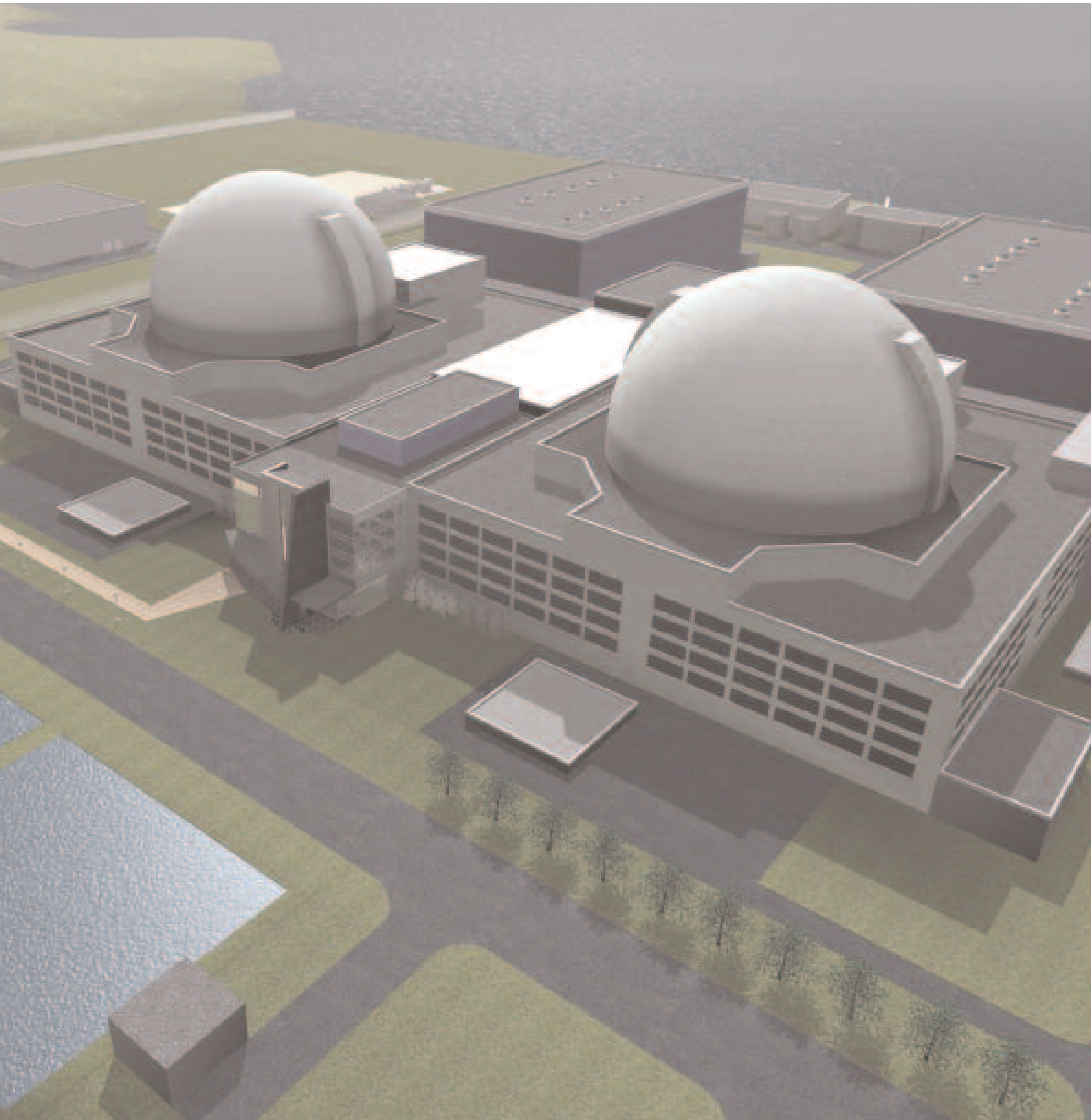
HSE

Health and Safety Executive

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

Atomic Energy of Canada Limited ACR-1000 Nuclear Reactor

Conclusions of the Fundamental Safety Overview of the ACR-1000 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' design.

