provided during the GDA process and reflect the impact of any changes to the plant design since to issuing of the DAC. Before pouring of the concrete raft on which the reactor sits, the Licensee must obtain consent to pour first nuclear safety concrete.

3.111 Similarly, the issuing of a SoDA or an iSoDA by the EA does not guarantee that they will issue a license to construct or operate the plant in the UK. Additional submissions and approvals must be obtained such as a DCO and other environment approvals before construction and operation of the plant can proceed.

3.112 **Legal status of DAC and Period of Validity**

A DAC or SoDA has no legal status and is not a formal requirement of the UK's nuclear licensing regime for new nuclear power plant. Developers could choose to apply directly to ONR for a site licence based on a design which has not been subject to GDA. However, it has been shown that the GDA process which ends in the issue of a DAC or SoDA is the most cost and time efficient route to obtaining a site licence for new nuclear plant in the UK.

3.113 A DAC, SoDA or other Step 2 and Step 3 GDA statements represents regulator's view at the time of issue. A DAC or SoDA would be valid for a period of ten years from the date of issue. This period is consistent with the requirement for Licensees in UK to undertake periodic safety reviews of their existing nuclear facilities every ten years. If during that period any new information emerges which calls into question the basis of the original assessment of the plant, such as changes to the design basis threat, then the regulators would need to consider whether the issued documents remained valid.

3.114 **Additional guidance documentation produced by the Regulators**

As part of the revised GDA roll-out, the ONR has developed discipline specific guidance notes in all the relevant technical areas covered by the GDA process. These will supplement the existing TAGs with information specific to the GDA process.

The EA will update its process and information document to reflect the changes in its GDA processes. It is expected that these changes will be minimal.

Nuclear Safety Culture

Definition of Nuclear Safety and Security Culture

4.1 Most companies operating in the UK are aware of the necessity for robust health, safety and environment performances and attention to these issues must pervade through all aspects of their business. Companies who have not worked in the nuclear industry may not be familiar with the term 'Nuclear Safety Culture' (NSC). The following section aims to provide an overview of NSC and provides guidance on measures which can be taken to embed this culture within an organisation.

4.2 To reach an understanding of the meaning of NSC it is worthwhile examining the meaning of various subsets of the clause such as culture, safety culture and nuclear safety. The definitions of these sub-clauses can then be incorporated into a comprehensive definition of NSC which define its key elements.

The definition of 'Culture' varies considerably in its complexity. One of the simplest is:

“*The way we do things around here*”

The definition of 'Safety' can be considered as:

“*Those actions or activities which provide protection, avert danger and foster confidence*”

4.3 Combining the terms 'Safety' and 'Culture' into one term 'Safety Culture' results in a much more powerful term with a much broader meaning. Safety Culture can be seen as a concept that describes the shared corporate values within an organisation which influences the attitudes and behaviours of its members. The International Atomic Energy Agency (IAEA) states that:

Safety Culture has two major components:

- i. the framework determined by organisational policy and managerial action,
- ii. the response of individuals working within and benefiting from the framework.

4.4 Combining the terms 'Nuclear' and 'Safety', leads to an industry specific definition of 'Nuclear Safety'. It is the various provisions made at all stages of the design, manufacture, construction, operation and decommissioning of nuclear facilities to protect people and the environment against accidents on nuclear sites and thus prevent the dispersal of radioactive substances to the environment. To achieve these goals, it is necessary to ensure that the plant is correctly designed, built to the required standards and operated within its normal operating envelope. Human beings have the greatest impact on achieving Nuclear Safety and actions should always be aimed at preventing incidents and accidents occurring.

4.5 Nuclear safety is based on a concept of 'Defence in Depth' which is typified by multiple layers of engineered features such as diverse protection systems, geographically separated back-up systems, multiple primary back-up energy sources and several layers of physical barriers around and inside the plant. The activities of individuals need to be controlled in a similar manner such as independently checking engineering output, peer review of work plans and independent oversight of safety performance of work on the plant. The intent of nuclear safety is to keep the nuclear matter inside its designated confines and in a controlled state. Nuclear safety is the first value adopted during the design and construction and operation of a nuclear power plant and must never be compromised or abandoned.

4.6 When the terms of ‘nuclear’, ‘safety’ and ‘culture’ are combined, a definition results which encompasses the strengths of the individual words into “an all-embracing way of executing activities on a nuclear plant”. The combination of the words ‘Nuclear Safety Culture’ recognises nuclear operations as special – from design through construction, operation and decommissioning. It encompasses conventional safety, nuclear safety, environmental safety and excellence of working practices in a truly integrated approach. This is underpinned by a strong culture within the workforce at all levels which means it is collectively unacceptable to put people, the environment or the plant at risk by individual or corporate actions. Achieving these goals requires a high level of professionalism and attention to detail in the execution of works for or on a nuclear plant. A number of definitions of NSC have been developed by various organisations

4.7 The IAEA provide a definition that relates it to personal attributes and habits and to the style of the organisation:

“Nuclear Safety Culture is that assembly of characteristics and attitudes in organisations and individuals which establishes that, as an overriding priority, nuclear plant safety issues receive the attention warranted by their significance.”

The World Association of Nuclear Operators (WANO) defines it as:

“An organisation’s values and behaviours – modelled by its leaders and internalised by its members – that serve to make nuclear safety the overriding priority.”

4.8 Both definitions emphasise that the concept of NSC applies to every employee in the organisations working on nuclear plant, from the board of directors to the individual contributor and that the joint focus of the organisation must be on ensuring nuclear safety. The same principles can apply to industrial safety, and protection of the environment, but nuclear safety must be the first value adopted by organisations working in the nuclear industry and must never be compromised.

The most important indication of a strong NSC within an organisation is the extent to which employees are actively involved in safety, quality and cultural alignment on a daily basis. If there is little involvement with these aspects, and it is solely dependent on specialists, then it can be concluded that the organisation has not engaged its people in the basic principles of NSC. A strong NSC is observable, tangible and is demonstrated by all staff in organisations where it is an embedded characteristic.

4.9 In recent years terrorism events have meant security has been added to the values required to work on a nuclear plant. Under the Security and Safety⁴¹ topic the IAEA states:

“Establishing a strong safety and security culture is one of the fundamental management principles for an organization dealing with radioactive material. Such a culture influences the organization’s structure and style, as well as the attitudes, approaches and commitment of individuals at all levels in the organization.”

41] International Atomic Energy Agency (IAEA), Nuclear Security Culture (September 2008) www.iaea.org/publications/7977/nuclear-security-culture

- 4.10 In the IAEA document on Safety and Security, there are references to other IAEA documents which describe methods for the self-assessment of security culture within organisations. There is also an IAEA implementing guide on how to achieve a Nuclear Security Culture⁴² within organisations.
- 4.11 Although the IAEA statement on safety and security places the requirement for achieving nuclear safety and security on those organisations dealing with radioactive material, the reality is all parties involved in the design manufacture, construction and operation of nuclear facilities have a duty to protect sensitive information and to prevent unauthorised access to the plant by adopting the security measures outlined in Chapter 3 of this publication.

Nuclear Safety and Security Culture

- 4.12 In the following section the characteristics of a strong NSC are defined and the implications for new nuclear power plant projects are considered. Although the following two sections refer to NSC, the word 'Safety' could easily be replaced by 'Security' to provide the equivalent characteristic and application of Nuclear Security in new nuclear power plant

Characteristics of Nuclear Safety Culture

- 4.13 There are 8 internationally accepted characteristics associated with a strong NSC:
- i. Everyone is personally responsible for nuclear safety**
Responsibility and authority for nuclear safety are well defined and clearly understood by all. Reporting relationships, positional authority, staffing, and financial resources all support the achievement of nuclear safety. Corporate policies emphasise the overriding importance of nuclear safety in all activities.
 - ii. Leaders demonstrate commitment to safety**
Executive and senior managers are the leading advocates of nuclear safety and demonstrate their commitment both in word and action. The nuclear safety message is communicated frequently and consistently. Leaders throughout the organisation set an example for nuclear safety.
 - iii. Trust permeates the organisation**
A high level of trust is established in the organisation, fostered in part through timely and accurate communication. There is a free flow of information from management to workforce and vice-versa in which issues are raised and addressed. Employees are informed of steps taken in response to their concerns.
 - iv. Decision-making reflects safety first**
Personnel are systematic and rigorous in making decisions that support the safe construction and operation of nuclear plant. Individuals are vested with authority, so that when faced with unexpected or uncertain conditions, their first action is to place the work in a safe condition pending resolution of the issue. Senior leaders support and reinforce conservative decision making and employees are encouraged to '**stop and ask**' if in doubt over actions to be taken.

^{42]} IAEA, Nuclear Security Culture (September 2008) www.iaea.org/publications/7977/nuclear-security-culture



v. Nuclear technology is recognised as special and unique

The special characteristics of nuclear technology are taken into account in all decisions and actions. Radiological control, continuity of core cooling, and integrity of the nuclear circuit pressure boundary are valued as paramount.

vi. A questioning attitude is cultivated

Individuals demonstrate a questioning attitude by challenging assumptions, investigating anomalies, and considering potential adverse consequences of planned actions. All employees are watchful for conditions or activities which can have an undesirable effect on the integrity of the components or the safety of the plant.

vii. Organisational learning is embraced

Manufacture, construction and operational expertise is highly valued, and the capacity to learn from experience is well developed. Training, self-assessments, corrective actions and benchmarking are used to stimulate learning and improve the performance of people and the organisation.

viii. Nuclear safety undergoes constant examination

Oversight is used to strengthen nuclear safety and improve performance. Nuclear safety is kept under constant scrutiny through a variety of monitoring techniques, including independent peer reviews of activities being undertaken.

Achieving NSC in Nuclear New Build Projects

4.14

Experience has shown mistakes made at the early stages of a nuclear new build project can lead to significant problems later in the plant lifetime. These mistakes are sometimes found during the construction phase, but more often they result in significant issues later during operation of the plant. In simple terms, the safety of the nuclear power plant to be built in the UK will depend on the quality of the work done today.

Getting it right first time is especially relevant in design and manufacturing activities. Correct design ensures safety features are effective and adherence to a manufacturing quality plan ensures components are built to the integrity levels required by their duty.

QUALITY TODAY means NUCLEAR SAFETY TOMORROW

- 4.15 Achieving nuclear safety requires special care and attention to detail. Typically, an organisation will prepare a Nuclear Safety Policy which must be endorsed by the senior management team and should state that nuclear safety is the overriding priority. The policy should emphasise that nuclear activities involving design, manufacture and construction have special requirements and individuals within the organisation must understand the impact of their activities on the safety of the plant. These traits must be embedded in the people and the organisation and continually reinforced by ongoing training.

Human Performance

- 4.16 It can be seen from the above that there is a significant emphasis placed on the individual responsiveness and attitudes in maintaining nuclear safety and security. Many organisations now recognise that an improvement in human performance⁴³ can enhance safety and minimise potential for errors. As a result, human performance programmes have been operated by many companies in the nuclear industry.

Principles of Human Performance

- 4.17 In its simplest form human performance can mean “compliance with procedures and processes” or “doing the right thing when no one is looking” regardless of time or cost implications. It is all about recognising the nuclear safety significance of actions which are to be performed in designing, manufacturing, constructing, maintaining or modifying nuclear plant. It is about instilling into people the right attitudes and behaviours to promote a strong NSC into the workforce. Integrating these principles into an organisation’s processes and management practices will help the development of ever improving human performance. It will lead to a culture where deviating from procedures is totally unacceptable at individual, peer group or organisational level. The five principles of human performance are:

i. People are fallible, and even the best people make mistakes

Human fallibility is a permanent feature of human nature and we have a natural tendency to make mistakes. Human Performance should not be the sole control to manage activities critical to plant or equipment safety. Other additional defences should be in place to back up an individual’s performance such as quality systems, peer review and checking processes.

ii. Error-likely situations are predictable, manageable, and preventable

Experience has shown that errors associated with particular tasks are preventable. Recognising error traps and actively communicating these hazards to others facilitates the proactive management of work and prevent errors or unsafe events. Using previous experience allows work arrangements to be changed and thus prevent, remove or at least minimise, the chance for error to occur.

