The Nuclear Industry Association (NIA) is the trade association and representative voice of the UK’s civil nuclear industry. We represent 63,000 UK nuclear workers across more than 260 member companies.

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Introduction

The nuclear renaissance in the UK has been a subject of significant interest over the last five years. It has engaged a broad spectrum of organisations such as the UK Government, Utilities and Suppliers, with each having a significant influence on making the nuclear 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 and the proposed reform of the Electricity Trading Act. The Department of Energy and Climate Change (DECC) in conjunction with UK business has recognised the significant opportunities for UK industry and have been promoting the new build opportunities through various initiatives. Some of these include:

- The SC@nuclear programme which has been operated by the Nuclear Industry Association over the past three years.
- Nuclear Advanced Manufacturing Research Centre (Nuclear AMRC) which was established in 2010 to assist manufacturing companies in upgrading their manufacturing skills for the nuclear program.
- National Skills Academy Nuclear (NSAN) which has been operating to develop and harmonise skills development and standards across the industry.

The Department for Business, Innovation and Skills (BIS), the Office for Nuclear Development (OND) and the Department of Energy and Climate Change (DECC) have actively supported these activities and are promoting activities in the UK which will ensure UK firms are aware of the opportunities available to grow their business and increase employment. Utilities and technology vendors have played their part in holding several workshops and Open Forum days to help companies understand the key supply chain issues from their perspective and to provide information on the timing of their investment decisions.

Companies with experience of the nuclear industry in the UK have quickly understood the magnitude of the nuclear new build opportunity, the development activities they needed to undertake to maximise their share of the work and have already put investment plans in place. However to maximise UK contribution to the new build programme, the involvement of smaller UK companies is required, many of whom have had little or no nuclear history.

Initially, the NIA SC@nuclear programme ran several events throughout the UK and published “The Essential Guide to the new build nuclear supply chain” in February 2011. This document set out the scale of opportunities and the key issues for UK industry. It was primarily focused on Tier 3 and Tier 4 companies with little or no experience of the UK nuclear industry. This document served its purpose at the time but it was recognised that a subsequent document was required which would:

- Update the market opportunities.
- Provide more detail on a broader range of subjects relevant to nuclear new build.
- Form the basis of a suite of documents which would cover different market sectors of the UK Nuclear Industry, such as, Nuclear Operational Support, Decommissioning, etc.

This document, The Essential Guide for the nuclear new build supply chain, covers:

- Project Certainty and Timeline
- Routes to Market
- Nuclear Safety Culture
- Regulatory Processes and Licensing
- Quality Arrangements
- Codes and Standards
- Health and Safety Processes
- Nuclear Security Arrangements
It has been developed with the input of the Utilities, Technology Vendors and a number of Tier 1 companies who have major involvement in the nuclear industry. Input has also been provided by DECC, BIS and the Health and Safety Executive (HSE) to ensure it has the widest possible cross-industry support and endorsement.

The primary aim of the document is to provide lower tier contractors with an introduction to the processes, procedures and working arrangements required to design, construct and commission new nuclear power plant in the UK. These contractors should not be concerned if they are not familiar with the detail of the topics described in this document. It is the responsibility of the higher tier contractors to ensure that their subcontractors are familiar with all the detailed requirements of any contract and to provide any necessary training or inductions before work commences.
1.1 At present, three Developers have expressed a wish to construct new nuclear stations in the UK. In all cases the decision to proceed into construction is subject to acceptable economic conditions (projected demand for power) and certainty of return on investment. The current stated position of each Developer is detailed below. As more certainty develops on the Electricity Market Reforms, the regulatory environment and the timescales, the position of each of the potential nuclear new build investors will be updated on the NIA SC@nuclear website www.nuclearsupplychain.com.

1.2 Fukushima was a shock to the nuclear industry worldwide and the skill and bravery of the operators of the plant in averting a much more serious accident should be recognised. As a result of the incident Governments and the nuclear industry worldwide has set up a series of reviews to assess:
  - The robustness and independence of the regulatory processes.
  - The security of existing plants to extreme events.
  - The level of preparation and responsiveness of the industry to a major incident.
  - The robustness of the designs of proposed new nuclear plant developments.

1.3 The UK Government asked the UK Senior Nuclear Inspector, Dr Mike Weightman, to carry out a detailed review of the UK nuclear industry ranging from the nature of UK nuclear regulation, the robustness of incident management processes on nuclear facilities, the security of plant against abnormal events and the appropriateness of new nuclear developments.

1.4 Dr Weightman produced an excellent report (“Japanese Earthquake and Tsunami: Implications for the UK Nuclear Industry”) which indicated that our regulatory approval process was sound and that there were no reasons to doubt the safety or security of our nuclear facilities. He did identify a total of 38 recommendations which should be implemented by the industry to improve nuclear safety in the UK. These recommendations will improve the safety, security and preparedness of the industry, further improving its already very high standards of nuclear safety.

1.5 The report produced a secure platform on which nuclear new build could proceed in the UK. The thoroughness and quality of the report has gone a long way to assure the public of the safety of the UK nuclear industry. It has removed the post-Fukushima risks to the new build programme and ensured it can proceed.

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

1.7 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. Moorside in Cumbria is on land adjacent to Sellafield nuclear site.
  - Bradwell
  - Hartlepool
  - Heysham
  - Hinkley Point
  - Oldbury
  - Moorside
  - Sizewell
  - Wylfa
Developers Planning to Build New Nuclear Power Stations in the UK

1.8 EDF Energy has formed a UK Subsidiary Nuclear New Build Generation Ltd (NNB GenCo). NNB GenCo has offices in London and Bristol and will be the Licence Holder of the proposed new nuclear power plant developments at Hinkley Point in Somerset (HPC) and at Sizewell in Suffolk (SZC).

1.9 NNB GenCo has selected the technology it wishes to use, the French EPR™ reactor. NNB GenCo plans to construct two EPR reactors generating 3.2 GW at Hinkley Point and a further two EPR reactors at Sizewell. The EPR design received its Interim Design Acceptance Confirmation (iDAC) and Interim Statement of Design Acceptability (iSODA) in December 2011 from the Office for Nuclear Regulation (ONR) and the Environmental Agency. Although some outstanding issues have been identified which will require resolution over the next year, these were largely as expected and there are no show stoppers for the EPR development in the UK. However the identified issues have to be satisfactorily resolved before construction of the plant can commence.

1.10 NNB GenCo has completed its public consultation for HPC and submitted a Planning Application to the Infrastructure Planning Commission (IPC) in October 2011 for the development of two EPR reactors at Hinkley Point in Somerset. This was accepted as a valid application by the IPC in November 2011 and assessment work by the IPC has commenced with a recommendation to the Secretary of State expected at the end of 2012. Note, the Infrastructure Planning Commission (IPC) was abolished on the 1st April 2012 by the Localism Act 2011 and has been replaced by the Planning Inspectorate (PINS). West Somerset District Council has granted permission for the site preparation works ahead of IPC approval and NNB GenCo commenced earthworks on the site in 2012.

1.11 NNB GenCo hosted a major conference in December 2011 with a number of key presentations. This provided a very positive message to the industry and demonstrated that NNB GenCo has a viable plan to develop new nuclear plant at Hinkley Point. Although Sizewell C will be a few years after Hinkley Point, NNB GenCo has commenced engagement with the local community about its plans to develop two EPR reactors at Sizewell in Suffolk. The strong commitments from NNB GenCo to successfully complete these developments were evident and gave industry a very positive message.

1.12 NNB GenCo has been developing detailed plans for the Hinkley Point C project to ensure certainty on cost and programme before seeking final investment decision from its parents. This is expected to be in early 2013, but as stated by Vincent De Rivaz, Chief Executive of EDF Energy, “We will not proceed until we are ready and have the required certainty of delivery”. He stated that selected supply chain companies will have a major role in assisting NNB GenCo in developing detailed costs and programmes which give the level of confidence that they require. In this respect the supply chain can influence the certainty and timing of the Hinkley Point C development.
Horizon Nuclear Power was a 50/50 Joint Venture formed by E.ON and RWE, based in the UK with headquarters in Gloucester. It originally had plans to construct approximately 6 GW of new nuclear power capacity; 3 GW at Wylfa in Anglesey, North Wales, followed by 3 GW at Oldbury in Gloucester.

In March 2012 E.ON and RWE stated that they would no longer pursue nuclear developments in the UK. At the time of writing this report Hitachi Ltd has confirmed that it has purchased Horizon Nuclear Power as a going concern and that it plans to build ABW reactors at Wylfa and Oldbury. As more information becomes available it will be placed on Horizon's website, www.horizonnuclearpower.com and the NIA SC@nuclear website www.nuclearsupplychain.com.

NuGeneration Ltd (NuGen) is a Joint Venture between GDF Suez and Iberdrola which has been formed to develop a new nuclear power plant with up to 3.6 GW in Cumbria. NuGen has acquired a suitable site adjacent to the Sellafield plant, called Moorside, and has established offices at Westlakes, near Whitehaven in Cumbria, and in London. NuGen is building its teams at both locations.

NuGen has been delivering very positive messages to the market about its intent to complete the development. It has established a high level programme and is working on the technology selection process to decide between AP1000, EPR and possibly ABWR reactors. Although NuGen is somewhat behind EDF Energy in its timescale, its messages and the level of investment in staff and offices provides a positive message to the industry and a level of confidence that the development will proceed.

