Office for Nuclear Regulation

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Generic Design Assessment – New Civil Reactor Build

Step 4 Radioactive Waste and Decommissioning Assessment of the EDF and AREVA UK EPR™ Reactor

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PREFACE

The Office for Nuclear Regulation (ONR) was created on 1st April 2011 as an Agency of the Health and Safety Executive (HSE). It was formed from HSE's Nuclear Directorate (ND) and has the same role. Any references in this document to the Nuclear Directorate (ND) or the Nuclear Installations Inspectorate (NII) should be taken as references to ONR.

The assessments supporting this report, undertaken as part of our Generic Design Assessment (GDA) process and the submissions made by EDF and AREVA relating to the UK EPR^{TM} reactor design, were established prior to the events at Fukushima, Japan. Therefore, this report makes no reference to Fukushima in any of its findings or conclusions. However, ONR has raised a GDA Issue which requires EDF and AREVA to demonstrate how they will be taking account of the lessons learnt from the events at Fukushima, including those lessons and recommendations that are identified in the ONR Chief Inspector's interim and final reports. The details of this GDA Issue can be found on the Joint Regulators' new build website www.hse.gov.uk/newreactors and in ONR's Step 4 Cross-cutting Topics Assessment of the EDF and AREVA UK EPR^{TM} reactor.

EXECUTIVE SUMMARY

This report presents the findings of the Radioactive Waste and Decommissioning assessment of the UK EPR reactor undertaken as part of Step 4 of the Health and Safety Executive's Generic Design Assessment. The assessment has been carried out on the November 2009 Pre-construction Safety Report and supporting documentation submitted by EDF and AREVA during Step 4.

This assessment has followed a step-wise-approach in a claims-argument-evidence hierarchy. In Step 2 the claims made by EDF and AREVA were examined, in Step 3 the arguments that underpin those claims were examined.

The scope of the Step 4 assessment was to review the safety aspects of the UK EPR reactor in greater detail, by examining the evidence, supporting arguments and claims made in the safety documentation, building on the assessments already carried out for Steps 2 and 3, and to make a judgement on the adequacy of the Radioactive Waste and Decommissioning information contained within the Pre-construction Safety Report and supporting documentation.

It is seldom possible, or necessary, to assess a safety case in its entirety, therefore sampling is used to limit the areas scrutinised, and to improve the overall efficiency of the assessment process. Sampling is done in a focused, targeted and structured manner with a view to revealing any topic-specific, or generic, weaknesses in the safety case. To identify the sampling for the Radioactive Waster and Decommissioning an assessment plan for Step 4 was set-out in advance.

My assessment has focussed on:

- Whether the wastes that a UK EPR will produce have been identified in sufficient detail to underpin the subsequent assessments.
- The suitability of the plans put forward for short-term storage; and conditioning of the wastes for long-term storage and eventual disposal
- The suitability of the plans for long term storage of Intermediate Level Waste and spent fuel to show that this is safe and that the waste will be in a condition that would allow it to be transported for disposal.
- Whether the wastes that a UK EPR will produce are suitable for disposal.
- The plans for decommissioning a UK EPR, to show that this can be achieved in a safe and environmentally acceptable way and that the wastes produced are suitable for disposal.
- The suitability of proposals for knowledge management over the lifetime of the facilities.
- The ability of EDF and AREVA to produce the Radioactive Waste Management Case for the UK EPR, showing the safety proposals from cradle to grave.
- The EDF and AREVA plan for the development of waste management facilities to show that these can be developed in a timely manner.

A number of items have been agreed with EDF and AREVA as being outside the scope of the Generic Design Assessment process and are therefore not included in my assessment. For example, I need evidence that the spent fuel can be safely stored away from the reactor and then transported, but I do not require EDF and AREVA to specify the storage method. Therefore the emphasis for these facilities is less on the specific design details and more on the evidence to show that there is a credible route. For the waste facilities, EDF and AREVA have had 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 waste streams and their packaging evolve over the storage period; data and records management; knowledge of the constraints placed on the wastes by the disposal facilities; identification of knowledge gaps and the resulting research and development programme; and robust estimates of the required capacity.

As a result of my assessment EDF and AREVA have developed a robust set of credible waste management processes that could be used by a licensee to deal with the wastes produced by a UK EPR. I encouraged them to work together with the Nuclear Decommissioning Authority's Radioactive Waste Management Directorate to show that these wastes could be disposed of in a Geological Disposal Facility. EDF and AREVA have also undertaken additional work to show that there is sufficient flexibility in the design to allow the spent fuel storage facilities to address the requirements of long-term storage.

From my assessment, I have concluded that:

- EDF and AREVA have identified the typical wastes that a UK EPR will produce in sufficient detail to underpin the subsequent assessments.
- There is sufficient flexibility within the layout of the Effluent Treatment Building to provide safe and environmentally acceptable short term storage options for the wastes that a UK EPR is foreseen to produce.
- The wastes are compatible with a range of conditioning processes and there is no reason to believe that the resulting products are not suitable for long-term storage and eventual disposal.
- The plans for long term storage of Intermediate Level Waste are similar to those used elsewhere in the UK nuclear industry.
- There is sufficient flexibility in the design of the spent fuel storage facilities to allow a licensee to address the needs of the long-term storage requirements so that spent fuel remains in a condition that would allow it to be transported for disposal. The licensee will need to continue to consider potential degradation mechanisms and periodically inspect the stored fuel to maintain confidence that it remains in a suitable condition.
- In the UK the Environment Agency issues the permits for the disposal of radioactive waste. I accept their advice that they foresee no reason why the wastes, likely to be produced by a UK EPR, shouldn't be suitable for disposal.
- The plans for decommissioning a UK EPR are developed to a suitable level to show that this can be achieved in a safe and environmentally acceptable way and that the wastes produced are suitable for disposal.
- The Radioactive Waste Management Case Mapping Document for the UK EPR, shows that the proposals by EDF and AREVA for cradle to grave management of waste are in sufficient detail to be confident that there are no foreseeable reasons why the waste cannot be managed safely.
- EDF and AREVA have produced the basis for a credible plan for the development of waste management facilities. The licensee will need to demonstrate that the activities can be realised in a timely manner.
- There is a suitable basis for the licensee to develop a suitable system for knowledge management over the lifetime of the facilities.

In some areas there has been a lack of detailed information which has limited the extent of my assessment. As a result the Health and Safety Executive's Nuclear Directorate will need additional information to underpin my conclusions and these are identified as Assessment Findings to be carried forward as normal regulatory business. These are listed in Annex 1. Examples include a requirement that the licensee provides the evidence necessary to underpin their spent fuel storage, transport and disposal strategy, the activities needed to secure this evidence and the time needed for these activities (AF-UKEPR-RW-07); or the action on the licensee to produce a pre-construction safety report for the interim spent fuel storage facilities prior to the first fuel load (AF-UKEPR-RW-10).

Overall, based on the sample undertaken in accordance with the Health and Safety Executive's Nuclear Directorates procedures, I am broadly satisfied that the claims, arguments and evidence laid down within the Pre-construction Safety Report and supporting documentation submitted as part of the Generic Design Assessment process present an adequate safety case for the generic UK EPR reactor design. The UK EPR reactor is therefore suitable for construction in the UK, subject to satisfactory progression and resolution of the additional information that becomes available as the Generic Design Assessment Design Reference is supplemented with additional details on a site-by-site basis.

I have identified no matters that need to be progressed as Generic Design Assessment Issues.

LIST OF ABBREVIATIONS

ALARP	As Low As Reasonably Practicable
AGR	Advanced gas cooled Reactor
BAT	Best Available Technique
BMS	(Nuclear Directorate) Business Management System
BRIMS™	British Radwaste Information Management System
CoRWM	Committee on Radioactive Waste Management
DECC	Department of Energy and Climate Change
EDF and AREVA	Electricité de France SA and AREVA NP SAS
FDWMP	Funded Decommissioning and Waste Management Programme
GDA	Generic Design Assessment
GDF	Geological Disposal Facility
HSE	The Health and Safety Executive
IAEA	The International Atomic Energy Agency
ILW	Intermediate Level Waste
ISF	Interim Storage Facility
IWS	Integrated Waste Strategy
LLW	Low Level Waste
LoC	Letter of Compliance
MDEP	The Nuclear Energy Agency Multinational Design Evaluation Program
MRWS	Managing Radioactive Waste Safely
ND	The (HSE) Nuclear Directorate
NDA	The Nuclear Decommissioning Authority
NIA	Nuclear Industry Association
NII	Nuclear Installations Inspectorate
NPP	Nuclear Power Plant
NNL	National Nuclear Laboratory
NRC	The United States Nuclear Regulatory Commission
NTG	Nuclear Topic Group
OECD-NEA	Organisation for Economic Co-operation and Development - Nuclear Energy Agency
PCER	Pre-construction Environment Report
PCSR	Pre-construction Safety Report
PWR	Pressurised Water Reactor
RI	Regulatory Issue
RIA	Regulatory Issue Action

LIST OF ABBREVIATIONS

RO	Regulatory Observation
ROA	Regulatory Observation Action
RW&D	Radioactive Waste Management and Decommissioning
RWMC	Radioactive Waste Management Case
RWMD	The Nuclear Decommissioning Authority's Radioactive Waste Management Directorate
SAP	Safety Assessment Principle
SEPA	Scottish Environment Protection Agency
SQEP	Suitably Qualified and Experienced Person
SSC	System, Structure and Component
SSM	Swedish Radiation Safety Authority
STUK	The Radiation and Nuclear Safety Authority of Finland
TAG	(Nuclear Directorate) Technical Assessment Guide
TQ	Technical Query
TSC	Technical Support Contractor
VLLW	Very Low Level Waste
WENRA	The Western European Nuclear Regulators' Association
WGWD	WENRA Working Group on Waste and Decommissioning

TABLE OF CONTENTS

1 INTRODUCTION....1
2 NUCLEAR DIRECTORATE'S ASSESSMENT STRATEGY FOR RW&D....2
2.1 Background....2
2.2 Assessment Plan....3
2.2.1 Strategy....3
2.2.2 Co-Ordination with Other Nuclear Directorate Assessment Areas....4
2.2.3 External Dependencies....4
2.3 Standards and Criteria....5
2.3.1 Safety Assessment Principles (SAP)....5
2.3.2 Management of Higher Activity Radioactive Waste on Nuclear Licensed Sites....5
2.4 Assessment Scope....6
2.4.1 Findings from GDA Step 3....7
2.4.2 Additional Areas for Step 4 RW&D Assessment....7
2.4.3 Use of Technical Support Contractors....9
2.4.4 Interactions with other Assessment Topic Areas....11
2.4.5 Integration with Other Assessment Topics....17
2.4.6 Out of Scope Items....18
3 EDF AND AREVA'S SAFETY CASE....19
3.1 Introduction....19
3.2 The Identification of the Wastes That a UK EPR Will Produce....20
3.3 EDF and AREVA Plans for Short Term Storage and Conditioning....21
3.3.1 Operational Wastes, Other Than Spent Fuel....21
3.3.2 Spent Nuclear Fuel....23
3.4 EDF and AREVA Plans for Long Term Storage....24
3.4.1 Operational Wastes, Other Than Spent Fuel....24
3.4.2 Spent Nuclear Fuel....25
3.4.3 The Solid Radioactive Waste Strategy Report....28
3.5 EDF and AREVA Proposals for the Disposal of the UK EPR Wastes....28
3.5.1 Operational Wastes, Other Than Spent Fuel....28
3.5.2 Spent Nuclear Fuel....28
3.6 Decommissioning....29
3.6.1 Principles Underpinning the Design....29
3.6.2 Decommissioning Logistics....29
3.6.3 Timings of Decommissioning....30
3.6.4 Hazards and Challenges....30
3.6.5 Assumed Plant Status at Decommissioning....30
3.6.6 Disposability Assessment....30
3.6.7 Decommissioning Plans....30
3.7 Knowledge Management....31
3.8 The Radioactive Waste Management Case....32

