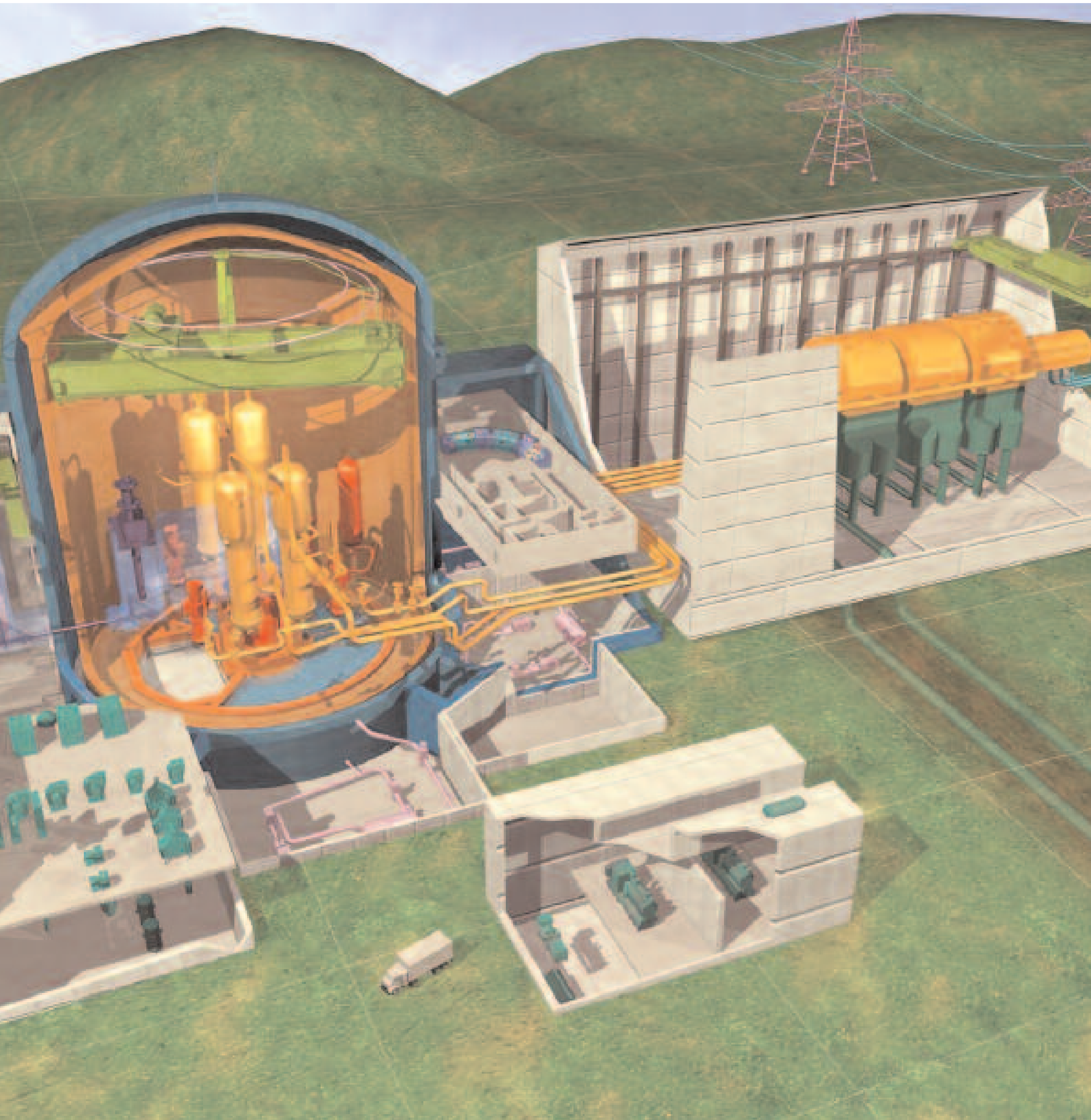
HSE

Health and Safety Executive

Public Report on the Generic Design Assessment of New Nuclear Reactor Designs

AREVA NP SAS and Electricité de France SA UK EPR Nuclear Reactor

Conclusions of the Fundamental Safety Overview of the UK EPR Nuclear Reactor (Step 2 of the Generic Design Assessment Process)



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Foreword

Our job is about protecting people and society from the hazards presented by the nuclear industry. As new nuclear power stations are now being considered for the UK, it is right for us as regulators to start our work to examine the safety and security aspects associated with those power stations' designs.

We are looking at the reactors within a new process called Generic Design Assessment (GDA), which seeks to get the nuclear regulators involved at an early stage in development of proposals for new nuclear power stations. GDA allows the technical assessments of the reactors to be conducted before the any specific nuclear site licence assessments are undertaken, thus identifying and resolving any potential regulatory issues before commitments are made to construct the reactors. The assessment is in several steps and includes initial and then more detailed examinations of the safety and security of the proposed reactors.

I am really pleased to be able to publish this report today and to set out the conclusions of our initial assessment of the UK EPR reactor. In summary, at this stage, we have found no safety shortfalls that would rule out its eventual construction on licensed sites in the UK.

The GDA process is new both for us and for the industry and we have set out very clear guidance on how it will be conducted. This report provides real proof that we are moving forwards in our assessment work, with the rigour, quality, and openness expected by the public.

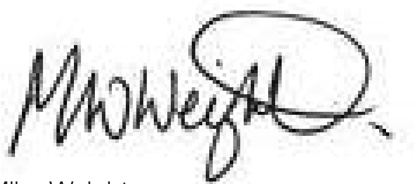
In doing this work we are setting new standards in efficiency. For example we have set up a Joint Programme Office with our colleagues at the Environment Agency so that the industry has a one-stop shop for nuclear regulatory issues.

We are also undertaking our assessment work in a more open manner than seen in the UK before. We have set up new reactor assessment information websites, put leaflets in libraries and set up an e-bulletin system. The industry has supported this open approach by putting GDA announcements in the press, making their safety documentation available on their websites, and inviting comments from the public. By acting in such an open manner, we aim to earn public confidence in our work.

We have also put ourselves up for independent scrutiny. In 2006 we underwent a review by the International Atomic Energy Agency, and in the past few weeks, we have had an independent team look at how we have applied our GDA process. These reviews highlight that our regulation is effective and efficient, but they also help us identify areas for improvement and we will strive to learn from what they tell us.

There are challenges ahead. For example, we need more staff and we are actively recruiting to help us continue our assessment of new reactors and to ensure that people will continue to be properly protected if these reactors are eventually constructed.

If you have any comments on this report I will be pleased to hear from you, especially if you can help us in our drive for continuous improvement.



Mike Weightman
HM Chief Inspector of Nuclear Installations and Head of HSE's Nuclear Directorate.

Executive summary

The role of the Health and Safety Executive's (HSE's) Nuclear Directorate (ND) is to protect people and society from the hazards of the nuclear industry. To achieve this aim in the light of proposals for construction of new nuclear power stations in the United Kingdom, we have been assessing the nuclear safety and security aspects of four reactor* designs. We are examining these particular designs as they have been identified by the Department for Business, Enterprise and Regulatory Reform (BERR) as those most likely to be built in the UK, and which would thus be those that are most likely to present a hazard to the public.

The assessment being undertaken by HSE, along with the Environment Agency, is part of a new process called Generic Design Assessment (GDA). This report is an interim progress report on our GDA assessment and it summarises our findings to date on safety and security aspects. In parallel, the Environment Agency is publishing a separate report on its assessment of environmental aspects.

