

NUCLEAR DIRECTORATE

GENERIC DESIGN ASSESSMENT – NEW CIVIL REACTOR BUILD

**STEP 3 RADIOACTIVE WASTE AND DECOMMISSIONING ASSESSMENT OF THE EDF AND
AREVA UK EPR**

DIVISION 6 ASSESSMENT REPORT NO. AR 09/033-P

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EXECUTIVE SUMMARY

This report presents the findings of the radioactive waste and decommissioning assessment of the EDF and AREVA UK EPR Pre-Construction Safety Report (PCSR) undertaken as part of Step 3 of the Health and Safety Executive's (HSE) Generic Design Assessment (GDA) process.

This report provides an overview of the safety case presented in the PCSR and supporting safety documentation; the standards and criteria adopted in the assessment; and an assessment of the claims, arguments and evidence provided within the safety case.

For Step 3 of GDA, HSE's guidance requires me to confirm that EDF and AREVA have comprehensive plans for dealing with radioactive waste from creation through to disposal on the nuclear power plant. This guidance goes on to say that HSE will undertake an assessment on a sampling basis primarily directed at the system level and by analysis of the supporting arguments of EDF and AREVA. On the topic of radioactive waste and decommissioning this includes consideration of the results of Step 2 assessment, which highlighted the need for more information on disposability of the wastes and the through-life storage of wastes and spent fuel.

EDF and AREVA have set out their safety arguments for radioactive waste and decommissioning in the PCSR and a number of supporting references. These include details of the source and types of radioactive waste produced; the design and operation of the at-reactor spent fuel pond; details of the Waste Treatment Building, which will house the processing and packaging systems for operational wastes, other than spent fuel; proposals for an Intermediate Level Waste (ILW) storage facility that will provide retrieval, inspection and, if necessary, refurbishment of waste packages; and a number of options for the long-term storage of spent fuel.

The Nuclear Directorate's (ND) assessment sample included the type of waste produced, which is important as it underpins all of the other assessments; and the long-term storage of wastes, including spent nuclear fuel, which is important because of the timescales involved.

At the start of the GDA process the level of information on the management of radioactive waste was limited. As we reach the completion of Step 3 the information developed by EDF and AREVA on the management of radioactive wastes produced by a UK EPR is at a level where I can undertake a meaningful assessment.

In undertaking my Step 3 assessment, I have worked closely with the Environment Agency and Department for Transport to ensure that all significant waste arisings and discharge routes have been identified by EDF and AREVA, and that those wastes can be effectively managed. This has been successful as I have been able to share information and knowledge, making effective use of resources and co-ordinate feedback to EDF and AREVA.

In performing my Step 3 assessment of EDF and AREVA proposals for radioactive waste and decommissioning I have taken on board feedback from a wide range of stakeholders. For example, the request to EDF and AREVA for more detail on the timings of their waste management plans.

During Step 3, EDF and AREVA have provided verbal assurance that the radioactive wastes produced by a UK EPR are suitable for disposal. The written disposability assessment prepared by the Nuclear Decommissioning Authority (NDA) is now complete and has been provided to the Environment Agency (EA) and HSE by EDF and AREVA. In Step 4, EDF and AREVA need to show that an operator can safely condition and store waste in a manner compatible with the conclusions of the NDA disposability assessment.

Finally I have commenced my assessment of whether a UK EPR can be safely decommissioned. This will be concluded in Step 4.

During the assessment I have not identified any significant issues, or significant design or safety case changes that could impact on radioactive waste arisings or have a significant negative environmental impact.

LIST OF ABBREVIATIONS

ALARP	As Low As Reasonably Practicable
BMS	(Nuclear Directorate) Business Management System
CoRWM	Committee on Radioactive Waste Management
EA	The Environment Agency
EDF and AREVA	Electricité de France SA and AREVA NP SAS
FDWMP	Funded Decommissioning and Waste Management Programme
GDA	Generic Design Assessment
HSE	The Health and Safety Executive
IAEA	The International Atomic Energy Agency
ILW	Intermediate Level Waste
LLW	Low Level Waste
ND	The (HSE) Nuclear Directorate
NDA	The Nuclear Decommissioning Authority
NRC	The United States Nuclear Regulatory Commission
PCER	Pre-construction Environment Report
PCSR	Pre-construction Safety Report
TAG	(Nuclear Directorate) Technical Assessment Guide
TQ	Technical Query
RI	Regulatory Issue
RIA	Regulatory Issue Action
RO	Regulatory Observation
ROA	Regulatory Observation Action
RP	Requesting Party
RW & D	Radioactive Waste Management and Decommissioning
RWMC	Radioactive Waste Management Case
SAP	Safety Assessment Principle
SEPA	Scottish Environment Protection Agency
SSC	System, Structure and Component
STUK	The Finish nuclear safety authority
TSC	Technical Support Contractor
WENRA	The Western European Nuclear Regulators' Association