^{43]} Nuclear Institute, Human Performance Blueprint (November 2014) www.nuclearinst.com/write/MediaUploads/SDF%20documents/HUP/Human_Performance_Blue_Print.pdf

iii. Individual behaviour is influenced by organisational processes and values

In most organisations, work is executed within the framework of management control and work planning systems, and these can heavily influence the behaviour of individuals. Poor management and control systems are often the root causes of poor individual performance problems caused by:

- Applying unnecessary time pressures
- Under resourcing of tasks
- Employing inexperienced personnel to deliver complex tasks
- Having poorly written control processes
- Providing a poor working environment

iv. People achieve high levels of performance largely because of the encouragement and reinforcement received from leaders

The level of safety, quality and reliability of performance within an organisation is directly dependent on the behaviour of people. Behaviour is reinforced by the consequences which the individual has experienced as a result of their delivery and their inherent behavioural traits. Management has therefore a key role in enforcing good behaviour and discouraging poor behaviour.

v. Events can be avoided through an understanding of the reasons mistakes occur

Improvement in human performance has historically been the outcome of corrective actions derived from an analysis of past events and mistakes. Learning from mistakes and the mistakes of others is reactive – it's after the fact, but is still important for continuous improvement. Events from other industries can provide an insight into attitudes, behaviours and actions of people which have caused serious incidents in the past.

Alternatively, an analysis of the task to be done to determine what might go wrong or where errors could occur is proactive, and proactive methods provide a more cost-effective means of preventing errors. Both approaches should be applied in assessing work activities

4.18 The Impact of a Human Performance implementation programme at an Individual, Management and Organisational Level is described in Appendix 2. It defines the behaviours expected of all parties within a Human Performance programme.

Courtesy of Balfour Beatty

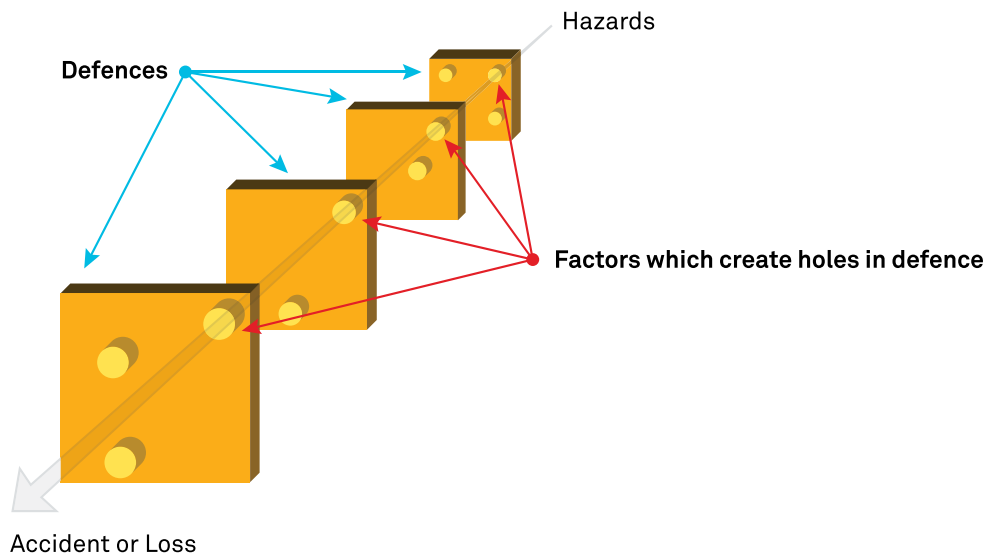


Error Reduction Techniques

4.19 As we have seen a key premise of human performance is that people make errors. As a result, a set of Error Reductions Techniques has been developed to help people devise a way of working which minimises errors. These tools form a set of barriers or defence in depth so that if one barrier is breached then other tools still form an effective barrier to stop errors or accidents occurring. Only in the extreme case where all barriers have been breached will errors or accidents occur as shown by the 'Swiss Cheese' model below.⁴⁴

Fig. 11 The Swiss Cheese Model

Accidents or errors only occur when a number of factors or holes in the defence mechanisms align



4.20 The main error reduction tools (or defences) employed in the nuclear industry are:

- ▶ Pre-Job Briefs
- ▶ Review of Operating Experience
- ▶ Procedural Use and Adherence
- ▶ Self-Checking – the STAR Principal (Stop, Think, Act, Review)
- ▶ Maintaining a Questioning Attitude
- ▶ Peer Checking of Work
- ▶ Independent Verification
- ▶ Clarity of Communication
- ▶ Post Job Brief
- ▶ Task Observation/Coaching

4.21 A detailed description of each tool is provided in Appendix 2. These tools are then integrated into the overall work execution processes at the Work Planning, Work Awareness, Work Performance and Work Feedback stages to reduce the likelihood of errors occurring. Robust management of work execution using error prevention tools has been shown to significantly reduce the frequency of errors or accidents occurring in the execution of tasks on nuclear plant. Tier 3 and 4 contractors should develop their own error prevention tools specific to their business and employ them robustly to minimise the potential for errors and improve their performance.

44] University of East Anglia, Swiss cheese model by University of East Anglia (16 January 2019) www.youtube.com/watch?v=JRCMxfBULB4

Quality Arrangements

- 5.1 If project specifications and the associated codes and standards were rigorously followed, the delivery of a safe, high integrity nuclear power plant would be assured. However, as has been discussed in Chapter 4, activities from design through to commissioning require significant human input and interpretation which causes the potential for error. The implementation of a good Quality Management System (QMS) can help to ensure compliance with project specifications, codes and standards by:
- ▶ Providing a clear and unambiguous plan for the work to be undertaken with appropriate inspection hold points
 - ▶ Defining roles, responsibilities and authorities for the execution of work
 - ▶ Providing instruction and guidance on what needs to be done, when, and by whom
 - ▶ Ensuring all personnel are Suitably Qualified and Experienced (SQEP) for their allocated tasks
 - ▶ Providing a structured method for linking the level of checking and inspection with the nuclear safety significance of the component
 - ▶ Providing demonstration of compliance with specifications, codes, standards, nuclear safety, environmental and other requirements associated with components or the plant
 - ▶ Providing opportunities for learning and continuous improvement

The International Organisation for Standards states that the use of a QMS such as ISO 9001⁴⁵ can:

“ help businesses and organizations to be more efficient and improve customer satisfaction.”

- 5.2 Quality arrangements must be put in place for all projects and compliance with the applicable specifications, codes, standards and regulations is always expected. The main differences between the quality requirements for nuclear compared to conventional projects are:
- ▶ A risk based 'graded approach' to quality appropriate to the safety criticality of the product
 - ▶ An increase in the level of plans and procedures
 - ▶ Increased level of documentation and verification
 - ▶ Increased levels of checking and inspection of the works
 - ▶ The need to demonstrate that what was planned has actually been achieved
- 5.3 A graded approach to quality recognises that not all activities carry the same risk. It enables the greatest controls to be applied to those activities or components which carry the highest risks. It ensures that equipment with the highest impact on nuclear safety will be subjected to a much greater level of checking, verification and independent assessment. The latter may involve additional checks by the Licensee, the regulatory inspectors, the independent third-party assessor, and the Tier 1 contractor. These provisions will safeguard the integrity of the plant and ensure the protection of both the environment and the public from radioactive releases.

Licensees Quality Assurance Specifications

- 5.4 A Licensee will specify the quality assurance specifications and the quality management arrangements applicable to their projects. They must ensure these flow down through all tiers of their supply chain. The approach taken by the various Licensees is described in the following pages.

45] International Organization for Standardization (ISO), Reaping the benefits of ISO 9001 (2015) www.iso.org/files/live/sites/isoorg/files/archive/pdf/en/reaping_the_benefits_of_iso_9001.pdf

EDF Energy and CGN for EPR Plant

- 5.5 The 'General Quality Assurance Specification' (GQAS) will be applied to all contracts awarded by HPC Gen Co and SZC Gen Co for construction of the EPR in the UK. GQAS is based on compliance with ISO 9001: 2015; elements of the IAEA GSR suite of documents, plus some additional requirements specific to Quality Grade 1 components. There are three quality assurance grades used in GQAS as shown below.

QA Grade 1	Appropriate to all safety classified products
QA Grade 2	Applied and to all non-safety classified works and products which are considered as important for plant availability or operator health and safety
QA Grade 3	Only applies, by exception, to non- safety classified works or products considered as low risk commodity items

- 5.6 A major concept introduced by the GQAS is that of a 'Quality Related Activity' (QRA). A QRA is defined as "an activity, failure of which, can lead to a product which is not compliant with the nuclear safety requirements". QRAs are only relevant to QA Grade 1 products (safety-classified structures, systems and components) and all QA Grade 1 products will contain at least 1 QRA. The customer in their works information and specifications for the product will identify the high level QRA(s) associated with each QA Grade 1 product. The designers and manufacturers of these products will then document which of the activities that they will carry out during the manufacturing or installation process are QRAs. The customer will review and approve the proposed QRAs for all safety classified products. The agreed QRAs must be cascaded throughout the entire supply chain involved in the production of safety classified products.
- 5.7 Where any manufacturing activity with an associated QRA is to be subcontracted, contractors procuring the item must detail all the required QRAs in their procurement specifications and purchase order. They must also specify how they will inspect and monitor the completion of the QRA including any hold points they wish to introduce into the works for inspection purposes.
- 5.8 Examples of quality-related activities:
1. Pipework in certain areas of the reactor may be identified as a safety classified product. The QRA associated with this product is not necessarily failure of the pipework itself, but the damage falling pipework may cause to equipment or control instrumentation during a seismic event. The QRA therefore is that the pipework can break or rupture during the seismic event, but the pipe supports must be sufficiently strong so that the broken pipework does not fall and damage other safety critical equipment. The supplier will require to demonstrate how this risk will be eliminated through the design, manufacture and installation of pipework and its supports.
 2. In a safety critical weld, the welding activity itself may not be a QRA. However, the control of the root penetration to avoid 'hot spots' of contaminants building up during operation (and which could cause problems in future decontamination and decommissioning) is a QRA associated with the welding process. Steps must therefore be taken to control the form of the root of the weld.



3. QRAs are not limited to hardware. For example, the procurement of a safety classified product is clearly a QRA and the procurement process will be subject to the same rigor and controls as the manufacture of a safety critical product.
4. Electrical panels that are subject to qualification for seismic conditions may require additional cable connection design to ensure termination points remain intact during a seismic event. The design, manufacture and validation of these connection types would be a QRA.

Additional requirements of IAEA GSR suite of documents

- 5.9 In addition to the quality management requirements under GQAS and ASME NQA-1, compliance with IAEA GSR-R-3⁴⁶ had previously been required. In 2016 this document was replaced by the GSR suite of documentation and elements of this suite of documentation may be required by both the ONR and Licensees for activities associated with the development of new nuclear plant in the UK.
- 5.10 GSR Part 2 (leadership and management for safety) now supersedes GSR-R-3 (the management system for facilities and activities). As indicated in the title, the new standard focuses on leadership responsibilities in the management of safety and the management systems that support this. Fundamentally the documents are similar and are supported by GS-G-3.1 (application of the management system for facilities activities) and GS-G-3.5 (the management system for nuclear installations) which in turn have superseded the old 50-SG-QA suite of documents.
- 5.11 The application of elements of the IAEA GSR suite of documents is only a requirement for larger companies, but lower tier companies should be aware of its existence. They can extract elements from it which will improve their business management systems. GSR Part 2 is issued by the IAEA and defines many of the requirements it deems as being necessary for Tier 1 companies to work in
- 46] The American Society of Mechanical Engineers (ASME), IAEA GS-R-3 Management System for Facilities and Activities Safety Requirements www.asme.org/wwwasmeorg/media/ResourceFiles/Events/NuclearCodesStandards/2014PragueWorkshop/Roeschlova.pdf

the nuclear industry. The key focus is the application of an Integrated Business Management System within a company. This ensures disciplines such as quality, health and safety, environment and sustainability are integrated into one business management system and are not seen as standalone entities. Integration of reporting arrangements are essential, and it is necessary that performance in respect of quality, health and safety, environment and sustainability have direct reporting access to the CEO and the Board of the company to ensure full oversight at the highest level in the company.