3.9 The Plan for the Development of the Waste Management Facilities 33
3.10 Supporting Site Visits 33
4 GDA STEP 4 NUCLEAR DIRECTORATE ASSESSMENT FOR RW&D 35
4.1 The Identification of the Wastes That a UK EPR Will Produce 35
4.1.1 Assessment 35
4.1.2 Findings on the Identification of the Wastes That a UK EPR Will Produce 37
4.2 EDF and AREVA Plans for Short Term Storage and Conditioning 38
4.2.1 Assessment 38
4.2.2 Findings on Plans for Short Term Storage and Conditioning 39
4.3 EDF and AREVA Plans for Long Term Storage 39
4.3.1 Assessment 39
4.3.2 Findings on the Plans for Long Term Storage....42
4.4 Disposability....43
4.4.1 Assessment 43
4.5 Decommissioning 44
4.5.1 Assessment 44
4.5.2 Findings on Decommissioning 46
4.6 Knowledge Management....46
4.6.1 Assessment 46
4.6.2 Findings on Knowledge Management....47
4.7 The Radioactive Waste Management Case 47
4.7.1 Assessment 47
4.7.2 Findings on the Radioactive Waste Management Case....49
4.8 The Production of a Credible Plan for the Waste Management Facilities....49
4.8.1 Assessment 49
4.8.2 Findings on the Production of a Credible Plan for the Waste Management Facilities .51
4.9 Overseas Regulatory Interface 53
4.9.1 Bilateral Collaboration....53
4.9.2 Multilateral Collaboration....54
4.10 Interface with Other Regulators 54
4.10.1 Have the Wastes That a UK EPR Will Produce Been Identified? 55
4.10.2 Are There Suitable Plans for Conditioning and Storage?....55
4.10.3 Are Wastes Disposable?....55
4.10.4 Can a UK EPR Be Safely Decommissioned? 55
4.10.5 Can a Radioactive Waste Management Case Be Produced for a Uk EPR? 55
4.10.6 Is There a Credible Plan for the Waste Management Facilities? 56
5 CONCLUSIONS....57
5.1 Key Findings from the Step 4 Assessment....57
6 REFERENCES....59

Tables

Table 1: Relevant Safety Assessment Principles for Radioactive Waste and Decommissioning Considered During Step 4

Table 2: Key Learning Points from Site Visits

Annexes

Annex 1: Assessment Findings to be Addressed During the Forward Programme as Normal Regulatory Business - Radioactive Waste and Decommissioning – UK EPR

Annex 2: GDA Issues - Radioactive Waste and Decommissioning – UK EPR

Figures

Figure 1: Table 4 out of the PCSR Chapter 11.3 (Ref. 32)

Figure 2: EDF and AREVA Radioactive Waste Stream Flow Diagram

Figure 3: Simplified Flow Diagram of the Liquid and Gaseous Waste Routes

1 INTRODUCTION

1 This report presents the findings of the Step 4 Radioactive Waste and Decommissioning (RW&D) assessment of the November 2009 UK EPR reactor Pre-construction Safety Report (PCSR) (Ref. 1) and supporting documentation provided by EDF and AREVA under the Health and Safety Executive's (HSE) Generic Design Assessment (GDA) process. Assessment was undertaken of the PCSR and the supporting evidentiary information derived from the Submission Master List (Ref. 2). The approach taken was to assess the principal submission, i.e. the PCSR, and then undertake assessment of the relevant documentation sourced from the Submission Master List on a sampling basis in accordance with the requirements of The (HSE) Nuclear Directorate (ND) Business Management System (BMS) procedure AST/001 (Ref. 3). The Safety Assessment Principles (SAP) (Ref. 4) have been used as the basis for this assessment. Ultimately, the goal of assessment is to reach an independent and informed judgment on the adequacy of a nuclear safety case.

2 During the assessment a number of Technical Queries (TQ) and Regulatory Observations (RO) were issued and the responses made by EDF and AREVA assessed. Where relevant, detailed design information from specific projects for this reactor type has been assessed to build confidence and assist in forming a view as to whether the design intent proposed within the GDA process can be realised.

3 A number of items have been agreed with EDF and AREVA as being outside the scope of the GDA process and hence have not been included in this assessment, see Section 2.4.6.

2 NUCLEAR DIRECTORATE'S ASSESSMENT STRATEGY FOR RW&D

4 The intended assessment strategy for Step 4 for the RW&D topic area was set out in an assessment plan that identified the intended scope of the assessment and the standards and criteria that would be applied (Ref. 5). This is summarised below.

2.1 Background

5 The GDA process has been carried out against a background of continuing development of national policy in the area of radioactive waste and decommissioning.

6 Low Level Waste (LLW) is routinely produced by UK industry and disposed of at the national near-surface disposal facility near Drigg in Cumbria. It is assumed that LLW from new build will be disposed of at this or a subsequent facility.

7 Intermediate Level Waste (ILW) is also produced by existing nuclear power stations during both operation and decommissioning. There is no existing disposal facility for ILW in the UK. So ILW arisings are conditioned at the reactor site into a passively safe form suitable for long-term storage.

8 Spent fuel from the Magnox and AGR programmes have typically been reprocessed at Sellafield and the national strategy for spent fuel reflects this. But the Government has stated (Ref. 6) that consideration of new build should assume its ultimate disposal. Therefore throughout this report when discussing spent fuel it is assumed to be a waste, equally when discussing waste this includes spent fuel.

9 The Government has stated that it considers that it is technically possible and desirable to dispose of new higher activity radioactive waste in a Geological Disposal Facility (GDF) and that this would be a viable solution and the right approach for managing waste from any new nuclear power stations. The Government considers that waste can and should be stored in safe and secure interim storage facilities until a GDF becomes available.

10 The Government has committed (Ref. 7) through the Managing Radioactive Waste Safely programme (MRWS) to develop a GDF in the UK for higher activity wastes, including spent fuel. The Nuclear Decommissioning Authority (NDA), through its Radioactive Waste Management Directorate (RWMD) has been charged with leading the design implementation of the GDF and is subject to scrutiny by both regulators as it develops the concept.

11 The timescale for the availability of a GDF for disposability of waste and spent fuel from a new build programme is inevitably an estimate which is subject to many parameters, but the RWMD has stated (Ref. 8) that it expects a GDF to be able to receive ILW and spent fuel from a new build programme by 2040 and 2075 respectively. The case for storage of ILW and spent fuel, while adopting the consequential timescales as targets must also demonstrate an expectation that safety can be maintained beyond these dates should it be necessary.

12 In order to gain assurance that higher activity wastes from existing nuclear facilities can be accommodated in a GDF the regulators and industry have developed the Letter of Compliance (LoC) protocol (Ref. 9). Assessments under the LoC process are undertaken at predetermined stages fitting in with the developer's 'stage gate' process, starting at the Concept stage, moving to an Interim stage before major contracts are placed, and then at a Final stage prior to active operations. For GDA RWMD has developed a specific approach to the disposability assessments, which apply those parts

of the LoC process that are relevant in the context of the GDA (Ref. 10). The results of RWMD's work have been submitted to the regulators as part of the EDF and AREVA case.

13 The Government has also been developing a methodology to ensure that the cost of decommissioning does not fall to the taxpayer (Ref. 11). It is intended that operators will develop a decommissioning plan to allow the costs of decommissioning to be conservatively estimated, so that the Government can be assured that the funds for decommissioning are accrued during the operational lifetime of the plant. Decommissioning plans will be developed and refined over the lifetime of the plant, taking account of operational history and the opportunity for direct measurements of some parameters rather than the conservative estimates made during the design process.

14 The timescale for the implementation of the decommissioning plan is likely to depend on a number of factors, including the availability of disposal routes and transportation logistics. For the purposes of GDA EDF and AREVA have therefore been asked to detail the stages of decommissioning and their likely duration, recognising that there will be a need for review and revision as technology and policy develops.

2.2 Assessment Plan

2.2.1 Strategy

15 The design and supply of a nuclear reactor normally includes the development of facilities for the short term management of spent 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 the radiological classification system for radioactive wastes are different to other countries. Therefore all proposals need to be tailored to meet UK requirements.

16 At the start of the GDA process the Environment Agency published their Process and Information Document (Ref. 12) outlining it's information requirements. This was supplemented in June 2009 by a joint position statement (Ref. 13) issued by the Environment Agency, Department for Transport and ND outlining the level of design required on the waste plants in GDA.

17 At the start of the GDA the level of information presented by EDF and AREVA on the management of radioactive waste was limited. By the completion of Step 3 the information developed by EDF and AREVA on the management of radioactive wastes produced by a UK EPR was at a level where meaningful assessment was possible.

18 So at the end of Step 3 (Ref. 14) I had completed a number of aspects of our assessment of RW&D. In the remaining areas there were two types of deliverable for assessment during Step 4, these were:

- five reports submitted towards the end of Step 3, when there was insufficient time to assess them; and
- two reports and four presentations that EDF and AREVA had committed to provide during Step 4.

19 I was also aware that the assessment of these deliverables could produce further lines of enquiry. I therefore developed the assessment strategy to increase the probability that these could be provided in time for my assessment in Step 4.

20 This approach has been successful. I have completed a meaningful GDA of the EDF and AREVA proposals for managing radioactive waste and decommissioning for a UK EPR. Therefore there are no outstanding issues. There are a number of findings that will be detailed within this report. These are in line with my expectations at the beginning of GDA and can be considered to be normal business that a licensee should address during construction and operation in the UK.

2.2.2 Co-Ordination with Other Nuclear Directorate Assessment Areas

21 There were a number of areas where I needed to consult with other assessors as part of the RW&D assessment process during Step 4. These areas were overseen by the Project Technical Inspectors in conjunction with Assessment Unit Heads to ensure that potential interactions were captured and that duplicate assessment work was prevented. The key interactions are discussed below.

22 Where there was overlap with other ND disciplines I initiated discussions on areas of common interests: these included the determination of As Low As Reasonably Practicable (ALARP), which involved a balance between worker doses, waste generation and disposal to the environment; and review of the reactor chemistry to balance the needs of ALARP and Best Available Technique (BAT). I developed close working relationships with the radiological protection and reactor chemistry assessors. These relationships were reinforced with regular internal meetings and joint meetings with EDF and AREVA.

23 I gave regular updates to members of ND’s Waste Management and Decommissioning Nuclear Topic Group (NTG) on progress of the RW&D assessment. I asked for the input of the NTG on the development of a guide on good practice in Pressurised Water Reactor’s (PWR) to minimise radiation doses and radioactive waste, and new GDA guidance on the storage of spent fuel. Subsequently the NTG asked me to develop this later guide into a Technical Assessment Guide (TAG) for use across ND.

24 Where issues were broader than the NTG remit I consulted other ND experts. For example, I discussed spent fuel issues with ND’s fuel specialist inspectors. This allowed me to ensure a consistent view was taken in GDA and to monitor the development of strategies to deal with spent fuel at operating UK sites such as Sizewell B.

2.2.3 External Dependencies

25 The principal external dependencies related to the source documentation identified and supplied by EDF and AREVA for the GDA process. EDF and AREVA also arranged a number of site visits to help illustrate the claims they were making.

26 I coordinated my assessments with the Environment Agency through a schedule of meetings and joint assessments. In 2010 the Environment Agency went out to consultation on their preliminary view of the GDA submissions. I supported this by informing the Environment Agency of the significant changes to my assessment subsequent to the publication of the Step 3 RW&D assessment report. Also the feedback from the Environment Agency on their consultation has informed my assessment of RW&D.

27 I continued to assess RW&D during the Environment Agency consultation. Therefore I continued to meet and work with the Environment Agency inspectors so they were aware of the results of my assessment. One specific area of joint interest was the ability to dispose of the radioactive waste from the UK EPR, I developed and implemented a joint plan for assessing this area with the Environment Agency (Ref. 5).

28 I worked with a number of international project teams on issues significant to waste management and spent fuel. This included, the Radiation and Nuclear Safety Authority of Finland (STUK); the United States Nuclear Regulatory Commission (NRC); and the independent Swedish Radiation Safety Authority (SSM). In September 2010 I attended a meeting on radiological protection under the auspices of the Nuclear Energy Agency Multinational Design Evaluation Program (MDEP) EPR Working Group. Radioactive waste was one of the key aspects of this meeting. The output from this interaction has informed my assessment of RW&D.