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1 INTRODUCTION

- 1 This report presents the findings of the radioactive wastes and decommissioning assessment of the EDF and AREVA UK EPR Pre-Construction Safety Report (PCSR) (Ref. 1) undertaken as part of Step 3 of the Generic Design Assessment (GDA) process. This assessment has been undertaken in line with the requirements of the Business Management System (BMS) document AST/001 (Ref. 2) and its associated guidance document G/AST/001 (Ref. 3). AST/001 sets down the process of assessment within the Nuclear Directorate (ND) and explains the process associated with sampling of safety case documentation. The Safety Assessment Principles (SAPs) (Ref. 4) have been used as the basis for the assessment of the proposals for radioactive waste management and decommissioning (RW & D) associated with the UK EPR design. The SAPs provide Nuclear Directorate (ND) inspectors with a framework for making consistent regulatory judgements on radioactive waste and decommissioning aspects of nuclear safety cases. Ultimately, the goal of assessment is to reach an independent and informed judgment on the adequacy of a nuclear safety case.
- 2 There are four Steps in GDA: Step 1, Discussion with requesting party; Step 2 Fundamental safety review; Step 3 Overall design safety review; and Step 4 Assessment for design acceptance. By the end of Step 2 there was only limited information from EDF and AREVA on RW & D. As a result the Environment Agency raised a regulatory issue in February 2008. In November 2008, EDF and AREVA provided additional information. Subsequently a number of Technical Queries (TQs) were raised and a joint Regulatory Observation by Environment Agency and ND requested a standalone strategy for waste management. In June 2009 a joint position statement (Ref. 5) was issued by the Environment Agency, Department for Transport and ND outlining the level of design required on the waste plants in GDA. This stated that detailed designs were required for the at-reactor fuel pond and the management of Intermediate Level Waste (ILW) until it was in a conditioned form.
- 3 ND was not fully resourced on RW & D until July 2008. When recruited I took responsibility for assessing the EDF and AREVA plans for RW & D of the UK EPR.
- 4 EDF and AREVA have to comply with UK Government policy. One aspect of the developing UK Government policy is to ensure that operators estimate the full costs for decommissioning and waste management through the Funded Decommissioning and Waste Management Programme (FDWMP). This requires an operator to provide for the steps necessary to decommission and manage and dispose of radioactive waste. The information produced by EDF and AREVA on waste management for GDA can also be used to inform the work on FDWMP. Therefore there is a need for consistency. As UK Government policy states their assumption (Ref. 6) that spent fuel from a UK EPR will, after cooling, be sent for geological disposal my assessment will be on this basis.
- 5 In undertaking my Step 3 assessment, I have worked with the Environment Agency and Department for Transport to ensure that all significant waste arisings and discharge routes have been identified by EDF and AREVA, and that those wastes can be effectively managed.
- 6 For the waste facilities, I need EDF and AREVA to demonstrate that they can safely handle, store and dispose of the wastes they generate. This will require sufficient levels of design to justify credibility of the storage options proposed; understanding how wastes evolve over the storage period; knowledge of the constraints placed on the wastes by the disposal facilities; and robust estimates of the required capacity. For the longer-term storage facilities detailed plans showing key milestones can satisfy the needs of GDA. A detailed review of the storage requirements will underpin the plans. This will include:
 - The types of facility that could be used;
 - When facilities will be developed and constructed; and

- The research needs that ensure the waste and spent fuel can be stored, transported and disposed of.
- 7 These planning requirements are similar to those of the Nuclear Decommissioning Authority (NDA) for legacy sites. Therefore, requiring EDF and AREVA to adopt similar approaches to the Site Licence Companies will provide the required level of information and give synergies across the UK nuclear industry. It will also allow EDF, AREVA and the operators to incorporate knowledge gained across the industry.
- 8 The RW & D issues addressed in new build are cross cutting; I have built consensus to the approach adopted for new build by:
- Working closely with my colleague, who is looking at RW & D for the Westinghouse AP1000 design, to ensure consistency in our approach.
 - Initiating discussions with other ND disciplines where there is overlap of interests, for example the determination of As Low As Reasonably Practicable (ALARP), which includes a balance between worker doses, waste generation and disposal to the environment. I have worked closely with the radiation protection and reactor chemistry assessors. This relationship is reinforced with regular meetings and joint meetings with EDF and AREVA. We have also initiated joint pieces of work.
 - Where issues are broader I have consulted with other ND experts. For example, I have discussed spent fuel matters with the ND's fuel behaviour inspector. In this way I check consistency between GDA and the development of strategies to deal with spent fuel at Sizewell B. It is worth noting that EDF own Sizewell B.
 - Other regulators have an interest in the plans of EDF and AREVA for RW & D. I have close working relationships with the Environment Agency, the Department for Transport and the Office of Civil Nuclear Security. I hold joint planning meetings with them and I have attended a number of joint meetings with them and EDF and AREVA. Most of the technical queries and regulatory observations on EDF and AREVA are jointly raised with the Environment Agency.
 - Working with international project teams I keep abreast of issues significant to waste management and spent fuel. I have had discussions with STUK, the Radiation and Nuclear Safety Authority of Finland and the United States Nuclear regulatory Commission (NRC).
- 9 GDA is an inclusive process involving the public. The public are particularly interested in EDF and AREVA proposals for RW & D. In June 2009 a meeting with Non-Governmental Organisations was held on GDA; feedback is informing my assessment. Also in June 2009 I made initial contact with the Committee on Radioactive Waste Management (CoRWM) whose remit now includes wastes from new reactors. The CoRWM programme (Ref. 7) indicates that they will discuss new build wastes with ND late in 2009.
- 10 To meet the GDA deadlines I have engaged Technical Support Contractor(s) (TSC) to assist with the RW & D assessment work. This includes a review of practice used in Pressurised Water Reactors to minimise radiation doses and radioactive waste and the development of guidance on the management of used fuel for GDA. This TSC support is to provide me with information, which I will use to inform my assessment of EDF and AREVA work on RW & D.

2 NUCLEAR DIRECTORATE'S ASSESSMENT

2.1 Requesting Party's Safety Case

- 11 EDF and AREVA have provided me with a number of documents to show that RW & D can be managed safely. Figure 1, taken from this documentation, outlines the waste processes for solid waste that EDF and AREVA propose for a UK EPR. The facilities shown are discussed below.
- 12 The reactor is the source of the radioactive material in the waste. In the safety documentation it is assumed that the reactor operates for 60 years. Over this period the documentation includes arguments that the generation of waste is avoided. Where waste is generated the quantity will be minimised and, where practicable segregated at source. In addition EDF and AREVA will show, through assessment, that there is a disposal route for all waste generated.
- 13 The UK EPR includes a fuel pond and ancillaries designed to allow the safe receipt of fresh fuel, transfer into the reactor, transfer out of the reactor, management in the pond during reactor shutdown, storage prior to dispatch to the long term store and dispatch to the longer-term store. This facility will have a longer operating life than the reactor as it is used to receive fresh fuel before the start of reactor operations and will be used to store spent nuclear fuel from the end of reactor operations prior to dispatch to a longer-term storage facility.
- 14 The Waste Treatment Building will house the processing and packaging systems for operational wastes, other than spent fuel, produced by the reactor. The processing and packaging system is based on proven and internationally recognised technologies. The waste is processed into standard packages for safe handling. The Waste Treatment Building includes a buffer store for wastes prior to processing. After processing ILW waste is dispatched to an on-site, interim long-term store and Low Level Waste (LLW) dispatched to a disposal facility.
- 15 An ILW storage facility will be provided that allows waste packages to be retrieved, inspected and, if necessary, refurbished. The storage facility will be designed to allow it to be refurbished. At the end of the storage period the waste packages will be sent for disposal. The type of disposal will be dependant upon the waste package's level of radioactivity at the time of disposal.
- 16 A number of options have been proposed for the long-term storage of spent fuel. The options include long-term pond storage, dry storage in casks and dry storage in purpose designed stores. The designs allow for retrieval, inspection and refurbishment. At the end of the storage period the spent fuel will be prepared for, and then dispatched to, a geological disposal facility.
- 17 The information in the initial EDF and AREVA submission referred to radioactive solid waste and spent fuel, but did not present a formal strategy. On the 1 February 2008 the Environment Agency raised Regulatory Issue RI-EPR-0001, requesting information required by the Environment Agency for the detailed assessment stage.
- 18 In April 2008 EDF and AREVA issued the PCSR. This included Chapter 11, Discharges and Waste - Chemical and Radiological, comprising four sub-Chapters: 11.0, safety requirements; 11.1, sources of radioactive material; 11.2, details of the effluent management system; 11.3, outputs of the operating installation; and 11.4, effluent and waste treatment system design architecture. This addressed some of the issues raised in RI-EPR-0001.
- 19 EDF and AREVA have also produced a Pre-Construction Environmental Report in parallel with the PCSR. Throughout my assessment I have used the two synonymously to confirm that they are coherent.