Application of Quality Arrangements Throughout the Supply Chain

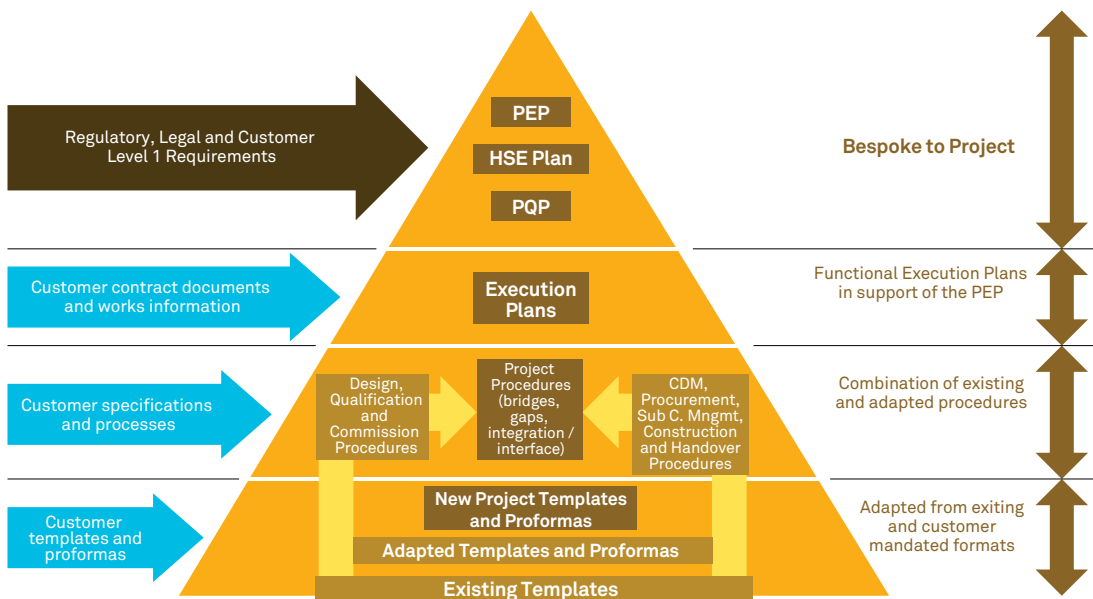
- 5.12 Regardless of the type of QMS (GQAS or ASME NQA 1) selected by the Licensees, there are common roles and responsibilities which apply throughout the supply chain as detailed below.

Licensee and Tier 1 Contractor responsibilities

- 5.13 For any quality system to provide the required level of protection, it must be rigorously applied throughout the entire project. All activities, no matter how small, should be included in the quality regime. As described above, the Licensee, as the nuclear site licence holder, has the responsibility for defining the overall project quality arrangements. The ONR will review the Licensee's proposed quality arrangements and their applications to ensure that they:
- ▶ Are robust, with accountability well defined
 - ▶ Follow a risk-based graded approach appropriate for safety critical products
 - ▶ Cover all aspects of the work
 - ▶ Can be applied by, and flowed down to, all levels of the supply chain
 - ▶ Have provision for adequate oversight through the use of independent third-party authorities
 - ▶ Apply a graded approach to quality, which aligns the level of checking and inspection with the nuclear safety significance of the component
- 5.14 The Tier 1 contractors will be required to have a proven QMS in place which is certified to ISO 9001:2015 or equivalent. They will be required to review the quality arrangements specified in their contract with the Licensee and embed any additional contract specific quality requirement into a project-specific Project Quality Management arrangement to control all aspects of their activities. These arrangements will then flow down into specification for their own work and to those activities which they will subcontract to lower tier contractors.
- 5.15 It will be the responsibility of the lower tier contractors to execute their own works in line with the specified quality arrangements and to ensure that they flow these arrangements, as appropriate, down throughout their supply chain. The ONR and the Licensee have the right to audit the application of the quality arrangements throughout the supply chain at any time during the project.
- 5.16 The Tier 1 contractors will select and assess suppliers and sub-contractors they intend to use for any proposed scope of work. This will include confirming that suppliers have a QMS which comply with ISO 9001: 2015; that they have demonstrated an ability to align with the requirements of the contract specifications; and that they have the capacity and technical capability to perform the work scope. Confirmation of compliance with ISO 9001:2015 may be by acceptance of certification by an accredited body or by a specific Tier 1 audit.

5.17 It is important the Tier 1 contractors use their knowledge of, and expertise in, the nuclear industry to interpret the requirements of the Licensee including the codes, standard and quality arrangements for the specific scope of work to be subcontracted. This will minimise the possibility of misunderstanding of the requirements by the subcontractors, some of whom may have limited understanding of nuclear codes and standards.

An example of this process is represented in this schematic:



◀ Fig. 12 Example of a quality management process

5.18 At the start of the subcontracting process the Tier 1 companies should develop a **Contract Management Requirement** and prepare a bespoke **Product Specification** for each piece of equipment or service required from a subcontractor. Typical content lists for both documents is shown below:

Contract Management Requirement:

- Project management and programme requirements
- Quality arrangements and quality documentation (Project Quality Plans) with the hold and witness points specified
- QA/QC Inspection Strategy including Customer/Third Party Surveillance
- Document submission schedules
- Qualification of special processes and operators
- Arrangements for issuing, tracking and close out of technical queries
- Application of non-conformance process and non-conformance reporting
- Reporting requirements including a process for identifying and closing out concessions

Product Specification:

- Technical and functional requirements
- Design codes to be used plus any special additional requirements
- Material specifications and additional material testing requirements
- Inspection and test procedures to be applied
- Packaging and shipping requirements
- Lifetime records/handover documentation



Courtesy of Wood

- 5.19 During the execution of the project, Tier 1 contractors have a duty to support the lower tier contractors in the execution of tasks as well as audit and check on their performance. Typical areas of support which should be provided by Tier 1 contractors to ensure compliance with Licence Condition 17 (Management Systems) are:
- ▶ Project briefing on overall technical quality and execution arrangements to help suppliers and contractors understand their position in the structure and delivery arrangements
 - ▶ Explanation of the meaning of nuclear safety culture and the requirements for transparency and openness in working arrangements, quality reporting and delivery issues
 - ▶ Briefing and an understanding of the requirements within the supply chain to mitigate against Counterfeit Fraudulent and Suspect Items (CFSI)
 - ▶ Detailed discussions on the technical specifications, to ensure that the suppliers/contractors fully understand requirements, the reasons for them and their implications
 - ▶ Review and approve the specification, monitoring and closeout of contract quality requirements
 - ▶ Application of technical queries, non-conformance and concession processes as they apply to the scope of work

Roles and Responsibilities of Lower Tier Contractors

- 5.20 The lower tier contractors must work to the contract specifications provided by their customer within the framework of their own QMS. These contract-specific specifications define the level of intervention required by the customer including procedure approval, review of inspection plans, witnessing of inspections or tests, and should be built into the product specific Inspection and Test Quality Plan(s) developed by the contractor. The customer will also provide a project Quality Audit Schedule which allows them to check that the contractor is complying with their QMS, the purchase order and the contract requirements. Contractors must do all they can to facilitate such audits of their own work and that of their subcontractors.

- 5.21 Tier 2 and 3 contractors must take full responsibility for the management of their own subcontractors' quality arrangements and for the quality and correctness of the documents and products that their supply chain produces. This will include ensuring that customers' requirements are taken into account by their sub-contractors, and that relevant contract quality requirements flow down to their subcontractors. The Tier 2 and Tier 3 contractors must ensure that subcontracted work is controlled and performed in accordance with the applicable, approved specifications.
- 5.22 The level of intervention by customers will be directly aligned with the nuclear safety classifications of the equipment or services being provided. For nuclear safety classified components, the ONR, the Licensee, and Tier 1 contractors have the right to audit any lower tier contractors and their subcontractors at any time, including the right of access to their premises. This will be included in the contractual arrangements between the parties.
- 5.23 Such audits may not be restricted to the conformance of the product or service, but could also incorporate areas of quality, health and safety and environmental compliance across the whole of the subcontractors' business. For non-safety critical components of the type most Tier 3 and Tier 4 contractors are likely to produce, the level of audit will be much less.

Process for Control of Work on Nuclear New Build Projects

Contract Quality Requirements

- 5.24 Each customer will have their own terminology for quality requirements whether it be QRAs or quality class under ASME as described previously. Each company in the supply chain is required to identify all the quality requirements related to their contract and how they will comply with and execute the quality requirements. It is acceptable to further subdivide each quality requirement into a further subset of quality activities in order to achieve the level of control required. Suppliers must get the agreement of their customer as to the breakdown and definition of these before starting work.

Controlling documentation in Contract Quality Requirements

- 5.25 Examples of the documents and controls necessary to deliver nuclear projects are described in Appendix 3. Tier 1 contractors will issue lists of required processes and documents to lower tier contractors, with descriptions of what is required.

The key documents which must be produced by the subcontractors are:

- ▶ Project Execution Plan (PEP)
- ▶ Design Quality Plan
- ▶ Project or Contract Quality Assurance Plan (PQAP/CQAP) or Project Quality Plan (PQP)
- ▶ QA/QC Strategy
- ▶ Manufacturing and Test Philosophy Document
- ▶ Manufacturing and Test Quality Plan
- ▶ Manufacturing Processes and Method Statements

- 5.26 It will be the responsibility of the subcontractors to prepare the documents listed above for their scope of work. Many of the documents will require to be approved by the Tier 1 contractors, in some cases by the independent third-party inspector and, in a few cases, by the Licensee. The approval requirements should be made clear in the contract specifications.

Competence – Qualification and Experience

5.27 It is expected that all companies will have procedures in place for the selection and appointment of individuals to roles within a project team. This process must be able to demonstrate that people who are appointed to positions are SQEP for the role.

Implicit in this is that companies will have:

- ▶ Job descriptions for positions which define qualifications and level of experience required. For certain projects and key positions, relevant nuclear experience will be specified
- ▶ A selection process whereby individuals within the company (e.g. technical authorities) have sufficient knowledge of the requirements to ensure the appointment of the right (SQEP) people to the roles
- ▶ A process which records the qualification, training and experience of each individual which can be used to justify the selection of that individual for the role
- ▶ A review process in place to assess competence
- ▶ Where gaps are recognised in an appointed individual's experience, a process to provide mentoring and support until sufficient experience is gained

5.28 When contractors appoint individuals to key project positions, their customer has the option to interview individuals prior to their formal appointment. Once individuals are appointed, they cannot be replaced without the authorisation of the customer.

5.29 However comprehensive and sophisticated a quality system may be, it will only be effective if it is operated by personnel who have the relevant expertise and who are committed to embracing a nuclear safety culture. All those involved in the process, from the project director to the personnel on the shop floor, must be SQEP and competent to carry out their allotted activities but also understand what it means to work in the nuclear industry. Details are provided in Chapter 4 on the attributes of a nuclear safety culture within an organisation and the human performance skills and behaviours requires of all personnel.

Verification and Checking in Contract Quality Requirements

5.30 For equipment with a high impact on nuclear safety, a much greater level of checking, verification and independent assessment will be required. This may involve the Licensee and the regulatory inspectors as well as the Tier 1 contractor and the independent third-party assessor.

Some of the particular requirements associated with the verification process are:

- ▶ Design activities must be checked and verified by competent persons, other than the person who created the design
- ▶ Before being distributed, documents and data must be verified by a competent person, other than the person(s) who prepared them
- ▶ All documentation relating to particular products must be unambiguously linked to the products including checks for CFSI
- ▶ All inspection activities of quality related products shall be conducted by competent persons different from those who conducted the activity
- ▶ All controls and verifications must be documented

Codes and Standards



Overview of Applicable Codes and Standards

- 6.1 There are a number of codes and standards employed to design and construct nuclear plant around the world. This section will concentrate on those codes and standards which are likely to be used for new nuclear plant components in the UK.
- 6.2 Several codes and standards will be used for the design and manufacture of parts of the new nuclear power stations in the UK. Nuclear codes, such as RCC-M, RCC-E and ASME III, will be used for the design, manufacture and installation of the nuclear safety critical components. These are classified as Class 1 to 3 according to their nuclear safety significance. Primary circuit components, such as the reactor vessel, steam generators and primary pipework, are designated as Class 1 components as their failure could lead to significant radiation release. Components whose failure could disrupt or put in danger the stability of the plant are designated Class 2. Class 3 components have a lesser nuclear safety significance and their failure would have a limited impact on the stability of the plant.
- 6.3 The exact designation into Class 1, 2, 3 or 'No Class' is dependent on the safety case made for equipment. The sourcing of the various classes of components from the supply chain is summarised below. This is not a definitive listing but gives a broad indication of where in the supply chain the primary equipment procurement responsibility will reside.