NuGen is currently focussed on key development activities that will confirm the business case for new nuclear build at its Moorside site, including site studies, technology selection, planning and licensing. Its project timetable shows site investigation and characterisation works are expected to be completed by 2013. The development phase is planned to complete around 2015 prior to commencing the construction phase, with the aim of achieving commercial operation from 2023 onwards.

Summary

As can be seen from the above section, EDF Energy and their UK subsidiary, NNB GenCo remain the furthest advanced in the nuclear new build cycle followed by Horizon and NuGeneration. This document however, can only present the current snapshot of their position. Updates will be featured at the NIA SC@nuclear website www.nuclearsupplychain.com.
Project Timescales

1.19 There are several factors which will determine when the nuclear new build projects proceed, and when the orders will flow into the supply chain. Factors remaining to be resolved are:
- UK economic conditions (demand).
- Electricity Market Reform.
- Satisfactory completion of Generic Design Assessment (GDA) – The Office for Nuclear Regulation (ONR) and the Environment Agency (EA) have given ‘Interim Design Acceptance’ for the EPR and the AP1000 designs. These interim certificates will be developed to full certification for the EPR during the next 12 months.
- The Planning Inspectorate (PINS) delivering consent within the expected timescales.
- Achievement of local planning consent.
- Development by the Developers of robust programme, price and delivery schedules.

1.20 The majority of the above is in the control of the Government, Regulators, Utilities and Local Authorities and cannot be influenced by the supply chain. However, supply chain companies can assist by developing reliable delivery plans and cost models for the developers to assist them in developing project costs and programmes.

As a result of the above there are no formally issued timescales for the nuclear construction programme. From the information in the market an estimate has been made by the NIA as to possible timescales. These are indicative only at the time of publication and are not necessarily endorsed by the Utilities. This schedule is referred to as the NIA Assumed Programme. The start dates in this programme are the pouring of first nuclear concrete on site. Significant amounts of project development, procurement and supply chain work takes place for a few years prior to this.

While the timescales above are indicative, the chart does demonstrate a sustained programme of development lasting over 15 years. This demonstrates a long term business opportunity for UK industry and industry needs to start investing for this programme NOW to ensure capabilities and resources are available over the totality of the 15 years.
The pouring of First Nuclear Concrete sets many of the other key major sub-project order placement dates. Again estimates have been made by the NIA as to when major contracts may be placed relative to first nuclear concrete.

With a projected first nuclear concrete date for Hinkley Point of 2013 / 2014, many of the major packages are being awarded now and will continue to be awarded over the next two years. In the case of the main civil contract, Bouygues / Laing O’Rourke have been named as the ‘Preferred Contractor’ and are developing detailed costs and program for NNB GenCo. Many contractors will be engaging with EDF Energy during 2012 and 2013, either submitting tenders or prequalification documents. Lower tier contractors therefore need to be engaging with these companies now. They also need to be developing Business and Investment Plans, to demonstrate to the Tier 1 contractors that they will have the capacity and capabilities in place to meet the expected market demands.

Whilst this paper focuses on the UK market it should not be forgotten that there are also several nuclear new build developments in continental Europe. Based on successful delivery to the UK nuclear new build programme, UK companies should be well placed to win work on these European developments.
Routes to Market

2.1 The procurement strategies employed by the Developers are at various levels of maturity and reflect the status of their project development. NNB GenCo procurement strategies are well developed and are detailed below. There is less clarity regarding the strategies to be pursued by NuGeneration Ltd. As the latter develop they will be updated on the NIA SC@nuclear website, www.nuclearsupplychain.com, and in any subsequent revisions of this document. We await details of the Hitachi project execution and procurement strategy.

EDF Energy

2.2 EDF Energy has formed NNB GenCo, a UK based company who will be the Licensee for the Hinkley / Sizewell developments. NNB GenCo has appointed EDF DIN to lead their procurement process, using EDF DIN personnel from France supported by NNB GenCo personnel from the UK. NNB GenCo has set up a National Supplier Database accessible via www.edfenergy.com to allow UK companies to register an interest in its nuclear new build programme and has engaged with Somerset and Suffolk / Norfolk Chambers of Commerce to provide business support to local suppliers.

A typical procurement pyramid is shown below.

![Procurement Pyramid](image)

2.3 The market opportunities associated with the development of the two reactors at Hinkley Point can be split into:
- Civil Works
- Nuclear Steam Supply System
- Mechanical Systems – nuclear and non-nuclear
- Electrical Systems – nuclear and non-nuclear
- Turbine Island

2.4 This document is primarily concerned with opportunities for lower tier contractors for the mechanical and electrical systems but a brief overview of the status of the civil works will be provided for completeness. It should be noted that EDF ENERGY is already building an EPR at Flamanville and has previously awarded similar contracts to a largely European supply chain. Competition / collaboration with this existing supply chain will be necessary to ensure success in tendering for packages on Hinkley Point C. Several UK companies have already formed Joint Ventures with French suppliers to execute packages of work. This ensures that lessons learned will be brought to the UK, but it also means a sharing of work scope.
Civil Works

2.5 The three main civil packages are:
   ▶ Earthworks
   ▶ Marine and Tunnelling Works
   ▶ Main Civil Works

2.6 The Earthworks contract has been let to Kier BAM Joint Venture and involves preparation of the site prior to main civil works, including site clearance and excavation, sea wall construction and elements of the temporary site infrastructure. It is expected to last approximately 12 months. The temporary jetty construction contract has been awarded to Dean & Dyball Civil Engineering. The tendering for the Marine and Cooling Water Tunnelling works is underway and this contract is expected to be awarded during 2013.

2.7 The main civil works enquiry has been in the market for some time. Bouygues/Laing O'Rourke has been selected as 'Preferred Contractor'. A period of detailed scope development and planning is underway to finalise the civil programme and price.

2.8 The Civil Contractor will have nominated their key subcontractors during the tender process and will therefore have some of their supply chain in place. There still may be opportunities for other suppliers and subcontractors during 2013 as the works commence on site.

2.9 There are other civils / building packages covering the following works:
   ▶ Associated Developments, including, accommodation campuses, park and ride facilities, highway and wharf improvement works, mostly outside the nuclear site.
   ▶ Ancillary Buildings

All of these have or are being tendered during 2012 and 2013.

Nuclear Steam Supply System

2.10 The long lead forging contract for the reactor vessel, steam generators and loop pipework (primary circuit Class 1 components) has been awarded to AREVA. This is expected to be followed by a preliminary design and fabrication engineering contract which is likely to be awarded to AREVA. As AREVA has its supply chain already in place for these Class 1 components it is very unlikely that there will be many opportunities for lower tier contractors to be involved in these contracts, except in niche market areas.

2.11 The potential follow on contract for AREVA is likely to be the on-site erection of the primary circuit equipment. If this contract is awarded to AREVA it may require support services from the UK supply chain associated with:
   ▶ Transportation, lifting and mechanical installation of major equipment and pipework.
   ▶ Supply, prefabrication and installation of small bore ancillary pipework around the reactor vessel / steam generator.
   ▶ Provision of structural steel restraints and pipework supports.
   ▶ Welding services.
   ▶ NDT services.
Mechanical Systems

2.12 NNB GenCo has broken down the supply and installation of the main mechanical equipment into a series of discrete packages. Some of these are for equipment design and manufacture only for equipment such as pumps, valves, compressors, tanks, pressure vessels, heat exchangers, chillers, etc. Potential suppliers for some of this equipment are already likely to be in dialogue with NNB GenCo on the scope, timing and technical requirements. Companies which are not large enough to directly supply this equipment to NNB GenCo need to contact manufacturers of this type of equipment and position themselves to provide equipment, sub-assemblies or support services associated with these contracts.

2.13 There are several mechanical installation packages to be awarded such as:
- Balance of Nuclear Island Mechanical Equipment
- Balance of Plant Mechanical Equipment
- Nuclear HVAC Plant Installation
- Non Nuclear HVAC Plant Installation
- Waste Treatment Packages

2.14 NNB GenCo has already issued prequalification calls for all of the above and contractors have responded with detailed submissions. NNB GenCo is in the process of evaluating these submissions and is currently involved in a review / down selection process to select the number of companies who will be asked to tender for the various packages. It should be noted that these are generally large packages of several tens of million of pounds and main mechanical contractors for each package will have to have extensive nuclear experience, robust quality systems and extensive Suitably Qualified and Experienced (SQEP) resources to execute the work. Smaller companies can play a large role in supporting the major mechanical contractors by executing sub-packages of work either in their factories or on-site or by providing specialist services to the main contractors.

Electrical Systems

2.15 The electrical contracts will be split into at least five major packages. These include:

i. Construction Electrical Supplies. (Awarded)
ii. IEG Scope (general electrical erection)
iii. Small Power and Lighting
iv. Fire and Hydrogen Detection
v. IT and Communications Infrastructure
vi. Ancillary Buildings' Works

2.16 The Construction Electrical Supplies contract was recently awarded to UK Power Networks for the provision of the site electrical infrastructure to facilitate power for the construction activities.