Progress through GDA does not guarantee that any of these designs will eventually be constructed in the UK. What it does do is allow us to examine the safety and security aspects at an early stage when we can have significant influence, and to make public reports about our opinions so that:

- the public can be informed about our independent review of the designs; and
- industry can have clarity on our opinions and thus take due account of them in developing new construction projects.

This new GDA process is being conducted with a high degree of openness. We have made information about our process and the reactor designs available to the public via our website www.hse.gov.uk/newreactors. Furthermore, the public have been encouraged to comment on the reactor designs and we are considering these comments, along with the responses from the designers, within our assessment.

A further advantage of the GDA process is that it has been designed to allow the nuclear regulators (HSE and the Environment Agency) to work closely together. In support of this we have set up a Joint Programme Office, which administers the GDA process on behalf of both Regulators, providing a 'one-stop shop' for this phase of the assessment of potential new nuclear power stations. We believe this is improving efficiency both for the Regulators and the Industry, and it will help to provide more effective regulation of potential hazards.

There are four steps to the GDA process. Step 1 of the GDA was devoted to preparatory work and we made a statement on our website in August 2007 that this was complete and that Step 2 was commencing.

This report is the first of our public statements for the UK EPR reactor and it comes at the end of GDA Step 2. The aim of Step 2 was to provide an overview of the fundamental acceptability of UK EPR within the UK regulatory regime. It was also intended that Step 2 would allow HSE inspectors to familiarise themselves with the design and provide a basis for planning subsequent assessment work.

* In this report, the word 'reactor' can be taken to cover all nuclear safety and security related areas of the proposed nuclear power station design.

To achieve these aims, HSE has undertaken a high-level review of the claims of Electricité de France (EDF) and AREVA for a number of different safety aspects of the UK EPR reactor, and we have considered the security aspects of the design.

In summary, we have not found any safety or security shortfalls that are so serious as to rule out at this stage eventual construction of the UK EPR on licensed sites in the UK.

As anticipated, our assessment has identified a number of topics that will need to be addressed in more detail during GDA Step 3 and Step 4, should the UK EPR proceed through to the next steps of the GDA process. In this event, we will summarise our progress on these topics in a public report at the end of Step 3 and in a final GDA report at the end of Step 4.

Background

In response to growing interest in nuclear power and in anticipation of possible applications for new build in the UK, HSE began development in 2005 of a progressive generic design assessment approach for new nuclear power stations. HSE outlined the proposed assessment process in its Expert Report on new energy technologies, which was submitted to DTI* in June 2006 to inform the Government's Energy Review. The Government subsequently asked HSE to fully develop its assessment proposals and this led to the production of guidance on HSE's GDA process for new nuclear power stations, which was published in January 2007 and updated in July 2007.

HSE considers that the GDA approach not only offers benefits to an expanding nuclear industry, but also strengthens HSE's position as an independent regulator with a focus on protecting workers, the public and society, by ensuring that it has sufficient time to address regulatory and technical issues relating to a design for a new nuclear power station, in advance of and separate from any public planning inquiries based on a site-specific proposal.

Following on from its Energy Review, the Government published an Energy White Paper in May 2007, alongside which DTI launched a public consultation on the future of nuclear power. At the same time, DTI invited interested parties to submit proposals to the Regulators for reactor designs to be subject to GDA. In the event, four designs were proposed which DTI (BERR) confirmed were each suitable for the regulators to start GDA assessment. The four designs were:

- ACR-1000 (Atomic Energy of Canada Limited)
- AP1000 (Westinghouse)
- ESBWR (GE-Hitachi)
- UK EPR (EDF and AREVA)

Based on DTI's advice that there was potential support from industry for building these four designs, HSE formally started a dialogue with each 'Requesting Party' in July 2007. In parallel, the Environment Agency also began its regulatory assessment work. HSE and the Environment Agency's work on GDA has been co-ordinated by a Joint Programme Office, which has been set up specifically for this project and is based in HSE's Merseyside headquarters.

* At the time, the Department of Trade and Industry (DTI) was the lead department for UK Government energy policy. This role now falls to the Department for Business, Enterprise and Regulatory Reform (BERR).

Having considered the views expressed during its nuclear public consultation, the Government published a further White Paper on the future of nuclear power* on 10 January 2008. This concluded that it would be in the public interest to allow energy companies to invest in new nuclear power stations. To ensure that people and society are properly protected, HSE will continue to apply the GDA process to the designs which are most likely to be chosen for construction in the UK. In allocating resources to this ongoing GDA process, HSE will therefore take due account of advice from the Government and others about the designs that are considered most likely to be progressed for construction.

Introduction

The safety of nuclear installations is achieved by good design and operation, but it is assured by a system of regulatory control at the heart of which is the nuclear site licensing process. This requires a licence to be granted before any construction work can start. The licence is granted, after assessment of the application, to a corporate body (eg an operator) to use a site for specified activities. In doing this we look at the siting and organisational factors. Licensing and the licence conditions apply throughout the lifetime of an installation from manufacture, through construction, commissioning, operation, modification and on to eventual decommissioning.

Following renewed interest in nuclear power in the UK, HSE introduced a new procedure for assessing the safety of new nuclear power stations. The updated arrangements are based on a two-phase process which separates the design assessment from the site-specific licensing assessment (Phase 2).

Phase 1, termed Generic Design Assessment (GDA), is a review of the safety features and ultimate acceptability of nuclear reactor designs. It is undertaken independently from any specific site. The process will allow a rigorous and structured examination of detailed safety and security aspects of the reactor designs, and is likely to take around 3.5 years to complete.

If successful, we will issue a 'Design Acceptance Confirmation' – a statement that the design is acceptable for nuclear safety and security. Guidance on the GDA process is provided in *Nuclear power station generic design assessment – guidance to requesting parties*[1] and *Guidance document for generic design assessment activities*.[2]

Phase 2 will involve an applicant seeking a nuclear site licence to construct and operate such a reactor at a specific site (or sites). Phase 2 will take approximately one year and will enable HSE to carry out a site licence assessment, in which we will examine the proposed design, the site and the management organisation of the operating company. If the application is judged to be acceptable we will grant a Nuclear Site Licence. More information on the licensing process can be found in *The licensing of nuclear installations*.[3]

Phase 1 (the GDA process) consists of four steps:

- Step 1, which was completed for UK EPR in late August 2007, was for the preparatory part of the design assessment process. The majority of the work was undertaken by EDF and AREVA, as the Requesting Party, in assembling the safety submissions for Step 2. It involved discussions between the Requesting Party and HSE to ensure a full understanding of the requirements and processes

* *Meeting the Energy Challenge: A White Paper on Nuclear Power* CM 7296 The Stationery Office January 2008

that would be applied, and to arrive at formal agreements to allow HSE to recover its costs associated with the assessment from the Requesting Party.
- Step 2, which is completed with the publication of this report, was an overview of the fundamental acceptability of the proposed reactor design concept within the UK regulatory regime. The aim was to identify any fundamental design aspects or safety shortfalls that could prevent the proposed design from being licensed in the UK. It also introduced HSE inspectors to the design and provided a basis for planning subsequent assessment. This report provides HSE's findings and the conclusions of the fundamental overview.
- Step 3 will be a system design safety and security review of the proposed reactor. The general intention will be to move from considering the fundamental safety claims of the previous step to an analysis of the design, primarily by examination at the system level and by analysing the Requesting Party's supporting arguments. From a security perspective, the foundations for developing the conceptual security plan will be laid through dialogue with the Requesting Party.
- Step 4 is designed to move from the system-level assessment of Step 3 to a detailed examination of the evidence given by the safety analyses, on a sampling basis. We will also seek to examine the proposed conceptual security plan for UK EPR. If the design is considered acceptable, we will issue a 'Design Acceptance Confirmation' at the end of Step 4. There may be certain exceptions or exclusions attached to the Design Acceptance Confirmation, eg on any issues that are not fully resolved, or where the design is not sufficiently complete.