Designation	Type of Company	Applicable Codes	Tier of Supplier
Class 1	Technology Provider	Nuclear Codes such as RCC-M, ASME III, RCC-E, plus additional customer requirements.	Technology Provider and specialist manufacturers
Class 2	Nuclear experienced companies with proven Quality Systems certified to ISO 9001.	Nuclear codes such as RCC-M, ASME III, RCC-E. EN codes, plus additional customer requirements.	Tier 1 and Tier 2
Class 3	Companies with experience of producing high quality equipment with Quality Management arrangements certified as being compliant with ISO 9001.	EN or National Standards, plus additional customer requirements.	Tier 2 and Tier 3
Industrial Equipment	General industrial companies with Quality Management Systems that meet ISO 9001 requirements.	EN or National Standards. Pressure System Regulations.	Tier 2 and Tier 3

- 6.4 The above table shows where the primary procurement responsibility rests, but lower tier companies can manufacture equipment under their in-house quality arrangements, which must be approved by the Tier 1 contractor. It should be noted that if a lower tier contractor subcontracts any activity, they must undertake the role of the 'intelligent customer' by specifying the required codes, standards and quality arrangements to be used by their supply chain.
- 6.5 In the UK, the Pressure Equipment Regulations (PER) are for new equipment, and do not apply to equipment which, in the event of a failure, would incur a radioactive release. Classified components and equipment are excluded from the PER regulations. The rationale is classified equipment will be designed and installed to the high demands of a nuclear proven code such as RCC-M, RCC-E or ASME III plus



Courtesy of URENCO

the additional customer requirements which will exceed the requirement of the Pressure Systems Safety Requirements (PSSR).

For 'No Class' or industrial components, the PER will apply. These regulations are generally satisfied by industrial standards such as EN 13445 for pressure vessels and EN 13480 for piping.

- 6.6 The nuclear pressure equipment codes that are likely to be used for the current generation of nuclear reactors being proposed for the UK will be the American ASME III code and the French RCC-M code for the EPR design. This section of the guide describes the ways that the various design and manufacturing processes are addressed within the respective codes. Additionally, a short overview of the RCC-E code entitled 'Design and Construction Rules for Electrical Components of Nuclear Islands' is presented.

RCC-M Code for the Design and Construction of Mechanical Equipment

- 6.7 The RCC-M⁴⁷ code was written by the AFCEN (French Association for Design, Construction, and In-service Inspection Rules for Nuclear Island Components) for use in France. In some areas the code is very prescriptive as it was written to reflect the significant operational experience from the very large fleet of French PWR's over many years. In other areas, such as in design, more responsibility is placed on the designer to justify design assumptions that are made in the design calculations rather than rely on a prescriptive set of rules.
- 6.8 Quality requirements in RCC-M is covered in Section A5000, which is brief compared with ASME III. In practice, additional requirements over and above that specified in RCC-M are imposed in France through French Law. The use of RCC-M outside of France therefore requires that these additional measures will have to be included in the technical specifications appended to the contracts.

The approach likely to be adopted in the UK will be to supplement the RCC-M requirements with an 'RCC-M Adaptation Document' that will introduce requirements corresponding with those embedded in French law. The relevant requirements will then be made available by the prospective Licensee to inform the supply chain of the additional measures required for use of the RCC-M under a UK licensing regime. Unlike the ASME code, RCC-M does not require

^{47]} AFCEN, RCC-M Design and Construction Rules for Mechanical Components of PWR Nuclear Islands <https://afcen.com/en/publications/rcc-m>

manufacturers to attain any type of RCC-M specific stamp or accreditation before they can manufacture equipment to RCC-M.

- 6.9 The design sections of RCC-M were originally taken from the ASME III code and if companies are familiar with the ASME III design approach, they will recognise the ASME influence on RCC-M. However, it should not be assumed that the RCC-M design requirements are the same as the ASME requirements. Using RCC-M can be more demanding on the designer, as additional design steps are specified, and many decisions have to be justified rather than just following code guidance as in the case of ASME.
- 6.10 The RCC-M code uses a classification system which is similar to ASME, having Class 1, Class 2 and Class 3 components. The allowable levels of stress, or more precisely stress intensities, also vary according to the reactor 'service loadings' that are under consideration. However, the service limits and material allowable stress levels in RCC-M are different to ASME.
- 6.11 The welding requirements specified in the RCC-M code covers both general provisions and RCC-M specific requirements such as the required welding data pack information and weld filler material qualification. The required weld qualification procedures and welder qualification is covered by the appropriate EN and ISO standards, but again with additional requirements.
- 6.12 The manufacturing section of the RCC-M Code covers a collection of topics considered important to nuclear equipment manufacture. Topics addressed include marking, forming, cleanliness and heat treatment procedures. The methods described here are quite prescriptive and need to be followed to avoid rejection of the finished component.
- 6.13 As the RCC-M code is specific to the PWR Nuclear Island equipment; the code describes the methods of examination to be used together with the permissible defect acceptance criteria. The choice and extent of the examination method to be used are determined by safety classification, operating conditions and the stress levels in a particular area. European standards (EN and ISO) are widely stipulated and supplemented where necessary to align with the safety classification of the component.
- 6.14 The RCC-M code is periodically updated. Modification requests may be submitted to AFCEN at any time. These are examined and, once accepted; modification sheets are completed and sent to the requesting party. The sheets are then incorporated in an addendum, which is incorporated in the next edition. It should be noted that some design specifications may call for a specific version of the RCC-M code, say 2007, with the addition of selected modification sheets, and not necessarily the full addenda. This exact specification of the code and addenda must be incorporated in the various technical specifications, flowing down from the Licensee.

RCC-E Code for Design and Construction of Electrical Equipment

- 6.15 The RCC-E⁴⁸ code comprises a set of technical rules to be applied and implemented by a constructor, manufacturer or supplier for the design and construction of electrical equipment for nuclear power plant.
- 48] AFCEN, RCC-E Design and construction rules for electrical equipment of PWR nuclear islands <https://afcen.com/en/publications/rcc-e>





- 6.16 The code states that it is the responsibility of the contractor and the constructor to define the list of electrical equipment and systems that will need to be produced in accordance with the RCC-E. The requirements of the RCC-E are fully applicable to all safety classified electrical equipment and systems, unless otherwise stated in the project data sheets. In practice, the list of equipment that needs to comply with RCC-E will be specified by the Licensee as these parameters are an important part of the safety case made by the Licensee to the nuclear regulator.
- 6.17 The qualification of equipment and the methodology to be employed in RCC-E is quite complex. For example, an actuator mounted onto a valve designed to RCC-M sub section B (Class 1), may well be required to operate in an extreme operating condition (temperature, humidity and Safe Shutdown Earthquake Seismic Loading). In such a case the equipment will be given a K1-equipment classification and the corresponding K1 Qualification Procedure specified in the RCC-E would be applicable.
- 6.18 When a generic reference is made to RCC-E on the purchase order, all of its requirements are applicable. If reference is made to one or more specific parts of the RCC-E, then only those parts are applicable, to the exclusion of all others (e.g. Volume A).
- 6.19 The RCC-E code is periodically updated. Modification requests may be submitted. These are examined by the AFCEN and, once accepted; modification sheets are completed and sent to the requesting party. The sheets are then incorporated in an addendum, which is then incorporated into the next edition.

ASME III Boiler and Pressure Vessel Code

- 6.20 Written by the American Society of Mechanical Engineers (ASME),⁴⁹ the ASME III Boiler and Pressure Vessel Code (BPVC) Division 1 is the most widely used nuclear pressure vessel code around the world. It was used for Sizewell B, the last nuclear power station built in the UK.
- 6.21 The ASME Quality and Quality Control process is based on an exhaustive range of company and facility specific, generic prequalification assessments, which then enable the manufacturer to obtain a specific stamp, e.g. the 'N' stamp for nuclear components. There are also NA, NPT and NV stamps for nuclear installers, nuclear parts and nuclear safety valve manufacturers. These stamps certify companies have the right quality systems and work control practices to make the quality grade of components allowed by the stamp. ASME III refers the users to the NQA-1 Quality Assurance Requirements for Nuclear Facility Applications. It is very unlikely lower tier contractors will require the above stamps.
- 6.22 Design to ASME III NB has been carried out for almost 50 years, offering a consistent set of rules backed by structural analysis and a good understanding of material behaviour. Many of the design techniques used in ASME are also used in non-nuclear codes and will be familiar to pressure vessel designers who work to EN13445 or PD5500. The classification of vessels into Class 1, Class 2 and Class 3 are specific to nuclear applications, together with the requirement to design pressure equipment for a specifically quantified lifetime transient loading. The allowable levels of stress, or more precisely stress intensities, also vary according to the reactor 'service loadings' planned.

⁴⁹ ASME, Boiler and Pressure Vessel Code 2019 edition www.asme.org/shop/standards/new-releases/boiler-pressure-vessel-code

- 6.23 The control of materials under ASME requires material to be supplied from a ‘Material Organisation’ (MO) or a ‘Certificate Holder’ as defined in the ASME NCA-3800. Also NQA-1 requires the N stamp manufacturer to audit the MO. The code requires that all material must be accompanied by a heat analysis, melting, heat treatment and proof of no weld repair. In practice therefore, a material to be designated as an ASME material has to be specified as an ASME material from the initial metal pour.

- 6.24 Welding under ASME is recognised as being so important that the requirements are incorporated in to the dedicated Section IX of the code. This section includes code specific requirements for the qualification of welders and welding procedures, together with guidance on-weld joint design, base metal and filler material properties. Unlike RCC-M, use of EN welding standards is not allowed by the ASME code.

- 6.25 To manufacture nuclear components in accordance with ASME III, the ASME code specifies far more detailed manufacturing requirements than is included in RCC-M, particularly for Class 2 and 3 components. For Class 1 components, the ASME approach firstly requires the manufacturer to achieve the ‘N’ stamp accreditation. The process of assessment is a significant commitment for a manufacturer and can take over a year from the initial enquiry through to the final ASME survey. Therefore there can be a significant cost to achieving an ASME ‘N’ accreditation. For Class 2 and Class 3 components an ASME ‘N’ stamp is not required although the organisations must have a QMS which will be audited by the purchaser and their independent inspection authority.

- 6.26 The NDE requirements of the ASME III code are found in ASME Section V, but modified by articles NB/NC/ND-5000 depending on the equipment classification, again these are specific to ASME and EN standards are not allowed by the ASME code.

Courtesy of EDF Energy



- 6.27 The ASME nuclear code refers out to other sections of the code for many aspects of the work. This includes Section II for materials, Section V for non-destructive examination and Section IX for welding qualifications.
- 6.28 Updating of the ASME B&PV Code will now occur every two years with no yearly addenda. In addition to bi-annual changes, there is also the code case route which allows the user of the code to seek clarifications / modifications to the code from the ASME committee.
- 6.29 ASME may issue a code case in the event there is an urgent need for alternative rules concerning materials, construction, or in-service inspection activities not covered by existing BPVC rules, or for early implementation of an approved code revision. Code cases are effective immediately upon ASME approval and do not expire. Approved code cases are published quarterly. ASME provides a free service to code users to enable viewing of cases that are currently under review as well as cases that have been approved but not yet published.

ASME vs RCC-M General Organisation

- 6.30 The diagram below shows the correspondence between the sections of the RCC-M code and the ASME III BPVC.

RCC-M Code		ASME Code
Section 1	Nuclear Island Components	Section III
A	General Requirements	NCA
B	Class 1 Components	NB
C	Class 2 Components	NC
D	Class 3 Components	ND
E	Small Components	None
G	Core Support Structures	NG
H	Supports	NF
J	Storage Tanks	NC/ND 3800-3900
P	Containment Penetrations	NE
Z	Technical Appendices	Appendices
Section 2	Materials	Section II
Section 3	Examination Methods	Section V
Section 4	Welding	Section IX (Qualifications)
Section 5	Fabrication	Various parts of section III

A useful document has also been published by TWI which summarises the difference between the two codes in the areas of welding and NDT.⁵⁰

^{50]} TWI Ltd, Comparison between ASME and RCC-M requirements for welding and NDT (30 July 2012) www.twi-global.com/technical-knowledge/published-papers/comparison-between-asme-and-rcc-m-requirements-for-welding-and-ndt

Fig. 13 Table showing comparison of RCC-M and ASME structures

EN Codes

- 6.31 EN standards⁵¹ will be specified for many of the items of pressurised equipment outside of the nuclear island. These may include some nuclear Class 3 items plus all the non-safety classified plant and equipment. For pressurised equipment and their supports, the main EN manufacture and construction standards are EN 13445 for vessels; EN 13480 for piping and EN 1990 for support structures.
- 6.32 In general, the Pressure Equipment Directive will apply directly to the non-nuclear safety classified components. Where the directive does not apply directly to nuclear safety Class 3 components, additional requirements will be specified. These will probably invoke the conformity assessment requirements of the directive, as implemented in France.
- 6.33 EN standards are referenced by the RCC codes for many aspects of design, equipment and construction. This includes welding, inspection, applies to some material specifications. However, the RCC codes frequently impose additional requirements to that of the EN standards, and these should be specified by the Tier 1 contractors in their enquiries to their subcontractors.