2.17 The remaining packages are of a significant size and are likely to involve design, procurement, prefabrication, installation and commissioning activities. In some cases there will be significant interaction with the mechanical contractors and integrated planning with the mechanical contractors will be vital to ensure high productivity on site.

2.18 Again the main contractors for these packages will require nuclear experience, robust quality systems and extensive SQEP resources to execute the work. Smaller contractors can support the main electrical contractors as described above.
**Turbine Island**

2.19 EDF Energy has issued enquiries for the Turbine Island to three companies – Alstom, Mitsubishi Heavy Industries and Siemens. The successful turbine contractor will be selected in 2013. The companies will supply their own proprietary turbine, but may release enquiries into the market for packages such as:
- Main Steam and Feed Water Pipework Systems
- Turbine Auxiliary Pipework
- Moisture Separator Reheater and Deaerator Vessels
- Feed Heaters
- Assorted Vessels and Tanks

2.20 At present the exact format and bundling of the above equipment is not clear. The packages could be supply and install or supply only with a separate mechanical installation contractor chosen to carry out the ancillary equipment installation. Again these are likely to be high value equipment supply packages or large site installation packages. They will be undertaken by experienced fabrication and construction contractors with proven quality systems, extensive manufacturing facilities and significant SQEP site installation resources. Smaller companies may find a role as selected subcontractors for the provision of sub-assemblies, provision of niche site installation services or niche services such as NDT.

2.21 It should also be noted that Siemens has supplied its turbine for the EPR at Olkiluoto and Alstom is installing its turbine on the EPR at Flamanville. In each case the companies will have European suppliers who have experience of delivery these packages for their existing contracts.

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**Horizon Nuclear Power**

2.22 The procurement strategy for Horizon Nuclear Power will not be known until its new owner, Hitachi Ltd, has decided on its project delivery strategy. The SC@nuclear website www.nuclearsupplychain.com will be updated as more information is received.

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**NuGeneration Ltd**

2.23 NuGeneration Ltd (NuGen) is currently evaluating the EPR and AP1000 reactor and may consider the ABWR technology. It is in the early stages of this process and there is little information on the likely procurement route. Its activities are now ramping up and its procurement arrangements will become clearer through 2013. Details will be placed on the NIA SC@nuclear website www.nuclearsupplychain.com as they emerge.
Nuclear Safety Culture

3.1 Most companies operating in the UK are aware of the necessity for robust health and safety cultures which must pervade through all aspects of their business. However, if companies have not worked in the nuclear industry they may not be familiar with the term ‘Nuclear Safety Culture’. It is a term which is widely used throughout the industry to describe the overarching health, safety and behavioural culture that will be expected of companies delivering contracts associated with nuclear plant. The following section aims to provide an overview of Nuclear Safety Culture and provides guidance on what measures need can be taken to embed the right culture within an organisation.

Definition of Nuclear Safety Culture

3.2 In reaching an understanding of the meaning of Nuclear Safety Culture it is worthwhile examining the meaning of various subsets of the clause such as Culture, Safety and Nuclear Safety. The definitions of these sub-clauses can then be incorporated into a detailed definition of Nuclear Safety Culture which incorporates the key elements.

The definition of “culture” varies considerably in its complexity. One of the simplest is: “The way we do things around here”

Another more inclusive definition is:
“Culture is the human made part of the environment”.

The definition of “safety” can be considered as:
“Those actions / activities which provide protection, avert danger and foster confidence”.

3.3 The position of senior safety staff in an organisation’s hierarchy gives a visible indication of the importance attached to safety. If the senior safety staff have direct and unimpeded access to the head of the organisation, it can be said that the organisation actively recognises the important contribution that the safety function makes to the organisation and its business.

3.4 In combining the terms “Safety” and “Culture” into one term “Safety Culture” we have 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. It affects the attitudes and beliefs of personnel in their execution of their tasks.

3.5 The International Atomic Energy Agency states that:
“Safety Culture has two major components: the framework determined by organisational policy and by managerial action, plus the response of individuals in working within and benefiting from the framework”.

3.6 By combining the terms “Nuclear” and “Safety” we start to obtain an industry specific definition of safety. “Nuclear Safety” is the various provisions made at all stages in the design, construction, operation and decommissioning of nuclear facilities to protect man and his environment against the dispersal of radioactive substances. To achieve this we have to ensure that the plant is correctly designed, built to the required standards and operated within its normal operating envelope. Our actions should prevent incidents and accidents occurring.
3.7 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 separation from the nuclear fuel. The intent of nuclear safety is to keep the nuclear matter inside its designed confines and in a controlled state.

3.8 When we combine the terms “Nuclear”, “Safety” and “Culture” we develop a definition which encompasses the strengths of the individual words into “an all-embracing way of executing activities on a nuclear plant”.

3.9 “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. It requires a high level of professionalism and attention to detail in the execution of works on a nuclear plant.

3.10 A number of definitions of Nuclear Safety Culture have been developed and these have been interpreted in different ways.

3.11 “The Nuclear Safety Culture of an organisation is the product of individual and group values, attitudes, perceptions, competencies and patterns of behaviour that determine the commitment to an organisation’s health and safety management. Organisations with a positive safety culture are characterised by communications founded on mutual trust, by shared perceptions of the importance of safety and by confidence in the efficacy of preventive measures”.

3.12 The IAEA provide a definition more specific to Nuclear Safety Culture that relates Safety Culture 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”.

3.13 (Nuclear) Safety Culture is defined by the World Association of Nuclear Operators (WANO) 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”.

3.14 Implied in these definitions is the notion that nuclear power plants are designed, built, and operated to produce power in a safe, reliable, efficient manner; that the concept of nuclear safety culture applies to every employee in the nuclear organisation, from the board of directors to the individual contributor and that their joint focus is on nuclear safety. The same principles apply to radiological safety, industrial safety, and environmental safety; but nuclear safety is the first value adopted at a nuclear station and is never compromised.

3.15 Probably the most important indication of a strong nuclear safety culture in an organisation is the extent to which employees are actively involved in safety and quality on a daily basis. If there is little involvement, with safety solely dependent on safety specialists, then it can be concluded that the organisation has not engaged its people in the basic principles of safe working. A strong nuclear safety culture is observable, tangible and demonstrated by all staff.
There are 8 internationally accepted principles of a strong Nuclear Safety Culture:

1. **Everyone is personally responsible for nuclear safety.**
   Responsibility and authority for nuclear safety are well defined and clearly understood. Reporting relationships, positional authority, staffing, and financial resources support nuclear safety responsibilities. Corporate policies emphasise the overriding importance of nuclear safety.

2. **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 nuclear organisation set an example for nuclear safety.

3. **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 in which issues are raised and addressed. Employees are informed of steps taken in response to their concerns.

4. **Decision-making reflects safety first.**
   Personnel are systematic and rigorous in making decisions that support safe, reliable plant construction and operation. Individuals are vested with the authority that when faced with unexpected or uncertain conditions, their responsibility is to place the plant in a safe condition. Senior leaders support and reinforce conservative decisions. Employees are encouraged to stop and ask if in doubt over actions to be taken.

5. **Nuclear technology is recognised as special and unique.**
   The special characteristics of nuclear technology are taken into account in all decisions and actions. Reactivity control, continuity of core cooling, and integrity of nuclear circuit pressure boundary are valued as paramount.

6. **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 that can have an undesirable effect on plant safety or on the integrity of the component being manufactured.

7. **Organisational learning is embraced.**
   Operating and manufacturing experience 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 organisation and people.

8. **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, some of which provide an independent peer review of activities being undertaken.
The Human Performance

3.17 It can be seen from the above that there is a significant emphasis placed on the individual responsiveness and attitudes in maintaining Nuclear Safety. Many organisations now recognise that an improvement in Human Performance can enhance safety and minimise potential for errors. As a result Human Performance programmes have been operational in many companies in the Nuclear Industry.

3.18 **Principles of Human Performance**

In its simplest form Human Performance can mean “compliance with procedures and processes” or “doing the right thing when no one is looking”. It is all about recognising the nuclear safety significance of the actions which are to be performed in designing, manufacturing, maintaining or modifying nuclear plant. It is about instilling into people the right attitudes and behaviours to promote a strong Nuclear Safety Culture into the workforce.

3.19 Integrating these principles into both an organisation's processes and management practices will help the development strategy of ever improving Human Performance. It will lead to a culture where deviating from procedures is totally unacceptable at individual, peer group and organisational level.

3.20 The five principles of Human Performance are:

1. **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 Process as well as physical back-up systems.

2. **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 permit us to manage situations proactively and prevent errors and events. Work arrangements can be changed to prevent, remove or at least minimise, the chance for error to occur.

3. **Individual behaviour is influenced by organisational processes and values.**
   Organisations are characterised by goal-directed behaviour and managers develop processes to direct the behaviour of the individuals in the organisation to achieve these goals. Work is executed within the context of management planning and control systems within organisations and these can force the individuals into certain courses of action or responses. Poor management and control systems are often the root causes of poor human performance problems by:
   - Applying time pressures.
   - Having poorly written control processes.
   - Providing a poor working environment.