- 20 In November 2008 EDF and AREVA provided a number of supporting references. Together these provided the detailed responses to RI-EPR-0001; subsequently this regulatory issue was closed. The references were:
- PCSR Chapter 11.5 interim storage facilities and disposability for UK EPR.
 - Solid radioactive waste strategy report, AREVA NP FGF NESH-G/2008/en/0123 (Ref. 8)
 - Interim storage facility for spent fuel assemblies coming from an EPR plant, ELI0800224
 - Dry Interim Storage facility for ILW, ELI0800226
 - EPR UK – Decommissioning waste inventory, ELIDC0801302
- 21 In June 2009 Chapters 11.1, 11.2, 11.3, 11.4 and 11.5 of the PCSR were re-issued.
- 22 In February 2009 I raised two technical queries on EDF and AREVA requesting further evidence on their plans for the interim storage facilities. In July 2009 EDF and AREVA responded to these with the following two documents:
- Longer Term ILW Interim Storage Facility, UKEPR-0008-001 Issue 00 (Ref. 9)
 - Longer Term Spent Fuel Interim Storage Facility, UKEPR-0009-001 Issue 00 (Ref. 10)
- 23 The documents identified in paras 20, 21 and 22 comprise the current EDF and AREVA submission on radioactive waste management. In addition there are a number of responses to technical queries raised separately or in conjunction with the Environment Agency. EDF and AREVA have committed to incorporate the responses to these technical queries in future updates to the PCSR. Where relevant they are referred to in the text of this assessment report.
- 24 In support of their submissions EDF and AREVA have arranged a number of presentations and site visits for me. These are beneficial as they allowed me direct access to the systems they are referring to in their submissions, which gives me a better understanding of the strengths and weaknesses of the systems. Of particular note were:
- a visit in October 2008 to Penly, France and ISAR in Germany to look at operating Pressurised Water Reactors of the previous AREVA generation of design;
 - a presentation in March 2009 on the operation of the UK EPR chemistry circuits;
 - a meeting with EDF and AREVA in April 2009 on the Environment Agency's feedback on the November 2008 PCSR and the associated documentation;
 - an EDF and AREVA hosted presentation in May 2009 to all three regulators by the Nuclear Decommissioning Authority on the conclusions of their disposability assessment;
 - a series of meetings with EDF and AREVA, arranged by the Environment Agency, in July and August 2009 on their development of Best Available Techniques documentation, the Integrated Waste Strategy and the Radioactive Waste Management Case;
 - a presentation by EDF in September 2009 on their processes for recording and analysing information on radioactive wastes at their sites; and
 - an Environment Agency sponsored visit to Sizewell B in June 2009 to look at their waste management arrangements, which demonstrated the advantages of a flexible conditioning process

- 25 Three significant documents, provided by EDF and AREVA on radioactive waste management were not available in time for assessment in Step 3 of the GDA. These are:
- EDF and AREVA conclusions from their review of the disposability assessment being produced for them by the Nuclear Decommissioning Authority.
 - The Integrated Waste Strategy for the UK EPR.
 - The outline of the Radioactive Waste Management Case for the UK EPR
- 26 The Integrated Waste Strategy and outline of the Radioactive Waste Management Case are the subjects of a joint Regulatory Observation on EDF and AREVA, RO-UKEPR-33 Integrated Waste Strategy. This regulatory observation also calls for a detailed assessment of the application of Best Available Technique to the design. Whilst this is a Environment Agency requirement it is likely that some of its information will be used in my assessment.
- 27 For decommissioning PCSR sub-Chapter 20.1, general principles, and sub-Chapter 20.2, implementation for the EPR, deal with the decommissioning plans of EDF and AREVA. In addition the previous documents address the management and disposal of wastes coming from decommissioning.

2.2 Standards and Criteria

- 28 The production of radioactive waste should be avoided as far as possible. The judicious choice of materials; the integrity of the fuel; and operational control all play a part in reducing the potential for the production of radioactive waste and in turn are influenced by the control of the coolant chemistry. In addition, some options which may lead to an increase in radioactive waste production may be acceptable because of consequential reduction in dose to plant operators.
- 29 Some of the radioactive material created by operating a UK EPR will be waste. EDF and AREVA need to show their proposals: minimise the amount of waste; and that there are adequate controls to manage the waste and its associated safety and environmental hazards until it is sent for disposal.
- 30 EDF and AREVA have to comply with UK Government policy. Government policy states their assumption that spent fuel from a UK EPR will, after cooling, be sent for disposal (Ref. 6). This is the basis of my assessment.
- 31 There are a number of SAPs specific to waste management and decommissioning. The SAPs on nuclear matter will supplement them because of the diverse nature of the material. Table 1 details the SAPs specific to RW & D. I will assess the Requesting Party's (RP) safety case on all of this sub-set in a proportionate way as some are more relevant to site specific assessment than GDA.
- 32 There are also a number of international standards, specifically those produced by the International Atomic Energy Agency and the Western European Nuclear Regulators' Association. Table 1 shows the relationship between the SAPs for RW & D and these standards.
- 33 In 2006 the Government's response to recommendations by CoRWM, established in England and Wales, that deep geological disposal is the preferred route for the long-term management of radioactive waste that is not suitable for near-surface disposal. It also gave the responsibility for delivering the program for a deep geological repository to the Nuclear Decommissioning Authority (NDA).
- 34 To take this into account, HSE, the Environment Agency and the Scottish Environment Protection Agency (SEPA) have developed a series of joint guidance documents on the management of higher activity radioactive waste. These specify the production, content,

maintenance and review of Radioactive Waste Management Cases (RWMCs), and further guidance on the components of a RWMC.