UK Pressure Systems Regulations

- 6.34 In the UK, the PER do not apply to equipment which, in the event of its failure, a radioactive release would occur. Classified components and equipment are therefore excluded from the PER regulations. The rationale is that classified equipment will be designed and installed to the higher demands of a nuclear proven code such as RCC-M, RCC-E or ASME III which will exceed the requirement of the PER.
- 6.35 For 'No Class' or 'Industrial components', the PER will apply. These regulations are generally satisfied by industrial standards such as EN 13445 for pressure vessels and EN 13480 for piping. Guidance as to the responsibilities of manufacturers under these regulations has been published by the UK Government.⁵²



- ⁵¹] European Committee for Standardization (CEN), European Standards in relation to pressure equipment (November 2014) www.cen.eu/news/brochures/brochures/CEN_Pressure_2014.pdf
- ⁵²] Health and Safety Executive (HSE), Pressure Equipment Regulations (11 September 2012) www.gov.uk/guidance/pressure-equipment-manufacturers-and-their-responsibilities

Health and Safety Processes

Health and Safety Regulation

- 7.1 As outlined in Chapter 3, the Health and Safety at Work Act 1974 is the primary piece of legislation which compels companies to conduct their business in a way which ensures the health, safety and welfare of workers and the wider public. Historically, the Health and Safety Executive was responsible for all matters associated with health and safety on nuclear plant in the UK. In 2013 this was changed by the Energy Act and the ONR became the agency responsible for ensuring compliance with the Health and Safety Act 1974 on nuclear plant in Great Britain.
- 7.2 The ONR has a range of tools at its disposal to secure compliance with health and safety law, enabling it to take a proportionate approach in each case. Inspections and assessments are undertaken by inspectors and they may offer companies guidance and advice via face-to-face meetings and in writing. This could include warning a company that, in the opinion of the inspector, it is failing to comply with the law.
- 7.3 The HSW Act places a fundamental duty on employers to ensure the health, safety and welfare of all their employees. It also imposes a duty to ensure people not in their employment are not exposed to risks as a result of the activities undertaken by contractors. This includes employees of other companies at the workplace, but also general public in the local community.

Health and Safety Management

- 7.4 Traditionally health and safety issues have been addressed by companies through:
- ▶ Compliance with the relevant legislation
 - ▶ Establishment of robust health and safety management systems, procedures and work methods
 - ▶ Development of a trained and competent workforce
 - ▶ Provision of a safe workplace with well designed, constructed and maintained buildings, plant, and equipment
 - ▶ Systems for monitoring the long-term health of employees including annual medicals for workers likely to be exposed to any form of radiation in the course of their duties
- 7.5 This approach has been developed over many years and has resulted in a steady reduction in accidents and incidents. However, industry has been challenged to make further reductions in health and safety risk, both in accident and incident statistics.
- 7.6 The approach taken to achieve this goal has been to adopt a Behavioural Safety Culture throughout organisations and extending across the entire supply chain. When tendering for work in the nuclear industry, these expectations will be encountered as part of supplier questionnaires. Extensive audits of contractors' approach to safety management, their management systems and their safety statistics should be expected as part of the tender evaluation process. During the execution of the works the lower tier contractors will be expected to integrate into the overall project Behavioural Safety Culture as set out by their main contractor and the Licensee.
- 7.7 There is a high degree of alignment between behavioural health and safety and aspects such as Nuclear Safety Culture (NSC) and Human Performance as described in Chapter 4 of this document. In reality, all of these aspects must be rolled into one collaborative, consistent and aligned set of processes across the

supply chain, with shared project nuclear safety culture, health and safety values, and vision for the project. This could also mean shared project key performance indicators with common health and safety standards, forms and procedures.

- 7.8 The IAEA has compiled a series of documents relating to safety associated with activities relating to nuclear plant. In GSR Part 2 there is an emphasis on the Leadership and Management of Safety⁵³ The content includes chapters on:
- ▶ Responsibility for Safety
 - ▶ Leadership for Safety
 - ▶ Management for Safety
 - ▶ Culture for Safety
 - ▶ Measurement Assessment and Improvement
- 7.9 The key focus is the application of an Integrated Business Management System within companies. This ensures disciplines such as quality, health and safety, environment and sustainability are integrated into one business management system and are not seen as standalone entities. Integration of reporting arrangements are essential and it is necessary that performance in respect of quality, health and safety, environment and sustainability have direct reporting access to the CEO and the Board of the company to ensure full oversight at the highest level.

Integration of Contractors into Project Health and Safety Arrangements

- 7.10 As with Nuclear Safety Culture and Quality, the Licensee is responsible for setting the Health and Safety Culture and Standards for the project. These must flow down in a consistent manner throughout the supply chain. Health and safety processes must be embedded in all aspects of the project from design through to manufacture, site construction and commissioning. One set of values must apply to everyone on the project.
- 7.11 The Licensee will agree the policy for the health, safety and environmental principles of the project with the ONR and the Environmental Agency. These will be interpreted into a set of:
- ▶ Inductions e.g. Project-Specific and Site-Specific
 - ▶ Personnel training requirements and Behaviours Standards
 - ▶ Working Arrangements e.g. Roles and Responsibilities, Authorities etc.
 - ▶ Processes e.g. Risk Assessment, Near Miss Reporting and Observational Improvement Schemes
 - ▶ Monitoring Tools
 - ▶ Audits
 - ▶ Reporting Arrangements
- 7.12 These arrangements will be embedded in the Licensee's project execution plan and are likely to be incorporated in contractual requirements placed on the main contractors. These will then flow down to the lower tier contractors. At project kick-off meetings it is essential lower tier contractors are fully briefed as to how these arrangements impact on their contract, processes and personnel.

⁵³ IAEA, GSR Part 2 Leadership and Management of Safety (June 2016) www-pub.iaea.org/MTCD/Publications/PDF/Pub1750web.pdf



Courtesy of Wood

Audit and Surveillance of the Supply Chain

- 7.13 The interrogation of the health and safety culture and performance of the supply chain usually commences at the contract prequalification stage, where companies are asked to provide details of their accreditation to the Occupation Health and Safety Assessment Standards such as OHSAS 18001, their health and safety management systems, the reporting route of health and safety issues to their Board, and their health and safety statistics. As companies move into the tender and contract award stages, clients at the Licensee or Tier 1 levels will progressively seek more information on health and safety culture, behavioural safety programmes, lessons learned processes, remedial action processes and performance improvement programmes. Information will be initially provided in writing but will need to be verified by formal audit before any contract can be placed. Audits and surveillance visits from clients are extensive, often involving several people over one or two days.
- 7.14 The supply chain audits could be expected to include supplier offices, as well as manufacturing and construction sites. The auditing team could include representatives from the Tier 1 contractor and potentially the Licensee. The audit would cover health and safety-related topics such as assessments of the behavioural safety culture, relevant training and competences of personnel, health and safety performance, as well as health and safety-related contractual aspects. The audits will be documented with action plans produced. Close out of actions resulting from such audits in a timely manner is essential.

Construction Design and Management (CDM) Requirements

- 7.15 As companies must comply with the requirements of the relevant health and safety laws in the UK, it is not intended to undertake a detailed summary of their requirements in this document. However, one statutory requirement worthy of further consideration is the Construction, Design and Management Regulations 2015 (CDM 2015) which will apply to all major nuclear new build projects. These regulations define various roles, under CDM 2015, within a project, namely Client, Principal Designer, Principal Contractor, Contractor and Designer. The specific role of each of the above duty holders within the development and delivery of a particular project is detailed.

- 7.16 For nuclear new build projects, lower tier suppliers will be defined as contractors under the CDM 2015 regulations and this will mean they will have several regulatory duties. Under CDM 2015, contractors must:
- ▶ Check their client is aware of the client duties assigned within the CDM 2015 regulations
 - ▶ Review their roles and responsibilities under the contract and ensure they have the ability to comply with the assigned CDM duty holder responsibilities
 - ▶ Ensure personnel are trained and competent for the tasks they are to carry out
 - ▶ Ensure all project inductions and site-specific inductions have been completed
 - ▶ Plan and resource the work so all activities can be accomplished without undue time pressures
 - ▶ Manage and monitor their own activities ensuring:
 - All potential risks are identified and avoided, eliminated or mitigated
 - All residual risks are identified, communicated and appropriately managed
 - All personnel are properly briefed about the tasks to be undertaken and the risks identified
 - Work is paused or suspended if unforeseen hazards emerge until the work is reassessed and appropriate controls are implemented
 - ▶ Co-operate with the client and other contractors to ensure good communication and that risks identified are managed
 - ▶ Ensure all subcontractors they appoint have sufficient time to plan and undertake their activities
- 7.17 Additionally, for notifiable projects under CDM 2015, a category which would include nuclear new build projects, contractors must also:
- ▶ Check a Principal Designer has been appointed, the HSE has been notified of the project and form F10 has been completed and submitted
 - ▶ Co-operate with the Principal Designer, Principal Contractor and other contractors on the project
 - ▶ Ensure they understand the specified arrangements contained within the Construction Phase Plan (CPP) and acknowledge hazards identified within the Pre-Construction Information (PCI) that may impact on their works
 - ▶ Ensure they have visibility of any residual design risks where it affects their works
 - ▶ Share risk assessments with the Principal Contractor and specifically communicate with them on risks the contractor introduces which may impact on other contractors
 - ▶ Where joint access to areas of work is required, ensure risks resulting from simultaneous operations (SimOps) are identified and mitigated
 - ▶ Inform the Principal Contractor if revision of safe systems of work will require the amendment of the CPP or construction programme
 - ▶ Identify any delays to the programme of work early on, so mitigation measures can be planned
 - ▶ Inform the Principal Contractor of all near misses, incidents, accidents or ill health occurring within the workplace
 - ▶ Provide input to the project health and safety file in a timely manner
- 7.18 Where contractors have design aspects within their contract scope, they have additional responsibilities to ensure that:
- ▶ Design risk reviews are undertaken involving designers, manufacturing and construction personnel, commissioning staff, plant operators and plant maintenance staff
 - ▶ HAZOP studies are completed, minutes of meetings are issued, and issues are closed out
 - ▶ Risks are mitigated at the design stage as far as possible, and any residual construction or operational risks are promptly notified to the Principal

Designer and Principal Contractor, and that such risks are recorded and included in the project health and safety file

- ▶ HAZCON studies are completed and minutes of meetings are issued, and issues are closed out

- 7.19 To implement the CDM duties effectively the lower tier contractors will require considerable flow down of project information and support from the main contractor. As well as project-specific briefings on health and safety, the main contractor should formally brief their suppliers on the project arrangement with specific CDM briefings.



Training

- 7.20 The nuclear new build industry will create a demand for competent design, manufacturing and construction personnel. As is common in the operational nuclear industry, such personnel will need to be able to demonstrate their competence, by meeting the requirements defined for each job role as a SQEP. Employers must ensure they have the relevant information available relating to their employee's competences, including CVs, copies of relevant training records and SQEP assessments.
- 7.21 To meet the predicted demand for professional staff and construction workers, competency demonstration schemes such as the Nuclear Skills Passport,⁵⁴ the Certificate of Nuclear Professionalism and the Triple Bar for Nuclear have been developed. NSAN, in partnership with the Open University, developed the Certificate of Nuclear Professionalism, a higher education programme designed to equip new entrants to the industry, graduates and existing workers with the required skills to work within the nuclear industry. More information on this course is detailed on the NSAN website.⁵⁵ It is likely such competency demonstration schemes will become a required component for work in the nuclear new build sector. Additionally, from a health and safety perspective, the Client Contractor National Safety Group (CCNSG) Safety Passport or equivalent may also be a prerequisite for working on nuclear new build project sites.

^{54]} National Skills Academy for Nuclear (NSAN), Nuclear Skills Passport www.ns4p.co.uk

^{55]} NSAN www.nsan.co.uk

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balfourbeatty.com

bureauveritas.co.uk

gov.uk



en.cgnpc.com.cn

doosanbabcock.com

edfenergy.com/energy

HORIZON
NUCLEAR POWER



IndelibleDataLtd
A graphic consisting of a horizontal chain of links with a padlock in the center.

horizonnuclearpower.com

hse.gov.uk

indelibledata.co.uk

NSAN A logo graphic consisting of a square with a smaller square inside, and a vertical line extending from the top right corner.



nsan.co.uk

onr.org.uk

risktec.tuv.com



wood.

urencoco.com

woodplc.com



I. Legal Framework and Regulatory Bodies

Appendix 1.1

Licence Conditions

There are 36 standard licence conditions (www.onr.org.uk/documents/licence-condition-handbook.pdf) which are used by the ONR to ensure nuclear plant is designed, manufactured, installed, commissioned and decommissioned safely in the UK. The licence conditions which are most likely to be encountered by the supply chain are summarised here:

Licence Condition 6: Documents, records, authorities and certificates

'The Licensee shall make adequate records to demonstrate compliance with any of the conditions attached to this licence. Without prejudice to any other requirements of the conditions attached to this licence, the Licensee shall make and implement adequate arrangements to ensure that every document required, every record made, every authority, consent or approval granted, and every direction or certificate issued in pursuance of the conditions attached to this licence is preserved for 30 years or such other periods as ONR may approve.'