The Design Acceptance Confirmation could then be carried forward to support a site-specific nuclear site licence application. It is the intention that there will be no reassessment of aspects included in the Design Acceptance Confirmation except, of course, to address any of the exceptions or exclusions. The assessment of UK EPR during Phase 2 should therefore be limited to any site-specific aspects and any proposed design changes.

HSE expectations for modern reactors

HSE expects that any nuclear reactor that is built in the UK in the near future will be of a robust design that provides adequate protection against potential accidents to a degree that meets modern international good practice. In other words, reactors built in the UK should be at least as safe as modern reactors anywhere else in the world.

Potential accidents in a reactor could arise from failures of equipment, for example pipe leaks or pump breakdowns, or from hazards such as fires, floods, extreme winds, earthquakes, or aircraft crash. HSE expects the reactor to be designed to withstand all these scenarios. We expect to see a robust demonstration of three key features: the ability to shut down the reactor and stop the nuclear chain reaction; the ability to cool the shutdown reactor; and thirdly the ability to contain radioactivity.

The adequacy of protection provided should be demonstrated by a comprehensive safety analysis that examines all the faults and hazards that can threaten the reactor. This should show that the reactor design is sufficiently robust to withstand these faults and hazards and that it operates with large margins of safety. HSE expects an approach of defence-in-depth to be adopted. This means that if one part of the plant fails then another part is available to fulfil the same safety duty. To maximise protection, different backup systems and other safety features can be provided. This multi-barrier protection concept should be repeated until the risk of an accident is acceptably low.

In modern reactor design, these concepts are well understood and HSE therefore expects to see a comprehensive demonstration that an acceptably low level of risk has been achieved. The principles used by HSE in assessing whether the safety demonstration is adequate are set out in the document *Safety assessment principles for nuclear facilities*[4] (SAPs). To help ensure HSE applies good international practice in its assessment, the SAPs have recently been revised and updated and this included benchmarking against the IAEA Safety Standards.

HSE expectations from the GDA process

Details of HSE's expectations for Step 2 of the GDA process can be found in the GDA guidance.[1] For the completeness of this report a key section of that document, which describes what HSE expects from a Requesting Party, is repeated in Annex 1.

Some of the items listed in Annex 1 (specifically items 1, 3, 4, 7 and 16) are generic and have been considered as an integral part of all the assessments described in this report. In the other cases, the items relate to the specific topic areas assessed and reported below.

Details of the expectations of the Office for Civil Nuclear Security (OCNS) for Step 2 can be found in the OCNS guidance.[2] In summary, the expectation was that a Requesting Party would provide sufficient information to allow an initial review of design submissions to enable OCNS to become familiar with the technology, and to form a view of the measures required to deliver appropriate security.

A key aim of this report is to provide a summary of the information HSE has gathered from EDF and AREVA during Step 2 to address the points listed in Annex 1.

The safety standards and criteria used and links to WENRA reference levels and IAEA Standards

The main document used for the Step 2 assessment was the 2006 edition of HSE's *Safety assessment principles for nuclear facilities*[4] (SAPs). We also benchmarked the relevant SAPs against the Western European Regulators' Association (WENRA) reference levels[5] and the IAEA document *Safety of Nuclear Power Plants: Design – Requirements*.[6]

Assessment strategy

The aim of Step 2 was a high-level review of the fundamental safety issues. In particular we focused on the claims made by the Requesting Party in the safety documentation.

Throughout this report the words 'claims, arguments and evidence' are used. The concept behind these words is explained below by using a simple everyday analogy.

> Many people purchase cars and one criterion for the purchase is often the claimed fuel economy, one important part of which is the urban cycle. So if the manufacturer states in the brochure that the urban cycle is 55 mpg, that is a **claim**. Responsible manufacturers do not leave it at that and often they give **arguments**, within the car's brochure, why the car can meet its urban cycle claim. Valid arguments might be the development of advanced engine

management systems, use of advanced lightweight construction materials, development of low rolling resistance tyres and many more. In addition, **evidence** can be provided by the manufacturer by publishing the results of independent tests on the car's performance under urban cycle conditions.

So, for the Step 2 assessment, we have focused on the claims. Our objective was to make sure that the claims were complete and that they were reasonable in the light of our current understanding of reactor technology. Examination of the detailed arguments and evidence will come in our assessment during Step 3 and Step 4 of GDA.

In our Step 2 assessment, we have made a judgement on the claims in EDF and AREVA's safety, security and environmental report (SSER)[7] when compared against the relevant parts of HSE's SAPs. To help us in this task, we developed a strategy to define both the technical areas to be covered and those SAPs most relevant for Step 2 of the GDA process.

Main features of the design and safety systems

The UK EPR as proposed to us by EDF and AREVA is described in the *UK EPR Safety, Security and Environmental Report* .[7]

EDF and AREVA describe the UK EPR as an evolutionary four-loop pressurised water reactor, with a net electrical output of 1660 MWe being an evolution of the N4 and Konvoi designs. The N4 series is the latest family of four PWRs commissioned in France at the end of the 1990s, and the Konvoi is a series of German PWRs commissioned in the early 1990s. EDF and AREVA claim that the UK EPR meets the 1993 Franco–German Safety objectives and has a good level of compliance with the European Utility Requirements. The design therefore draws maximum benefit from the operating experience of the French and German fleets.

The UK EPR core can accommodate different fuel assembly designs. There are 241 fuel subassemblies, each containing 265 fuel rods. It is designed for enrichments up to 5wt% U^{235}, for high fuel burn-up (up to 60 GWd/t) and it can operate with up to 50% mixed oxide fuel (MOX) load.

The core is contained in a reactor pressure vessel (RPV), and the reactor coolant system is a conventional design. The primary heat transfer mechanism is pressurised light water in four loops circulating through the core, transporting the heat to the four steam generators. The steam from the steam generators is transported to the single turbine by the secondary circuit pipework.

EDF and AREVA claim that the general layout of primary and secondary circuits closely resembles the N4s, with a few significant differences:

- Larger primary and secondary water volumes to increase the thermal inertia of the system and slow down changes of temperature in transients.
- The provision of a larger RPV. There is a heavy neutron reflector (baffle) between the core and the RPV to reduce the neutron fluence on the vessel, which is claimed to reduce the effect of irradiation embrittlement of the RPV.
- There are no RPV bottom penetrations: removal of the bottom mounted in-core penetrations has the advantage of removing the risk of having to repair leaking penetrations in very adverse conditions, as well as that of facilitating implementation of a core catcher in the reactor pit.

EDF and AREVA claim that the main safety systems, safety injection, steam generator emergency water feed and supporting electrical systems are designed along a four-train architecture (which gives four separate lines of protection for design basis accident sequences). Each safety train is set up in a separate building. Furthermore, two of these four buildings are 'bunkerised' to strengthen their resistance to external hazards (as is the fuel building).

EDF and AREVA claim that the UK EPR safety systems are designed to mitigate the consequences of plant failures, ensuring reactor shutdown, removal of decay heat and prevention of radioactive releases. Key systems identified by EDF and AREVA are:

Reactor shutdown

- Reactivity is controlled by adjusting the boron concentration in the primary circuit and by adjusting the position of the rod control cluster assemblies (RCCA). The RCCAs are a fast shutdown system consisting of 89 rod control assemblies containing neutron-absorbing materials. The extra borating system provides high-pressure boration to shut down some reactor accidents.