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 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 ACR-1000 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.

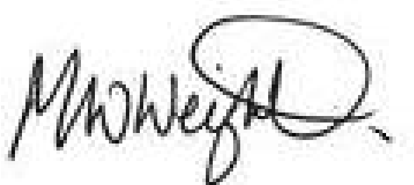
In doing this work we are setting new standards in efficiency. For example we have set up a Joint Programme Office with our colleagues at the Environment Agency so that the industry has a one-stop shop for nuclear regulatory issues.

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 the 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 a 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 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 ACR-1000 reactor designed by Atomic Energy of Canada Limited (AECL) and it comes at the end of GDA Step 2. The aim of Step 2 was to carry out an overview of the fundamental acceptability of ACR-1000 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 AECL's claims for a number of different safety aspects of the ACR-1000 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 ACR-1000 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 ACR-1000 proceed through to the next steps of the GDA process. 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 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 reactors, 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 from the risks, 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 and again from 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 ACR-1000 in late August 2007, was for the preparatory part of the design assessment process. The majority of the work was undertaken by AECL, as the Requesting Party, in assembling the safety submissions for Step 2. It involved discussions between the Requesting Party

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

and HSE to ensure a full understanding of the requirements and processes 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 ACR-1000. 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 ACR-1000 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 AECL 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 AECL's head document[7] when compared against the relevant parts of HSE's SAPs.[4] 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 ACR-1000 is described in the ACR-1000 Technical Description ACR-1000 10820-01371-TED-001-NP Revision 1.[8]

AECL describe the ACR-1000 as a light water cooled, heavy water moderated pressure-tube nuclear reactor with a 60-year design life. The reference station design comprises two integrated ACR-1000 units, each with a nominal gross electrical output of 1165 MWe. It is derived from and retains basic CANDU (CANadian Deuterium Uranium) design features but incorporates some innovative features and state of-the-art technologies.

The ACR-1000 reactor assembly consists of a horizontal steel cylinder called the calandria, and its end-shield assemblies. The calandria contains heavy water moderator at low pressure and the 520 pressure tubes that house the fuel assemblies. The reactor is supported within a concrete calandria vault that is filled with light water. Fuel is enclosed in the pressure tubes that pass through the end shields. Each fuel channel permits access for on-line fuelling operation while the reactor is at power.

The fuel design is a modified fuel bundle similar to that already demonstrated in the CANDU 6 Point Lepreau reactor (in New Brunswick, Canada), except the ACR-1000 uses low-enriched uranium, whereas previous CANDU designs have used non-enriched uranium. The fuel consists of 42 elements (rods) containing uranium dioxide fuel pellets plus a central element containing burnable poison. The fuel element sheaths are made from zirconium alloy. The 43 elements are assembled between end plates to form a fuel bundle. Each of the 520 channels contains 12 bundles.

Heavy water is the neutron moderator, which is circulated by pumps through the calandria at a relatively low temperature and low pressure and is cooled by the moderator heat exchangers.

The heat transport system (HTS) circulates pressurised light water coolant through the reactor fuel channels to remove heat produced by nuclear fission in the core. The fission heat is carried by the reactor coolant to the four steam generators, to produce steam on the secondary side that subsequently drives the turbine generator.

AECL claim that the ACR-1000 safety systems are designed to mitigate the consequences of plant failures, ensure reactor shutdown, remove decay heat and prevent radioactive releases. Key systems identified by AECL are:

- **Shutdown System 1**, consisting of mechanical shut-off rods that drop by gravity into the core.
- **Shutdown System 2**, consisting of an injection system for a concentrated solution of gadolinium nitrate (which poisons the moderator to shut down the nuclear fission reaction) into the low-pressure moderator.
- **Emergency Core Cooling System**, consisting of two subsystems:
  - *Passive emergency coolant injection system* has accumulator tanks that AECL claim will supply high-pressure water to the heat transport system (HTS) and refill the fuel channels in the short term after a loss of coolant accident (LOCA); in addition, core make-up tanks (CMTs) provide passive make-up to the intact HTS loop;
  - *Long-term cooling system*: This provides long-term recirculation and recovery. It is used for cooling the reactor after postulated transients, including LOCA, and during maintenance.
- **Containment**. The ACR-1000 containment consists of a steel-lined, pre-stressed concrete reactor building which forms a continuous, pressure-retaining envelope around the reactor core and the heat transport system. There is also a spray system connected to the elevated reserve water tank (RWT) to reduce reactor building pressures, if required, in the unlikely event of severe accidents.