29 GDA is an inclusive process involving the public. The public are particularly interested in the EDF and AREVA proposals for RW&D. A number of meetings have been held with ND and interested stakeholders present. These stakeholders have included the public; Non-Governmental Organisations; and learned bodies. The feedback from these meetings has informed my assessment of RW&D. (In particular the views expressed regarding potential difficulties of storing and disposal of high burn up fuel (Ref.15) in response to the Environment Agency consultation).

30 The Committee on Radioactive Waste Management (CoRWM), is a group of independent experts appointed by Government to scrutinise plans for managing UK higher activity radioactive waste. Their remit includes wastes from new reactors. Meetings with CoRWM were held in late 2009 and early 2011. CoRWM published their views on new build wastes early in 2010 (Ref. 16); I used this publication to inform my assessment of RW&D.

2.3 Standards and Criteria

2.3.1 Safety Assessment Principles (SAP)

31 The Safety Assessment Principles for Nuclear Facilities (Ref. 4) provides a framework to guide regulatory decision making in the nuclear permissioning process. It is supported by Technical Assessment Guides (TAG) which further aid the decision-making process. The principles of particular relevance to the assessment of RW&D are listed in Table 1, at the end of the report.

2.3.2 Management of Higher Activity Radioactive Waste on Nuclear Licensed Sites

32 This is joint guidance (Ref. 17) between the Environment Agency, the Scottish Environment Protection Agency and HSE. It covers the management of higher activity radioactive waste on nuclear licensed sites. It specifically requires the production of a Radioactive Waste Management Case (RWMC). EDF and AREVA need to show that they could comply with this guidance.

2.3.2.1 WENRA Waste and Spent Fuel Storage Safety Reference Levels

33 The objective of The Western European Nuclear Regulators Association (WENRA) is to develop a common approach to nuclear safety in Europe by comparing national approaches to the application of The International Atomic Agency (IAEA) safety standards. The WENRA reference level report (Ref. 18) contains the results of the work of the Working Group on Waste and Decommissioning (WGWD) in the area of the safety for spent fuel and radioactive waste storage facilities.

34 Whilst the reference levels are generally reflected within our SAPs I have taken due cognisance of them within my assessment of RW&D.

2.3.2.2 IAEA Safety Standards

35 The IAEA Safety Standards (Requirements and Guides) were the benchmark for the revision of the SAPs in 2006 and are recognised by NII as relevant good practice. Although I have used these in my assessment, where relevant, it should be appreciated that they are recommended safety standards rather than regulatory standards.

36 Of particular relevance to this assessment are:

- Predisposal Management of Radioactive Waste Including Decommissioning, WS-R-2, IAEA, Vienna (2000).
- Management Systems for Facilities and Activities, Safety Requirements, GS-R-3, Vienna (2006).
- Storage of Spent Fuel, DS371, (in draft at the time of writing).
- The process and methodology developed in the Safety Assessment Driving Radioactive Waste Management Solutions project.

2.4 Assessment Scope

37 The GDA process allows a rigorous and structured assessment of detailed safety, security and environmental aspects of the design of new build reactors. The joint ND and Environment Agency position statement on the RW&D assessment (Ref. 13) clarifies the minimum position for GDA so that the output is meaningful and without exclusions.

38 For waste management facilities on the nuclear island a typical detailed assessment would continue to be applied. For those waste management facilities not on the nuclear island I need confidence, through the GDA process, that the spent fuel and waste can be stored and retrieved, conditioned, transported, and disposed of at the end of storage. Therefore for these facilities the emphasis is less on the specific design details and more on the evidence to show that the chosen route is suitable. 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 waste streams and their packaging evolve over the storage period; data and records management; knowledge of the constraints placed on the wastes by the disposal facilities; identification of knowledge gaps and the resulting R&D programme; and robust estimates of the required capacity.

39 When assessing RW&D I have chosen to consider the proposals under the following headings:

- 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?
- Have EDF and AREVA shown that wastes are disposable?
- Can a UK EPR be safely decommissioned?
- Are there suitable proposals for knowledge management?
- Can a Radioactive Waste Management Case be produced for a UK EPR?

- Is there a Credible Plan for the Development of Waste Management Facilities?

40 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 is assessed separately in this report.

41 Finally it is noted that, as per reference 13, the security arrangements for waste and spent fuel in long term storage is not part of GDA and will be addressed when approving a Site Security Plan for any prospective new build site.

2.4.1 Findings from GDA Step 3

42 In undertaking my Step 3 assessment, I 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 had been identified by EDF and AREVA, and that those wastes can be effectively managed. This was successful as I was able to share resources and co-ordinate feedback to EDF and AREVA.

43 At the end of Step 3 EDF and AREVA had:

- identified all of the wastes that a UK EPR will typically produce;
- confirmed there were no safety issues with their plans for the short-term storage of all wastes, except spent fuel (see below);
- whilst arguments had been provided for spent fuel we required further clarification during Step 4;
- provided detailed arguments for the safety of long term storage. Whilst I judge the reports supplied during Step 3 showed that safe long-term storage was feasible I still required further evidence on specific aspects of the storage regime;
- not provided sufficient evidence to show that long-term pool storage of spent fuel could be ALARP; and
- provided verbal assurance that the radioactive wastes produced by a UK EPR were suitable for disposal.

44 During the Step 3 assessment I did not identify any significant issues, or significant design or safety case changes that could impact on radioactive waste arisings or have a significant negative environmental impact.

2.4.2 Additional Areas for Step 4 RW&D Assessment

45 Using the set of questions detailed in section 2.4, Assessment Scope, my Step 4 assessment built on the outputs of the Step 3 report. This included three specific aspects that were relevant to all six of the questions:

- the proposals for the management of records;
- the demonstration that Radioactive Waste Management Cases (RWMC) could be produced; and
- the production of a credible plan for the development of waste management facilities.

46 The aspects that were considered for each of the six original questions are detailed below.

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

47 This was effectively completed as part of Step 3 when evidence was presented by EDF and AREVA showing they had identified all of the typical wastes that a UK EPR will produce.

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

48 The suitability of plans of EDF and AREVA for the conditioning of wastes was assessed during Step 4. This considered whether the potential processes:

- were consistent with the requirements of the disposability assessment;
- did not create unnecessary waste;
- minimised the generation and accumulation of radioactive waste; and
- had the ability to segregate and characterise ILW.

49 My assessment also considered proposals to send packaged ILW as LLW after a period of decay storage, and the management of spent fuel ancillary components.

2.4.2.3 Are There Any Safety Issues with EDF and AREVA Plans for Short Term Storage?

50 In the UK EPR design the facilities for the conditioning of wastes also provide the short term storage area for LLW/ILW. This had been considered during Step 3. However, I confirmed these findings during my assessment of conditioning.

51 For irradiated fuel the UK EPR includes an at-reactor storage pool. The questions that I have specifically considered are:

- what are the implied storage requirements on the short term store from the long-term storage case;
- whether there is sufficient capacity in the pool to provide this storage; and
- the ability to inspect, retrieve and remediate waste and facilities.

2.4.2.4 Are There Any Safety Issues with EDF and AREVA Plans for Long Term Storage?

52 During my Step 3 assessment I raised a number of questions about the long-term storage of wastes. EDF and AREVA provided the responses to these questions for assessment during Step 4.

2.4.2.5 Have EDF and AREVA Shown That Wastes Are Disposable?

53 This assessment was closely coordinated with the Environment Agency. The Environment Agency is responsible for disposability; their reported assessment is not repeated here. I agreed with the Environment Agency to look at the following aspects during Step 4:

- An initial analysis to identify any significant issues and whether any information is missing.
- A meeting with EDF and AREVA to present the findings from the initial analysis.

- An assessment of the ability to condition and store waste so that it is suitable for disposal.

54 I also provided an update on my assessment to the Environment Agency prior to their consultation.

2.4.2.6 Can a UK EPR Be Decommissioned Safely?

55 I assessed the EDF and AREVA proposals for decommissioning during Step 4.

2.4.3 Use of Technical Support Contractors

56 I have used a number of technical support contractors in the assessment of RW&D for the UK EPR. These fall into two broad categories, those that have undertaken assessments for me, and those that have provided additional technical support.

57 I contracted React Engineering Ltd to support my assessment of decommissioning and Babcock Ltd to review the proposals for the RWMC. The outputs of their assessments are reported in the main body of this report.

58 The provision of additional technical support has allowed my assessment to draw on a wider pool of knowledge. The contractors have considered the potential lifetime of spent fuel in long term storage; practices used in PWRs around the world and their effects on the wastes produced; the type of faults that have occurred when managing wastes on power stations, and a review of the published experience on decommissioning PWRs.

59 In 2009 I 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 (Ref. 19). This work included:

- 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; and
- 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.

60 The conclusions of the National Nuclear Laboratory (NNL) report for dry storage of fuel that had experienced a burn-up of 65 GWd/tU were that:

- clad creep should not lead to clad rupture if spent fuel assemblies are first cooled. NNL suggested that sufficient initial cooling should also allow dry storage without creep rupture, although the clad temperatures during assembly drying may be high enough to cause problems.
- irradiation conditions will be borderline for the possible onset of radiation induced sensitisation in stainless steel, which could render the components vulnerable to attack by nitric acid (formed by radiolysis of moist air). However, the probability is that these conditions will not be met, and the likelihood of this mechanism occurring is therefore low.
- With respect to zirconium alloy components, the re-orientation into a radial geometry of zirconium hydride platelets formed during irradiation can lead to embrittlement or

delayed hydride cracking, both of which can threaten component integrity. However, the probability of structural component failure by this means is considered low, and NNL calculations indicate that cladding failure should be avoided given sufficient initial spent fuel cooling. It also acknowledged a risk during the initial cooling period that assembly drying temperatures may be high enough to cause problems.

61 The report also recognises that firmer conclusions on dry storage can generally only be drawn once dry storage and assembly drying systems are defined.

62 I had intended to involve EDF and AREVA in the development of the report. However, I decided that given other assessment activities associated with the design of the fuel refining these calculations further within GDA was not required (Ref. 20). Instead I have asked EDF and AREVA to consider the effects on the operation and decommissioning of the UK EPR of having to cool fuel in the at-reactor spent fuel pool for an assumed period of ten years.

63 The actual period that the fuel has to be cooled before it is placed into long-term storage will need to be derived on a site specific basis by the licensee. So I placed the following assessment finding:

> ***AF-UKEPR-RW-07:*** *the licensee shall identify the evidence necessary to underpin their spent fuel storage, transport and disposal strategy, the activities needed to secure this evidence and the time needed for these activities prior to the pouring of nuclear island safety related concrete.*

64 I commissioned Hyder Consulting (UK) Ltd, AMEC and Serco to review a number of standard practices used in PWRs around the world (Ref. 21). The aim of this work was to understand the implications of using the different practices. The work examined:

- the nature of the radioactivity produced;
- the mechanisms by which it arises and is transported from its source of origin;
- how it is accumulated in plant systems, thus causing occupational dose;
- how it is treated (abated) prior to authorised discharge; and
- the resulting “solid” radioactive waste that is generated as a result of abatement processes.

65 In addition a number of technologies and procedures used to reduce dose and waste arisings were reviewed. These practices represent the worldwide nuclear industry’s technological developments and learned experience over many decades.

66 It is important to note that such technologies and procedures have been primarily developed to address worker dose issues on operating plant. However, many (but not all) of these practices provide wider benefits in reduced off-site discharges (and therefore, public dose) and in reduced volumes and activities of radioactive waste generation.

67 The technologies and procedures can be considered to fall into groupings of practices that aim to:

- minimise the radioactive source term in the first place;
- minimise the transport of the radioactive source material in the primary circuit;
- adoption of radiological protection practices to minimise worker dose uptake;
- methods of waste treatment;

- decontamination methods; and
- other technologies to replace entire large components.

68 Each of the top three groupings can add additional defence in depth with respect to minimising the radiation exposure of plant operators, while simultaneously reducing doses to the public and minimising waste volumes. For the lower two groupings, the operator radiation exposure reductions are typically traded off against potential higher discharges and increased waste arisings. Generally, it is through the use of a mix of technologies and procedures from across all groupings that the greatest reductions in dose and, where applicable, waste arisings can be achieved.