Emergency cooling

- The emergency feedwater system supplies water to the steam generators to maintain water level and remove decay heat following a loss of normal feedwater supplies.

- In the unlikely event of a loss of cooling accident, there is a Safety Injection/Residual Heat Removal System consisting of four independent trains, each providing injection capability by an accumulator pressurised with Nitrogen gas, a Medium Head Safety Injection System and a Low Head Safety Injection System. The High Head Injection System conventional in other pressurised water reactors has been replaced by the Medium Head Safety Injection System. This has been made possible by the large volume of reactor water and EDF and AREVA claim this can have benefits in some accident scenarios. Each of the four safety injection trains is provided with a separate suction connection to the In-containment Refuelling Water Storage Tank (IRWST).

- The IRWST is the source of borated water for safety injection and containment cooling in the event of a severe accident. In addition, the IRWST collects water discharged from the Reactor Coolant System, allowing it to be recirculated by the Safety Injection System.

Containment

- The UK EPR has a double concrete containment. The inner containment is made of pre-stressed concrete with a steel liner. The outer containment is made of reinforced concrete, much thicker than the N4s, and is primarily intended to withstand severe external hazards (airplane crash, explosion etc). There is a containment heat removal system to control the containment pressure in the event of a severe accident.

Core meltdown

- EDF and AREVA claim that the conception of the UK EPR decreases the potential core meltdown frequency by a factor 10 compared to plants presently in operation. In addition, in the unlikely event that core melt should happen, EDF and AREVA claim that the following UK EPR systems would limit the consequences:
  - a depressurisation system to prevent pressurised meltdown;
  - a 'core catcher' to cool and contain the molten Corium (ie the mix of fuel and reactor internals resulting from the meltdown of the core) if it were to escape the RPV;
  - implementation of some 40 catalytic recombiners inside the containment, to significantly reduce the likelihood of hydrogen reaching a potentially explosive concentration;
  - a spray system dedicated to pressure control and cooling inside the containment after meltdown.

Summary of HSE findings

This section summarises the findings of the fundamental safety overview which comprised Step 2 of the GDA process.

Quality management and safety case development arrangements

HSE considers that leadership and management for safety are key to achieving appropriate high levels of safety, and establishing and sustaining a positive safety culture.

HSE believes that good quality design and safety documentation is dependent on an organised management system, effective procedures (especially for change control) and sufficient appropriately trained and qualified staff. As part of the examination of EDF and AREVA claims in this area, HSE and the Environment Agency jointly inspected the offices of EDF and Areva in France. To assist us, we were joined by an inspector from the French nuclear regulatory body, Autorité de Sûreté Nucléaire (ASN).

The inspection found that EDF and AREVA have developed a UK-EPR GDA organisation, which has an element of independence from its parent organisations yet benefits from the significant resources each brings to the joint undertaking. This GDA project organisation has set clear organisational interfaces and responsibilities that are necessary to co-ordinate the day-to-day operations of the project. Both companies work in a spirit of mutual co-operation, presenting a common interface with the UK Regulators. Roles and responsibilities for posts within the UK-EPR GDA project team are described in a Project Quality Assurance Plan, as are the interfaces with organisations that have been contracted to carry out some aspects of the project (including submission preparation) and independent safety assessment. EDF and AREVA recognise the quality function as central to the delivery of projects and have qualified and experienced staff working within these functions.

We noted that the EDF and AREVA quality management arrangements are written to comply with national and international quality standards, including the French Ministerial decree (*Arrêté du 10 août 1984 relatif à la qualité de la conception, de la construction et de l'exploitation des installations nucléaires de base*), and these cover the design and whole life cycle of the nuclear installation. In addition, management systems based on ISO 9001, ISO 14001 and IAEA 50-C-Q[8] provide an appropriate set of requirements against which EDF and AREVA have developed their arrangements.

We found that auditing and review processes are in place for both organisations and these have operated for some years as a standard element in their Quality Assurance (QA) systems. Work is ongoing to extend the coverage of audits and reviews to GDA-related activities and organisation. We noted that arrangements have been established between EDF and AREVA to ensure that documents relating to the GDA process are properly controlled. Both companies have established electronic document management systems, with appropriate access rights, control authorisation and change protocols in place.

We believe that the arrangements for the production and review of safety documentation within the joint organisation are robust with authors from one organisation and reviewers from the other. Rolls Royce has been commissioned to perform an independent nuclear safety assessment role, with the recommendations being considered by a Design and Safety Review Committee. We consider this a high level of scrutiny and in organisational terms it is similar to arrangements we would expect to see under a Nuclear Site Licence. Established change control processes have existed for many years within the EDF and AREVA individual organisations and the joint arrangements supplement these. We found that review and authorisation of design changes were appropriate.

EDF and AREVA have significant technical resources, as may be expected from such large, well-established organisations, and the commitment to the ongoing recruitment of core skills was obvious to us. Succession planning is an integral part of both organisations' strategies and the retention of skilled and experienced staff is not a problem for either company. Both organisations' approaches to identification of skills, recruitment, training, mentoring and retention are impressive.

Overall, we conclude that EDF and AREVA's quality management arrangements provide a sound basis for this stage of the UK GDA process.

Standards

As noted above, HSE works on the basis of linking its SAPs to international standards, such as those of IAEA and WENRA. To evaluate detailed design information, we also use more detailed international standards such as International Electrotechnical Commission (IEC) standards, implemented by the British Standards Institution (BSI).

Our Step 2 examination of the EDF and AREVA documentation shows that it has used French standards or 'Eurocodes'. HSE has therefore asked EDF and AREVA to produce, as part of the future safety documentation submissions, a document demonstrating that the standards used are consistent with modern international good practice.

The approach to ALARP

In respect of 'as low as reasonably practicable' (ALARP), Step 2 of the GDA guidance[1] requires the Requesting Party to provide a description of the process being adopted to demonstrate compliance with the UK legal duty to reduce risks to workers and the public 'so far as is reasonably practicable' (SFAIRP). The GDA guidance goes on to say that HSE will undertake 'an assessment directed at reviewing the design concepts and claims' and, specifically, 'the approach to ALARP'. Hence whether or not ALARP has yet been demonstrated has not been assessed in Step 2; rather we have looked at high-level claims on how ALARP will be shown to be met by EDF and AREVA during Step 3 and Step 4.

EDF and AREVA's case is outlined in chapter C of the SSER[7] in which they describe a 20-year process of progressive safety improvement evolving from the N4 and Konvoi designs, claiming significant reduction in risk in comparison to these baseline plants. They also describe their efforts in relation to accidents and normal operation. EDF and AREVA claim low numerical risk estimates but their argument is not based solely on this element. They describe real safety improvements for operational dose such as materials selection, equipment design to minimise radiation levels, and reduced exposure time by designing for reduced maintenance. For accident risk, EDF and AREVA describe their consideration of a number of design options, eg to reduce the impact of containment bypass events associated with steam generator tube rupture events, and severe accidents where the intent is to both reduce likelihood and mitigate consequences, the latter by inclusion of the core catcher.

Overall we conclude that EDF and AREVA have provided an adequate description of the approach to ALARP for Step 2. Our assessment for Step 3 and beyond will consider whether or not the approach described by EDF and AREVA actually delivers a design for which the risks have been reduced ALARP.