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 having in place an organised management system, effective procedures (especially change control) and sufficient appropriately trained and qualified staff. As part of the examination of AECL's claims in this area, HSE and the Environment Agency jointly inspected AECL's offices in Canada. To assist us, we were joined by an inspector from the Canadian nuclear regulatory body, the Canadian Nuclear Safety Commission (CNSC).

The inspection found that AECL has a well-defined ACR-1000 project organisation, with about 500 staff supporting the project on a full-time basis, and a related quality management system, which is developed from and linked to mature corporate quality assurance arrangements. There are clearly defined responsibilities, and staff deployed on the New Build CANDU (NBC) project have considerable experience and knowledge in the nuclear industry and of CANDU specifically. We noted that AECL use few contractors on the design phase of the project, preferring to maintain knowledge and experience in-house.

Quality management is a major discipline within AECL which, together with appropriate organisational structures, enables the codification and documentation of processes and activities that are central to ensuring safety is properly considered during design. The AECL corporate quality assurance system has operated for over 15 years and the related project-specific arrangements have been applied to a number of major projects. Our inspection found that AECL's quality management system has been developed to meet Canadian requirements (the Canadian Standards Association (CSA) N286 series), as well as ISO 9001, for which it has gained certification, and IAEA 50-C/SG-Q.[9] This gives us confidence that the quality management system is soundly based and is appropriate to the design phase of the project.

The ACR-1000 project has a specific quality assurance manual, which defines the NBC organisation and processes used for performing all aspects of work. AECL has a suite of established procedures which include design verification and change control, personnel capability and document control.

We noted that AECL has a succession planning process that is designed to ensure that personnel are recruited, developed, managed and retained. Recognising the increasing global interest in nuclear power, the corporate HR function has developed recruitment targets and uses a variety of means to achieve these.

The project organisation and resource levels indicate AECL's positive commitment to the generic ACR-1000 design. This underpins a programme of work to continue to develop the ACR-1000 design.

Overall, we conclude that AECL'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 AECL's documentation shows that it has used mainly Canadian and some US standards. HSE has therefore asked AECL 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 AECL during Step 3 and Step 4.

AECL's case is outlined in Section 2.2 of its head document[7] and expanded on in a specific ALARP submission.[10]

AECL describes a process of progressive safety improvement with the evolution of the ACR-1000, claiming continuous improvement over a 60-year period of design, construction and operation. The ACR-1000 is said to retain proven strengths of CANDU reactors while incorporating improvements in safety. Section 2 of the ALARP submission is a summary of AECL's interpretation of the ALARP process in the UK. In Section 5 of that report, AECL describe a design process that involves the adoption and use of appropriate standards and extensive operational feedback. Section 6 notes that the probabilistic safety analysis (PSA) is not yet complete (although PSA studies have been used in the design assist process) and give a commitment to carry out further ALARP assessment. AECL also claims that the ACR-1000 enhancements are expected to demonstrate improvements over historical CANDU performance for worker dose.

The ALARP submission highlights a number of safety enhancements in Sections 7 and 8 such as improved safety margins, additional gravity-driven water source for safety systems, and passive coolant injection. AECL conclude in Section 9 that they have effectively followed ALARP principles in the design of the ACR-1000.

Overall we conclude that AECL has 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 AECL 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 is not being assessed in Step 2; rather the aim is 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 ACR-1000 is a design that has evolved making extensive use of the operating experience of existing generations of CANDU reactors. New features include: providing light water as the reactor coolant and enriching the fuel, both of which improves the stability of the core.

As part of the safety and fault analysis in support of the design of the ACR-1000, AECL has presented sufficient information to allow Step 2 judgements to be made on the following:

- Core stability
- Design basis analysis
- Severe accident evaluation

AECL claims 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, AECL claims 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, AECL 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 AECL to arrive at these conclusions will form an important part of our assessment in future steps.