- 35 The RWMC should demonstrate the long-term safety and environmental performance of the management of specific wastes from their generation to their conditioning into the form in which they will be suitable for storage and eventual disposal. It should provide a complete picture of the management of waste streams that cannot necessarily be seen from examination of the individual plant safety cases. It may deal with a single waste stream or several related waste streams, but all radioactive wastes produced by a UK EPR should be covered by a RWMC.
- 36 Much of the information required should already be available in other documents, e.g. the integrated waste strategy and relevant plant safety cases. The RWMC does not aim to duplicate such information which can be incorporated through brief summaries and referencing. The added value of a RWMC is a demonstration of how the various components interact together with a description of any necessary arrangements for managing such interactions.
- 37 GDA allows the safety, security and environmental implications of new power station designs to be assessed before an application is made for the permissions required to build that design at a particular site. For radioactive waste there is a tension as a proposition acceptable for GDA may not be optimum across a reactor fleet. In recognition of this a paper has been produced clarifying the regulators expectations (Ref. 5).

2.3 Nuclear Directorate Assessment

- 38 When assessing RW & D I have chosen to consider the proposals under the following six topics:
- Have EDF and AREVA identified all of the wastes that a UK EPR will produce?
 - Do EDF and AREVA have suitable plans for conditioning of the wastes?
 - Are there any safety issues with EDF and AREVA plans for short term storage?
 - Are there any safety issues with EDF and AREVA plans for long term storage?
 - Can EDF and AREVA dispose of the wastes?
 - Can a UK EPR be safely decommissioned?
- 39 For each of these areas I considered spent fuel separately from other wastes. This is because spent fuel requires different means of managing its storage and disposal. Each of the areas are considered separately below.

2.3.1 Have EDF and AREVA Identified All of the Wastes That a UK EPR Will Produce?

- 40 The UK EPR will produce a range of different wastes over the lifecycle. My assessment is only considering the radioactive wastes, although I note Environment Agency is considering both the radioactive and non-radioactive wastes. My assessment of the reactor lifecycle starts with the introduction of radioactive material on to the site and finishes once all nuclear material has been removed from the site.
- 41 The way that the UK EPR is operated will affect the quantity and proportions of radionuclides in the different waste types. I recognise that changes in the operating regime will also affect other areas of operation. To indicate typical effects of different operating regimes I, together with colleagues, have commissioned AMEC to produce a

report on practices used in Pressurised Water Reactors. The overall aim of the report is to:

- review technologies and practices that will reduce worker doses, public doses and radioactive waste arising (but not necessarily all three simultaneously);
- identify the effects associated with the technologies and practices;
- identify examples where the technology/practice has been used;
- identify whether each technology or practice can be used with other technologies or practices (synergy) or whether it cannot be used with other technologies or practice due to conflicting requirements;
- give a broad estimate of the cost to deploy the technology or practice and whether there may be other costs to incur;
- identify the key references with more detailed information;
- identify any issues associated with the technology or practice;
- identify questions related to the process;

42 It is very important to stress that the output is not meant to indicate which technologies and practices are the best, this is something EDF and AREVA will substantiate in the safety assessments.

2.3.1.1 Wastes, Other Than Spent Fuel

43 In the April 2008 PCSR Chapter 11.2 provides an overview of the radionuclides likely to be significant in these wastes and Chapter 11.3 gives an overview of the wastes. The November 2008 PCSR updated this information.

44 The Solid Radioactive Waste Strategy Report (Ref. 8) provided a lot more detail of the wastes produced by a UK EPR. Tables in the report identify the waste origin; waste physical description; nature of radioactive material; annual arising; total arising; waste classification at time of generation; main radionuclides; and hazardous substances.

45 Having reviewed the November 2008 PCSR and the Solid Radioactive Waste Strategy Report I am confident that the information in these reports is a good representation of wastes typically produced during the operation of a Pressurised Water Reactor. However, from the information presented I have not been able to confirm that EDF and AREVA have identified all possible wastes that they may have to deal with over the operational life of a UK EPR. This gives me a number of difficulties with my assessment, which I have addressed in different ways.

46 Firstly it was important that the assessment of disposability of the wastes, being undertaken for EDF and AREVA by the Nuclear Decommissioning Authority, was on a consistent basis with my assessment. In December 2008 I wrote to EDF and AREVA informing them of the risk that I was not able to agree with the bases for the disposability assessments until I had reviewed the information submitted, (EPR70069R). EDF and AREVA responded in April 2009, providing me with a copy of the information they had submitted to the Nuclear Decommissioning Authority. Provision of this information demonstrated an appropriate level of consistency and so closed the issue.

47 Secondly I need to understand how decisions taken in the design and operating regime for a UK EPR will affect the types of waste produced. Following discussion with the Environment Agency I have agreed that they will now take the lead in this area. In June 2009 a joint Regulatory Observation, RO-UKEPR-33, was issued to EDF and AREVA. One of the actions required a detailed assessment of the application of Best Available Technique to the design. EDF and AREVA response to this should provide sufficient

information to address this issue. The response was submitted at the end of Step 3 and will be part of my Step 4 assessment.

- 48 Thirdly the information provided does not identify potential operating anomalies that will affect waste production. Such anomalies may include replacement of large items, such as a Reactor Pressure Vessel Head; changes in operating methodologies or ageing of the reactor. Whilst I am not providing any judgement as to whether a UK EPR would be more or less susceptible to such anomalies it is important that I understand the potential consequences of them. As an anomaly is outside of routine operation it is difficult to identify all anomalies. Throughout Step 3 I have interacted with EDF and AREVA to define the scope. As a consequence in September 2009 in conjunction with the Environment Agency I raised separate TQs, two requesting further evidence of the techniques used to collect data and one on plans to deal with anomalous wastes. On the information provided to date I am satisfied that EDF and AREVA will be able to provide evidence, in response to these TQs, that anomalous waste can be safely dealt with.