4. **People achieve high levels of performance largely because of the encouragement and reinforcement received from leaders.**
   The level of safety 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 behavioural traits. Management has therefore a key role in enforcing good behaviour and discouraging poor behaviour.
5. Events can be avoided through an understanding of the reasons mistakes occur and application of the lessons learned from past events (or errors). Improvement in Human Performance has historically been the outcome of corrective actions derived from an analysis of past events and mistakes. Learning from our mistakes and the mistakes of others is reactive – it’s after the fact, and is important for continuous improvement. Anticipating how an event or error can be prevented is proactive, and proactive methods provide a more cost-effective means of preventing errors. Events from other industries can provide an insight into attitudes, behaviours and actions of people which have caused serious incident. This people specific learning can readily be translated into the nuclear industry.

3.21 The Impact of Human Performance implementation at an Individual, Management and Organisational Level is described in Appendix 1.1. This defines the expected positive behaviours expected of individuals, management and the organisation.

Error Reduction Techniques

3.22 Error Reduction Tools can be used to complement Human Performance as they are aids to help people carry out tasks to the correct processes and standards.

3.23 A series of Tools have been developed to help ensure error free performance during the execution of tasks. 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 occurring. Only in the extreme case where all barriers have been breached will errors occur as shown below.

3.24 The main Error Reduction Tools employed in the nuclear industry are:
- Pre-Job Briefs
- Review of Operating Experience
- Procedure Use and Adherence
- Self Checking – the STAR (Stop Think Act Review) Principal
- Maintaining a Questioning Attitude
- Peer Checking of Work
- Independent Verification
- Clarity of Communication Techniques
- Post Job Brief
- Task Observation / Coaching
A detailed description of each Tool is provided in Appendix 1.2. These tools are then integrated into the work execution process to ensure errors do not occur. A typical way in which they can be integrated into a work task is shown below.

### Work Planning:
- Identify what is to be accomplished, including the identification of critical steps. Review the allowed timescale for task completion to avoid the application of unnecessary time pressures.
- Identify potential challenges to error-free performance, such as poor access, lighting and environment by inspecting the workface before work commences.
- Select the right people for the job relative to the complexity of the task (SQEP).
- Anticipate possible errors and their consequences and put the appropriate defences in place.
- Ensure that sufficient resources are available to carry out the work in the required timescale.
- Key Tools to be used in the Work Planning stage are:
  - Pre-Job Briefs
  - Review of Operating Experience
  - Procedural Use and Adherence

### Work Awareness:
- Everyone should have knowledge of the Nuclear Safety Significance of the work to be executed and the implication of improper work execution.
- Every person should have access to the Work Method Statements to be executed and be fully aware of the task they have to complete. Each individual is responsible for ensuring they are fully trained and competent for executing their allocated task.
- All personnel engaged in a task must be aware of the Hold Points in the sequence of work and proactively prevent any execution beyond that point.
- All parties must have a team mentality to support each other to deliver the task to the required quality levels with safety of the plant and individuals being paramount.

### Work Performance:
- Prior to the start of any task, the team leader should hold a full formal Pre-Job Brief with the team to ensure the method of work executions are clear, risks are known and hold points are understood. Any emergency evacuation arrangements must be clearly defined and if necessary practised beforehand.
- On arrival at the Point of Work, personnel at Supervisor and Craft level should carry out a Point of Work Risk Assessment to ensure the job is “as briefed” and all equipment including emergency equipment is available. This risk assessment must include availability and knowledge of emergency egress routes. Each individual is responsible for their own personal task specific Risk Assessment.
- Key tools to be used in the Work Execution stage are:
  - Pre-Job Briefs
  - Review of Operational Experience
  - Self Checking – STAR Principle
  - Peer Review
  - Task Observation and Coaching
  - Procedural Use and Adherence
  - Independent Verification
  - Maintaining a Questioning Attitude
  - Clarity of Communication
3.29 **Work Feedback:**

- On completion of the task, the team leader should convey information on the quality of work preparation, related resources, and workplace conditions to Supervision and Management via post-job completion reviews. This aids planning for future works.
- Personnel should receive feedback on their performance in the execution of tasks through observations by Managers and Supervisors. Future training identified as a result of any weakness in performance should be documented.
- Key tools to be used in the Work Feedback stage are:
  - Review of Operational Experience
  - Task Observation and Coaching
  - Post Job Briefs

3.30 Robust management of work execution using error prevention tools has been shown to significantly reduce the frequency of errors 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.
Regulatory Processes and Licensing

UK Nuclear Regulation, Licensing and Regulatory Control

4.1 The safety of nuclear installations in the UK is assured by a system of regulatory control based on a licensing process by which a corporate body is granted a licence to use a defined site for specified activities.

4.2 The Health and Safety Executive (HSE) was established by the Health and Safety at Work Act 1974 (HSW Act). HSE’s primary function is to make arrangements to secure the health, safety and welfare of persons at work, and the public, in the way that undertakings are conducted. This includes developing health and safety policy, proposing new law and standards, conducting research, inspecting premises of duty holders, enforcing health and safety legislation, investigating work-related accidents and complaints, and providing information, guidance and advice on health and safety matters.

4.3 HSE reports to the Secretary of State for Work and Pensions (DWP), though it may report on specific matters to other Secretaries of State as appropriate. HSE is the licensing authority for nuclear installations and advises the Secretary of State for Energy and Climate Change (DECC) on nuclear matters. Licensing and regulatory functions are administered on HSE’s behalf by the Office for Nuclear Regulation (ONR), an agency of HSE. ONR’s mission is: “securing the protection of people and society from the hazards of the nuclear industry”. ONR brings together the regulatory functions for safety, security, safeguards, radioactive materials and conventional health and safety at nuclear sites. The 2012 Energy Bill proposes establishing ONR as a statutory corporation, at which point licensing and regulatory powers will be transferred to the new body.

The Law and the Regulatory Regime

4.4 The Health and Safety at Work Act
The operators of nuclear facilities in the UK, like their counterparts in other industries and places of work in general, are required to comply with the Health and Safety at Work Act 1974 and its relevant statutory provisions. The HSW places a fundamental duty on employers to ensure, as far as is reasonably practicable, the health, safety and welfare at work of all their employees. It also imposes a duty on employers, so far as is reasonably practicable, that persons not in their employment are not exposed to risks to their health or safety as a result of the activities undertaken.

4.5 In determining whether any measures are necessary to reduce risk and achieve compliance with the HSW Act, employers should compare the effort involved in the task, whether in money, time or man hours, and the risk which would be averted by the implementation of the task. Tasks should be implemented unless the effort is grossly disproportionate to the risk which would be averted. In short, risks must be reduced so far as is reasonably practicable, which is generally termed “as low as reasonably practicable” – the ALARP principle.

4.6 The Nuclear Installations Act
Relevant parts of the nuclear industry must also comply with the Nuclear Installations Act 1965 (NIA65) which has three key purposes:

a) It requires the licensing of sites which are to be used for the installation or operation of nuclear reactors;

b) It provides for the control, via permit, of processes for the enrichment of uranium and the extraction of plutonium or uranium from irradiated matter and the application of associated security measures;

c) It provides a special legal regime to govern the liability of nuclear site
licensees towards third parties for certain kinds of damage caused by nuclear matter on, or coming from, their sites.

4.7 The Nuclear Site Licence
The safety of nuclear installations in the UK is secured primarily through the nuclear site licence and the conditions attached to it. Any organisation wishing to install or operate a prescribed nuclear installation will need a nuclear site licence. The Nuclear Installations Act, 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 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.

4.8 NIA65 requires ONR to attach to each nuclear site licence such conditions as it considers necessary or desirable in the interests of safety or with respect to the handling, treatment and disposal of nuclear matter. The licence and licence conditions apply at all times throughout the life of a nuclear licensed site and therefore cover design, construction, commissioning, operation, maintenance, modifications, decommissioning etc. NIA65 empowers ONR to add, vary or revoke conditions at any time allowing ONR the flexibility, if it considers necessary, to tailor the requirements placed on the licensee to specific circumstances and the phases of the installation's life.

4.9 In the main, the licence conditions require the licensee to make and implement adequate arrangements to address the requirements of the licence conditions. Each licensee can develop licence condition compliance arrangements which best suit its business whilst demonstrating that safety is being managed properly. Similarly, the arrangements may change as the plant progresses through its life from initial design to final decommissioning.

4.10 The licence conditions provide the basis for regulation by ONR. They do not relieve the licensee of the responsibility for safety. They are generally non-prescriptive and set goals which the licensee is responsible for meeting, amongst other things by applying detailed safety standards and safe procedures. The arrangements which a licensee develops to meet the requirements of the licence conditions constitute elements of a safety management system. ONR reviews the licensee's licence condition compliance arrangements to ensure they are clear and unambiguous and address the main safety issues adequately.


Key Regulatory Organisations and People

4.12 Powers to licence and regulate nuclear licensed sites rest with HSE by virtue of NIA65. Licensing and regulatory functions are administered on HSE’s behalf by ONR which regulates the whole lifecycle of nuclear installations, including nuclear power stations.

ONR regulates by:
Permissioning Inspection – before ONR can permission key activities, it assesses licensees' safety cases, on a sample basis 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 HSE's 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.

4.13 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 that the Programme functions effectively and efficiently, ensuring that the necessary administration and legal considerations are in order, handling enquiries from members of the public and other parties, and maintaining lines of communication between inspectors and licensees.

4.14 All inspection and assessment is done on a sampling 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 changes, the maturity of the organisation and ONR's knowledge of the licensee's safety performance history.