The design basis analysis/fault study approach

For Step 2 of the GDA process, Section 2.5 of the GDA guidance[1] requires the Requesting Party to provide 'an overview statement of the approach, scope, criteria and output of the deterministic safety analysis'. The GDA guidance goes on to say that HSE will undertake 'an assessment directed at reviewing the design concepts and claims' to include, among other things 'the design basis analysis/fault study approach'. Hence the detail of the deterministic safety case itself was not assessed in Step 2; rather the aim was to see that claims have been made in respect of the relevant SAPs, for example on the reactor core, design basis analysis and severe accidents. The arguments and evidence supporting these claims will be assessed in Step 3 and beyond.

The UK EPR is a mature design that has evolved making extensive use of the operating experience of existing generations of PWRs.

As part of the safety and fault analysis in support of the design of the UK EPR, EDF and AREVA have presented information on the following:

- Core stability – SSER[7] 2.D.3
- Design basis analysis – SSER[7] 2.P.2
- Severe accident evaluation – SSER[7] 2.S.2.

EDF and AREVA claim that the core will be stable under normal operation and fault conditions, such that there will be no uncontrollably large or rapid increases in reactivity due to any changes in temperature, power, xenon distribution or coolant voiding.

In the design basis analysis, EDF and AREVA claim to have carried out a comprehensive study to identify a complete set of faults (ie those things that could go ‘wrong’ on the reactor). The core transients resulting from these faults have been modelled using validated codes embodying appropriate assumptions and data. This includes, for example, assuming the worst combination of plant temperature, pressure and power distribution that could exist just before a fault occurred, and the worst possible performance by the safety systems after the fault occurs. Even with such pessimistic assumptions, EDF and AREVA claim that the plant has appropriate protection against these faults and that consequences such as, for example, melting of the fuel, are avoided. The methods used by EDF and AREVA to arrive at these conclusions will form an important part of our assessment in future steps.

Severe accidents have been addressed to identify necessary actions and provisions to contain large-scale fuel melting and prevent a large activity release from the containment building. The philosophy is not to attempt to contain the molten fuel and debris within the vessel by exterior cooling. Instead, a ‘core catcher’ is provided to contain the molten Corium (ie the mix of fuel and reactor internals resulting from any potential core meltdown). This allows the Corium to spread within a confined area to promote cooling, which is assisted with a passive flooding system, preventing escape from the containment.

Overall, we conclude that EDF and AREVA have carried out what appears to be an extensive study identifying all significant faults and analysing the effects on the core and where necessary making provision for the containment of severe accidents. In doing this they claim to meet the Fault Analysis SAPs covering Design Basis Analysis and Severe Accidents, identifying the relevant sections in the SSER.[7] The quality of the submission leads us to be confident that they will be able to substantiate their claims in the later Steps 3 and 4.

The probabilistic safety analysis (PSA) approach

For Step 2 of the GDA process, Section 2.6 of the GDA guidance[1] requires the Requesting Party to provide ‘an overview statement of the approach, scope, criteria and output of the probabilistic safety analysis’. The GDA guidance goes on to say that HSE will undertake ‘an assessment directed at reviewing the design concepts and claims’ and specifically in point 2.22 ‘the PSA approach’. Hence the PSA itself is not being assessed in Step 2; rather the aim is to see that appropriate claims have been made in respect of PSA SAPs and that there is a reasonable prospect of meeting the SAPs Basic Safety Objective numerical targets. The arguments and evidence supporting these claims will be assessed in Step 3 and beyond.

EDF and AREVA’s report of their PSA is outlined in Chapter R of their submission[7] and it includes discussion of: objectives and targets, methodology (including common cause failure and data analysis) and results, risk reduction and internal and external hazards. The uses made of the PSA include design assist, consideration of the balance of the design, justification of test and maintenance activities and confirmation of robustness against hazards. All reactor operating states are claimed to have been included and all types of internal and external hazards covered. In addition, EDF and AREVA claim to have addressed accidents associated with the spent fuel pool and analysis of long-term (>24 hour) sequences. Initiating event analysis is based largely on French PWR experience and EDF and AREVA list a fairly typical set of event groups. The way in which the initiating event frequencies are determined is also discussed and EDF and AREVA use an expert judgement process, in preference to a statistical approach, to establish the frequency of postulated initiating events that have not occurred. Their approach to common cause failure is also discussed.

EDF and AREVA's preliminary estimate of the UK EPR total core damage frequency is of the order of 1 x 10^{-6}/year which, in conjunction with the arguments presented, gives HSE a strong indication that the Basic Safety Objective numerical targets set out in our SAPs will be met.

HSE recognise that PSA provides **estimates** of the risks, not a precise measure of them, and that these cannot be readily compared between designs. The way in which uncertainty over input parameters and sensitivity to assumptions affects the results will feature in the more detailed assessment in Step 3 and beyond.

Overall, we conclude that EDF and AREVA have provided an adequate overview of the approach, scope, criteria and output of the PSA they have produced.

Structural integrity

For Step 2 of the GDA process, HSE's review of design concepts and claims for the integrity of metal components and structures includes aspects of:

- the safety philosophy, standards and criteria used;
- the design basis analysis/fault study approach;
- the overall safety case scope and extent;
- an overview of the claims in a wide range of areas of the safety analysis.

A fundamental aspect of the SAPs for integrity of significant safety-related metal components and structures (pressure vessels and piping, their supports and vessel internals) is the identification of those components where the claim is that gross failure is so unlikely that the consequences can be discounted from consideration in the design of the station and its safety case. For such components, the SAPs require an in-depth explanation of the measures over and above normal practice that support and justify the claim. In these circumstances, the emphasis falls on the arguments and evidence to support the claim that gross failure is so unlikely that it can be discounted. Similar claims have featured in safety cases for operating nuclear stations in the UK and the supporting arguments and evidence have been considered by HSE.

For the UK EPR, EDF and AREVA have implied (ie without explicit claims) in the submission that gross failure of the reactor pressure vessel (RPV), of the four steam generators, or the pressuriser will not occur. On the other hand, gross failure of certain piping is explicitly claimed to be discounted based on a set of arguments and evidence referred to as 'break preclusion'.

The Step 2 review has not examined in detail the arguments and evidence to support claims on structural integrity of metal components and structures. However, some of the items in question are long-lead time components and, to reduce their regulatory risk, EDF and AREVA may wish to ask HSE to assess such items at an early stage.

Relevant general matters which are likely to arise in the Step 3 and Step 4 assessment are:

- material specification for ferritic forgings and welds to be used in main vessels;
- design of the RPV, which, as submitted for Step 2, indicates a circumferential weld at core mid-height;
- nature of the arguments and evidence to support integrity claims for some piping ('break preclusion').

Overall, we conclude that EDF and AREVA have provided an adequate overview of the claims made for structural integrity of metal components and structures. However, for Step 3 and Step 4 there will need to be an explicit listing of those components where gross failure is claimed to be so unlikely it can be discounted. EDF and AREVA have also provided some coverage of the type of arguments and evidence to support the claims.

Waste and decommissioning

The objective of HSE's Step 2 GDA radioactive waste and decommissioning assessment was to identify any fundamental aspects or safety shortfalls that could prevent the proposed design from being constructed on a licensed site in the UK. The Environment Agency have also assessed radioactive waste and decommissioning proposals and their findings are reported separately.