2.3.1.2 Spent Fuel

- 49 The PCSR and supporting information provide details of the radionuclide content of the fuel and the amount used in a reactor. For GDA the fuel assessed is uranium oxide fuel whose isotopic composition depends upon the initial enrichment and the fuel management regime to which it is subject in the reactor. Whilst the average core region fuel burn-up is less than 65,000 MWd/tU, it is assumed that all fuel has seen 65,000 MWd/tU for the disposability assessment and storage regimes.
- 50 Prior to disposal the spent fuel will be stored in cooling ponds for a period of time, followed by interim stores on the site. So at the time of disposal the thermal output of the fuel will have reduced. Assuming all fuel has seen 65,000 MWd/tU will indicate the maximum storage period of the fuel at the reactor site. It is likely that much of the fuel will have a lower burn-up and so could be disposed of sooner.
- 51 Therefore for GDA the level of information provided on spent fuel is sufficient for my use. I recognise that at a site specific stage a more detail analysis maybe required to show how long spent nuclear fuel having different burn-ups would be stored on site.

2.3.2 Do EDF and AREVA Have Suitable Plans for Conditioning of the Wastes?

- 52 The SAPs (Ref. 4) indicate that wastes should be made passively safe.
- 53 The intention of EDF and AREVA is that ILW should be grouted into drums and boxes compatible with the repository concept. Segregation may allow some wastes containing short-lived radionuclides, classified initially as ILW, to be disposed of as LLW after a period of decay storage. ND has advocated such a strategy for a number of years as it allows better use of disposal routes and has the potential to allow earlier disposal.
- 54 The conditioning of waste is influenced by the plans for disposal, which place requirements on the packaging process. The demonstration of suitability will use the information provided in the November 2008 PCSR and the documented implications of the review by EDF and AREVA of the Nuclear Decommissioning Authority disposability assessment.
- 55 During my visits to Penly, France; ISAR Germany; and Sizewell, England; I saw the advantages of a flexible conditioning process. A typical system would be skid mounted so that equipment can be easily updated as it ages or new techniques are introduced. We have experience in the UK of this type of equipment from decommissioning projects (Ref. 11). I will be looking to see how EDF and AREVA have built flexibility into their proposals.

2.3.3 Are There Any Safety Issues With EDF and AREVA Plans for Short Term Storage?

56 In June 2009 HSE published guidance outlining the amount of detail that regulators expect for the design of waste plants in GDA (Ref. 5). For ILW the regulators only require demonstration that storage of ILW is feasible. For spent fuel we require a fully detailed design.

2.3.3.1 Wastes, Other Than Spent Fuel

57 As I only require EDF and AREVA to show that short term storage is technically feasible the assessment is subsumed into my assessment of the conditioning process and long-term storage.

58 LLW is to be disposed of as it arises, although, prudently a buffer capacity is to be provided, to minimise the effect of any disruptions to the disposal or transport services. Batches will be sent for disposal at the Low Level Waste Repository. I have looked at storage of ISO-containers holding LLW prior to their dispatch for disposal. EDF and AREVA have provided me information to show that there is two years storage capacity for the ISO-containers. I am therefore satisfied that if, for any reason, shipment of the ISO-containers is delayed there is sufficient storage capacity for a UK EPR to continue to manage its Low Level Waste safely.

2.3.3.2 Spent Fuel

59 I am co-ordinating assessment of the spent fuel storage pond at the reactor. This will cover receipt of fresh fuel, transfer into the reactor, transfer out of the reactor, management in the pond during reactor shutdown, storage prior to dispatch to the long term store and dispatch to the store. The assessment will be multi disciplined involving a number of assessors. To provide a common understanding EDF and AREVA are planning to present their case for spent fuel storage on the reactor in November 2009.

2.3.4 Are There Any Safety Issues With EDF and AREVA Plans for Long Term Storage?

60 Following my assessment of the November 2008 PCSR and its supporting documentation I arranged a meeting, in February 2009, with EDF and AREVA to discuss the storage of wastes associated with a UK EPR. Subsequent to this meeting I raised two substantive technical queries. These asked EDF and AREVA to provide additional information on:

- The design principles and safety aims for the storage facility.
- A demonstration that the need for active safety management during longer-term storage has been minimised.
- Identification of the characteristics of the waste packages and equipment needed to maintain integrity and handling over the storage period. The characteristics then need to be analysed to see how they will evolve over the storage period. Subsequent to this analysis details of the provisions that will be made for waste packages or equipment that fails to meet the required characteristics.
- Details of the provisions and functions for retrieval and inspection of waste packages, including details of the inspection regime.
- Details of the changes necessary to the retrieval and inspection regime as materials age and their characteristics change.

- Plans for the facilities, and their functions, needed to retrieve the waste packages and prepare them for onward processing or disposal.

61 These bullet points were derived from the SAPs (Ref. 4). In July 2009 EDF and AREVA responded to my technical queries with reports (Ref. 9 & 10). My assessment of the responses is detailed in the following sections.

62 In addition guidance on the storage of spent fuel for use in GDA is being drafted by VT Nuclear for endorsement by the Environment Agency and ND. Once endorsed this will be available to inform my Step 4 assessment. I have been involved in the drafting of the guidance. Therefore I have used my knowledge of the draft guidance to confirm that EDF and AREVA proposals are generally compliant with the guidance.

2.3.4.1 Wastes, Other Than Spent Fuel

63 The EDF and AREVA report on ILW storage facilities (Ref. 9) is to a level of detail broadly in line with that outlined in the paper issued by the regulators on the required level of design of waste plants (Ref. 5). It also provides the detail I expected on how radioactive wastes will be managed in the longer-term on a reactor site. Therefore I am satisfied that EDF and AREVA have made sound arguments showing their plans for long term storage of radioactive wastes should be safe to implement.

64 However, in assessing the response I need more evidence in a number of areas. These requirements are summarised below.