4.15 Every licensed 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.

4.16 Other regulators that may be relevant to some licensee and supply chain activities include the Environment Agency for England and Wales and the Scottish Environment Protection Agency for Scotland (SEPA). Civil nuclear security and transport safety are now part of ONR.

**Regulation of the Supply Chain for New Build**

4.17 There are some broad principles 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.

1. 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.
2. Licensee choices between sourcing work in-house or from contractors should be informed by a clear policy that takes due account of the nuclear safety implications of those choices.
3. The licensee should maintain an “intelligent customer” capability for all work carried out on its behalf by contractors that may impact upon nuclear safety (see right).
4. The licensee should ensure that it only lets contracts for work with nuclear safety significance to contractors with suitable competence, safety standards and resources.

5. The licensee should ensure that all contractor staff are familiar with the nuclear safety implications of their work and interact in a well-coordinated manner with its own staff.

6. The licensee should ensure that contractors’ work is carried out to the required level of safety and quality in practice.

4.18 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 supply chain.

4.19 It is the responsibility of licensees and higher tier contractors to fully interpret the nuclear 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. Lower tier contractors have a duty to ensure that they have a general understanding of nuclear regulation and application of licence conditions so they can appreciate the context in which the higher tier contractor’s requirements are set. This understanding will allow subcontractors to ask intelligent questions to clarify, correctly interpret and implement all relevant requirements.

4.20 Although it is the responsibility of the licensee to ensure compliance with licence conditions, each tier within the supply chain should be made aware of, and understand, the nuclear safety significance of the work that it is doing, and be able to demonstrate that it has arrangements to comply with the contract specification. Each link in the supply chain should therefore ensure that its staff, and any subcontractors, 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.

4.21 The licensee must have a “make or buy” policy to determine whether work should be undertaken “in house” by its own resources or outsourced from the supply chain. It must have an in-house capability to fully understand the nuclear safety significance of any purchased expertise or equipment, specify requirements, supervise the work, and technically review the output before, during and after implementation. This requirement is known as the Intelligent Customer capability.

4.22 A contractor should have an “intelligent contractor” capability to understand the technical and quality process requirements of his customer. The contractor should be aware that failure to meet safety significant requirements could have severe consequences for its customer, other organisations further up the supply chain (up to and including the licensee) and potentially members of the public in the event of a major failure. 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 ‘intelligently’.

4.23 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 Safety Assessment Principles (SAPs) and Technical Assessment Guides (TAGs) which are available on the ONR website, as well as details of exactly how relevant licence conditions are to be interpreted and
applied. 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.

4.24 Lower Tier contractors should have management and working arrangements to cover their activities on nuclear plant. This will require all contractors to have a formal Quality Management System (QMS) which is certified to ISO 9001 Quality Management Standard or can be demonstrated to meet the intent of the standard. If lower Tier contractors do not have ISO 9001 certification, their Tier 1 contractor is likely to conduct a form of in-depth audit of their QMS to ensure it is robust and will seek evidence that QMS arrangements are being followed.

4.25 Contractors at all levels in the supply chain should expect to be audited by their customer on a regular basis as part of the contractual arrangements. Audits from organisations higher up the supply chain are also possible. It should be noted that a contractor at any level in the supply chain could be visited by the ONR as part of a regulatory intervention, particularly if the equipment they are manufacturing has high nuclear safety significance.

4.26 An outline schematic representation of the relationship between ONR, the licensee and the licensee’s supply chain is given above. It indicates the major information flows to and from the organisations, where licensee and Tier 1 contractor audits and ONR interventions may take place.

4.27 Licensees and contractors should have demonstrably competent staff with the right qualifications, knowledge and experience to carry out the duties expected of them. Records should be available to demonstrate personnel are competent to fulfil their allocated tasks.
Quality Arrangements

Why are Quality Arrangements Important?

5.1 If project specifications and the associated codes and standards are followed rigorously, delivery of a safe, high integrity nuclear power station would be assured. However, it must be recognised that the activities, from design through to commissioning, require significant human effort and human interpretation of the project specifications and the code requirements. The implementation of a good Quality Management System will ensure the required level of compliance with project specifications and code requirements 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 and providing opportunities for learning and continuous improvement.
- Ensuring that all personnel are suitably qualified, experienced and equipped 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 the nuclear plant.

These provisions will enhance the integrity of the plant and ensure the protection of both the environment and the public from radioactive releases.

5.2 Quality arrangements must be put in place for all projects and both corporate and personal compliance with the applicable specifications, codes, standards and regulations are always expected. The main differences between the quality requirements for nuclear and conventional projects are:

- An increase in the level of plans and procedures.
- Increased rigour with which they are implemented.
- The need to demonstrate that what was planned has actually been achieved.

Licensees’ Quality Assurance Specifications

5.3 The licensees will specify Quality Assurance Specifications applicable to their projects. The “General Quality Assurance Specification” (GQAS) is likely to be applied for NNB GenCo UK EPR contracts. ASME NQA-1 will be applicable for any AP1000 plant and probably any ABWR constructed in the UK. GQAS is based on compliance with ISO 9001:2008 plus additional requirements.

5.4 A major concept introduced by the GQAS is that of “Quality Related Activity” (QRA). The procurement of a Safety Classified Product is clearly a “Quality Related Activity”. The designers and manufacturers of Safety Classified Products will need to document which of their activities are QRAs. The Client 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.

5.6 ASME NQA-1

It is likely that NQA-1 will be specified for AP1000 and ABWR projects. NQA-1B-2011 and “Addenda to NQA-1-2008”, provide a detailed comparison between NQA-1 and ISO 9001:2008, which is intended to provide guidance for organisations which require working to both specifications. Numerous detailed differences are
identified by this comparison – too numerous to be summarised in this guide. While the detailed discussions below focus directly on GQAS, practically all of the issues will be equally applicable to AP1000 and ABWR projects.

5.6 **NSQ-100**
This is a relatively new specification issued by the Nuclear Quality Standards Association, a joint initiative of AREVA and Bureau Veritas. It is based on ISO-9001:2008, which it integrates with the principles of NQA-1 and IAEA specification GS-R-3. NSQ-100 may become a specified standard in the future.

5.7 **IAEA GS R-3**
IAEA GS R-3 is generally for larger companies, but lower Tier companies should be aware of its existence and extract elements from it which will improve their business management and reporting. This document is issued by the International Atomic Energy Agency which defines the quality requirements it deems as being necessary to work in the nuclear industry. The key focus of this standard is the application of an integrated business management system within a company. This ensures that disciplines such as quality, health and safety, environment and sustainability are integrated into one business management system and are not seen as stand-alone entities. Reporting arrangements under this standard are important and it is necessary that the above disciplines are under one set of management arrangements which have direct reporting access to the CEO and the Board of the company.

**Application of Quality Arrangements**

5.8 The following provides an overview of the requirements and typical activities that should be carried out by the supply chain to ensure compliance with the Licensee's quality requirements. The following discussion uses the GQAS specification as an example; similar requirements can be expected for the other specifications mentioned above.

5.9 **Licensee and Tier 1 contractor responsibilities**
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. The Licensee, as the Nuclear Site Licence holder, has the responsibility for defining the overall Project Quality Arrangements. The Office of Nuclear Regulation may wish to review the Licensee's proposed high level quality arrangements and their applications to ensure that they:
- Are robust, with accountability well defined.
- Cover all aspects of the work.
- Can be applied by, and “flow 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.

5.10 The Tier 1 contractors will take the quality arrangements as specified in their arrangements with the Licensee and embed them into the contracts they let to lower Tier contractors for design, procurement, manufacturing, installation and commissioning activities. It will be the responsibility of the lower Tier contractors to ensure that they flow these arrangements, as appropriate, down throughout their supply chain. The Nuclear Regulator and the Licensee have the right to audit this process at any time during the project. The Licensee and Tier 1 contractors have the right to review and approve the use of any subcontractor in the supply chain.
5.11 The Tier 1 contractors will have to select and approve their suppliers and sub-contractors for the scope of their work. This will include confirming that suppliers have Quality Management Systems that comply with ISO 9001:2008, that they have demonstrated an ability to align with the additional requirements of the contract specifications and that they have the capacity and technical capability to perform the work scope. This includes the ability to identify, execute and close out Quality Related Activities (QRA) as defined by GQAS. Confirmation of compliance with ISO 9001:2008 may be by accredited certification or by a Tier 1 audit.

5.12 It is important that the Tier 1 contractors use their knowledge of and expertise in the nuclear industry to interpret the requirements of the codes, standard and quality arrangements for the specific scope of work to be subcontracted. Tier 1 companies should specify Contract Management requirements (identified in blue below) and prepare a Product Specific Specification (identified in green below) for each piece of equipment or service required including details such as:

- Technical and functional requirements.
- Project management and programme requirements.
- Quality arrangements and quality documentation (Quality Plans) with the hold and witness points specified.
- QA / QC Inspection Strategy including Client / 3rd Party Surveillance.
- Document submission schedules.
- Qualification of special processes and operators.
- Design codes to be used plus any special additional requirements.
- Material specifications and additional material testing requirements.
- Inspection and test procedures to be applied.
- 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.
- Packaging and shipping requirements.
- Lifetime records / hand over documentation.