AECL claims that severe accidents have been addressed to identify necessary actions and provisions to contain fuel melting and prevent a large activity release from the containment building.

Overall, we conclude that AECL has carried out a 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. The quality of the submission and interactions with AECL lead us to be confident that they will be able to substantiate their claims in the later Step 3 and Step 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 the meeting the SAPs Basic Safety Objective numerical targets. The arguments and evidence supporting these claims will be assessed in Step 3 and beyond.

AECL's case is outlined in Section 2.6 and Appendix D of the head document[7] and is given further support by their UK compliance document.[11] Section 2.6 of the head document notes that the PSA has yet to be completed, but the intent is to produce a PSA that meets the requirements of the SAPs. Appendix D of the head document identifies the intended scope which covers the reactor at power (which for the ACR-1000 includes refuelling), shutdown and selected hazards (internal fire and flood and seismic) together with a commitment to deal with other site-specific external hazards at a later date. The methodology AECL is going to use is described and covers initiating faults, accident sequence analysis, systems analysis, human reliability analysis, data analysis, quantification and containment performance. The UK compliance document gives details of AECL's claims for each of the SAPs as well as for a number of the numerical targets.

AECL's PSA targets for the ACR-1000 for severe core damage from internal events at power, shutdown, fire, flood etc are 8×10^{-8} to 8×10^{-7}/yr.

By comparison, the PSA for the earlier ACR-700 design had an estimated severe core damage frequency (SCDF) at power of 3.4 x 10-7/yr. AECL claim that the ACR-1000 design benefits from improvements over the ACR-700 design, such as a four quadrant design, more reliable emergency feed water system, passive make-up systems and passive containment cooling. These improvements should lead to a lower SCDF for the ACR-1000. These values, in conjunction with the arguments presented by AECL, 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 AECL has provided an adequate overview of the approach, scope, criteria and output of the PSA they intend to produce. Support for their ability to meet numerical PSA targets has been furnished based on the ACR-700 PSA results with reasonable claims that the ACR-1000 will represent an improvement.

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 operational nuclear stations in the UK and the supporting arguments and evidence have been considered by HSE.

For the ACR-1000, AECL has implied (ie without explicit claims) that gross failure of any of the four steam generators and the pressuriser will not occur. The ACR-1000 does not have a reactor pressure vessel; instead the nuclear fuel is contained in a number of horizontal pressure tubes. Failure of a pressure tube is a design basis event and is therefore considered as tolerable within the safety analysis.

For some areas of piping, the safety claim is not clear and we will need to examine this further within GDA Step 3.

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

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

- material specification for ferritic forgings and welds to be used in main vessels (steam generators, pressuriser);
- basis of the safety case for some pipework.

Overall, we conclude that AECL has 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 that it can be discounted. AECL has provided some coverage of the type of arguments and evidence to support the claims. However, in this area, and at this step, more detail would have been useful.

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 licensed sites in the UK. The Environment Agency have also assessed radioactive waste and decommissioning proposals and their findings are reported separately.

For Step 2 of the GDA process, 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.

AECL presents information on radioactive waste management in Section 2.6 of the ACR-1000 technical description.[7] The final disposal methods are not defined, but stated to depend on 'the particular site, regulatory requirements, and policies of the utility'. Further analysis of whether the waste streams can meet the acceptance criteria for UK disposal facilities will be required during subsequent steps of the GDA process. AECL intend spent fuel to be stored in a fuel pond and subsequently transferred into an interim dry fuel store, which would be a novel installation for the UK. We will examine these proposals further during GDA Step 3 and Step 4.

Section 3 of the decommissioning strategy[12] explains the strategies available to the operator and the design features which facilitate decommissioning. Details of design methods for facilitating decommissioning (including materials selection) is given in subsidiary documentation.[13]

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 low level waste (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 we will be asking AECL 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 AECL has 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 are either Canadian or American in origin and appear to be specifically intended for nuclear structures. The standard design incorporates a foundation which it is claimed is adequate for a range of rock or soil sites. These issues will be reviewed in much more detail in the next steps of the GDA process.