65 Timescales: The response needs to identify the likely minimum and maximum time period over which radioactive wastes will be stored on a site. This must be consistent with the assumptions provided to the NDA to undertake their disposability assessment. I expect the response to include arguments about:

- The approach that the licensee is assumed to take to the export of radioactive wastes.
- The time it will probably take to export all of the radioactive wastes to the disposal facility.

66 In providing this information EDF and AREVA will have demonstrated their assumptions about the scale of the storage regime they are proposing to implement.

67 Integrity, Research and Inspection: EDF and AREVA identify a number of different types of packages that could be used for radioactive wastes. The preferred container will be the one that presents the minimal risk. So in the response I want to see a comparison of the benefits of the different types of waste package.

68 Characterisation: I have asked EDF and AREVA to provide a detailed and justified list of characteristics that will be recorded for the radioactive wastes, the reasons these characteristics are important and an overview of techniques that could be used to undertake the characterisation.

69 Human Factors: I have asked EDF and AREVA to produce a specific Design Safety Principle recognising the importance of human factors in waste management. The implications of this, on the arguments presented in the response, should then be considered.

2.3.4.2 Spent Fuel

70 The EDF and AREVA report on spent fuel storage facilities (Ref. 10) is to a level of detail broadly in line with that outlined in the paper issued by the regulators on the required level of design of waste plants (Ref. 5). It also provides the detail I expected on how

spent nuclear fuel will be managed in the longer-term on a reactor site. Therefore I am satisfied that EDF and AREVA have made sound arguments showing their plans for long term dry storage of spent fuel should be safe to implement.

71 However, in assessing the response I need more evidence in a number of areas. These requirements are summarised below.

72 Timescales: The response needs to identify the likely minimum and maximum time period over which spent fuel will be stored on a site. This must be based on information supplied by NDA in their disposability assessment. I expect the response to include arguments about:

- The approach that the licensee is assumed to take to the export of spent fuel.
- The time it will probably take to export all of the fuel to the disposal facility.

73 In providing this information EDF and AREVA will have demonstrated their assumptions about the scale of the storage regime they are proposing to implement.

74 Fuel design and reactor operations: I have asked EDF and AREVA to provide more details of the effect of fuel design and reactor operations on the lifetime of the fuel. In support of my assessment I have a TSC looking at the operating aspects that could challenge the long-term stability of the spent nuclear fuel, for details see para. 77 below.

75 Integrity, Research and Inspection: EDF and AREVA put forward an argument that the inspection regime for the spent nuclear fuel should be a flexible regime optimised around feedback from operational experience and continuing research. I consider this a reasonable approach.

76 EDF and AREVA do not indicate the maximum period for storage of fuel on site. Neither do they present evidence that fuel containment (cladding and assemblies) will last for conceivable storage periods. I need more information on the work/research that EDF and AREVA recommends for predicting the life of the fuel in the longer term and the actions that should be taken if it indicates that the fuel may fail during an extended storage period.

77 I have commissioned the National Nuclear Laboratory to undertake a piece of work to identify those mechanisms that could lead to early failure of the fuel cladding or the fuel assembly during storage. This work includes:

- proposing a definition of “failure” in the context of longer-term storage (i.e. what criteria should be employed to the cladding/assembly for it to be no longer considered safe to handle or transport);
- an identification of likely lifetimes for fuel cladding and the assembly for initial failure and chronic failure;
- identification of those factors that affect the lifetime of the cladding or assembly, supported by scoping calculations to indicate the scale of the effect;
- an initial review of the available literature and research to identify any areas of research that could identify other mechanisms that would affect the life of the cladding or assembly.

78 The National Nuclear Laboratory’s report will be available during Step 4. I will involve EDF and AREVA in the development of the report so that they are aware of the issues as the work develops and I am aware of any EDF or AREVA research that should be considered by the National Nuclear Laboratory.

79 Characterisation: I have asked EDF and AREVA to provide a detailed and justified list of characteristics that will be recorded for the fuel, the reasons these characteristics are

important and an overview of techniques that could be used to undertake the characterisation.

80 Replacement: I have asked EDF and AREVA to provide a list of aspects that would need to be considered in the design of the storage facility to allow for redundancy in the equipment supplied.

81 Human Factors: I have asked EDF and AREVA to produce a specific Design Safety Principle recognising the importance of human factors in waste management. The implications of this, on the arguments presented in the response, should then be considered.

82 EDF and AREVA have also put forward a case for long-term pond storage of Spent Nuclear Fuel. A number of the points discussed above are more challenging for long-term pond storage. If this option is to be pursued then EDF and AREVA will need to provide more evidence to demonstrate that the storage risks are As Low As Reasonably Practicable (ALARP).

2.3.5 Can EDF and AREVA Dispose of the Wastes?

83 Both ND and the Environment Agency are committed to ensuring that waste streams are not produced unless there is a clear indication that they can be disposed of. To assist in developing its case EDF and AREVA has commissioned a 'disposability assessment' from NDA, which will consider whether the identified ILW and spent fuel streams are likely to meet acceptance for a geological disposal facility.

84 In September 2009 EDF and AREVA provided documentation on the disposability of their wastes. This is outside the timescale for me considering it in my Step 3 assessment. However, EDF and AREVA have facilitated a number of meetings for me with the Nuclear Decommissioning Authority. Specifically the presentation in May 2009 gave me assurance that the wastes produced by a UK EPR could be conditioned and stored so they are suitable for disposal.

85 EDF and AREVA still need to show that the encapsulation of spent nuclear fuel for disposal is ALARP and that the environmental impacts are acceptable. I have raised a TQ requesting EDF and AREVA to provide this information.

2.3.6 Can a UK EPR be Safely Decommissioned?

86 EDF and AREVA have incorporated aspects into the design of the UK EPR, which they argue will facilitate easier decommissioning. For example, the reduction in the amount of activated cobalt in the primary circuit and improved fuel reliability would be expected to reduce the dose from decommissioning activities. These seem reasonable expectations.

87 During Step 3 a contract was placed for the review of EDF and AREVA documentation on decommissioning. The conclusions of this will be available in Step 4.

88 In addition the ability to safely dismantle a UK EPR is an aspect being assessed in GDA by another ND specialist inspector.