For Step 2 of GDA, Section 2.18 of the GDA guidance[1] requires the Requesting Party to provide 'information on radioactive waste and decommissioning'. The GDA guidance goes on to say that HSE will undertake 'an assessment directed at reviewing the design concepts and claims', to include 'any matters that might be in conflict with UK Government policy'. The aim of the Step 2 assessment is to identify whether the strategies put forward for radioactive waste and decommissioning are likely to comply with Government policy, SAPs and existing HSE guidance on waste and decommissioning matters. The arguments and evidence supporting these claims will be assessed in Step 3 and beyond. It should be noted that the UK Government recently announced its intention to make it a legal requirement for funded decommissioning plans to be approved by the Government before construction of new reactors commences.

Chapter K of Volume 2 of the UK EPR SSER[7] presents a breakdown relating to radioactive discharges and waste streams. EDF and AREVA claim that where appropriate wastes, including short-lived low level waste (LLW), will be stored on site before being sent for disposal in existing and future national disposal facilities. They also intend that spent fuel is to be stored in an interim pond facility, pending the availability of disposal routes.

Chapter T of Volume 2 of the SSER[7] presents the design principles which have been employed to facilitate decommissioning and catalogues some of the provisions (eg limiting the use of cobalt, which helps to reduce the level of radioactivity around the plant).

There are no indications of any waste streams which would present particular difficulties, and this is sufficient for HSE for Step 2. However, there is no attempt to demonstrate that the waste streams would meet the appropriate criteria for disposal in a LLW facility or an intermediate level waste (ILW)/spent fuel repository. HSE will therefore be seeking further detail of the acceptability for disposal of waste arisings during subsequent steps of the GDA process. Equally, there is no demonstration that facilities will be provided for through-life storage of wastes and spent fuel and we will be asking EDF and AREVA for further information for GDA Step 3.

Civil engineering and external hazards

As noted above, for Step 2 of the GDA process the Requesting Parties were required to provide a Preliminary Safety Report (PSR) that included sufficient information for the HSE fundamental safety overview assessment, in particular:

- design philosophy and a description of the resultant conceptual design;
- overview of the approach, scope, criteria and output of the deterministic safety analyses;
- specification of the site characteristics used as the basis for the safety analysis (the 'generic siting envelope');
- reference to and justification of standards and design codes used.

A review of these aspects has been undertaken in the light of civil engineering, external hazards and siting. External hazards include potential challenges to the plant that arise from outside the site, such as extreme winds or earthquakes. Our assessment has found that EDF and AREVA have clearly identified the design classification for structures and plant in what appears to be a systematic manner. This has been linked to design codes and standards. These standards have been specifically developed for use in the French nuclear programme. However, it is understood that they have been benchmarked at a principle level against Eurocodes. The standard design incorporates a foundation which is primarily designed for siting on a range of rock or soil sites, which it is anticipated would envelope the majority of existing UK sites.

We note that EDF and AREVA have not undertaken a review of the design against other HSE requirements, such as the requirements of the Construction (Design and Management) Regulations 2007. These Regulations apply during the design phase and so we expect them to be addressed later in the GDA process.

The design basis external hazards applied to the structures and plant have been clearly identified by EDF and AREVA as have the limitations on the standard design. It is recognised by EDF and AREVA that there are a number of hazards, such as external flooding, the magnitude of which cannot readily be determined until a site(s) has been identified. There has been a limited attempt to put the design basis hazards into a UK context at this stage. The standard design includes specific consideration of aircraft impact of a non-accidental nature. We will review the completeness of the external hazards considered by EDF and AREVA in more detail in the next steps of the GDA process.

Overall, we conclude that the submission is sufficient at this stage to allow progression to Step 3 of the assessment process. EDF and AREVA have acknowledged the need for fully placing the design into a UK context, and for considering other UK-specific regulations which apply to the design of installations such as this.

Internal hazards

For Step 2 of the GDA process, Section 2.5 of the GDA guidance[1] requires the Requesting Party to provide 'an overview statement of the approach, scope, criteria and output of the deterministic safety analyses'. The deterministic analysis includes, among others, consideration of internal hazards. The guidance goes on to say that HSE will undertake 'an assessment directed at reviewing the design concepts and claims'. Hence the analysis of internal hazards itself is not being assessed in Step 2; rather the aim is to see if appropriate claims have been made against the internal hazard related SAPs. The arguments and evidence supporting these claims will be assessed in Step 3 and beyond.

The overall objective of the hazard principles is to minimise the effects of internal hazards such as fires. In particular, we want to ensure that internal hazards do not adversely affect the reliability of safety systems. One of the threats posed by hazards such as fires is that they can, if not properly addressed, affect a range of different plant at the same time. This is called a 'common cause' effect and it is important to ensure that this is avoided. Safety systems and safety-related systems should therefore be qualified to withstand the effects of internal hazards or they should make appropriate use of redundancy, diversity, separation or segregation. The SAPs therefore require that a comprehensive and systematic approach be used to identify the internal hazards and protection provided. This should include combining the hazards with other potential simultaneous hazards and/or faults and taking into account plant out for maintenance.

EDF and AREVA addressed their compliance with the internal hazard SAPs in their response to a regulatory technical query. The query contained cross-references to the EDF and AREVA SSER[7] which contained additional information supporting compliance with the SAPs.

EDF and AREVA have identified a range of potential internal hazards. Separation of systems and components important to safety is principally achieved, outside primary containment, with two-hour fire-rated hazard barriers and within containment with a combination of structural walls, local fire barriers, distance and equipment qualification. The passive approach to ensuring segregation outside containment is the preferred approach and is consistent with IAEA recommendations.[9]

Overall we note that EDF and AREVA claim compliance with the internal hazard SAPs and conclude that they have provided an adequate overview of the concept and approach being adopted to address internal hazards within the deterministic safety analysis. This approach provides reasonable confidence that EDF and AREVA will be able to substantiate their claim in Step 3 and Step 4.

Reactor protection and control

The objective of the Step 2 GDA Control and Instrumentation (C&I) assessment was to identify any fundamental design aspects or safety shortfalls that could prevent the proposed design from being constructed on a licensed site in the UK. In particular, to determine whether an adequate claim of compliance exists for those C&I SAPs which address fundamental design aspects.

EDF and AREVA provided a number of submissions relevant to C&I assessment including a specific response against those C&I SAPs that address fundamental design aspects. The main submission[7] describes the C&I. The C&I provisions claimed include those that would be expected of a modern nuclear reactor such as:

- safety systems (eg reactor shutdown systems such as the protection system that initiates insertion of neutron-absorbing rods);
- plant control and monitoring systems (eg the process automation system and process information and control system);
- main control room with backup via the remote shutdown station; and
- communications systems allowing information transfer both within and external to the plant.

An important aspect of the safety demonstration is the classification of systems important to safety and the application of appropriate design standards. The accepted practice is that the standards are more onerous for those systems that are more important to safety. In the UK the importance to safety is typically judged by a combination of deterministic and probabilistic criteria. The deterministic analysis considers the functions performed by the system, such as to shut down the reactor, and the probabilistic analysis considers the reliability required of the system. The EDF and AREVA UK EPR C&I design concept reflects French custom and practice, and is largely based on French standards (eg RCC-E) and French regulatory requirements.

During Step 3 and Step 4, EDF and AREVA will address the issue of the use of international standards (IEC and IAEA), grading of the importance to safety through the use of three system classifications (ie safety system, safety-related system and non-classified), and use of probabilistic criteria in the design of C&I systems important to safety.

The EDF and AREVA submission provides a satisfactory overview of the C&I provisions and adequate claims of compliance for all of the fundamental C&I Step 2 SAPs. In addition, the Step 2 C&I assessment has not identified any fundamental issues that would prevent EDF and AREVA from proceeding to Step 3.