The implication for the supply chain is the production and retention of documentation to demonstrate the adequacy of the design, manufacture or installation of any product supplied for use in nuclear plant. It is increasingly common that work will not be signed off as complete and payments made until all documentation required by the contract is approved and issued to the client.

Licence Condition 9: Instructions to persons on the site

'The Licensee shall ensure that every person authorised to be on the site receives adequate instructions (to the extent that this is necessary having regard to the circumstances of that person being on the site) as regards the risks and hazards associated with the plant and its operation, the precautions to be observed in connection therewith and the action to be taken in the event of an accident or emergency on the site.'

This places the duty on the Licensee to provide training to all personnel who work on the site as to the hazards present and the safety procedures in place on the site. Contractors need to make allowance for their personnel to undertake this training and proactively remind their staff as to the importance of remaining familiar with safety procedures on an ongoing basis such as the different alarm sequences which operate on the site.

Licence Condition 12: 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 (SQEP) 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 which may affect plant safety.'

This condition places a duty on all parties (including the supply chain) to ensure that work is only undertaken by personnel who are fully trained and competent to carry out the activity (i.e. they are SQEP as required above). It is necessary to demonstrate that the skills required for the task have been considered and that persons have actively been selected to carry out the works. Training and competency records are required to justify personnel selection. The condition also requires active supervision of the works by a qualified supervisor. Contractors are required to demonstrate that they have a SQEP system in place and audits of the system will be requested.



Courtesy of EDF Energy

Licence Condition 14: Safety documentation

'Without prejudice to any other requirements of the conditions attached to this licence 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.'

This condition again refers to the production and maintenance of records of the work in support of the above activities. The supply chain must provide documentation to the extent specified in the contract to demonstrate the safety and quality of the product produced.

Licence Condition 19: Construction or installation of new plant

'Where the Licensee proposes to construct or install any new plant which may affect safety the Licensee shall make and implement adequate arrangements to control the construction or installation. Where ONR so specifies the Licensee shall not commence nor thereafter proceed from one stage to the next of the construction or installation without the consent of ONR. The arrangements shall include a requirement for the provision of adequate documentation to justify the safety of the proposed construction or installation and shall where appropriate provide for the submission of this documentation to ONR.'

Where the supply chain provides a service to the Licensee in the construction of new plant, they need to be aware of the requirement to produce adequate documentation in support of their activities. They also need to understand that in certain circumstances, hold points may be introduced to facilitate main contractor or ONR inspections.

Licence Condition 20: Modification to design of plant under construction

'The Licensee shall ensure that no modification to 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.'

Where a design has been approved, it is not permissible to modify that design without a formal review to ensure this condition is being met. Subcontractors cannot change the design; manufacturing methodology or testing/inspection plans without approval from their client.

Licence Condition 21: Commissioning

'The Licensee shall make and implement adequate arrangements for the commissioning of any plant or process which may affect safety. The arrangements shall include a requirement for the provision of adequate documentation to justify the safety of the proposed commissioning and shall where appropriate provide for the submission of this documentation to ONR. The Licensee shall ensure that full and accurate records are kept of the result of every test and operation carried out in pursuance of this condition.'

The supply chain must develop a commissioning plan for any equipment they supply and ensure that adequate records are kept. In most cases it is expected that the supply chain will be in a supporting role to the Tier 1 contractor or the Licensee during commissioning activities.

Appendix 1.2

Technical Assessment Guides relevant to Supply Chain

A listing of some of the technical assessment guides which may be of interest to the supply chain is shown below:

Document ID	Review Date	Title
Management of Contractors		
NS-TAST-GD-049 (Rev 5)	April 2019	Licensee use of contractors and intelligent customer capability - www.onr.org.uk/operational/tech_asst_guides/ns-tast-gd-049.pdf
NS-TAST-GD-077 (Rev 4)	February 2021	Supply Chain Management Arrangements for the Procurement of Nuclear Safety Related Items or Services - www.onr.org.uk/operational/tech_asst_guides/ns-tast-gd-077.pdf
CNS-TAST-GD-4.2 (Rev 0)	March 2020	Supplier Capability - www.onr.org.uk/operational/tech_asst_guides/cns-tast-gd-4.2.pdf
CNS-TAST-GD-4.3 (Rev 0)	March 2020	Oversight of Suppliers - www.onr.org.uk/operational/tech_asst_guides/cns-tast-gd-4.3.pdf
CNS-TAST-GD-4.1 (Rev 0)	March 2020	Procurement and Intelligent Customer Capability - www.onr.org.uk/operational/tech_asst_guides/cns-tast-gd-4.1.pdf
Design and Safety		
NS-TAST-GD-044 (Rev 0)	N/A	Procedure Design and Administrative Controls
NS-TAST-GD-042 (Rev 3)	July 2019	Validation of Computer Codes and Calculation Methods - www.onr.org.uk/operational/tech_asst_guides/ns-tast-gd-042.pdf
NS-TAST-GD-060 (Rev 3)	November 2020	Procedure Design and Administrative Controls - www.onr.org.uk/operational/tech_asst_guides/ns-tast-gd-060.pdf
NS-TAST-GD-036 (Rev 4)	April 2020	Diversity, redundancy, segregation and layout of mechanical plant - www.onr.org.uk/operational/tech_asst_guides/ns-tast-gd-036.pdf
NS-TAST-GD-094 (Rev 0)	November 2018	Categorisation of Safety Functions and Classification of Structures and Components - www.onr.org.uk/operational/tech_asst_guides/ns-tast-gd-094.pdf
NS-TAST-GD-079 (Rev 3)	April 2019	Licensee design authority capability - www.onr.org.uk/operational/tech_asst_guides/ns-tast-gd-079.pdf
NS-TAST-GD-067 (Rev 1)	November 2020	Pressure Systems Safety - www.onr.org.uk/operational/tech_asst_guides/ns-tast-gd-067.pdf
NS-TAST-GD-057 (Rev 4)	December 2020	Design Safety Assurance - www.onr.org.uk/operational/tech_asst_guides/ns-tast-gd-057.pdf
NS-TAST-GD-016 (Rev 5)	March 2020	Integrity of Metal Components and Structures - www.onr.org.uk/operational/tech_asst_guides/ns-tast-gd-016.pdf
NS-TAST-GD-006 (Rev 4)	Pending review	Deterministic Safety Analysis and The Use of Engineering Principles in Safety Assessment
NS-TAST-GD-005 (Rev 9)	March 2021	Guidance on the Demonstration of ALARP (As Low As Reasonably Practicable) - www.onr.org.uk/operational/tech_asst_guides/ns-tast-gd-005.pdf

Delivery

CNS-TAST-GD-5.2 (Rev 0)	March 2020	Examination, Inspection, Maintenance and Testing - www.onr.org.uk/operational/tech_asst_guides/cns-tast-gd-5.2.pdf
CNS-TAST-GD-6.6 (Rev 0)	March 2020	Nuclear Construction Sites - www.onr.org.uk/operational/tech_asst_guides/cns-tast-gd-6.6.pdf
NS-TAST-GD-062 (Rev 3)	February 2020	Workplaces and work environment - www.onr.org.uk/operational/tech_asst_guides/ns-tast-gd-062.pdf
NS-TAST-GD-027 (Rev 5)	July 2020	Training and assuring personnel competence - www.onr.org.uk/operational/tech_asst_guides/ns-tast-gd-027.pdf
NS-TAST-GD-009 (Rev 3)	November 2018	Examination, Inspection, Maintenance and Testing of Items Important to Safety - www.onr.org.uk/operational/tech_asst_guides/ns-tast-gd-009.pdf
NS-TAST-GD-017 (Rev 3)	Pending review	Civil Engineering
NS-TAST-GD-033 (Rev 6)	February 2022	Duty Holder Management of Records - www.onr.org.uk/operational/tech_asst_guides/ns-tast-gd-033.pdf
NS-TAST-GD-061 (Rev 3)	March 2020	Staffing levels and task organisation - www.onr.org.uk/operational/tech_asst_guides/ns-tast-gd-061.pdf
NS-TAST-GD-072 (Rev 3)	July 2021	Function and content of a safety management prospectus - www.onr.org.uk/operational/tech_asst_guides/ns-tast-gd-072.pdf
NS-TAST-GD-076 (Rev 2)	September 2019	Construction Assurance - www.onr.org.uk/operational/tech_asst_guides/ns-tast-gd-076.pdf

Security

CNS-TAST-GD-7.1 (Rev 0)	March 2020	Effective Cyber and Information Risk Management - www.onr.org.uk/operational/tech_asst_guides/cns-tast-gd-7.1.pdf
CNS-TAST-GD-7.2 (Rev 0)	March 2020	Information Security - www.onr.org.uk/operational/tech_asst_guides/cns-tast-gd-7.2.pdf
CNS-TAST-GD-7.4 (Rev 0)	March 2020	Physical Protection of Information - www.onr.org.uk/operational/tech_asst_guides/cns-tast-gd-7.4.pdf
CNS-TAST-GD-7.5 (Rev 0)	March 2020	Preparation for and Response to Cyber Security Events - www.onr.org.uk/operational/tech_asst_guides/cns-tast-gd-7.5.pdf
CNS-TAST-GD-8.1 (Rev 0)	March 2020	Cooperation of Departments with responsibility for delivering vetting and ongoing personnel security - www.onr.org.uk/operational/tech_asst_guides/cns-tast-gd-8.1.pdf

Appendix 1.3

Personnel Security Checks

The following personnel security clearances are required to work in the nuclear industry in the UK:

Baseline Personnel Security Standard (BPSS)

This applies to all individuals employed in the civil service, armed forces private sector employees working on Government contracts and those with access to nuclear facilities or

nuclear information. It applies to both permanent and temporary staff. The BPSS requires the verification of the following four elements:

- ▶ Identity checks
- ▶ Verification of nationality and immigration status
- ▶ Verification of employment history (past three years)
- ▶ Verification of criminal record 'unspent convictions'

Additionally, individuals are required to give a reasonable account of any significant periods (a total of six months or more in the past three years) of time spent abroad.

Higher National Security Vetting Clearances:

There are three levels of national security vetting clearance: A Counter Terrorist Check (CTC), Security Check (SC) and Developed Vetting (DV). Before any such clearance is undertaken the requirements of the BPSS must be successfully completed.

Counter-Terrorist Check (CTC)

CTC vetting is for personnel whose work involves them gaining access to information or material assessed to be of value to terrorists, or involve unescorted access to certain military, civil, industrial or nuclear establishments which may be at risk from terrorist attack.

The process for CTC clearance includes:

- ▶ Completion of a security clearance questionnaire by the candidate
- ▶ Checks against UK criminal and security records

It may also include an interview and is the most common level of security vetting necessary to work on the design, manufacture and construction of new nuclear plant in the UK. Gaining CTC clearance will normally require the individual to have been a resident in the UK for a minimum of three years.

Security Check (SC)

Security Check clearance is for personnel whom require long-term, frequent and uncontrolled access to HIGH RISK assets such as operational nuclear plant.

The process for SC clearance includes:

- ▶ CTC clearance
- ▶ A credit reference check
- ▶ Checks against the criminal and security records of relevant foreign countries

An interview may be necessary if any anomalies emerge from the above. Gaining SC clearance will normally require individuals to have been a resident in the UK for a minimum of five years.

Developed Vetting (DV)

Developed Vetting is for personnel whom require frequent and uncontrolled access to nuclear material or TOP SECRET assets. The process for DV clearance includes:

- ▶ SC clearance
- ▶ Completion by the applicant of a DV supplementary questionnaire
- ▶ Completion by the applicant of a financial questionnaire
- ▶ A review of the applicant's personal finances
- ▶ Interviews with an applicant's referees conducted by a vetting officer
- ▶ A detailed interview with an applicant conducted by a vetting officer

Gaining DV clearance will normally require the individual to have been a resident in the UK for a minimum of 10 years.