3 CONCLUSIONS AND RECOMMENDATIONS

- 89 The design and supply of a nuclear reactor normally includes the development of facilities for the short term management of spent nuclear fuel within the reactor building and space for facilities to manage other wastes. It is then the responsibility of the operator to develop the detailed plans for the processing and management of wastes. GDA placed a requirement on EDF and AREVA to develop these plans and show that they comply with all UK requirements. It should be noted that plans in the UK for disposal of wastes and our radiological classification system are different to other countries. Therefore all proposals need to be tailored to meet UK requirements.
- 90 At the start of the GDA process the Environment Agency published their Process and Information Document outlining the information requirements. However, the level of information presented by EDF and AREVA on the management of radioactive waste was limited. As we reach the completion of Step 3 the information developed by EDF and AREVA on the management of radioactive wastes produced by a UK EPR is at a level where I can undertake a meaningful assessment. It is a success of the GDA process that EDF and AREVA have willingly invested so much time and effort to reach this point.
- 91 In undertaking my Step 3 assessment, I have worked closely with the Environment Agency, the Department for Transport and the Office of Civil Nuclear Security to ensure that all significant waste arisings and discharge routes have been identified by EDF and AREVA, and that those wastes can be effectively managed. This has been successful as I have been able to share resources and co-ordinate feedback to EDF and AREVA.
- 92 An example of the regulators interacting to provide a single set of requirements on EDF and AREVA can be seen in the paper on the level of design of waste plants in GDA (Ref. 5). This clarifies the minimum position that EDF and AREVA have to establish for radioactive waste management to be confident that the output of GDA for this aspect is meaningful and without exclusions.
- 93 In performing my Step 3 assessment of EDF and AREVA proposals for RW & D I have taken on board feedback from a wide range of stakeholders. For example, the request to EDF and AREVA for more detail on the timings of their waste management plans.
- 94 At the end of Step 3 EDF and AREVA have identified all of the wastes that a UK EPR will typically produce. I am confident that this is suitable to underpin my assessment. In Step 4 I expect them to provide me with more evidence on dealing with anomalous wastes and confirmation, from the Best Available Techniques documentation, that all wastes have been identified.
- 95 In Step 4 EDF and AREVA will need to show that their plans for conditioning of the wastes are compatible with the disposability assessment performed by the NDA.
- 96 For short-term storage EDF and AREVA have to confirm that there are no safety issues with their plans. EDF and AREVA are making a presentation on short-term storage of spent fuel in November 2009. For the remaining wastes the arguments made in support of other areas show that short term storage is feasible.
- 97 EDF and AREVA have provided detailed arguments for the safety of long term storage. I judge the reports show that safe long-term storage is feasible. In Step 4 I will require further evidence on specific aspects of the storage regime.
- 98 For long-term pond storage EDF and AREVA need to provide significantly more evidence to show that it is ALARP. This will need to be complete before a decision is made on the use of long-term pond storage.
- 99 During Step 3 EDF and AREVA have provided verbal assurance that the radioactive wastes produced by a UK EPR are suitable for disposal. The written disposability assessment prepared by the Nuclear Decommissioning Authority is now complete and has been provided to EDF and AREVA. In Step 4 my interest is how EDF and AREVA

proposes that an operator should safely condition and store the waste in a manner compatible with the conclusions of the NDA disposability assessment.

- 100 It should be noted that the wastes identified by EDF and AREVA are similar to wastes previously identified in the UK Radioactive Waste Inventory (Ref. 12). NDA have used this inventory to underpin their concepts. Therefore I judge it likely that ILW from a UK EPR should be disposable after suitable conditioning. So my interest is how EDF and AREVA propose to safely condition and store the waste in a manner that meets the requirements of the NDA.
- 101 Finally I have commenced my assessment of whether a UK EPR can be safely decommissioned. This will be concluded in Step 4.
- 102 During the assessment I have not identified any significant issues, or significant design or safety case changes that could impact on radioactive waste arisings or have a significant negative environmental impact.
- 103 If during our Step 4 detailed assessment I identify an issue that impacts on radioactive waste arisings or other environmental impact, I will notify the Environment Agency and the Department for Transport. I will do this through our routine joint working arrangements on GDA, and where appropriate in response to the Environment Agency's questions.

4 REFERENCES

- 1 *UK EPR Pre-Construction Safety Report*. UK EPR-0002-132 Issue 02, EDF and AREVA, June 2009.
- 2 *ND BMS, Assessment Process*. AST/001, Issue 2, HSE, February 2003.
- 3 *ND BMS, Guide: Assessment Process*. G/AST/001, Issue 2, HSE, February 2003.
- 4 *Safety Assessment Principles for Nuclear Facilities*. 2006 Edition, Revision 1, HSE, January 2008.
- 5 *Level of design of waste plants for new build reactors in the GDA*. HSE, June 2009.
- 6 *Meeting the Energy Challenge A White Paper on Nuclear Power*. January 2008, CM 7296 HM Government, Department for Business, Enterprise & Regulatory Reform, *January 2008*.
- 7 *CoRWM Work Programme 2009/2010, Proposed Work Plans*. CoRWM doc. 2665, Draft 1, 12 August 2009.
- 8 *Solid radioactive waste strategy report*. AREVA NP FGF NESH-G/2008/en/0123, November 2008.
- 9 *Longer Term ILW Interim Storage Facility*. UKEPR-0008-001 Issue 00, July 2009.
- 10 *Longer Term Spent Fuel Interim Storage Facility*. UKEPR-0009-001 Issue 00, July 2009.
- 11 *Nirex interactions with Waste Producers on plans for packaging radioactive wastes April 2003 to March 2004*. Nirex Report no. N/116, March 2005.
- 12 *The 2007 UK Radioactive Waste Inventory: Main Report*. Defra/RAS/08.002, NDA/RWMD/004, March 2008.
- 13 *EDF and AREVA UK EPR - Schedule of Regulatory Issues Raised during Step 3*. HSE-ND, TRIM Ref. 2009/358254.
- 14 *EDF and AREVA UK EPR - Schedule of Regulatory Observations Raised during Step 3*. HSE-ND, TRIM Ref. 2009/358253.
- 15 *EDF and AREVA UK EPR - Schedule of Technical Queries Raised during Step 3*. HSE-ND, TRIM Ref. 2009/358252.