Novel features

In the context of HSE's GDA assessment, the definition of novel agreed with all Requesting Parties is any major safety system, structure or component of a type not previously licensed to operate in a nuclear power plant anywhere in the world.

EDF and AREVA claim that UK EPR is an evolutionary development of existing reactor systems particularly the operational French N4 and German Konvoi plants. The only system that can be considered novel is the core melt retention system.

The robust design of the UK EPR should avoid accidents that could damage the reactor core. Although such accidents would be extremely unlikely, we still require them to be considered in the safety analyses. Part of the protection designed-in to the UK EPR concept is the core melt retention system (in effect a 'core catcher'). This allows the melt to spread within a confined area to promote cooling, which is assisted with a passive flooding system, preventing escape from the containment. There are significant merits to this claim. However, the arguments and evidence to support it will, in our view, be challenging to demonstrate with an appropriate degree of confidence. We will look at this further in Step 3 and Step 4.

Long-lead items

Large plant items such as the reactor pressure vessel and steam generators take a long time to manufacture and they are typically among the first items to be ordered. If there is a possibility that some of these orders could be placed while the GDA process is still ongoing then, to reduce regulatory risk, EDF and AREVA may wish to ask HSE to assess such items at an early stage.

Currently there is no specific request from EDF and AREVA related to long-lead items.

International Atomic Energy Agency technical review

As part of the Step 2 assessment, HSE requested that IAEA undertake a technical review of all four Requesting Parties' designs against the relevant IAEA standards. The reason for this is that the IAEA has ready access to considerable expertise on a wide range of reactor types in operation and under construction throughout the world.

The findings from the IAEA technical review have been taken into account by HSE during our own assessment. IAEA did not reveal any fundamental safety problems with the UK EPR. All of the findings in the report are recommendations for further assessment work, particularly in areas that are are novel or technically complex, and we will take these into account in Step 3 and Step 4 as appropriate.

Any matters that might be in conflict with UK Government policy

HSE has found no matters in the EDF and AREVA submission that are in conflict with UK Government policy.

Security

OCNS has begun familiarisation with the UK EPR design during Step 2. Initial discussions have been held with EDF and AREVA and a review of the documentation provided to date has been carried out. It is concluded that the design appears to be sufficiently developed to give confidence that during Step 3 and Step 4 of the GDA process a conceptual security plan can be developed which will provide the appropriate resistance to postulated threats. This outcome will of course depend on the detailed review of the design during Step 3 and Step 4 and adoption of any UK-specific design changes deemed necessary (eg UK-specific security furniture).

Discussions with the relevant French authorities are progressing to allow the transfer of sensitive nuclear information between countries to support the GDA process and its timescales. A process is in place to allow vetting clearances to be granted by the Director of OCNS to facilitate the exchange of such information.

Public involvement process

HSE has emphasised the importance it attaches to openness in the GDA process, and the opportunity for public involvement at key stages is an important part of this. By this means, we aim to give the public confidence in the GDA process.

Members of the public have been able to view the design information provided by EDF and AREVA for the GDA process. A comprehensive safety, security and environmental report for the UK EPR was made available on a joint EDF and AREVA website from 10 September 2007, www.epr-reactor.co.uk. The same information was also made available upon request in CD-ROM format.

In addition, to help encourage public participation, EDF and AREVA made announcements in the national press at that time to publicise the GDA openness arrangements. To supplement these the Regulators (HSE and the Environment Agency) published a leaflet, *Designs for potential new nuclear power stations: Public involvement*, which was distributed to public libraries. We also set up a new-build e-bulletin system and wrote to all UK Members of Parliament, Peers, Scottish Members of Parliament and Welsh Assembly Members to inform them of the public involvement opportunity.

Members of the public were invited to view the design information and comment on it – either electronically or in writing. Comments relevant to the published design information were forwarded to EDF and AREVA, to respond to the person who made the comment within 30 days of receipt. The regulators monitored this process and where appropriate the issues raised have been considered as part of our assessment during Step 2. Only those comments made between 10 September and 4 January 2008 have been considered in Step 2; any issues raised in comments made after that date will be considered in our assessment during GDA Step 3.

The number of website hits recorded indicated a good level of awareness of and interest in the public involvement process. However, only a small number of comments were received during GDA Step 2. Issues raised on the UK EPR included the Final Safety Assessment Report (FSAR) (request for English translation of the FSAR of the design being built in Flamanville, France), primary and secondary side chemistry (suggesting provision of inadequate information by EDF and AREVA), aircraft impact (can it be demonstrated that reactors can withstand deliberate high-speed aircraft impact?), and on-site storage of radioactive waste and spent fuel (how many years storage does the design provide for low level and intermediate level waste and spent fuel?).

The issues raised from the comments and their responses have been considered in the judgements made by HSE on the UK EPR as part of Step 2 of GDA. Where appropriate, these issues will be considered in more depth by assessors during Steps 3 and 4.

A number of the comments made by the public were not directly relevant to the UK EPR or the other designs being assessed; nevertheless these were considered by HSE and responded to as appropriate.

Overseas regulators' assessments

The EPR has been subject to review by several overseas nuclear regulators. However, it should be noted that there are a number of variations between the UK EPR and the EPR designs being assessed in other countries, and these are indicated in broad terms below, where relevant.

Franco–German

- Starting in 1989, the French and Germans collaborated in the initial EPR Basic Design Phase. This included collaboration between the French and German safety authorities (ASN, BMU), their technical support organisations and their advisory committees and led to the publication of general design objectives in 1993. After completion of the Basic Design Phase the German nuclear safety authority withdrew in 1998 from the EPR project, but German experts continued to participate as invited members of the French nuclear safety advisory committee.
- Based on the assessment performed on the basic design of the EPR, technical guidelines for the design and construction of new PWRs were adopted in 2000 by the French nuclear safety advisory committee and German invited experts. Subsequent French assessments of EPR have used these as reference guidelines.

France

- The first French EPR authorisation application was submitted by EDF for the third unit of the Flamanville nuclear power plant. ASN has assessed the 'Flamanville 3' Preliminary Safety Analysis Report and in 2007, ASN concluded that:
  - The 1993 general design objectives were met.
  - Current operating experience had been taken into account satisfactorily.
  - The changes introduced for operational or economic reasons were acceptable from a safety viewpoint.
  - There was no reason to question the main design choices for the large primary and secondary components.
  - No significant non-radiological industrial risk for the population or environment had been identified.
  - Additional assessment is required before operation is permitted.
- Based on ASN's conclusion, the Authorisation decree of 'Flamanville 3' was signed by the French Government in 2007. The construction phase is now in progress.
- ASN is currently carrying out inspection of the construction and an early review of the operating licence application file. This assessment will need to be complete before loading of the fuel will be permitted.
- EDF have stated that any design changes resulting from ASN's assessment of Flamanville 3 will be copied into the UK EPR submission, and will be subject to review and endorsement by the UK EPR design change committee.

Finland

The first EPR being constructed in the world is at Olkiluoto.

- The first stages of the pre-licensing process were an Environmental Impact Assessment, a political approval process and a feasibility study of all candidate designs.
- Following these, the construction licence application was made in January 2004. The Finnish nuclear safety authority (STUK) assessed this and reported its findings in January 2005, following which the Finnish Government granted a construction licence in February 2005.
- Assessment of the design against Finnish regulatory requirements resulted in a small number of design modifications (in comparison with the French EPR), including containment venting, provision of a diverse hard-wired C&I protection system, and pipe whip restraints.
- In addition, there are some differences in the design for non-regulatory reasons (eg operator requirements), including fuel pond design.
- There were some reservations and restrictions as a result of STUK's assessment. These addressed:
  - the fuel burn-up limit;
  - submission of more detailed design of the systems and structures;
  - consideration of OL3 waste management and suitability for disposal;
  - submission of the manufacturing schedule for safety components, structures and systems to enable regulatory oversight by STUK.