We note that AECL has 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 AECL, as have the limitations on the standard design. It is recognised by AECL 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 not been any 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 AECL 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. AECL has acknowledged the need to place the design in a UK context, and to consider 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'. Deterministic analysis includes, among others, consideration of internal hazards. The GDA 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 was 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.

AECL has addressed its compliance with the internal hazard SAPs in its submission *Preliminary review of ACR-1000 compliance with 2006 UK Safety Assessment Principles*.[11] Additional information was provided in the AECL head document.

AECL has identified a range of internal hazards. Separation of systems important to safety is principally achieved, outside the containment structure, using the 'Four Quadrant Separation Philosophy' which employs three-hour fire-rated hazard barriers and within the containment structure with a combination of distance, elevation, partial fire barriers and equipment qualification. The passive approach to ensuring segregation outside the containment structure is the preferred approach and is consistent with IAEA recommendations.[14]

Overall we note that AECL claims compliance with the internal hazard SAPs. We conclude that AECL has 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 AECL will be able to substantiate its 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 licensed sites in the UK. In particular, to determine whether an adequate claim of compliance exists for those C&I SAPs which address fundamental design aspects.

AECL has provided a number of submissions relevant to C&I assessment including a specific response against the SAPs. The ACR-1000 technical submission[4] 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 Shutdown System 1 that actuates shut-off rods and Shutdown System 2 that injects a concentrated gadolinium nitrate solution, and reactor core cooling systems such as the Emergency Core Cooling system);
- plant control and monitoring systems (eg the reactor regulating system that controls reactor power);
- main control room with backup via a secondary control building; 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 normal 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 of the system. The AECL ACR-1000 C&I design concept reflects Canadian custom and practice, and is largely based on Canadian and American C&I standards (eg Canadian Standards Association (CSA) and Institute of Electrical and Electronics Engineers (IEEE) standards) and Canadian Nuclear Safety Commission (CNSC) regulatory requirements. Four system classes are used (ie Safety Class 1 to 4).

During Step 3 and Step 4, AECL will address the use of international standards (IEC and IAEA), grading 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.

AECL's submissions provide 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 the ACR-1000 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. In terms of this definition the ACR-1000 has no novel features.

In the ACR-1000, there are some design evolutions in comparison with previous generations of CANDU reactors that AECL claims give safety improvements. These include the use of enriched fuel and light water coolant. While these are novel for CANDU reactors, they are the norm in other reactor designs.

Long-lead items

Large plant items such as the pressuriser 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 will be placed while the GDA assessment is still ongoing then, to reduce regulatory their regulatory risk, AECL may wish to ask HSE to assess such items at an early stage.

Currently there is no specific request from AECL related to the assessment of 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 ACR-1000. All of the findings in the report are recommendations for further assessment work, particularly in areas that are 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 AECL submission that are in conflict with UK Government policy.

Security

OCNS has begun familiarisation with the ACR-1000 design during Step 2. Initial discussions have been held with AECL and 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 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 Canadian authorities are progressing to allow the transfer of sensitive nuclear information between countries to support the GDA process. A procedure 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 AECL for the GDA process. A comprehensive safety, security and environmental report for the ACR-1000 was made available on the company's website from 10 September 2007, www.aecl-uk.co.uk. The same information was also made available upon request in CD-ROM format.

In addition, to help encourage public participation, AECL made announcements in the national press at that time to publicise the GDA openness arrangements. To supplement this, 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 AECL, 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 ACR-1000 include comparison with the RBMK reactor used at Chernobyl (could the same accident happen here?), waste management (adequacy of information provided on the management of waste streams), 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 (what is the total fuel capacity of the underwater fuel bay, 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 ACR-1000 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 ACR-1000 or the other designs being assessed; nevertheless these were considered by HSE and responded to as appropriate.

Overseas regulators' assessments

Canadian Nuclear Safety Commission (CNSC)

CNSC has carried out some pre-licensing review work on both the ACR-700 and ACR-1000 designs. This began with the ACR-700 design in May 2003, with the goal of establishing whether, in the opinion of CNSC staff, there were fundamental barriers that would prevent licensing the plant in Canada.