Table 1
Safety Assessment Principles Relevant to Radioactive Waste and Decommissioning

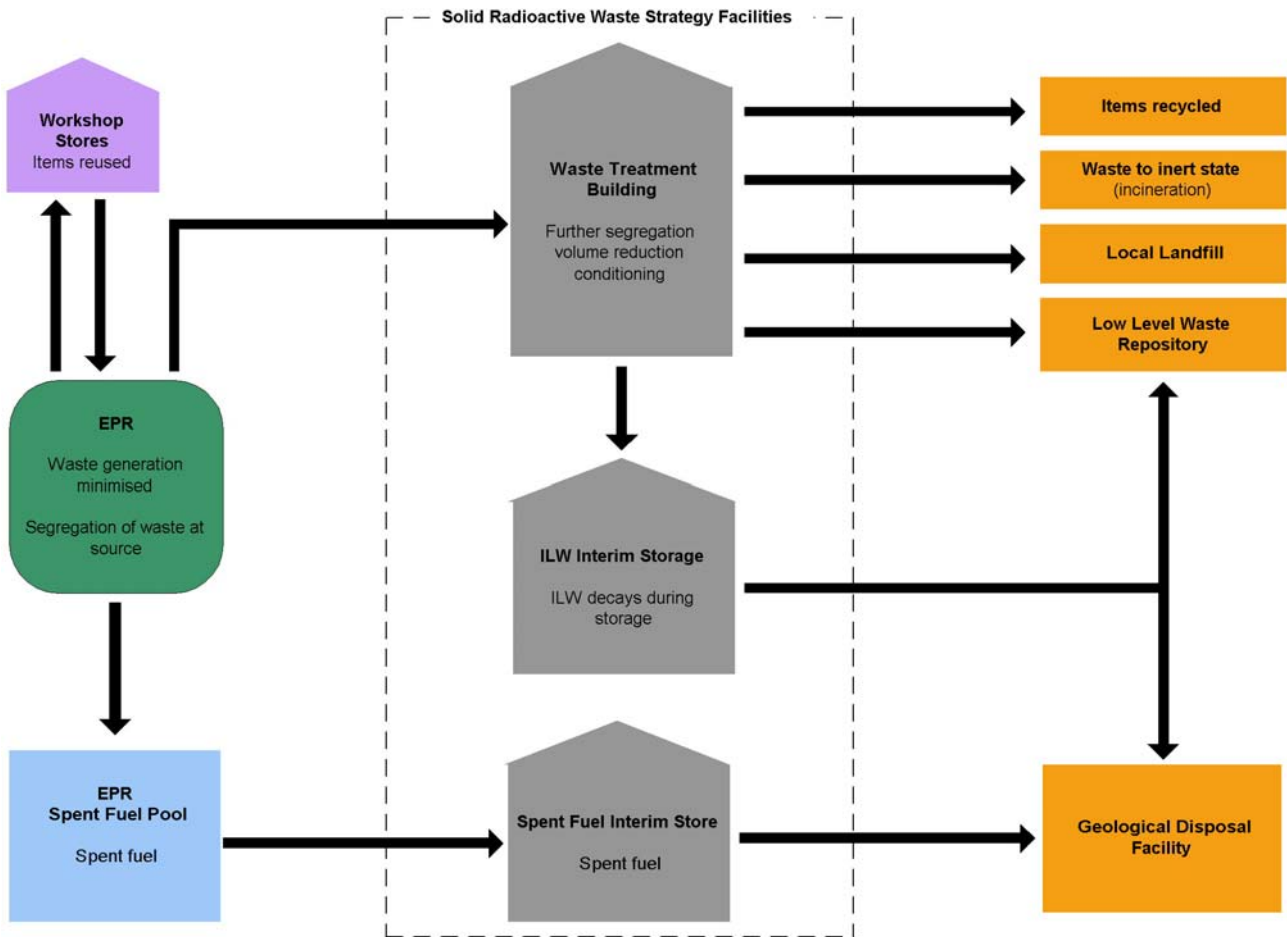
SAP No.	SAP Title	Assessed Category *	WENRA ** (Ref. 5, 6)	IAEA *** (Ref. 7)
DC.1	Design and operation	S3	D-12, D-13	
DC.2	Decommissioning strategies	S3	D-14 to D-25	
DC.3	Timing of decommissioning	S3		
DC.4	Planning for decommissioning	S3		5.68
DC.5	Passive safety	S3		
DC.6	Records for decommissioning	S3	D-10, D-11	
ENM.1	Strategies for nuclear matter	S3	S-62 to S-65	6.90
ENM.4	Control and accountancy of nuclear mater	S3		6.92
ENM.5	Characterisation and segregation	S3		
ENM.6	Storage in a condition of passive safety	S3	S-19, S21 to S-38	6.91, 6.97, 6.98
ENM.7	Retrieval and inspection of stored nuclear mater	S3	S-35 to S-38	6.91
RW.1	Strategies for radioactive waste	S3		6.90
RW.2	Generation of radioactive waste	S3		
RW.3	Accumulation of radioactive waste	S3		
RW.4	Characterisation and segregation	S3	D-43, D-44	
RW.5	Storage of radioactive waste and passive safety	S3	S-19, S21 to S-38	6.91, 6.92
RW.6	Passive safety timescales	S3	S-20, S-22	
RW.7	Records for management of radioactive waste	S3	S-15 to S-18	

* S3 = Assessment commences at STEP 3 or 4

** The WENRA reference levels are met by the relevant SAPs, but not in a one to one correlation. A number of the Wenra reference levels are relevant to the operation of the facilities, it is not appropriate to address these at this stage.

*** IAEA NS-R-1 sub para.s (7) is for Licence Applicants

Figure 1
EDF and AREVA Radioactive Waste Stream Flow Diagram



Annex 1 – Radioactive Waste and Decommissioning – Status of Regulatory Issues and Observations

RI / RO Identifier	Date Raised	Title	Status	Required timescale (GDA Step 4 / Phase 2)
Regulatory Issues				
RI-EPR-0001	1 Feb 2008	Information required by the Environment Agency for the detailed assessment stage	Closed.	-
Regulatory Observations				
RO-UKEPR-33	8 June 2009	Integrated Waste Strategy	Ongoing (Documents provided but not yet assessed.)	Step 4

(A list of all RIs, ROs and TQs can be found in Refs 13, 14 and 15).