Additional assessment and authorisation is required before operation is permitted.

USA

- AREVA submitted the US EPR for US NRC pre-application review in February 2005. This was in preparation for the design certification application that AREVA submitted in December 2007. The design certification review is currently underway with an expected completion date of 2011.
- As well as design certification, a separate construction and operation licence application is required to be made and assessed by US NRC before any construction could begin.
- In comparison with the UK EPR, there are modifications to the design and safety case to allow for the US climate, grid frequency and US NRC Regulations.

HSE collaboration with ASN, STUK and US NRC

- HSE has Information Exchange Arrangements (or is renewing them) with the regulators of the three countries above, and has had bilateral meetings with all three to discuss new-build assessment collaboration and transfer of information. This process is ongoing for the UK EPR and HSE intend to continue this through the GDA timeframe.
- A bilateral cooperation process has been set up with ASN and its technical support organisation IRSN, with the aim of having technical meetings to share the results of the safety assessment already performed on 'Flamanville 3'.
- In addition, HSE has had meetings with the French and Finnish technical support organisations that provide expert advice to ASN and STUK. We discussed access to existing review reports for EPR and the possibility of these organisations undertaking assessment work specifically for HSE. Formal agreements to facilitate this exist with the French and are being negotiated with the Finns.
- ASN, STUK and US NRC already participate trilaterally in the Multi-national Design Evaluation Programme (MDEP) Stage 1 which has been set up to share information on EPR assessments between regulators. HSE attended the January 2008 MDEP Stage 1 meeting as an observer with the intention of signing an appropriate agreement to join fully in future.

HSE sees great value in being able to share information with other regulators who have carried out relevant assessments, and we have published our views on how this information can be used in our GDA guidance.[1] However, because the UK legal and regulatory framework is UK specific, design approval by other regulators cannot be transferred automatically to the UK. Furthermore, under international conventions etc, nuclear safety regulation is a national responsibility and HSE must perform its duty to the UK public and workers. This has not prevented HSE from making appropriate use of overseas regulators' assessments, and it is HSE's intention that this practice will continue in future GDA Steps.

Conclusions

This report is our GDA Step 2 public statement for the UK EPR reactor.

The aim of Step 2 was to provide an overview of the fundamental acceptability of UK EPR within the UK regulatory regime. It was also intended that Step 2 would allow HSE inspectors to familiarise themselves with the design and provide a basis for planning subsequent assessment work.

HSE has undertaken a high-level review of the claims of EDF and AREVA for a number of different safety aspects of the UK EPR reactor, and we have considered the security aspects of the design.

In summary, we have not found any safety or security shortfalls that are so serious as to rule out at this stage eventual construction of the UK EPR on licensed sites in the UK. As a result of our assessment, we see no reason why the UK EPR should not progress to GDA Step 3.

As anticipated, our assessment has identified a number of topics that will need to be addressed in more detail during the GDA Step 3 and Step 4 assessment, should the UK EPR proceed through to the next steps of the GDA process. In this event, we will summarise our progress on these topics in a public report at the end of Step 3 and in a final GDA report at the end of Step 4.

Abbreviations

ALARP	As low as reasonably practicable
AREVA	AREVA NP SAS
ASN	Autorité de Sûreté Nucléaire (French nuclear safety authority)
BERR	Department for Business Enterprise and Regulatory Reform
BMU	Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit
BSI	British Standards Institution
C&I	Control and instrumentation
DTI	Department of Trade and Industry (now BERR)
EDF	Electricité de France
FSAR	Final safety analysis report
GDA	Generic design assessment
HSE	Health and Safety Executive
IAEA	International Atomic Energy Agency
IEC	International Electrotechnical Commission
ILW	Intermediate level waste
IRSN	Institut de Radioprotection et de Sûreté Nucléaire
LLW	Low level waste
MDEP	Multi-national Design Evaluation Programme
ND	Nuclear Directorate
OCNS	Office for Civil Nuclear Security
PSA	Probabilistic safety analysis
PSR	Preliminary safety report
RCCA	Rod control cluster assemblies
RPV	Reactor pressure vessel
SAPs	Safety assessment principles
SFAIRP	So far as is reasonably practicable
SSER	Safety, security and environmental report
STUK	The Finish nuclear safety authority
US NRC	Nuclear Regulatory Commission (United States of America)
WENRA	Western European Nuclear Regulators' Association

Annex 1: Summary of HSE's expectations for Step 2 of the GDA process

Details of HSE's expectations for Step 2 of the GDA process can be found in the GDA guidance.[1] From that document, the key expectations of Requesting Parties for Step 2 are:

Provide a Preliminary Safety Report that includes sufficient information for the Step 2 Fundamental Safety Overview, in particular:

1. A statement of the design philosophy and a description of the resultant conceptual design sufficient to allow identification of the main nuclear safety hazards, control measures and protection systems.

2. A description of the process being adopted by the applicant to demonstrate compliance with the UK legal duty to reduce risks to workers and the public so far as is reasonably practicable (SFAIRP).

3. Details of the safety principles and criteria that have been applied by the Requesting Party in its own assessment processes, including risks to workers and the public.

4. A broad demonstration that the principles and criteria are likely to be achieved.

5. An overview statement of the approach, scope, criteria and output of the deterministic safety analyses.

6. An overview statement of the approach, scope, criteria and output of the probabilistic safety analyses.

7. Specification of the site characteristics to be used as the basis for the safety analysis (the 'generic siting envelope').

8. Explicit references to standards and design codes used, justification of their applicability and a broad demonstration that they have been met (or exceptions justified).

9. Information on the quality management arrangements for the design, including design controls; control of standards; verification and validation; and interface between design and safety.

10. A statement giving details of the safety case development process, including peer review arrangements, and how this gives assurance that nuclear risks are identified and managed.

11. Information on the quality management system for the safety case production.

12. Identification and explanation of any novel features, including their importance to safety.

13. Identification and explanation of any deviations from modern international good practices.

14. Sufficient detail for HSE to satisfy itself that HSE's Safety Assessment Principles (SAPs) and that the Western European Nuclear Regulators' Association (WENRA) Reference Levels are likely to be satisfied.

15. Where appropriate, information about all the assessments completed by overseas regulators.

16. Identification of outstanding information that remains to be developed and its significance.

17. Information about any long lead items that may be manufactured in parallel with the Design Acceptance process.

18. Information on radioactive waste management and decommissioning.

The Requesting Party will also be required to respond to questions and points of clarification raised by HSE during its assessment, and to issues arising from public comments.

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4 *Safety assessment principles for nuclear facilities* (2006 Edition, Version 1) HSE December 2006 www.hse.gov.uk/nuclear/saps/saps2006.pdf.

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6 *Safety of Nuclear Power Plants: Design – Requirements* IAEA Safety Standards Series No. NS-R-1 IAEA 2000

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8 *Quality assurance for safety in nuclear power plants and other nuclear installations. Code and safety guides Q1 – Q14* IAEA Safety Series No. 50C/SG-Q IAEA 1996

9 *Protection against internal fires and explosions in the design of nuclear power plants* IAEA Safety Standards Series No. NS-G-1.7 IAEA 2004

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