5.13 Where lower Tier organisations sub-contract safety classified work or procure materials or equipment, they must take full responsibility for the management of their subcontractors’ quality arrangements. However their Tier 1 customers will remain responsible for ensuring that the necessary quality arrangements flow down throughout all levels of their supply chain. The main contractors should therefore assist the lower tier contractors by reviewing their specifications and ensuring that their suppliers understand the technical and quality requirements.

5.14 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 to ensure compliance with Licence Condition 17 include:

- 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.
- 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 QRA.
- Application of technical queries, non conformance and concession processes as it applies to the scope of work.
5.15 **Roles and Responsibilities of Lower Tier Contractors**
The lower tier contractors must work to the specifications provided for each project or component within their own Quality Management Systems (QMS). These detailed specifications define the level of intervention (including procedure approval, inspection and witnessing of inspections and tests, etc.) that will be aligned with the nuclear safety classifications of the equipment or services being provided.

5.16 In addition to the inspection activities detailed in the Inspection and Test Quality Plan(s), a project Quality Audit Schedule will be developed and applied to ensure Suppliers comply with their Quality Management System and the purchase order / contract requirements.

5.17 For nuclear safety classified components, the Nuclear Regulator, the Licensee, and Tier 1 contractors have the right to audit the 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. 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.

5.18 **Competence – Qualification and Experience**
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 (Suitably Qualified and Experienced) 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.
- Where gaps are recognised in an appointed individual's experience, a process to provide mentoring and support until sufficient experience is gained.

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 to carry out their allotted activities.

5.20 When contractors appoint individuals to key project positions, their client has the option to interview individuals prior to their formal appointment. Once individuals are appointed they can not be replaced without the authorisation of the client.

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**Process for Control of Work on Nuclear New Build Projects**

5.21 **Quality Related Activities (QRAs)**
A QRA is defined as "an activity, failure of which can lead to a product which is not compliant with the nuclear safety requirements".

5.22 Each supplier in the supply chain is required to identify all the QRAs related to their contract. Details of quality related materials, components or quality related sub-contracted activities must be included in their procurement specifications. The suppliers must then identify how they will comply with and execute the
QRAs. It is acceptable to further subdivide each QRA into a further subset of QRA activities in order to achieve the level of control required. Suppliers must get the agreement of their client into the breakdown and definition of the QRAs before starting work.

5.23 Verification and Checking of QRAs

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.

5.24 Some of the particular requirements for QRAs 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 who prepared them.
- All documentation relating to particular products must be unambiguously linked to the products.
- 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.

5.25 Where any QRA is to be subcontracted, or quality related components or quality related services are purchased, the lower tier contractors procuring these must detail all the QRAs in their Procurement Specifications and Purchase Order.

5.26 Controlling documentation

Examples of the documents and controls necessary to deliver nuclear projects are described in Appendix 2. Tier 1 contractors will issue lists of required processes and documents to lower tier contractors, with descriptions of what is required.

5.27 The key documents are:

- Project Execution Plan (PEP)
- Project Quality Assurance Plan (PQAP)
- Design Quality Plan
- Manufacturing and Test Philosophy Document
- Manufacturing and Test Quality Plan
- Manufacturing Processes and Method Statements

5.28 It will be the responsibility of the lower tier contractors 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.

5.29 Control of Sub-contractors

The lower tier contractors must take full responsibility for the management of their 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 all of the QRA's are controlled and performed in accordance with the applicable, approved specifications.

5.30 At all levels in the supply chain, suppliers must provide access to their premises for their customer, the Licensee, the UK Regulators and any designated Third Party Inspection Authority.
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 applicable to the EPR French reactor, and the AP1000 American reactor, which are the only two reactor designs currently being evaluated by the Generic Design Assessment process in the UK. The codes and standards for the ABWR recently proposed by Hitachi/Horizon have yet to be defined.

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 construction 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 Beyond these classified components are many items of plant and equipment which have no impact on the nuclear safety of the plant. This equipment will be manufactured to EN, ASME or comparable Industrial standards.

6.4 The exact designation into Class 1, 2, 3 or “No Class” is dependant 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.

<table>
<thead>
<tr>
<th>Designation</th>
<th>Type of Company</th>
<th>Applicable Codes</th>
<th>Tier of Supplier</th>
</tr>
</thead>
<tbody>
<tr>
<td>Class 1</td>
<td>Technology Provider e.g. AREVA, Westinghouse or Hitachi</td>
<td>Nuclear Codes such as RCC-M, ASME III, RCC-E, plus additional customer requirements.</td>
<td>Technology Provider and specialist manufacturers</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class 2</td>
<td>Nuclear experienced companies with proven Quality Systems certified to ISO 9001.</td>
<td>Nuclear codes such as RCC-M, ASME III, RCC-E. EN codes, plus additional customer requirements.</td>
<td>Tier 1 and Tier 2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Class 3</td>
<td>Companies with experience of pressure systems with Quality Management arrangements certified as being compliant with ISO 9001.</td>
<td>EN or National Standards, plus additional customer requirements.</td>
<td>Tier 2 and Tier 3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Industrial Equipment</td>
<td>General industrial companies with Quality Management Systems that meet ISO 9001 requirements.</td>
<td>EN or National Standards. Pressure System Regulations.</td>
<td>Tier 2 and Tier 3</td>
</tr>
</tbody>
</table>

6.5 The above 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 “customer” by specifying the required Codes, Standards and Quality Arrangements to be used by their supply chain.
In the UK, the Pressure Equipment Regulations (PER) are for new equipment specifically designed for nuclear use and do not apply to equipment which, in the event of a failure a radioactive release would occur. Classified components and equipment are excluded from the PER regulations. The rationale is that 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 the additional customer requirements which will exceed the requirement of the Pressure Systems Safety Requirements (PSSR) which apply to operating equipment and will include conformity assessment requirements.

For “No Class” components the Pressure Equipment Regulations (PER) will apply. These regulations are generally satisfied by Industrial standards such as EN 13445 for pressure vessels and EN 13480 for piping.

The nuclear pressure equipment codes that are likely to be used for the current generation of nuclear reactors which are being proposed for the UK will be the American ASME III code for the Westinghouse AP1000 design and the French RCC-M code for the AREVA 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 here.

It is apparent that ASME III and RCC-M codes are very similar in some areas. This is because the RCC-M code is derived from early editions of ASME III. However they are different in the way that quality is assured. It is therefore not possible to say that a component manufactured to RCC-M will automatically be compliant with ASME III, or vice versa.

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

The RCC-M 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.

The latest full version of the RCC-M code was issued in 2007, and there are now three addenda issued; the first in December 2008, the second in December 2009 and the third in December 2010.

Quality 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 manufacturers to attain any type of RCC-M specific
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.

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.

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.

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.

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.

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

The RCC-E 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.

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.

6.21 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.

6.22 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).

6.23 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

6.24 Written by the American Society of Mechanical Engineers (ASME), 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. The latest full version of the code was issued in 2010.

6.25 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 that 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 that lower Tier contractors will require the above stamps.

6.26 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.

6.27 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.

6.28 Welding under ASME is recognised as being so important that the requirements are incorporated into 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.

6.29 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 Quality Management System which will be audited by the purchaser and his Independent Inspection Authority.

6.30 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.

ASME Codes for Non-nuclear Safety Classified Components

6.31 The AP1000 will have a significant number of non-safety classified pressurised components. These are likely to be specified to ASME codes, other than the nuclear code, such as Section VIII for Pressure Vessels; ASME B31.1 for Power Piping or ASME B31.3 for Process Piping. For piping, ASTM materials may be used in lieu of ASME Section II materials in most cases.

6.32 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.

6.33 Updating of the ASME B&PV Code will now occur every two years with no yearly addenda, the next will be issued in 2013. 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.

6.34 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 Boiler and Pressure Vessel Code 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

6.35 The diagram below shows the correspondence between the sections of the RCC-M Code and the ASME III, Boiler and Pressure Vessel Code (BPVC).

<table>
<thead>
<tr>
<th>RCC-M Code</th>
<th>ASME Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section 1</td>
<td>Nuclear Island Components</td>
</tr>
<tr>
<td>A</td>
<td>General Requirements</td>
</tr>
<tr>
<td>B</td>
<td>Class 1 Components</td>
</tr>
<tr>
<td>C</td>
<td>Class 2 Components</td>
</tr>
<tr>
<td>D</td>
<td>Class 3 Components</td>
</tr>
<tr>
<td>E</td>
<td>Small Components</td>
</tr>
<tr>
<td>G</td>
<td>Core Support Structures</td>
</tr>
<tr>
<td>H</td>
<td>Supports</td>
</tr>
<tr>
<td>J</td>
<td>Storage Tanks</td>
</tr>
<tr>
<td>P</td>
<td>Containment Penetrations</td>
</tr>
<tr>
<td>Z</td>
<td>Technical Appendices</td>
</tr>
<tr>
<td>Section 2</td>
<td>Materials</td>
</tr>
<tr>
<td>Section 3</td>
<td>Examination Methods</td>
</tr>
<tr>
<td>Section 4</td>
<td>Welding</td>
</tr>
<tr>
<td>Section 5</td>
<td>Fabrication</td>
</tr>
</tbody>
</table>

Table showing comparison of RCC-M and ASME structures

EN Codes

6.36 EN standards will be specified for most of the items of pressurised equipment on EPR stations. 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.