69 I used this report to support my line of questioning in my assessment of RW&D.

70 AMEC have also produced a report correlating public concerns against specific industrial incidents (Ref. 22). In developing the report the public concerns were added to by AMEC's in-house experts. The enhanced list of issues was then compared with real data collated from the Joint IAEA/NEA International Reporting System for Operating Experience database to judge whether public concerns are borne out by the historical plant evidence, and also whether the industry has made improvements by reducing incidents over time.

71 A correlation was shown between 14 of the identified public concerns and the IAEA/NEA database, specifically fuel handling and off-site discharges. I have used this information to confirm that my assessment has addressed:

- key public concerns; and
- possible industrial incidents whilst managing radioactive waste and spent fuel.

72 I commissioned React Engineering to review publicly available information on previous reactor decommissioning projects in order to identify those aspects of decommissioning which were found to be particularly complex or challenging and conversely those that have consistently proven as straightforward or unproblematic to implement (Ref. 23).

73 Key findings from the review include:

- Spent fuel that remains in the at-reactor cooling pools will constraint dismantling and decommissioning operations.
- Segmentation of the reactor pressure vessel is a challenging aspect of reactor decommissioning.
- Remediation of contaminated land can prove to be a lengthier task than anticipated.
- Removal of components outside the reactor pressure vessel and building demolition activities have proven to be relatively straightforward to implement.

2.4.4 Interactions with other Assessment Topic Areas

74 The following interactions have been considered within this report:

2.4.4.1 The At-Reactor Spent Fuel Pool

75 For irradiated fuel the UK EPR includes an at-reactor storage pool. In Section 2.4.2.3 I stated that the questions that I specifically considered in my assessment were:

- what are the implied storage requirements on the short term store from the long-term storage case;
- whether there is sufficient capacity in the pool to provide this storage; and
- the ability to inspect, retrieve and remediate waste and facilities.

76 I have assessed these aspects in conjunction with my fellow assessors, specifically the civil engineering and external hazards assessment (Ref. 24); the fault study assessment (Ref. 25); and the radiological protection assessment (Ref. 26).

2.4.4.1.1 The Design of the At-Reactor Storage Pool

77 The at-reactor storage pool is a concrete structure that relies on a stainless steel liner to act as a primary barrier against leakage of pool water with a series of leak channels which aim to collect any leakage through the welds and direct it towards a collection point. The arrangement of collection points is such that the broad zone in which the leakage is occurring can be identified for further investigation. It is worthwhile noting that a leak through any part of the structure other than the welds may not necessarily be captured by the leak detection system, (Ref. 24).

78 Any leakage which does not pass into the leak detection channels will either pass through the concrete or down the liner to concrete interface. If the leakage were to pass through the concrete, there is a reasonable chance that this would be identified as white boric acid crystals tend to appear on the outer face of leak sites as the water is evaporated away.

79 Within the pool there are a series of underwater fuel storage racks, divided into 19 modules.

80 Each module is a self-supporting structure fabricated from stainless steel sheet, forming a square array of vertical cells. Each cell contains a borated stainless box section in which an individual fuel assembly can be stored. There are some modules where several cells are blocked out.

81 The geometry and design of modules are such that a fuel assembly may be inserted or extracted vertically using the overhead crane placed directly above a storage cell. No other handling operation is needed, thus avoiding any risk of collision with or damage to the fuel assembly.

82 One of the modules comprises five cells equipped with a filter near the base to hold defective fuel assemblies.

83 The main safety criteria for faults in the spent fuel pool are that the fuel remains covered by water while in the racks or while being handled, and that sub-criticality is preserved.

84 The underwater storage racks are designed so that the K_{eff} multiplication factor does not exceed 0.95 in normal operation and 0.98 in credible accident situations even when fuel assemblies with the highest enrichments are considered. Zero boron content in the pool is considered a credible accident.

85 The spent fuel pool purification and cooling system is required to remove the decay heat from spent fuel assemblies in the pool. It also contributes to the containment of radioactive substances by ensuring capability for isolation of the fuel building.

2.4.4.1.2 Civil Engineering and External Hazards Assessment

86 This assessment area has considered the limitation of leakage through the pool walls by control of cracking. It finds that EDF and AREVA could improve the design of the concrete to further control the through thickness cracking and subsequent leakage. If this change is implemented then it would not affect the size or dimensions of the pool. So it would not alter the conclusions of my assessment.

2.4.4.1.3 Fault Studies Assessment

87 This assessment considers the design basis analysis presented in the PCSR and its supporting references, concluding that it is logically and clearly presented.

88 The assessment identifies that the design has still to be finalised. As a result there are a series of findings that requires the capability of the systems to be demonstrated.

89 This assessment also identifies a GDA Issue, **GI-UKEPR-FS3** (Ref. 25), requiring a safety case for the fuel despatch and the cask loading pit area. The assessment goes on to state that, in the opinion of the assessor, it should be possible for EDF and AREVA to make an acceptable safety case.

90 At the start of this section I posed three questions about the size of the pool and the ability to carry out inspections. Considering only these questions I judge that the potential changes the fault studies assessment is seeking are such that my conclusions would remain unaltered.

2.4.4.1.4 Radiological Protection Assessment

91 The Radiological Protection Assessment (Ref. 26) considers the potential for a criticality in the spent fuel pool. The assessment finds the associated analysis performed by EDF and AREVA to be comprehensive, rigorous and well structured.

92 The assessment identifies three findings associated with this assessment. Two of the findings are associated with the licensee providing the evidence that the as built structure reflects the analysis performed in GDA. The remaining finding requires the establishment of systems to control and verify the enrichment of boron used in the fuel pond and to ensure its continued presence during operation.

2.4.4.1.5 Discussion

93 I have reviewed the Civil Engineering and External Hazards Assessment (Ref. 24); the Faults Studies Assessment (Ref. 25); and the Radiological Protection Assessment (Ref. 26). Following this review I judge that an as built UK EPR is likely to have about 1167 positions in the at-reactor spent fuel pool.

94 When calculating the spent fuel storage capacity of the at-reactor spent fuel pool allowance has to be made for a full core off-load and space for new fuel that is to be placed into the core. Allowing for these indicates a spent fuel storage capacity of around 15 years, after which fuel would have to be exported. The exact storage timescale will depend upon the reactors operating cycle and it is possible that an operator could choose to export fuel earlier.

95 In my assessment of the development of the technical basis for the long term management of spent fuel there is a finding that the licensee shall identify the evidence necessary to underpin their spent fuel storage, transport and disposal strategy, the

activities needed to secure this evidence and the time needed for these activities (**AF-UKEPR-RW-07**). I raised this finding because I recognised that there exists limited information on the performance of spent fuel in long-term storage, perhaps for periods as long as a hundred years, after receiving the burn-up likely to be achieved in a UK EPR.

96 In 2009 I commissioned NNL to undertake a preliminary study of those mechanisms that could lead to early failure of the fuel cladding or the fuel assembly during storage (Ref. 19). As a result of this work I asked EDF and AREVA to consider the effects on the operation and decommissioning of the UK EPR of having to cool fuel in the at-reactor spent fuel pool for an assumed period of ten years.

97 I recognise that a licensee's research could indicate a period of cooling before placement into long-term storage different to the ten years assumed here. The UK EPR could offer a typical cooling period of at least fifteen years before export. Therefore I judge that there is sufficient flexibility within the design to allow the licensee to put in place any contingency necessary to ensure the long-term performance of the spent fuel.

98 I have worked with the fault studies assessor and colleagues in the United States Nuclear Regulatory Commission (US NRC) on the design of the UK EPR at-reactor spent fuel pool export facility. The results of this are reported in the Fault Studies Assessment Report (Ref. 25). I note that there is an issue associated with this aspect of the design and the assessor's comments on the likelihood of EDF and AREVA being able to develop a safety case for the design. The Fault Studies Assessment also notes the visit to Chooz B where this design has been operated successfully. Therefore, providing the issue identified in the Fault Studies Assessment is successfully resolved, it should be possible to export the fuel.

2.4.4.1.6 Conclusions

99 I judge that there is sufficient flexibility in the generic at-reactor spent fuel pool design to allow the licensee to meet any cooling constraints imposed by the long-term storage regime.

2.4.4.2 Material Selection

101 As part of their assessment the Radiological Protection assessors have looked at the control of worker exposure to radiation due to activated corrosion product deposits within the primary circuit of the PWR (Ref. 26). This specifically considered the selection of materials which result in reductions in the use of cobalt, silver and antimony. This topic is of direct interest to RW&D as there is a correlation with the levels of activity within the waste, (Ref. 21).

102 In many nuclear power plants (NPP), activated corrosion products in the primary coolant increase dose rates through activation of cobalt-59 to cobalt-60 in the Stellite^{TM} content of hard facings, and activation of nickel-58 to cobalt-58 in inconel 690 alloys and some stainless steels; cobalt-58 and cobalt-60 typically account for over 80% of equivalent dose rates associated with the primary coolant.

103 In many NPPs, activated corrosion products in the primary coolant increase dose rates through activation of silver-109 to silver-110m in helicoflex seals, and activation of antimony-123 to antimony-124 in bearings, and these activated corrosion products contribute to worker exposure from the primary coolant.

104 The Radiological Protection Assessment (Ref. 26) expressed the opinion that the evidence to substantiate the arguments relating to radiation sources regarding information on the source term, and reductions in the source term through selection of materials associated with the primary circuit was suitable and sufficient.

105 The report also included the following finding:

- The licensee shall provide procurement procedures that require a review of materials associated with the primary coolant before purchase of those materials from their supplier in order to identify if there are any improvements in reductions in levels of cobalt or any other elements in materials which might lead to further reductions in radiation exposure of workers, and which would not compromise the functionality of those materials (Ref. 26).

106 Similar findings are recorded in the Mechanical Engineering Assessment (Ref. 27) and the Reactor Chemistry Assessment (Ref. 28).

2.4.4.2.1 Conclusions

107 As there is a correlation between the levels of activity in the primary circuit with those in the waste, I endorse the conclusions of the Radiological Protection Assessment and the associated findings.

2.4.4.3 Information on the Source Terms

108 The definition and appropriate use of the source term is an important stage in understanding and deriving the safety requirements of any nuclear activity. This source term often takes the form of a radioactive inventory plus any other parameters relevant to that particular nuclear activity. In the PCSR, radioactive inventories are used in a number of different assessment areas, and radioactive inventories may be manipulated to address specific purposes. For example, in some areas worst case inventories may be used, whereas in others more realistic inventories are required.

109 This aspect has been the subject of a detailed assessment in the Radiological Protection Assessment Report (Ref. 26). The assessment concludes that the evidence presented satisfied the regulatory expectations regarding derivation of the source term, identification of assessments where the source term was used, use of the source term consistently across assessment areas, and use of the source term in specific assessment areas. No GDA Assessment Finding was identified.

110 For the RW&D Assessment this is important as I want to know that the wastes I have assessed are consistent with the assumptions that EDF and AREVA has made elsewhere. In demonstrating a consistent approach EDF and AREVA has shown that there is no reason to believe that the wastes are not consistent with the assumptions made elsewhere.

2.4.4.4 The Suitability of the Liquid and Gaseous Waste Processing Systems

111 The solid waste process, assessed in my report is directly influenced by the proposals for the liquid and gaseous waste processing system. So far as is reasonably practicable discharges should be reduced. Generally this is interpreted as requiring the radioactive waste producers to concentrate and contain their radioactive wastes.

112 Figure 3, is a simplified flow diagram, produced by the Environment Agency, of the liquid and gaseous waste routes for a UK EPR, it shows the relationship with the solid waste processing systems.

113 Section 4 of this report provides details of my assessment of the solid waste aspects. The assessment of the liquid and gaseous waste processing systems is a fundamental part of any RW&D Assessment. Therefore it might appear anomalous that it is not considered directly within this report. The reason is that it is reported in a lot of detail in the Environment Agency's Assessment, (Ref. 15) and the Reactor Chemistry Assessment, (Ref. 28). I have summarised the outcome of those assessments here and provided an overview of the outcomes.