II. Nuclear Safety Culture

Appendix 2.1

Implementation of Good Human Behavioural Performance

Impact of Individuals

The collective behaviours of individuals in an organisation determine the level of safety and performance achieved. Their performance is influenced by diverse factors related to the management style, work environment and the demands of the task as well as their own individual capabilities. At high-performing sites, individuals at all levels, take responsibility for their behaviours and are committed to improving themselves, executing the task correctly and improving their work environment. In general, individuals exhibit the following behaviours:

- ▶ Communicate to create a shared understanding of good practice within their peer groups
- ▶ Anticipate error-likely situations
- ▶ Improve personal capabilities
- ▶ Report near-miss events together with explanation of the causes
- ▶ Implement techniques for improving Human Performance of the organisation

Management / Leadership

Leadership is a set of behaviours continually practised to direct and focus individual and team efforts toward accomplishing the organisation's goals. The term 'leader' describes any individual who influences the actions of others or organisational processes. Leaders promote positive outcomes into the work environment to encourage desired behaviours and results. All individuals in a leadership role need to demonstrate passion for the goal of preventing errors. Consequently, they act to influence both individual and organisational performance in order to achieve high levels of safety and performance by exhibiting the following behaviours:

- ▶ Promote open communication
- ▶ Promote teamwork to eliminate error-likely situations and strengthen defences
- ▶ Identify and eliminate organisational weaknesses that create conditions for error
- ▶ Reinforce desired behaviours in the workforce
- ▶ Value the prevention of errors, the reporting of near misses and the use of Human Performance techniques

Organisation

Organisational processes and values provide the framework for the human activities involved in plant design, construction, operation and maintenance. The goals, policies and priorities of an organisation directly influence individual behaviours by generating a pattern of shared understandings, processes and values. The organisation must:

- ▶ Provide a clear framework of organisational arrangements, processes and procedures.
- ▶ Encourage a culture that values prevention of errors.
- ▶ Strengthen the defences to prevent or mitigate the consequences of error.
- ▶ Eliminate the development of error-likely situations.
- ▶ Create a learning environment that encourages continuous improvement..

If these are implemented robustly a significant improvement in Human Performance will occur along with an increase in improvement in delivery efficiency within the organisation. The likelihood of incidents/events will also be significantly reduced. The application of Human Performance within the supply chain is strongly recommended. If lower Tier contractors do not themselves practice Human Performance improvement practices their Tier 1 and Tier 2 contractors can provide the necessary training.

Appendix 2.2

Typical Human Performance Error Reduction Tools

Tool 1 – Pre-job Briefs (PJB)

1. What is it?

A pre-job brief is a brief/review conducted before performing a job to ensure the tasks involved, hazards and related safety precautions, defences and contingencies are clearly understood. Effective pre-job briefs assist in the safe and efficient planning, preparation and execution of activities that directly or indirectly affect nuclear, radiological, industrial or environmental safety by helping participants avoid surprises and reinforce the idea that there is no such thing as a routine activity.

2. Why it is important

Pre-job briefs ensure that all involved individuals are mentally and physically prepared for the job they are to carry out. It focuses on those carrying out the brief to identify the critical steps in a job and specific control measures which will reduce the risk of error. Participants should prepare for the briefing by making themselves aware of the job in hand and the various tasks that make up that job.

This helps everyone attending the PJB to engage in an effective dialogue that concentrates people on what they are to accomplish and how they can minimise errors by using the appropriate error prevention techniques. The dialogue provides an opportunity for all participants to share their experience and knowledge and also to draw on more formal operating experience where appropriate. Effective pre-job briefs prevent errors.

3. When to apply

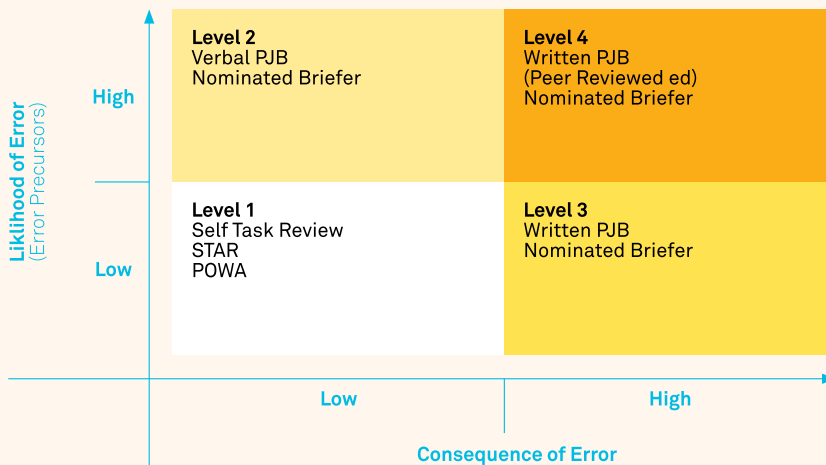
An appropriate level of pre-job brief shall be conducted for any task that directly or indirectly affects nuclear, radiological, industrial or environmental safety or at the discretion of the team leader or briefer. The degree of formality or style of brief shall be determined by the briefer or team leader by assessing the likelihood of error and consequences.

For example, for Level 1 tasks (low likelihood of error and low consequences) self briefing is sufficient. In this case, the individual carrying out the task fulfils the role of briefer and uses the appropriate tool (personal task review, Stop Think Act and Review (STAR), situational awareness and Point of Work Assessment (POWA) based on their specific work application.

The style or degree of formality of the brief can vary according to the nature of the work being carried out. Simple briefings (including self-briefing) such as task previews can be conducted for uncomplicated, repetitive, low risk tasks, while more detailed briefings are appropriate for complex or infrequently performed high risk tasks.

4. How to assess the style or degree of formality

Pre-job brief style, degree of formality and level of detail is determined by using the matrix below. The matrix should be used as a screening tool to determine the appropriate level of pre-job brief.



For example, for Level 4 Tasks (High Likelihood of Error and High Consequences) a written PJB peer reviewed and delivered by a nominated briefer who should be the supervisor for the task is necessary.

Tool 2 – Use of Operating Experience

1. What is it?

Use of operating experience is all about capturing and learning lessons from industry mistakes and events and using the information to prevent making those same mistakes or repeating the same events. A key to effectively using operating experience is for the right information to be communicated to the right people in time to make a difference.

2. Why it is important

To learn from previous events in order to promote good practices and prevent recurrence of errors.

3. When to apply

Use of operating experience shall always be incorporated into all formal pre-job briefs and training. It should also be considered for all other work activities. Examples include:

- ▶ Informal pre-job briefs
- ▶ Team briefs
- ▶ On job coaching

4. How do we do it?

Information should be incorporated into pre-job briefs and can be obtained from the following sources:

- ▶ Personal experience(s)
- ▶ Internal operating experience (OPEX) database
- ▶ Team OPEX Communicator
- ▶ International networks and databases

Tool 3 – Procedure Use and Adherence

1. What is it?

Procedure use and adherence is a set of principles and requirements to ensure that staff carry out activities following the intent, direction and approved process specified in written technical procedures, eliminating short cuts, the omission of steps and personally derived methods, otherwise known as a 'work-around'.

2. Why it is Important

To ensure the right actions are performed in the right sequence, thus ensuring:

- ▶ Safety to all personnel
- ▶ Compliance with legal requirements
- ▶ Commercial risks to the plant are minimised and controlled

3. When to apply

Approved procedures shall be adhered to at all times and always be used with a questioning attitude. Where procedures are available, workable, intelligible and correct, they must be used. Failure to do so may result in serious consequences, including, disciplinary action. Where procedures may not be followed as specified work must be stopped, made safe, and the procedure changed using the document change process.

4. How to do it

Ensure you have obtained the most current authorised procedure. Place-keeping shall be used when using any Continuous or Reference Use procedure as a means of preventing steps from being missed or repeated. As a minimum:

Continuous Use (QA Grade 1):

- ▶ Procedure must be in hand at point of work, and has been reviewed and understood before use
- ▶ Read, understand and challenge each step using STAR prior to performance
- ▶ Perform exactly as written in the order identified using a questioning attitude
- ▶ Place-keeping shall be carried out before proceeding to the next step
- ▶ Review the document at task completion to verify all appropriate steps are performed and documented

Reference Use (QA Grade 2 or 3):

- ▶ Procedure has been reviewed and understood before use
- ▶ Procedure is available at point of work so it may be actively read and followed during the activity
- ▶ Place-keeping shall be carried out, checking and marking off appropriate blocks of steps to certify that all segments are completed
- ▶ Review the document at task completion to verify all appropriate steps are performed and documented

Information Use (QA Grade 4):

- ▶ Intent and direction of procedure must be followed
- ▶ Activity need not be available at work location and may be performed from memory
- ▶ The User remains responsible for the results obtained

If the procedure is found to be ambiguous, incorrect or inappropriate:

1. Stop work
2. Make the job safe
3. Inform your supervisor
4. Get the procedure officially amended

Tool 4 – Self Checking – STAR

1. What is it?

Self-Check (STAR) helps the individual methodically focus his/her attention on the details of the task at hand. The individual consciously and deliberately reviews the intended action and expected response before performing the task. This includes distinct thoughts and actions designed to enhance an individual's attention to detail in the moment just before performing the task.

S	STOP
T	THINK
A	ACT
R	REVIEW

2. Why it is important

To ensure Nuclear Safety is not compromised:

- ▶ Do the right thing, to the right thing BEFORE you take the action.
- ▶ Ensure that the right thing happened, and only the right thing happened.

3. When to apply

Note: For activities that do not involve physical actions, such as reviewing and approving documents, some of the specific physical actions of self-checking do not apply. However, the fundamental principles of self-checking do apply.

STAR shall always be used for component identification and for each and every plant manipulation. Its use shall be considered for any activity where the consequence of error could be significant.

4. How to do it

Self checking is performed as follows:

STOP

This is the most important step.

Pause to focus on the task you're about to perform.

THINK

Think about and visualise what you are going to do and how you are going to do it.

Consider what actions will be required if the unexpected occurs.

If in doubt, seek advice.

ACT

Read – Read aloud the instruction that directs the manipulation of the component.

Touch – Identify the correct item by physically touching / pointing to the component label before taking any action.

Read – Read aloud the component label.

PAUSE for two seconds.

Perform – Complete the action.

REVIEW

Did the right thing happen? Was the outcome what you expected to happen? If not, make the job safe and notify your supervisor.

Tool 5 – Questioning Attitude – Validate Assumptions – Stop when unsure

1. What is it?

A Questioning Attitude encourages a person to think proactively before taking action to ensure the actions planned are appropriate and safe for the situation. It requires us to approach tasks with a 'healthy unease', which is between the two extremes of being unsure or being too sure. Voicing of issues or concerns is critical to a questioning attitude. For knowledgeable workers it is essential to validate assumptions to ensure that mental models, rules of thumb and assumed conditions are valid.

2. Why it is important

To challenge people's pre-conceptions and assumptions, to ensure Nuclear Safety. To continually review that you have the proper information to complete the job safely and prevent error-likely situations.

3. When to apply

Always maintain a questioning attitude but specifically applied in desk based assessments, calculations, plant modification design and assessment, in every plant walk-down, pre-job brief, and during performance of a task.

4. How to do it

Raise areas of concern and ensure they are properly resolved prior to proceeding.

- ▶ Do not make assumptions. Be aware when things don't feel right.
- ▶ Approach all tasks with a healthy unease.
- ▶ Be open and receptive to challenges by others.

Tool 6 – Peer Checking

1. What is it?

Peer-checking is a technique that involves a second person checking the correctness of another person's actions prior to that action. The fundamental principle is that human beings make mistakes and the involvement of a second person to check the first person's

actions provides a second barrier to prevent errors. Peer-checking does not relieve the performer of performing good self-checking. Effective application of both tools provides two barriers to human error.

Note: Peer-checking is not equivalent to Independent Verification. Independent Verification occurs after a given action and peer-checking occurs prior to a given action.

Verification requirements are typically specified in the written instructions and their use is governed by plant operating procedures.

2. Why it's important

To provide a second check to make sure that you are going to do the right thing to the right thing BEFORE you take any action.

3. When to apply

Peer Checking is performed for irreversible actions identified during the pre-job brief and/or identified per site specified guidance. Examples include:

- ▶ Irreversible action – evolution which, if performed incorrectly, could result in personnel injury, a plant transient, or equipment damage.
- ▶ Difficult procedure – procedure steps with large amounts of embedded information which may cause you to lose your place or skip a step.
- ▶ When required by procedure.
- ▶ When requested by a peer.

4. How to do it

- ▶ The performer self-checks the correct component.
- ▶ The peer self-checks the correct component.
- ▶ The performer and the peer agree on the action to take and on which component.
- ▶ The peer observes the performer before and during execution, to confirm the performer takes the correct action on the correct component.
- ▶ The performer executes the intended action on the correct component.
- ▶ If the performer's action is inconsistent with the intended action, the peer stops the performer.
- ▶ If the performer's action is consistent with the intended action, the peer informs the performer that the action taken is correct.