6.37 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.

6.38 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.
Health and Safety Processes

Health and Safety Regulation

7.1 The Health and Safety Commission (HSC) was established by the Health and Safety at Work etc Act 1974 (HSW Act). Its primary function is to make arrangements to ensure that business is conducted in a way that ensures the health, safety and welfare of workers and the public. This includes proposing new laws and standards, conducting research, providing information and advice, and controlling explosives and other dangerous substances. The Health and Safety Executive (HSE) is the body appointed to enforce health and safety law under the general direction of HSC.

7.2 The HSE 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 HSE Inspector, it is failing to comply with the law.

7.3 In the UK, all companies are required to comply with the Health and Safety at Work etc Act 1974 (HSW Act). 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 that people not in their employment are not exposed to risks as regards their health or safety as a result of the activities undertaken by contractors. This includes other people at the workplace, but also remote from site in the local community.

Health and Safety Management

7.4 Traditionally health and safety issues have been addressed by companies through:
- Robust Health and Safety management systems, procedures and work methods.
- Compliance with the relevant legislation.
- The establishment of a trained and competent workforce.
- The provision of a safe workplace with well designed, constructed and maintained buildings, plant, equipment, and processes.
- 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 seen a steady reduction in health and safety risks and associated accidents and incidents over the last few years. 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 make further reductions in health and safety risk is by adopting a Behavioural Safety Culture throughout company organisations and extending this across the entire supply chain. These expectations will be encountered as part of supplier questionnaires and requirements when registering on the customer’s approved supplier databases. Extensive audits of contractors’ approach to Safety Management, their Management Systems and their Safety Statistics should be expected as part of their 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 and Human Performance as described in Section 3 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,
Integration of Contractors into Project Health and Safety Arrangements

7.8 As with Nuclear Safety and Quality, the Licensee is responsible for setting the Health and Safety Culture and Standards. 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 to site construction and commissioning. One set of values must apply to all and to everyone.

7.9 The Licensee will agree the policy for the Health, Safety and Environmental principles of the project with the Health and Safety authorities and the Environmental Agency. These will be interpreted into a set of:

- Inductions (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.

7.10 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 flow down to the lower tier contractors. At project kick-off meetings it is essential that lower tier contractors are fully briefed as to how these arrangements have an impact on their contract, processes and personnel.

Audit and Surveillance of the Supply Chain

7.11 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 Series or 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, Tier 1 or Tier 2 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.

7.12 The supply chain audits could be expected to include supplier offices, project sites and manufacturing sites. The auditing team could include representatives from Tier 1 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 along the supply chain, as well as any health and safety-related contractual aspects. The audits would be documented with action plans produced. Close out of actions in a timely manner is essential.
Construction Design and Management (CDM) Requirements

7.13 As companies are familiar with and fully 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 requirement worthy of detailed consideration is the Construction, Design and Management Regulations 2007 (CDM 2007) which will apply to all major nuclear new build projects. These regulations define various roles (Designer, Client, Principal Contractor, Contractor, CDM Co-ordinator) and the role of each member of the supply chain within a particular project.

7.14 For nuclear new build projects, lower tier suppliers will be defined as Contractors under the CDM 2007 regulations and this will mean they will have several regulatory duties. Under CDM 2007, for all projects, including domestic and non-notifiable projects, less than 30 days duration. Contractors must:

- Check that their client is aware of client duties under the CDM 2007 regulations.
- Review their roles and responsibilities under the contract and ensure they have the ability to comply with CDM responsibilities.
- Ensure that personnel are qualified, 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 that all activities can be accomplished without undue time pressures.
- Manage and monitor their own activities ensuring that:
  - All potential risks are identified and mitigated where possible.
  - All residual risks are identified and managed.
  - All personnel are properly briefed about the tasks to be undertaken and the risks identified.
  - Work is suspended if unexpected risks emerge until revised procedures are in place.
- Co-operate with the client and other contractors to ensure good co-operation, communication and that risks identified are shared.
- Ensure that all subcontractors have sufficient time to plan their activities.

7.15 Additionally for Notifiable Projects under CDM 2007, Contractors must also:

- Check that a CDM Co-ordinator has been appointed, that the HSE has been notified of the project and Form 10 has been completed and the appropriate CDM appointments are in place.
- Co-operate with the Principal Contractor, CDM Co-ordinator and other Contractors on the project.
- Ensure they have visibility of any residual design risks as it affects their works.
- Share risk assessments with the Principal Contractor and in particular any risks which may impact on other contractors.
- With the Principal Contractor and other Contractors, identify where there is joint access to areas required and that cross-contractor risks are minimised.
- Inform the Principal Contractor if revised systems of work will require amendment of the Construction Plan or Programme.
- Identify early any delays to the programme of work.
- Inform the Principal Contractor of all near misses, accidents, injuries and Reporting of Injuries, Diseases and Dangerous Occurrences Regulations 1995 (RIDDOR) events.
- Provide input to the project Health and Safety file in a timely manner.
7.16 Where contractors have design and implementation contracts 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 and minutes of meetings issued and issues are closed out.
- Risks are mitigated at the design stage as far as possible and that any residual construction or operational risks identified in the project Health and Safety file.
- HAZCON studies are completed and that minutes of meetings are issued and issues are closed out.

7.17 To carry out 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**

7.18 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 Suitably Qualified and Experienced Person (SQEP). Employers must ensure that they have the relevant information available relating to their employee's competences, including CVs, copies of relevant training records and SQEP assessments.

7.19 To meet the predicted demand for demonstrable competency of nuclear new build professionals and construction workers, competency demonstration schemes such as the Nuclear Skills Passport, the Certificate of Nuclear Professionalism and the Triple Bar for Nuclear have been developed. The National Skills Academy Nuclear (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, www.nuclear.nsacademy.co.uk. It is likely that such competency demonstration schemes will become a required component for work in the nuclear new build sector.

7.20 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.

1. [www.nuclearskillspassport.co.uk](http://www.nuclearskillspassport.co.uk)
2. [www.ccnsg.com](http://www.ccnsg.com)
Security Arrangements

8.1 The information received by Tier 2, 3 and 4 contractors associated with the nuclear new build programme must be protected and handled securely. Some information requires a high level of security whereas other information can be treated in line with good business practice. The various types of information and the level of required protection are described below. There are also security implications for the employment of people and their access to operational nuclear sites.

8.2 The Licensee will establish the security requirements for information and people at the start of the project and flow these down into the supply chain.

Controlling Regulations

8.3 The two main regulations for controlling security of information and people are:
   - Anti Terrorism, Crime and Security Act 2001
   - Nuclear Industry Security Regulations 2003

8.4 These are interpreted by the Health and Safety Executive (HSE) through its nuclear regulating agency, the Office of Nuclear Regulation (ONR). The latter has a department called the Office for Civil Nuclear Security (ONR – CNS). This department sets out the required Security Policy Framework (SPF) and the established civil nuclear security standards for the nuclear industry in the UK. These policy rules and regulations are interpreted by the Licensee who sets out its site-specific security policies, processes and management arrangements to ensure regulatory compliance. These policies and procedures then flow down into the supply chain as shown in the figure below.

Security Flow Down Figure
8.5 There are a number of elements of security that contribute to the protection of Sensitive Nuclear Information (SNI). The five key elements are:
- Protection of Information in the Nuclear Industry
- Physical Security of offices and sites
- Personnel Security
- Document Security
- IT / Electronic Security

Protection of Information

8.6 Classification
The system for protection of information uses five levels of Classification, associated with keywords. The appropriate keyword is placed in all capital letters in the centre of the top and bottom of each page of a classified document as follows:

<table>
<thead>
<tr>
<th>Information Type</th>
<th>Marking (Keyword)</th>
<th>Level of Security protection measures required</th>
</tr>
</thead>
<tbody>
<tr>
<td>Company commercial confidential sensitive information e.g. Financial, Personal, Medical or employment records and some technical information.</td>
<td>PROTECT</td>
<td>LOW</td>
</tr>
<tr>
<td>Sensitive Nuclear Information (SNI as defined by ONR Classification Policy)</td>
<td>RESTRICTED</td>
<td></td>
</tr>
<tr>
<td></td>
<td>CONFIDENTIAL</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SECRET</td>
<td></td>
</tr>
<tr>
<td></td>
<td>TOP SECRET</td>
<td>HIGH</td>
</tr>
</tbody>
</table>

8.7 The bulk of any SNI provided to Tier 2 and 4 contractors during new build nuclear contracts will be in the PROTECT category although some may attract a higher classification.

8.8 Requirements for Handling and Protecting Information
The Licensee will define security policy and procedure to comply with the Nuclear Industry Security Regulations 2003 and to ensure that those procedures are flowed down and maintained by the supply chain. It will be the responsibility of the Tier 1 to Tier 4 suppliers to protect any information provided to them as part of a tender or contract.

8.9 The requirements on the Utility / Licensee are to:
- Make sure the supply chain is aware of the need for security of information.
- Only supply SNI on a ‘need to know’ basis, i.e. limit the dissemination of SNI.
- Help suppliers differentiate between the different types of information that requires protection.
- Help suppliers reach the required levels of physical and electronic protection for different types of information if they do not already have processes and procedures in place.
8.10 The requirements on the supply chain are to:
- Ensure the security of information provided to them.
- Understand the need for security in the 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.