2.4.4.4.1 The Environment Agency Assessment

114 The Environment Agency will grant permits for discharges from a UK EPR. As part of their assessment process they have required EDF and AREVA to undertake best available technique (BAT) assessments of the quantity of radioactive waste produced by a UK EPR and for the subsequent abatement processes. I have worked closely with the Environment Agency on their assessment (Ref. 15) of this aspect, see Section 4.1.

115 For gaseous radioactive wastes the Environment Agency concluded that the UK EPR utilises the BAT to minimise discharges of gaseous radioactive waste:

- during routine operations (subject to an assessment finding) and maintenance;
- from anticipated operational events.

116 For aqueous radioactive waste the Environment Agency concluded that the UK EPR utilises the BAT to minimise discharges:

- during routine operations and maintenance; and
- from anticipated operational events.

117 The Environment Agency has also identified a number of findings that a licensee would need to address. These include requirements for further BAT assessments, on a site specific basis to show that discharges have been minimised and to provide a mass balance on the flow of Carbon 14.

2.4.4.4.2 The Reactor Chemistry Assessment

118 Whereas the Environment Agency was looking at the suitability of the selected processes the Reactor Chemistry Assessment (Ref. 28) has considered the likelihood of the equipment operating as stated by EDF and AREVA.

119 For the gaseous waste systems the assessment concludes that the calculations for the gaseous waste systems appear conservative and EDF and AREVA have considered operational transients in the design. The design is based on well proven and mature technologies with many years of experience in PWRs. The assessor is content that an adequate case has been made.

120 For the liquid waste systems the assessment concludes that the design uses well proven techniques for chemical treatment of the liquid wastes. The assessor is content with the design described from a reactor chemistry perspective.

2.4.4.4.3 Conclusions

121 The Environment Agency and the Reactor Chemistry Assessments indicate that the liquid and gaseous waste processing systems for a UK EPR are broadly suitable. When a licensee is developing their operating regime it will be important to optimise the operation of these aspects. I have agreed with the Environment Agency and the Reactor Chemistry Assessors that it is appropriate to capture this as a finding in my report:

> ***AF-UKEPR-RW-04****: the licensee shall optimise the operation of the chemical volume control system and the liquid, gaseous and solid waste management processes to ensure that the risks associated with their operation and the management of the resulting wastes are as low as reasonably practicable prior to first fuel load.*

2.4.5 Integration with Other Assessment Topics

2.4.5.1 Radiological Protection

122 Radioactive waste operations, decontamination and decommissioning typically involve a lot of operator intervention. Therefore these are of interest to me and the Radiological Protection Assessors. So over the past eighteen months I have been working very closely with them.

123 This is an efficient and effective approach as there are a number of similar but distinct lines of enquiry. For example waste handling tends to be a relatively high dose activity. With both disciplines working together we are sure that all aspects are covered and that EDF and AREVA is asked one set of questions relative to both disciplines.

124 In this case close working means running joint intervention plans; raising joint Technical Queries (TQ) and Regulatory Observations (RO), holding joint meetings with EDF and AREVA and undertaking a number of benchmarking visits. My Technical Support Contractor (TSC), React Engineering, have been undertaking a number of these assessments on behalf of the Radiological Protection Assessors and myself.

125 An overview of where we have worked together is provided below. The specific outputs of our assessments are detailed in our individual assessment reports.

126 Radioactive Waste Operations: These are typically labour intensive as waste is sorted and conditioned for disposal. Whilst the background doses may be low the associated collective dose can be some of the largest for a site. Working together has allowed us to examine the balance between the benefits in waste minimisation, segregation etc, and the associated dose. In GDA the Radiological Protection Assessors and I have looked in a lot of detail at the operations carried out in the Effluent Treatment Building. We have also noted that there will be joint interest in the movement of fuel. However, this has been identified primarily as a site specific issue (Ref. 13) so there has not been so much scrutiny by us.

127 One area of our joint assessment is the design, layout and operation of the Effluent Treatment Building. We arranged a series of benchmarking visits to international sites to see how these types of facilities are operated, see section 3.10.

128 Benchmarking is a significant aspect of the assessment as both radiological protection and radioactive waste can be affected by the decisions taken by the operators, irrespective of the basic plant design. Benchmarking provides the Regulators with the assurance that there are radioactive waste management techniques that can be operated in a safe and environmentally aware manner.

129 Decontamination: This covers a range of activities. It includes major primary circuit decontamination, cleaning of spills, general housekeeping and the operation of the laundry.

130 For operations the radiological protection assessors are interested in the doses associated with the installation, operation, dismantling and maintenance of decontamination equipment. I am interested in the ability to decontaminate and the wastes produced by the decontamination process.

131 A similar approach is taken for decontamination during decommissioning. However, there is likely to be a very aggressive decontamination process on the active circuits prior to any decommissioning. So we are also interested in the residual activity after this specific decontamination process as it is a significant influence on the overall doses from the decommissioning activities and the quantities of ILW, LLW and VLLW produced.

132 Decommissioning: This covers all of those activities that occur after the reactor ceases operation. The radiological protection assessors and I are interested in the ability to safely decommission the reactor. We are specifically interested in those areas that could lead to the need for direct operator action in a high dose area.

133 Our joint regulatory approach has meant that EDF and AREVA have been able to provide one submission for each of decommissioning and decontamination that adequately addresses the concerns raised by each topic.

2.4.6 Out of Scope Items

134 The joint position statement on the RW&D Assessment (Ref. 13) clarifies the minimum scope for GDA so that the output is meaningful. For those facilities not on the nuclear island we sought confidence, through the GDA process, that the spent fuel and waste can be retrieved, transported, and disposed of at the end of storage. Therefore we did not require detailed designs, but required evidence to show that the chosen route is suitable.

135 EDF and AREVA have supported this evidence by a detailed plan showing when waste management facilities will be developed, see section 3.9. It should be noted that whilst it was the responsibility of EDF and AREVA to develop this plan it is for the licensee to implement the plan.

3 EDF AND AREVA'S SAFETY CASE

3.1 Introduction

136 This section provides a high level overview of the safety case for RW&D put forward by EDF and AREVA. As such it contains no assessment or judgement by me, this can be found in Section 4.

137 EDF and AREVA have provided me with a number of documents to show that RW&D can be managed safely. Figure 2, 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.

138 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 have provided evidence that there is a disposal route for all waste generated.

139 The UK EPR includes a dry storage reception pit and an at-reactor fuel pool together with associated ancillary equipment, designed to allow the safe receipt of fresh fuel, fuel transfer into the reactor, transfer out of the reactor, management in the pool 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 fuel from the end of reactor operations prior to dispatch to a longer-term storage facility.

140 The Effluent Treatment Building will house the processing and packaging systems for operational wastes, other than spent fuel. The processing and packaging system is based on proven and internationally recognised technologies. The waste is processed into standard packages for safe handling. The Effluent 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 LLW is dispatched to a disposal facility.

141 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.

142 A number of options have been proposed for the long-term storage of spent fuel. The options include long-term pool 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 (GDF).

143 As identified in section 2.4 I have looked at nine different aspects of the EDF and AREVA safety submission. The rest of this section discusses the EDF and AREVA safety submission relevant to each of these aspects.

3.2 The Identification of the Wastes That a UK EPR Will Produce

144 EDF and AREVA detail the potential waste arisings for a UK EPR over a number of documents, these are outlined below.

145 Chapter 11.2 of the June 2009 PCSR (Ref. 29) details the liquid and gaseous discharges and the radioactive waste and spent fuel strategy.

146 The third part of Chapter 11.2 outlines the 'reference case' solid radioactive waste and spent fuel strategy based on the waste and spent fuel management practices and arrangements of the UK EPR reference plant at Flamanville. This strategy is supported by a best available technique (BAT) analysis (Ref. 30).

147 In addition it is recognised from experience of EDF and AREVA projects worldwide that other potential UK EPR operators may wish to adopt alternative spent fuel and waste management arrangements. These possible options to the reference case are presented in a Solid Radioactive Waste Strategy Report (SRWSR) (Ref. 31). The SRWSR does not provide respective BAT assessments for the options but there is a high degree of confidence that such cases can be made by potential UK EPR operators.

148 Chapter 11.3 of the June 2009 PCSR (Ref. 32) deals with the estimation of the effluents discharged and the waste produced by the operation of the UK EPR reactor. The estimates cover:

- solid waste arisings (excluding fuel);
- liquid radioactive effluent discharges;
- gaseous radioactive effluent discharges; and
- chemical effluent discharges, whether associated with liquid radioactive effluent (lithium hydroxide and boron) or arising from operation of non-nuclear parts of the plant (conditioning amines and phosphate).

149 For my assessment the significant aspects are waste arisings. Table 4 of chapter 11.3 of the June PCSR (Ref. 32) presents an overview of the operational wastes that a UK EPR is likely to produce. This is reproduced at the end of this report, see Figure 1.

150 In support of their UK EPR Integrated Waste Strategy (IWS) document (Ref. 33) EDF and AREVA have produced a BAT report (Ref. 30). The objective of this report is to provide assurance that the UK EPR design meets the requirement for application of BAT.

151 The evidence provided in the BAT report (Ref. 30) includes the following information:

- Identification of radionuclides that can be produced in the facility in significant quantities and that will be present in radioactive wastes (solid, liquid and gaseous) for disposal.
- The mechanisms for production of the identified radionuclides and the source of arisings in terms of process streams and equipment.
- Quantification of the annual production at source of each identified radionuclide in terms of activity.
- The techniques used to prevent or minimise the amount of activity produced at source and for abatement.
- Assessment of the significance of each radionuclide with respect to either the activity generated, the total activity disposed of to the environment or the potential impact in terms of radiation dose to humans.

152 A small number of radionuclides are identified as significant and have been assessed in detail by EDF and AREVA. These are carbon-14, tritium, cobalt-58/cobalt-60, noble gases and iodines. The report notes that isotopes of cobalt can be considered to be broadly representative of other radionuclides arising as a result of corrosion processes that are relevant to radioactive waste discharge and disposals.

153 For the specific radionuclides identified more detailed information has been provided in "BAT forms". These contain information on:

- Mechanism of production of the radionuclide and the process in which it is produced.
- The source term including, where possible, information on the activity before and after the application of techniques to prevent or minimise at source.
- Demonstration that the techniques used to minimise at source are BAT by reference to all other options considered or rejected or by benchmarking against international practices.
- Demonstration that the techniques used for treating each process stream minimise the overall impact of the disposal and discharge of radioactive waste (including evidence of the consideration of disposal via different pathways).
- Demonstration that the techniques used to minimise impacts are BAT by reference to all other options considered and rejected or by benchmarking against international practices.
- Demonstration that the techniques used conform to the (Integrated Waste Strategy) IWS by cross-referencing to the relevant IWS sections.
- Identification of disposals resulting from the use of techniques to minimise overall impacts and quantification (where possible) annual volumes and activity of nuclides.

154 The report claims that the information presented demonstrates that the BAT are being applied in the design of the UK EPR to minimise radioactive wastes at source and to minimise the impacts of the disposal of wastes into the environment.

155 The report also covers the radioactive wastes arising from reactor operations, noting that the optimised UK EPR design will influence decommissioning waste management requirements. Although the primary focus of demonstration of BAT is on wastes arising from reactor operations, the information presented is also of relevance to future arisings of decommissioning wastes.

3.3 EDF and AREVA Plans for Short Term Storage and Conditioning

156 Chapter 11.4 of the June 2009 PCSR (Ref. 34) on discharges and waste gives an overview of the solid waste systems for ILW. The spent fuel chapter 9.1 of the PCSR (Ref. 35) outlines the at-reactor fuel pool.

3.3.1 Operational Wastes, Other Than Spent Fuel

157 The chapter describes the solid waste treatment system installed in the Nuclear Auxiliary Building and partly in the Effluent Treatment Building.

158 The system in the Nuclear Auxiliary Building performs the following functions:

- selective collection of active and inactive resins and transfer to the Effluent Treatment Building; and

- transfer of used filters to the Effluent Treatment Building for encapsulation.