Tool 7 – Independent Verification

1. What is it?

Independent Verification (IV) is an additional verification of product quality or system state by a second qualified individual, operating independently after the original performance, to verify a specified condition exists.

It is different to Peer Checking. Peer-checking is designed to catch errors before they are made. IV on the other hand, catches errors after they have been made. Consequently, IV is used when an immediate consequence to the plant or equipment is unlikely should an action be performed incorrectly. It is an act of checking a component's or document's status independent of the actions that established the existing state.

2. Why it is important

To provide an independent check to make sure that the right thing has been done to the right thing AFTER the action has been taken. Independent Verification is a more robust tool than a Peer Check, and is performed independently to reduce the possibility of one individual leading another.

3. When to apply

For activities that can result in a significant consequence that is not immediate or that can be reversed. Examples include:

- ▶ When specified in written procedures and safety rules.
- ▶ During system alignments.
- ▶ Preparing safety cases.
- ▶ Amending documents.

4. How to do it

Shall only be performed by suitably qualified personnel, and separated by time and space from the performer. In terms of plant activities and manipulations, IV is performed as follows:

Performer

- ▶ Using STAR, identify the correct component.
- ▶ Perform the action specified in the guiding document.
- ▶ Confirm the expected results.
- ▶ Document the position or condition on guiding document.
- ▶ Inform the supervisor upon completion of the task.

Verifier

- ▶ Using STAR, SEPARATELY identify the correct component.
- ▶ Determine the as-found condition without changing it.
- ▶ Document the as-found condition on the guiding document.
- ▶ Notify the supervisor if the component condition does not agree with the guiding document.
- ▶ Sign or initial the guiding document.
- ▶ In terms of calculations, IV means that a second qualified individual confirms using the same methodology and documentation as the first individual.

Tool 8 – Clear Communication Techniques (including phonetic alphabet)

1. What is it?

Clear communications is a set of verbal communication principles and a specific technique, three-part communications, that helps us more effectively communicate and reduce the potential for error. It is sometimes called 'secure communications'

2. Why it is important

To reduce the frequency of errors associated with verbal communication and to provide for the accurate, concise, clear and error-free transfer of information. Clear communications are meant to ensure that the intended message is properly received.

3. When to apply

When communicating important information or instruction, where miscommunication can result in a significant error not only on the radio and telephone, but also during face to face communications. Examples include:

- ▶ Communicating an important condition or parameter.
- ▶ Operating or testing critical equipment.
- ▶ Communicating instructions from a formal work document.
- ▶ Directing the activities of other workers.
- ▶ Directed by specific organisational guidance.

4. How to do it

- ▶ **Send the Message:** The sender states the name of the receiver and when attention is gained, clearly states the message.
- ▶ **Acknowledgement:** The receiver repeats back the message to the sender.
- ▶ **Confirmation of Acknowledgement:** The sender verbally acknowledges that the receiver repeated back the message correctly (Typically by responding, 'that is correct')

Phonetic Alphabet

Used when verbally communicating all alpha or alpha-numeric designations. For example, Start Standby Boiler Feed Pump 1A Leak Off valve (BF1A-WF-316B).

The phonetic alphabet shall be used in the train of specific identifiers: the 'Alpha' in 1A and the 'Bravo' in 316B. The system is described using the words Start Standby Boiler Feed Pump Leak Off valve.

It is not necessary to use the phonetic alphabet for system descriptor or the initial BF for boiler feed unless there is an immediate reason which may cause confusion (e.g. WB confused with WD, etc) and the use of system nouns is not sufficient.

Clear Numbering

Clear Numbering is used when verbally communicating numbers which sound similar. For example, '16' is spoken, 'one, six' and '60' is spoken as 'six, zero'.

Tool 9 – Post-job Debrief

1. What is it?

A Post-job Debrief is a simple and painless means of gathering information from workers about the work (planned versus actual). The extent, detail and length should be appropriate for the complexity and significance of the work. For routine or simple tasks a short discussion to confirm that the expectations of the job were achieved is sufficient. For jobs that required extensive preparations, or where problems were encountered, a more thorough critique is performed to capture areas for improvement or lessons learned during the job. It is the supervisor's responsibility to ensure an appropriate post-job debrief is conducted. The debrief is carried out following work completion aimed at capturing lessons learned and opportunities for improvement for the next time the job is performed. Post-job debriefs are essentially learning and business improvement tools.

2. Why it is important

To review both the task and the teamwork for a recently completed work activity. In addition, to:

- ▶ Capture lessons learned (including what went well).
- ▶ Identify unanticipated conditions.
- ▶ Identify flawed defences.
- ▶ Identify error-precursors.
- ▶ Identify latent organisational weaknesses.

3. When to apply

After completing work where complications occurred. When improvements have been identified. A post-job debrief is designed to identify and record learning points from the job. Level 3 and 4 briefs should always have a formal post-job debrief.

It is essential that strengths and opportunities for improvement are carefully detailed to ensure that subsequent jobs can benefit from the experience and the organisation continues to learn. A Level 2 job shall be followed by an informal post-job debrief which should capture any relevant learning points on the work order card. Workers involved with Level 1 jobs should ensure that learning is captured through discussion at team briefings or start of shift briefings.

4. How to do it

Post-Job debriefs should:

- ▶ Include attendance by all personnel involved in the task.
- ▶ Identify what went well and opportunities for improvement.
- ▶ Identify what went badly and why.
- ▶ Capture issues using controlled processes (e.g. Condition Reports, OPEX, Work Requests, etc.).
- ▶ Ensure two-way discussions and encourage questioning.

Tool 10 – Task Observation / Coaching

1. What is it?

Task observation / coaching provides a vehicle for line managers to reinforce appropriate behaviours and standards at the point of work. The aim is to recognise and reinforce good performance, challenge and correct adverse behaviours and consequently reduce errors, eliminate events and improve operational reliability. In particular, it is an opportunity to ensure understanding of the nuclear safety implications of the work prior to starting, and to ensure that the work receives the attention warranted based on its nuclear safety significance.

There are two types of task observation / coaching: formal and informal. In a formal observation, the worker's performance of a task is pre-planned and for a 'cradle to grave observation' is observed from beginning to end. An informal coaching opportunity is used to reinforce good behaviours and correct substandard behaviours as part of a leaders coaching role. Informal coaching provides the opportunity to give constructive coaching and recognition more frequently, and to a larger number of people, than formal, planned and cradle to grave coaching opportunities.

2. Why it is important

To provide positive feedback, promote the right job/site behaviours by reinforcing standards and expectations, and to identify opportunities for improvement in work site surroundings and processes.

3. When to apply

Frequently and for all Critical Task Pre-job briefs. Examples include:

- ▶ Outage activities.
- ▶ Infrequently Performed Activities.
- ▶ Routine work.
- ▶ Training.
- ▶ Any activity that would be enhanced by an observation.

4. How to do it

Observer

When performing a task observation, the following items should be considered:

- ▶ Introduce yourself and explain your purpose.
- ▶ Do not interact with or become a distraction to the task.
- ▶ Only interrupt the task if there is threat to personnel safety or potential damage to the plant.
- ▶ Provide effective timely feedback.

Observed

Whilst being observed, the following items should be considered:

- ▶ Ensure that the observer is not a distraction.
- ▶ Insist upon feedback following the observation.



III. Quality Arrangements

Appendix 3

Examples of Documents and Controls Necessary to Deliver Nuclear Projects

Project Execution Plan (PEP)

A PEP is a formal document which describes how contractors, at all Tier levels, intend to execute their works. It defines the scope of work, the organisational structure proposed; key processes which will be carried out and roles and responsibilities within the contract. Names should be attached to key roles with evidence that they are Suitably Qualified and Experienced for the role. Significant subcontracts associated with the work should be identified for Tier 1 approval. The PEP will define any contract requirements that differ from the company's own procedures, for example, the use of different forms or document control systems. PEPs are generated by each contractor/subcontractor for their scope of work and are approved by their customer and possibly by his customer's customer.

Project Quality Assurance Plan (PQAP)

A Project Quality Assurance Plan (PQAP) will be prepared specific to the contract. It is the document which sets out the policies, practices and procedures for the contract. It also identifies Key Performance Indicators (KPIs), control measures, control criteria, QA / QC strategy and records of verification associated with the project scope through all phases of its 'lifecycle'.

The overall objective is to develop a system of controls in order that the contract is completed in accordance with the project quality standards, customer codes, specifications and drawings.

The PQAP supports (or may be part of) the PEP in detailing the project quality requirements.

Design / Engineering Quality Plan

This document defines the design / engineering process including the preparation of design reports, design and manufacturing drawings, specifications for sub-contractors and other documents to be produced by the lower tier designers and engineers. The verification / checking process should be specified along with measures to ensure the checkers / verifiers are both independent of the original calculation process and are SQEP to carry out the role. For higher levels of safety classified products, and particularly QRAs, the level of independent checking must be increased to reflect the higher nuclear safety significance of the product. The Design / Quality plan should make provision for the various activities to be signed off as they are completed. The hold points at which Tier 1 or third party are to conduct reviews should be clearly identified. This is the means by which the Tier 1 contractor will demonstrate that the design and engineering aspects of the specification have been met. Compliance with these hold points is mandatory.

The design quality plan is normally prepared by the designer and is endorsed by the Tier 1 contractor. Design work should not commence until authorisation is received.

Manufacturing and Test Philosophy Document

This document provides the Tier 1 contractor with an early overview of the complete manufacturing, inspection and test processes being proposed by the lower tier contractors. It describes at a high level, the control processes which will be used to deliver an appropriate quality of product. Key subcontractors are identified so that the Tier 1 contractor can carry out any vetting it requires. The manufacturing philosophy is described, including the use of special processes such as methods of cutting and forming, weld processes, heat treatments and inspection philosophy. Outline test procedures

are described along with test acceptance criteria. This document is prepared by the manufacturing contractor and will be discussed with the Tier 1 contractor and used as a basis for developing the detailed Manufacturing and Test Quality Plan.

Manufacturing and Test Quality Plan

This document is the detailed manufacturing control document. It must describe every step in the process from the initial checks on the pedigree of the original material, right through to the sign off of the final acceptance certificate. It will contain several hold / witness points for the Tier 1 contractor and the Independent Third Party Inspector. Typical hold points might include:

- ▶ Verification of authenticity of material.
- ▶ Witness of transfer of markings.
- ▶ Verification of weld procedure qualification and welder qualifications.
- ▶ Intermediate inspection and dimension control checks during the manufacturing process.
- ▶ Verification of NDT procedure qualification and NDT operator qualification.
- ▶ Review of Inspection results.
- ▶ Review of documentation.
- ▶ Final inspection prior to shipping.

If any of the manufacturing activities are subcontracted, the contractor's quality plan must link to its subcontractors' quality plans. The manufacturing quality plan is prepared by the manufacturing contractor and it, plus any linked subcontractors' quality plans, must be signed off by the Tier 1 contractor and Independent Third Party Inspector before any manufacturing work commences.

All the activities on the Manufacturing and Test Quality plan must have been signed-off as complete before the equipment or material can be released for shipment.

Manufacturing Procedures and Method Statements

These documents are a development of the manufacturing philosophy and test document and must align with the requirements of the Manufacturing Quality Plan. The method statements should be detailed documents describing the manufacturing process as a series of detailed steps and processes.

The technical query process and non-conformance reporting processes need to be documented along with details of how both processes will operate, e.g. technical query or non-conformance numbering systems, distribution lists and identification of how authorisation to proceed will be given. A system of archiving must exist to ensure there are traceable records of communication and decisions regarding technical queries and non-conformances. It is very important to develop an open culture whereby subcontractors at all levels in the supply chain are actively encouraged to report non-conformances.

Documentation and record keeping of the manufacturing or test processes must be completed as the work is carried out to ensure a complete record is available on completion of the manufacturing activity. It is normally a contractual requirement that the final documentation pack for the manufactured component is completed and signed off by the Tier 1 contractor and the Independent Third Party Inspector before the component is shipped to site or to quarantined storage.

Generation and archiving of all the above documentation is extremely important. The requirements for the management of records should be clearly specified in the contract documents. This is one of the main differentiators between nuclear and non-nuclear contracts.





The Nuclear Industry Association (NIA) is the trade association for the civil nuclear industry in the UK, representing more than 250 companies across the supply chain. The diversity of NIA membership expertise in new build, management and decommissioning enables effective and constructive industry-wide interaction.

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