In May 2005, AECL redirected its efforts to the development of the ACR-1000 and requested the CNSC to wrap up the pre-licensing review of the ACR-700. A report was issued in April 2006, capturing the CNSC view at that time.

CNSC staff then started to consider the ACR-1000, beginning in May 2005, but dealt largely with generic aspects of the design. CNSC decided to terminate the pre-licensing review in December 2006, due to resource limitations. CNSC staff issued the Project Close-out Report in January 2007. As a result of this early closure, CNSC staff did not review any submissions specific to the ACR-1000 design, although a large amount of work had been done by both AECL and CNSC staff on the generic design process and the safety analysis methodology.

CNSC are currently considering recommencing design reviews of new reactors that are under consideration for development in Canada, starting with the ACR-1000.

US Nuclear Regulatory Commission (US NRC)

The US NRC carried out a pre-application review (an initial review before a full Design Certification review) of the ACR-700, beginning December 2002 and continuing until early 2005. In October 2004, US NRC staff prepared and issued the *Pre-Application Safety Assessment Report related to the Advanced CANDU Reactor 700 MWe*. US NRC stated that 'based on the information provided, the staff believe at this time that AECL will ultimately be able to satisfactorily address these potential policy, regulatory, and technical issues during the design certification review'.

Due to the fact that US regulations have been developed and written almost exclusively for pressurised water reactors and boiling water reactors, the potential policy and regulatory issues identified by US NRC staff are mostly related to the differences in the ACR-700 design (eg issues related to use of pressure tubes and pressure tube materials, use of on-power fuelling and thus of the fuelling machines' opening of the fuel channels during reactor operation). This type of issue may be less problematic in the UK because HSE has a less prescriptive approach; the SAPs are written on a technology-neutral basis, and we have experience of pressure tube reactors and on-load refuelling.

With respect to the potential technical issues identified by US NRC, a number of them are related specifically to the ACR-700 design and not to the ACR-1000. Where they were relevant to ACR-1000, some have been already taken into account and addressed by AECL as the ACR-1000 design has been developed since 2004. During GDA Step 3 and Step 4 we will seek assurance that relevant issues from the US NRC review have been appropriately addressed.

HSE collaboration with overseas regulators

HSE has an information exchange agreement with both CNSC and US NRC and has had exploratory bilateral meetings to discuss new-build assessment collaboration and transfer of information. This process is ongoing for the ACR-1000 and HSE intend to continue this through the GDA timeframe.

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 ACR-1000 reactor.

The aim of Step 2 was to provide an overview of the fundamental acceptability of ACR-1000 within the UK regulatory regime. It was also intended that Step 2 would allow HSE inspectors to become familiar with the design and provide a basis for planning subsequent assessment work.

HSE has undertaken a high-level review of AECL's claims for a number of different safety aspects of the ACR-1000 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 ACR-1000 on licensed sites in the UK. As a result of our assessment, we see no reason why ACR-1000 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 ACR-1000 proceed through to the next steps of the GDA process. 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
AECL	Atomic Energy of Canada Limited
BERR	Department for Business, Enterprise and Regulatory Reform
BSI	British Standards Institution
CANDU	CANada Deterium Uranium. The type of reactor designed by AECL
CMTs	Core make-up tanks
CNSC	Canadian Nuclear Safety Commission
CSA	Canadian Standards Association
C&I	Control and instrumentation
DTi	Department of Trade and Industry
GDA	Generic design assessment
HSE	Health and Safety Executive
HTS	Heat transport system
IAEA	International Atomic Energy Agency
IEC	International Electrotechnical Commission
IEEE	Institute of Electrical and Electronics Engineers
ILW	Intermediate level waste
LLW	Low level waste
LOCA	Loss of coolant accident
NBC	New build CANDU (a division of AECL)
ND	Nuclear Directorate
OCNS	Office for Civil Nuclear Security
PSA	Probabilistic safety analysis
PSR	Preliminary safety report
RWT	Reserve water tank
SAPs	Safety assessment principles
SCDF	Severe core damage frequency
SFAIRP	So far as is reasonably practicable
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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