159 The solid waste treatment system installed in the Effluent Treatment Building performs the following functions:

- selective collection of all solid radioactive waste produced by the UK EPR, including:
  - spent resins;
  - evaporator concentrates;
  - used filter cartridges;
- buffer waste storage (tanks and metal drums);
- conditioning of solid waste for consignment off site (filters, concentrates, operational waste); and
- intermediate storage of empty and full waste containers.

160 Active resins are pumped from the tanks to a mobile treatment plant in which they are conditioned and encapsulated. The mobile treatment plant (known as the MERCURE mobile encapsulation unit) moves from site to site.

161 To condition evaporator concentrates they are either:

- transferred to a nuclear incineration facility; or
- placed in a suitable container and encapsulated using a mobile unit.

162 Used filters are recovered from the Nuclear Auxiliary Building to the Effluent Treatment Building. The used filters are directed by filter exchange machine to the encapsulation cell. The filter is placed in a concrete container. A specially formulated mortar is poured into the container using a vibrating chute. The container is then transferred to a storage area for a period of curing. After the curing period, the containers are plugged with concrete whose composition and characteristics are identical to those of the container.

163 Low-activity operational waste is first conditioned in airtight vinyl sacks and stored temporarily in the Nuclear Auxiliary Building or the Effluent Treatment Building. It is then sorted, shredded or compacted and then conditioned in drums. Compacting is performed in the Effluent Treatment Building. The press used for compacting is equipped with a suction hood to prevent the spreading of dust, and a shield placed in the drum to prevent its deformation.

164 Once filled, the concrete containers conditioned in the Effluent Treatment Building cell are stored for around one month to allow curing to complete, in the main storage area of the Effluent Treatment Building. There is sufficient storage capacity to allow the production of packages by the mobile encapsulating machine for a packaging campaign.

165 EDF and AREVA presented these processes at a meeting in Lyon. This clarified design details of the processes, where wastes would be stored and the mobile processes located. The design details were for the Effluent Treatment Building at Flamanville 3.

166 In response to TQ-EPR-960 (Ref. 36) EDF and AREVA indicate that they intend to dispose of oils to an incinerator. An encapsulation process is described for conditioning the sludge produced by a UK EPR. It is noted that the process described needs further development before they considered it suitable for use on a UK EPR.

167 In response to TQ-EPR-961 (Ref. 36) EDF and AREVA provided further details on the encapsulation of the filters. Within the encapsulation facility two areas have been

identified as susceptible to problems with regards to the cleanliness of the facility. In order to help keep the cell clean of cement and contamination, the following are implemented in the design of the process and form part of the current EDF operator procedures:

- The filters are drained before they are lifted into the filter changing machine. Any liquids collected in the filter changing machine are drained to the Nuclear Vent Draining System. After the filter is placed to the concrete drum, a tundish arrangement is placed above the drum before the drum can be displaced. This prevents any droplets (contamination) from the transfer tube falling to the floor.
- Similarly, after the concrete has been poured into the concrete drum a tundish arrangement is placed above the drum before the drum can be displaced. This prevents any droplets of cement falling to the floor. The tundish is incorporated into the concrete transfer tube flushing system that is routed to the Nuclear Vent Draining System. The cement remains in a basket filter so that only the water flows into the Nuclear Vent Draining System. The transfer tube is cleaned (using water or manually if need be) after each usage in order to prevent a build up of cement blocking the tube.
- In addition, equipment within the encapsulation facility that is painted is required to follow painting specifications that make decontamination possible. The concrete drums themselves have a vinyl covering that protects the concrete itself from contamination. This vinyl is removed once the capping process is complete outside the encapsulation cell and the drum is ready for storage.

168 The report identifies a number of faults that could occur with the encapsulation process and how the licensee would handle these faults. The faults include failure to complete the encapsulation process and using the incorrect filling matrix.

169 The report concludes with discussion on clearing the drum for dispatch. It includes a detailed discussion on how this process could be automated.

170 The SRWSR, (Ref. 31) presents alternative conditioning options to the Flamanville 3 reference case presented in the PCSR.

3.3.2 Spent Nuclear Fuel

171 The technical note produced by AREVA (Ref. 37) provides an overview of international practice and on-going development on spent fuel encapsulation to show that the encapsulation of UK EPR spent fuel for disposal is technically feasible.

172 This technical note presents a high level description of some of the designs that have been developed in: Sweden; Finland; United States; Germany; and France.

173 The review concludes that the spent fuel encapsulation process is a feasible technology. The key points of this technology such as disposal canister manufacture and lid welding have been subject to demonstration and prototype development which have proved their feasibility at an industrial scale.

174 Other aspects of the short term spent fuel storage are dealt with in other reports; these are discussed in section 2.4.4.

3.4 EDF and AREVA Plans for Long Term Storage

175 EDF and AREVA detail the safety aspects of long term storage associated with a UK EPR over a number of documents, these are outlined below.

176 Chapter 11.5 of the June 2009 PCSR (Ref. 38) details the designs for interim storage facilities, for the

- ILW radioactive operational waste; and
- spent fuel, produced during the UK EPR 60 years of operation.

3.4.1 Operational Wastes, Other Than Spent Fuel

177 The chapter describes a separate interim storage facility (ISF). The ISF will provide interim storage for ILW pending removal to a final disposal facility. The expected lifespan of the ISF is 100 years.

178 The ISF is a single room storage facility. The facility has a reception hall, which allows: import and export; a temporary storage and inspection area; and a storage area for the travelling crane and the handling device for the lifting of packages. The main storage hall is designed to store the packages and to survey them. The hall includes: the waste package storage area; a storage area for overpacked non-compliant packages; and a cell for monitoring packages.

179 The risk of loss of containment from a waste package will be minimised by:

- minimising waste package handling operations and minimising the lift height of packages, where package movements cannot be avoided;
- inspection and monitoring of the waste packages in the storage hall to allow early intervention if any package defect is identified. Suspect packages can then be transferred to the monitoring and inspection cells for a more in-depth examination and package remediation measures implemented if necessary;
- the waste packages are designed to be robust against being dropped – no lift heights in the facility will exceed the rated drop height of a package; and
- the facility will be robust against foreseeable external hazards such as earthquake, loss of electrical power and severe weather.

180 The EDF and AREVA report on the longer term ILW ISF (Ref. 39) explains why they believe that the risks over the lifetime of the facility are as low as reasonably practicable. The report details the

- safety aims and design safety principles;
- a preliminary assessment of risks and hazards;
- minimisation of active safety management;
- maintenance of waste package and equipment integrity;
- retrieval and inspection of waste packages; and
- final retrieval and preparation of waste packages.

181 The report addresses both single and multi storage compartment options for the storage facility.

3.4.2 Spent Nuclear Fuel

182 Chapter 11.5 (Ref. 38) describes a long term wet ISF for spent fuel. It specifies a design life for the facility of 100 years. The facility is separate from the EPR plant and has the following functional areas:

- cask incoming and outgoing transport;
- cask reception;
- cask preparation;
- fuel removal, loading into racks and retrieval;
- rack movements; and
- long-term storage.

183 The safety functions of the building and systems are as follows:

- to maintain the primary barrier (fuel cladding);
- to supplement the primary barrier with a secondary barrier at all times;
- to prevent mechanical damage to the fuel primary and secondary barriers;
- to prevent thermal damage to the fuel primary and secondary barriers;
- to prevent long-term chemical damage and corrosion damage to the fuel primary and secondary barriers;
- to prevent staff and members of the public from receiving doses of ionising radiation; and
- to ensure the fuel remains sub-critical in all normal and fault conditions.

184 The EDF CIDEN report on the spent fuel ISF (Ref. 40) provides a concise description of the design, construction and operation of the proposed pool based ISF. It identifies the safety requirements and how these will be implemented.

185 The report states that the proposed design employs proven technology with a long and successful history and concludes that it would be suitable for construction and operation in the UK.

186 The EDF and AREVA response to TQ-EPR-874: Interface arrangements between the at-reactor fuel pool and the long-term stores, (Ref. 41) explains the interface arrangements between the at-reactor pool and the long-term store. This high level description shows practical solutions. Only the TN DUO, NUHOMS® or TN NOVA type storage systems could require an additional plant to perform the interface actions.

187 This is because the UK EPR design is based on bottom unloading of the spent fuel in the fuel building, using a TN 13/2 transport container (or similar). The TN DUO, NUHOMS® or TN NOVA containers have different geometrical features. EDF and AREVA recognise that studies would need to be performed to determine whether these containers can be directly connected to the current at-reactor spent fuel pool loading pit configuration or whether adaptations are required.

188 Therefore they state that if the TN DUO, NUHOMS® or TN NOVA containers were adopted that until detailed studies of adaptations on the storage containers and/or modifications of the at-reactor spent fuel pool pit loading systems have been performed - an additional dry transfer facility will be required (**AF-UKEPR-RW-09**).

189 The EDF and AREVA report on the longer term spent fuel ISF (Ref. 42) explains why they believe that the risks over the lifetime of the facility are as low as reasonably practicable. The report addresses the following four spent fuel storage technologies:

- wet ISF: fuel assemblies stored in a pool;
- dry ISF: fuel assemblies stored in metallic casks;
- dry ISF: fuel assemblies stored in vault type storage; and
- dry ISF: fuel assemblies stored in horizontal storage modules.

190 For all of these the report details the:

- safety aims and design safety principles;
- a preliminary assessment of risks and hazards;
- minimisation of active safety management over the lifespan of the facility;
- maintenance of integrity during storage;
- retrieval and inspection of spent fuel;
- plans for final fuel retrieval; and
- damaged fuel detection techniques.

191 The report on the safety of long-term spent fuel storage in pools (Ref. 43) gives additional context as to why EDF and AREVA consider long term wet storage of fuel as a solution that can be shown to be ALARP. It summarises their arguments.

192 The report concludes that spent fuel can be stored safely in a long-term storage pool for the following reasons:

- Due to low storage temperatures and satisfactory water chemistry, the preservation of cladding integrity is ensured which in turn guarantees the retrievability of stored assemblies at any time during storage.
- Monitoring of the assemblies is simple and inspection is performed regularly.
- Other systems such as ventilation, filters or make-up water add to the safety of the facility.
- The pool water inertia gives the operator a grace period sufficient to deal with incidents before the fuel integrity is compromised.
- The option also offers flexibility in the long-term management of spent fuel and in the retrieval of assemblies.

193 In addition to these reports there are a number of EDF and AREVA reports that address specific aspects of spent fuel long-term storage. These provide additional context for how long-term spent fuel can be managed in a manner that reduces the overall risk to the environment and society.

194 The AREVA report on human factors in long term waste management (Ref. 44) looks at the approach adopted by EDF and AREVA to build human factors considerations into longer-term waste management plans in respect of both ILW and spent fuel Interim Storage Facilities.

195 It presents a facility specific approach, looking at:

- design of equipment and processes to minimise reliance on the operator for safety throughout facility life; and
- design of equipment such as to avoid unnecessary complexity and facilitate operation maintenance and replacement of equipment.

196 This is complemented by a site-wide approach to determine and maintain adequate competency baseline across the site throughout the licensed period ensuring that only Suitably Qualified and Experienced Person (SQEP) individuals undertake or manage safety related tasks.

197 The AREVA report on the maintenance of interim storage in long term waste management (Ref. 45) identifies the maintenance aspects that need to be considered in the design of the ISF for spent fuel. The report focuses on how the design features of the EDF and AREVA proposed facilities for interim storage of UK EPR spent fuel assemblies permit refurbishment and replacement of key items of equipment during the operating lifetime of the facility.

198 The report shows that maintenance principles for both regular and exceptional interventions have a strong impact on the design and operation of the long-term store.

199 To ensure that adequate and suitable space is provided for equipment maintenance, repair or replacement operations a clear concept for maintenance must be followed at an early stage in the design of a long-term store. In particular provision must be made for:

- The inclusion of maintenance rooms and cells, crane parks, etc.
- Access ways, means of access to enclosures, lift paths.
- Storage facilities for tools, equipment and spare parts.

200 It concludes that these aspects need to be considered as a key issue in the design of the long-term store layout, and must be integral to the design process from its earliest stages.