8.11 Before any SNI is sent out to a supplier, they will be sent a Security Aspects Letter, which will guide them 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.

Physical Security of Offices and Sites

8.12 Companies can receive and use commercially sensitive information within their normal working areas subject to good access control being in place. These include:
- A secure building perimeter.
- Restricted building access (by swipe cards or manual control).
- Controlled working area access (by swipe card).

8.13 In addition, companies should encourage their staff to operate a clear desk policy with client information locked away during out of hours periods.

8.14 For SNI, a higher degree of physical security is required. This information should only be used in a controlled access area. The information must be locked in desks or cabinets even if there is no one present. There are restrictions on transmitting such information by post, email and facsimile.

8.15 By having separate secure areas for SNI documents, companies can utilise both SNI and PROTECT information. The arrangements will be audited to ensure adherence to security policies and that the building / offices are properly managed from a security view point.

Personal Security

8.16 Access to SNI is only given to personnel who have been vetted by the OCNS. Vetting is carried out on behalf of the Licensee to ensure that each individual does not present a risk to the UK’s security if allowed access to SNI. Access to sites will be regulated by the Nuclear Industries Security Regulations 2003 and, as such, all personnel requiring access to the site will need to be vetted to a level commensurate with site security classifications before being allowed access.

8.17 Five levels of vetting exist, as follows:

8.17.1 Counter-Terrorist Check (CTC)
CTC vetting is for personnel whose work involves ‘access to locations where protectively marked material is held’. A CTC does not allow access to protectively marked material. It is typically required for reception, catering or cleaning staff in a nuclear site.

8.17.2 Baseline Personnel Security Standard (BPSS)
A Baseline Personnel Security Standard (BPSS, commonly referred to as a BS and formerly known as Basic Check) allows routine and unrestricted access to material
marked 'restricted' with occasional, supervised, access to confidential material. A BS confirms identity, signature, address and employment/education.

8.17.3 **Security Check (SC)**
Security Check clearance allows routine and uncontrolled access to material marked 'Secret' and below with occasional supervised access to Top Secret material where required.

8.17.4 **SC clearance will normally consist of:**
- A check against the National Collection of Criminal Records and relevant departmental and police records.
- A check against Security Service records in accordance with the Security Services Act 1999.
- Credit reference checks and a review of personal finances.

In some circumstances further enquiries, including an interview with the person, may be required. The review period is normally every 10 years.

8.17.5 **Security Check Enhanced (SCE)**
Security Check Enhanced clearance allows routine and uncontrolled access to material marked 'Secret' and below with supervised access to top secret material where required. SCE is a relatively new level of clearance intended for those who carry out regular work related to top secret information, but do not require unrestricted access to top secret documents. It came into use in July 2007.

8.17.6 **SCE clearance will normally consist of:**
- A check against the National Collection of Criminal Records and relevant departmental and police records.
- A check against Security Service records in accordance with the Security Service Act 1989.
- Credit reference checks and a review of personal finances.
- An interview with the person being vetted and/or references from people who are familiar with the person's character in both home and work environments.

8.17.7 **Developed Vetting (DV)**
Developed Vetting allows routine and unrestricted access to material marked 'Top Secret' and below.

8.17.8 **DV clearance will normally consist of:**
- A check against the National Collection of Criminal Records and relevant departmental and police records.
- A check against Security Service records in accordance with the Security Service Act 1989.
- Credit references checks and a review of personal finances.
- An interview with the person being vetted.
- References from people who are familiar with the person's character in both the home and work environments. These may be followed by interviews.
- Clearance is re-examined following any stressful encounter and includes a psychological re-evaluation.

DV clearance is subject to periodic review with a maximum period of eighteen months.

8.17.9 **Timescales for Security Clearance**
When planning for contracts at any of the new build nuclear sites, companies must consider the impact of security clearance timescales on the availability of staff.

8.17.10 Timescales associated with the various vetting levels can typically be:
Security Arrangements

- Counter Terrorist Check – 6 to 8 weeks
- Baseline Personnel Security Standard – 2 to 3 months
- Security Check – 4 to 5 Months
- Security Check Enhanced – 4 to 6 Months
- Developed Vetting – 4 to 6 Months

It is believed that most of the supply chain will require Baseline Personnel Security Standard (BP).

Document Security

8.18 Documents produced during new build nuclear contracts may involve a mixture of SNI and Commercial information, and may be produced and stored in a number of different ways.

8.19 Documents should be classified correctly and protectively marked to help users of those documents protect them correctly. The onus for the correct classification of documents sent to the supply chain is with the sender of the information. Where documentation is produced in the supply chain which requires classification, care must be taken to correctly classify in accordance with ONR guidelines.

8.20 Details of the requirements for documentation protection will be contained within the contract.

IT / Electronic Security

8.21 The nuclear industry is heavily regulated with regards to the handling of SNI and spends significant effort defending it to an extremely high standard.

8.22 It is recommended that international standards of best practice are followed and an increasing number of supply chain companies are becoming ISO 27001 certified to demonstrate that they have an Information Security Management System (ISMS) in place. This gives confidence to clients and partners that information is being stored and handled appropriately and that there is a culture of security in the organisation.

8.23 If contractors intend to process RESTRICTED information, the IT System must go through a process of formal accreditation. This is an independent assessment that verifies that the system meets Information Assurance requirements and allows the client to be aware of the risk level of releasing the information electronically to the contractor. For CONFIDENTIAL and above IT systems must be accredited by the MOD or OCNS.

8.24 Processes involved to protect sensitive data held in IT systems
The requirement to defend nuclear information on computer networks is aligned with good IT security policy. Contractors must:

- Create an asset register of all IT systems and data storage locations noting the type of information held. A classification system should be used to identify the different types of information (such as Confidential, Internal Only, Public, etc).
- Identify those who need to access the information and implement the necessary controls to ensure it is handled correctly, such as:
  - User and group access rights.
  - Third Party Agreements for any outside agents that connect to the network.
- Policies and procedures must be in place for IT systems:
• Passwords (which should be changed regularly and be difficult to guess).
• Guidance for use and handling of information.
• Ensuring Anti Virus software, Firewalls and Operating Systems are kept up to date.

Security Awareness Training should be implemented to:
• Instil a culture of security within the company and ensure that all Security Policies have been understood by employees. This includes security of passwords, ensuring PCs and workstations are locked when unattended, etc.
• Highlight methods used by external parties to gain unauthorised sensitive system information so employees can recognise “attacks”.
• Ensure company information is excluded from home computers.

Auditing of network activity logs to be carried out to allow identification of external “attacks”.

This section has provided information on the complete range of security requirements. However most suppliers will only need to deal with PROTECT or RESTRICTED information.
Summary

9.1 The UK nuclear supply chain has a long and successful history of manufacturing and constructing, maintaining and upgrading nuclear power plant in the UK. There is also significant current experience of construction of new nuclear facilities in the UK, much of which is of similar quality standards to that required for new nuclear stations.

9.2 In addition there are a significant number of companies in the UK who are manufacturing and constructing new high integrity plant and equipment in the oil, gas, petrochemical and pharmaceutical industries. With the support of experienced Tier 1 contractors these companies can make the transition to the new nuclear manufacturing and construction market.

9.3 The key requirements to enable these companies to achieve this are to:
- Develop a workforce which has a Nuclear Safety Culture and which is demonstrably SQEP to undertake their roles and responsibilities on projects.
- Develop robust Quality Assurance arrangements including Quality Plans for manufacturing and construction activities with agreed hold points for independent inspection.
- Deliver on time and in accordance with the agreed Quality, Manufacturing and Construction Plans.
- Develop a culture of “in doubt stop and ask”.

By following these principles UK industry can manufacture and construct a significant proportion of the new nuclear power plant in the UK.

9.4 The UK market for nuclear new build is developing with NNB GenCo firming up their plans for the construction of EPRs at Hinkley and Sizewell. The progress of the Developers will be posted on the NIA website, www.nuclearsupplychain.com.

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Appendix 1.1
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 the above 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 1.2

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 that 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 that 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 that 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 peer executes the intended action on the correct component.
- If the performer’s action is consistent with the intended action, the peer informs the performer that the action taken is correct.
- If the performer’s action is inconsistent with the intended action, the peer stops the performer.

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.

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**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”.

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**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.
II. Quality Arrangements

Appendix 2

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.
Further Reading

Appendix 3

There are a large number of documents available, often free on the internet, which may help potential Tier 3-4 contractors in their decision making. Some of these are listed below. Internet links have been provided rather than referenced to formal paper documents.


2. The standard licence conditions are available at www.hse.gov.uk/nuclear/silicon.pdf


5. The Statement of Intent and Memoranda of Understanding between HSE and the Environment Agencies are at: www.hse.gov.uk/nuclear/legal.htm

6. The Office for Civil Nuclear Security is currently part of the Department for Trade and Industry. Information on the work of OCNS can be found on the DTI website: www.dti.gov.uk/energy/sources/nuclearpower/safetysecurity/security/page18896.html


The Nuclear Industry Association (NIA) is the trade association and representative voice of the UK’s civil nuclear industry. We represent 63,000 UK nuclear workers across more than 260 member companies.

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