201 The report shows that the planned facility for interim storage complies with the above described principles and requirements and makes a commitment that these principles will be further developed during the later design stages of the facility.

202 A third report looks at the current French and international research and development programmes for interim storage of spent fuel (Ref. 46). The report addresses the research and development work that has been carried out to determine acceptable storage conditions.

203 The EDF and AREVA report also presents the work being pursued in the following topic areas:

- criticality risk;
- the inspection regimes which are implemented depending on the storage technology used;
- management of failed fuel; and
- the characterisation of spent fuel which is required to assure spent fuel management.

204 The report concludes that periodic monitoring and data recording of the storage conditions of the used fuel assemblies is a key issue for the long term safety of interim storage facilities. There is a commitment to develop a proactive inspection regime that builds on existing knowledge and experience for the interim storage facilities.

3.4.3 The Solid Radioactive Waste Strategy Report

205 The Solid Radioactive Waste Strategy Report (SRWSR), (Ref. 31) presents alternative waste and spent fuel management options to the Flamanville 3 reference case presented in the PCSR.

206 The report describes and characterises the predicted waste arisings of solid radioactive waste and spent fuel from the UK EPR. The report sets out a range of options for waste and spent fuel treatment, conditioning, packaging, record keeping, storing, transporting and disposal. These options are based on internationally proven technologies and the experience gained from EDF and AREVA projects.

207 The options presented in the SRWSR are not developed to the same level as the options presented in the PCSR. For example there is no underpinning BAT assessment. EDF and AREVA assert that the necessary supporting information could be easily produced. They have supported this assertion by arranging a number of site visits to show the alternative processes in operation.

3.5 EDF and AREVA Proposals for the Disposal of the UK EPR Wastes

208 EDF and AREVA have worked closely with RWMD on the disposability of the wastes from a UK EPR. The work undertaken by RWMD was against their published specification (Ref. 10).

209 As stated in section 2.1, Background, the Government has stated (Ref. 6) that consideration of new build should assume that spent fuel is sent for direct disposal. It has therefore been included in the analysis of disposability performed by EDF and AREVA in conjunction with RWMD.

3.5.1 Operational Wastes, Other Than Spent Fuel

210 In the UK the Environment Agency issues the permits for the disposal of radioactive waste. They have assured me, based on the information contained in References 47 and 48, that the LLW produced by a UK EPR can be disposed of.

211 All of the ILW identified in section 3.2 has been assessed by RWMD for its suitability for disposal in a GDF. RWMD's detailed response was provided to EDF and AREVA in their disposability assessment of solid waste arisings from new build (Refs 49 and 50). A public summary of the disposability assessment is provided in Ref. 51, which is available on the NDA's website.

212 EDF and AREVA have reviewed the disposability assessments produced by RWMD and developed their case for the disposability of spent fuel and ILW, (Ref. 52). This report identifies when the outputs from the disposability assessment will be addressed.

3.5.2 Spent Nuclear Fuel

213 The reports identified for the operational wastes (Refs 49, 50 and 52) also cover the disposability of the spent fuel produced by a UK EPR.

214 In addition I have a copy of the published report produced for the NIA by RWMD (Ref. 53). This looks at four aspects of spent fuel management:

- a centralised storage facility;

- a centralised packaging plant;
- alternative cask types; and
- alternative disposal concept options which are optimised for spent fuel from new nuclear power stations.

215 It discusses the implications of adopting the approaches; noting that the studies have been pitched at a high level and further work is needed to develop the options.

3.6 Decommissioning

216 EDF and AREVA present their approach to decommissioning in their Decommissioning Non Technical Summary (Ref. 54). This recognises that whilst the decommissioning of the UK EPR will be the responsibility of the licensee, they have considered decommissioning at the early UK EPR design stage.

217 The report demonstrates that it would be feasible to decommission the UK EPR (including the interim storage facilities for spent fuel and ILW), using current technology, and that consideration of decommissioning issues has been made in the design. The baseline decommissioning plan covers the lifetime of the site, including achieving operational shutdown, Post Operational Clean Out, a care and maintenance period, if this is required and decommissioning to a brownfield site. However it does not address de-licensing of the site.

3.6.1 Principles Underpinning the Design

218 The report outlines the principles underpinning the UK EPR design, specifically:

- The principles that should be adopted by the licensee in the operation and maintenance of the plant.
- The baseline principles and objectives that should be adopted during decommissioning to enable adequate management of the decommissioning process and preparation of plans and proposals for the decommissioning of a UK EPR.
- Other principles that facilitate the licensee learning from experience, industry good practice and guidance.
- How ALARP considerations have been applied to the decommissioning aspects of the designs / philosophies.

3.6.2 Decommissioning Logistics

219 EDF and AREVA show:

- how shielding and containment design are effective during the logical sequence of the decommissioning; and
- how the major steps of the decommissioning sequence allow progressive reduction of the radiological hazards, the criticality risk, and contamination risks.

220 The report also shows how design and construction processes allow the preferred decommissioning scenario of the most activated and contaminated equipment to be completed in a safe manner, and the installation of dedicated dismantling sites within the premises to deal with the other components in a progressive and safe manner.

Technologies associated with the baseline scenario are presented, showing that the decommissioning can be carried out using current available technologies.

3.6.3 Timings of Decommissioning

221 EDF and AREVA set out their baseline assumption that a UK EPR will be promptly decommissioned. The report also considers the sensitivity to any deferment strategy, and the ability to conduct decommissioning early if required.

222 The effect on timings of the choice of interim storage technique for spent fuel are described; i.e. the time during which the spent fuel needs to be stored in the at-reactor fuel pool after operations, and the effect on other decommissioning activities of storing spent fuel assemblies in the at-reactor fuel pool.

3.6.4 Hazards and Challenges

223 The report provides details on the hazards and challenges expected to be met during the decommissioning of the UK EPR. Details are first provided of the EDF and AREVA experience of decommissioning, participation in working groups and the type of hazards encountered.

224 The potentially significant hazards that could reasonably be anticipated during the decommissioning of a UK EPR are identified, and the protection measures implemented are provided along with the controls that have been (or will be) put in place to protect against these hazards.

225 Similarly, the identification and control of the likely radiological and industrial safety hazards is provided. Finally, the criteria for the use of remote-controlled equipment / techniques in decommissioning tasks are discussed.

3.6.5 Assumed Plant Status at Decommissioning

226 EDF and AREVA explain the basis of the plant status assumed to exist at the cessation of power operations used to establish the decommissioning plan, and the underpinned allowances made for any reasonably foreseeable abnormal operations.

3.6.6 Disposability Assessment

227 The report shows that the disposability assessment presented in the GDA submission aligns with baseline decommissioning plans of EDF and AREVA. The physical and radiological inventory of the wastes, including those relating to the decommissioning of the interim storage facilities is presented, while additional information is provided on the secondary wastes during decommissioning. The sensitivity of the waste streams to the decommissioning processes is also discussed.

228 Waste management and waste routes from the buildings to interim storage are described. Finally disposability assessment and compliance with waste hierarchy and demonstration of BAT is presented.

3.6.7 Decommissioning Plans

229 The report presents a baseline decommissioning plan. The assumptions underpinning the plan are consistent with the assumptions previously stated and consider the whole

decommissioning lifecycle, including the decommissioning of interim waste stores is addressed.

230 The timescale is presented related to the operational date of the reactor, the relevant safety and environmental submission schedule and the technology choice for fuel storage. The impact on the programme of any necessary fuel storage period in the at-reactor fuel pool is also considered. Finally, consistency with Government policy and the disposability assessment is addressed.

3.7 Knowledge Management

231 The AREVA report on the Management of Records (Ref. 55) explains the requirement for the production, long-term management, maintenance and preservation of records for spent fuel and ILW. It defines the following performance objectives for the data collection and record keeping system:

- provide comprehensive and accurate baseline information about the condition of the facility's stored waste packages and equipment;
- provide historical information about operational management of the facility and maintenance history data;
- provide the means for the secure storage of this information;
- provide the means for timely and accurate retrieval of the information when required;
- provide adequate tools for data analysis; and
- provide for the automatic identification and highlighting of discrepancies and anomalies.

232 The report discusses the different types of baseline data, for spent fuel it identifies the baseline data of particular importance for fuel assemblies will be:

- spent fuel assemblies' characteristics, including reactor power history, radioactive inventory, transport data and all information obtained prior to storage (burn-up, cooling time, decay heat power, surface contaminants, minor cladding damage) via the initial characterisation process; and
- individual spent fuel assemblies' location within the storage arrays (storage pool, the storage wells or storage cask position on the storage pad depending on the preferred storage option);

233 In relation to engineered equipment, including containers, handling equipment and environmental control systems, the following will be of importance:

- design specifications and drawings and manufacturer's data (including material data, manufacturing procedures) to permit the manufacture of any replacement component or system over the lifetime of the facility; and
- pre-use inspection and commissioning data.

234 For the other wastes the baseline data is defined as:

- waste packages' characteristics, including Effluent Treatment Building history, transfer data and all information obtained prior to storage via the initial characterisation process including radionuclide inventories, dose rates, physical and chemical composition of wastes;

- individual waste package locations within the storage compartments;
- design specifications, drawings and manufacturer's data (including material data, manufacturing procedures) to permit the manufacturing of any replacement component or system over the lifetime of the facility;
- information derived from inspections during storage in relation to package condition; and
- pre-use inspection and commissioning data.

235 On the retention and preservation of records and data there is a commitment to integrate these into the safety management, quality and business systems to promote active management, to develop a process of understanding of the relevance of the records to the management of nuclear safety and to ensure fully informed management decision-making. The report recognises that employing diverse recording and management systems (e.g. hard copies, electronic files on hard drives and portable media, diverse software for data management and analysis) will facilitate keeping up with the evolution of technologies (including software and hardware) to keep the system capable of information retrieval at any time, even at the time of the final operations at the ISF. There is also a commitment to integrate into the British Radwaste Information Management System BRIMS™ the records generated over the lifetime of the plant.

236 In the Decommissioning Non Technical Summary, (Ref. 54), EDF and AREVA identify the types of information and knowledge to be preserved from the initial design stages for the EPR and associated facilities through their operational life and the decommissioning phase itself, so as to ensure that decommissioning may be undertaken safely and efficiently.

237 The systems to facilitate knowledge transfers from all stages of the life-cycle, including systems to identify and retain the knowledge most pertinent to decommissioning from the design, construction and operational phases are also discussed.

3.8 The Radioactive Waste Management Case

238 EDF and AREVA have produced a document that maps the information produced as part of GDA against the requirements of an RWMC, (Ref. 56). The objective of this mapping document is to identify existing GDA submissions that can be used as the basis for a RWMC for the UK EPR. It reflects the status of the GDA process and documentation at the end of December 2010. The wastes considered are the higher activity radioactive wastes generated in operation, maintenance and decommissioning. ILW and spent fuel are dealt with separately.

239 The body of the document consists of a table that links the requirement identified in the joint regulatory guidance, (Ref. 57); the reference to the EDF and AREVA documentation that satisfies the requirement; and any supporting comments.

240 EDF and AREVA identify in the mapping document where there is similar key material in different references or in different parts of a reference. This gives the licensee the opportunity to decide which reference may eventually be the more useful for an actual RWMC.

3.9 The Plan for the Development of the Waste Management Facilities

241 The Consolidation of the plan for Disposability of Waste and Spent Fuel, (Ref. 58) presents a plan that has been produced by EDF and AREVA to provide a potential credible work programme that a licensee could utilise to demonstrate disposability through the life of the power station. In producing the plan EDF and AREVA have held discussions with RWMD; an informal review of the draft response was performed by RWMD to provide confidence in the validity of the content.

242 The plan indicates that for ILW operational wastes, EDF and AREVA would anticipate that a licensee would achieve an Interim stage LoC prior to packaging operations with the waste conditioning strategy and packages determined by the operator; and that it should be possible to develop a joint programme of work with RWMD that is able to achieve this. A Final stage LoC for operational ILW would only take place following the active commissioning of the Effluent Treatment Building and the characterisation of the raw waste form. Therefore this could not be obtained prior to operations.

243 For ILW decommissioning wastes, EDF and AREVA would anticipate that a licensee would obtain a Conceptual stage LoC prior to operations and that it should be possible to develop a joint programme of work with RWMD that is able to achieve this. The Interim stage LoC would not be completed until more detailed information is available on the likely levels of activation products (e.g. based on the reactor operational history and the expected future reactor performance).

244 For spent fuel EDF and AREVA indicate that if the RWMD Disposal System Safety Case is produced to the proposed timescale and proves to be sufficient to allow for LoC assessment then it could be possible for the licensee to develop a Conceptual Stage LoC prior to the start of operations. They then suggest that it would be unreasonable for the licensee to enter into a regulatory commitment to produce the Conceptual Stage LoC for spent fuel prior to operations. EDF and AREVA do recognise the desirability of developing further the disposal case for spent fuel and therefore propose that the operator should use best endeavours to work with RWMD to produce a Conceptual stage LoC on the earliest practicable timescale, recognising the desirability of having a Conceptual stage LoC in place before the start of operations.

245 EDF and AREVA do not propose to perform any additional research to further develop the disposal case for new build spent fuel within the remit of the GDA. They recognise that the licensee will be required to demonstrate that their proposed strategies for the management of spent fuel will be acceptable for disposal. They indicate that this will be achieved by the development of site specific RWMC which will set out for a site the strategy for the management of radioactive waste and spent fuel throughout its lifecycle including generation, storage and disposal. As LoCs are developed, the findings and requirements will be incorporated into the licensee's RWMC.

3.10 Supporting Site Visits

246 The safety case put forward identifies a number of options for operating the UK EPR that are relevant to the RW&D assessment. To support the claims made in the safety case about the different methodologies a number of site visits were arranged.

247 During GDA, sites were visited in France, Germany, Sweden, UK and USA. On these sites operation of waste management facilities, training and maintenance facilities, decommissioning activities, at-reactor spent fuel pool operations and mobile plant were observed. I have used the knowledge gained to inform my assessment.

248 The visits were successful in establishing that different operational approaches can be successfully implemented. The relevant examples are referenced in the assessment text below. However these can be summarised into the following generic learning points for RW&D:

- Flexible processing systems allow the plant to use best practice that is developed over its lifetime.
- Space is needed in the waste management facilities to provide flexibility in dealing with the waste items a plant may produce over its operating life.
- There is a lot of experience of operating spent fuel pools with techniques well developed.
- There is a lot of experience of operating spent fuel dry stores with techniques well developed.
- Staged risk reduction based on pre-planned decommissioning stages is a good approach to decommissioning.
- The plants location (infrastructure, policies, etc.) will influence the approach to waste management.
- Waste processing and management is simpler if there is a defined end point.
- Waste containers, their contents and the associated processes need to be shown to produce a product that can be disposed of in the UK.

249 Key learning points from the site visits can be found in Table 2 of this report.

4 GDA STEP 4 NUCLEAR DIRECTORATE ASSESSMENT FOR RW&D

250 EDF and AREVA have produced a large amount of documentation to underpin their claims that wastes from new build reactors can be safely managed; this includes conditioning, storage and disposal.

251 The approach adopted by EDF and AREVA is to show that there are a number of different techniques available for processing and storing the wastes produced by a UK EPR. Whilst this allows flexibility it can lead to some confusion as to the EDF and AREVA preferred option. However, it will be the responsibility of the licensee to undertake the process optimisation and identify their own preferred option. Therefore I judge this as a suitable approach. Furthermore, I recognise that this may benefit the licensee because it identifies the broad range of options they may consider.

252 There is a lot of experience of operating PWRs, both in the UK and internationally. The wastes they produce through normal operations are well understood and the industry has developed different ways of dealing with them. The wastes produced by the UK EPR are similar to those produced by these other PWRs.

253 My assessments of the specific areas identified in section 2.4 are discussed below.

4.1 The Identification of the Wastes That a UK EPR Will Produce

4.1.1 Assessment

254 The UK EPR will produce a range of different wastes over its 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.

255 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 and that these will need to be optimised. To indicate typical effects of different operating regimes I, together with colleagues, commissioned AMEC to produce a report on practices used in PWRs, (Ref. 21). It is very important to stress that the output of the AMEC report is not meant to indicate which technologies and practices are the best; a licensee is responsible for selecting and substantiating their operating regime prior to first fuel load. Instead it provided me with a baseline of background information to undertake my assessment against. For example I was able to use this report to look at the effect of adding zinc into the primary circuit of the UK EPR; this indicates that it would not cause any unacceptable changes.

256 Both RPs arranged a number of site visits to show that waste management processes, currently used internationally, can deal with the potential wastes that arise from the operation of a UK EPR. Following these visits I judge that there are a range of waste management options able to deal with the possible wastes produced by a UK EPR.

257 The disposability assessments (Refs 49 and 50) undertaken for EDF and AREVA by the RWMD also looked at the waste produced by a UK EPR. They enhanced the radionuclide data supplied for their assessment. I judge that this enhanced data is sufficiently similar to the waste radionuclide data presented in the PCSR to mean that the disposability assessments are applicable for the range of wastes that a UK EPR will produce.

258 I was also interested whether the source terms used to predict the wastes were consistent with the source terms used in other areas. The report produced by EDF (Ref. 59) on the use of source terms shows that these are consistent.

4.1.1.1 Operational Wastes, Other Than Spent Fuel

259 My assessment of the operational wastes was completed during Step 3. Additional information on wastes became available during Step 4, such as TSC reports and additional information from EDF and AREVA on decommissioning and decontamination wastes. Therefore this section is an update of the assessment in the Step 3 report. In compiling the update I have completed a high level review of the revised documents to check that they are broadly equivalent to those documents that underpinned the Step 3 report.

260 In the June 2009 PCSR Chapter 11.2 (Ref. 29) provides an overview of the radionuclides likely to be significant in these wastes and Chapter 11.3 (Ref. 32) gives an overview of the wastes. The aim of my assessment has been to check that the information presented in these chapters is a suitable representation of the wastes a UK EPR would produce. This is important as it underpins the other areas I assess in this report.

261 The SRWSR (Ref. 31) provided a lot more detail of the wastes produced by a UK EPR. The report identifies 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.

262 As part of the environmental assessment EDF and AREVA have produced a detailed BAT report (Ref. 30) and an Integrated Waste Strategy (Ref. 33). These provide evidence of the EDF and AREVA analysis that underpins their statements about the wastes that a UK EPR will produce.

263 The BAT report (Ref. 30) includes a detailed analysis of the origin of the radioisotopes that are discharged from the reactor and the techniques that affect the eventual discharge route. For me this is an important document as it establishes that the UK EPR has minimised the amount of radioactive waste produced (SAP – RW2) and is unlikely to produce a radioisotope that would undermine the long term management of the wastes.

264 I recognise that the licensee will make choices about the way that the reactor is operated and this will probably cause variations in the wastes produced compared with those detailed in Table 4 of Chapter 11.3 (Ref. 32).

265 I am aware of operating regimes for the UK EPR that might change the wastes produced. Working with the Reactor Chemistry Assessors and referencing the AMEC report, (Ref. 21) I have considered a range of these possible regimes. For example the addition of zinc to the primary circuit, or the ageing of the reactor. I do not expect that the predictable operating regimes could produce waste for which there is no foreseeable management and disposal route. During licensing there will be a need to confirm this conclusion.

266 I have not included the need to confirm the wastes that will be produced as a specific finding. Instead it is included in the discussions in the subsequent sections and, where relevant, included in those findings.

267 Taken together these provide the necessary evidence that the operational wastes detailed in Table 4 of Chapter 11.3 (Ref. 32) are a suitable basis for assessment.

4.1.1.2 Large Waste Items

268 During the Step 3 Assessment I looked specifically at how large waste items, such as a Reactor Pressure Vessel head would be handled. EDF and AREVA provided outline information about this. During Step 4 this aspect of the assessment has been incorporated into the decommissioning assessment, so is dealt with there.

4.1.1.3 Spent Fuel

269 The SRWSR (Ref. 31) provides details of the radionuclide content of the fuel and the amount used in a reactor. For GDA the fuel assessed is fresh 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 GWd/tU, it is assumed for the assessment of storage regimes and disposability that all fuel assemblies have experienced a burn-up of 65 GWd/tU.

270 Currently there is a heat limit on fuel sent for disposal (Ref. 49); consequently prior to disposal the spent fuel will be stored in an at-reactor storage pool for a period of time, followed by interim storage on the site. So at the time of disposal the thermal output of the fuel will have reduced. For the calculation of the required storage period assuming all fuel has experienced 65 GWd/tU will indicate the maximum storage period of the fuel at the reactor site. It is likely that much of the fuel will have experienced a lower burn-up and so could be disposed of sooner.

271 Therefore for GDA the level of information provided on spent fuel is sufficient. I recognise that at a site specific stage a more detailed analysis maybe required to show how long spent fuel having different burn-ups would be stored on site.

4.1.2 Findings on the Identification of the Wastes That a UK EPR Will Produce

272 The UK EPR will produce a range of different wastes over its lifecycle. The way that the UK EPR is operated will affect the quantity and proportions of radionuclides in the different wastes. Recognising these constraints I judge the evidence provided by EDF and AREVA shows that the operational wastes detailed in Table 4 of Chapter 11.3 (Ref. 32) are a suitable basis for assessment.

273 For GDA the fuel assessed is fresh uranium oxide fuel assumed to have experienced a burn-up of 65 GWd/tU. I judge this is sufficient information for my assessment. I recognise that this is a high burn up for spent fuel, so at a site specific stage a more precise analysis will be required.

274 Recognising these constraints I have not placed any specific findings on the licensee to confirm that the wastes the as-built UK EPR will produce, this will be dealt with as normal regulatory business by both the Environment Agency and ND. However, a licensee should recognise the importance of resolving the uncertainties early so as to underpin their work on the waste management practices identified later in this report. They should also recognise that this will be part of the optimisation process discussed in section 2.4.4.4 and the associated finding (**AF-UKEPR-RW-05**).

4.2 EDF and AREVA Plans for Short Term Storage and Conditioning

4.2.1 Assessment

275 SAP RW3 indicates that the accumulation of radioactive waste on site should be minimised. Once the UK EPR is licensed this will be a mandatory requirement under Licence Condition 32. So in this area of the assessment I looked to see that the plans of EDF and AREVA provide for a short period of storage and then suitable conditioning.

276 Conditioning should allow the wastes to be segregated and characterised (SAP – RW4) so as to properly inform decisions about its subsequent management. Furthermore where waste is being packaged into a form that is intended to be suitable for final disposal, it should be sufficiently characterised to properly inform subsequent decisions about its suitability for disposal.

277 In accordance with SAP RW5 the conditioning process should also produce a product with the following characteristics:

- The waste form and its container is physically and chemically stable.
- The package is compatible with the long-term management strategy for the waste, which may include the need for further characterisation, treatment or conditioning, a prolonged period of storage, or disposal.
- The radioactive waste is immobile.

4.2.1.1 Wastes, Other Than Spent Fuel

278 For most of the wastes produced by a UK EPR the design intent is to use a mobile facility to process them. Therefore, in line with the SAPs detailed above, the level of proof that I am looking for in the submission is a demonstration that:

- there are conditioning processes that could be used without raising unacceptable safety or environmental issues; and
- there is sufficient short term storage space to store material prior to processing.

279 The encapsulation of the filters is the one exception to this approach. I was looking for a greater level of proof for this facility because it is a fixed facility on the nuclear island.

280 Chapter 11.4 of the June 2009 PCSR (Ref. 34) gives a high level overview of the short term storage facilities and the proposed approach to conditioning. This gives limited information on the available space or the feasibility of the conditioning processes.

281 This is acceptable as in the course of my assessment EDF and AREVA have provided a significant amount of supplementary information about the Flamanville processes. This is sufficient to satisfy me that the proposed conditioning processes presented in Chapter 11.4 are feasible. I have not referenced this supplementary information in my Assessment Report as the processes are not fixed and the final decision on the process to be used is for the licensee to develop through an optimisation process.

282 During the site visits both EDF and AREVA showed the space required for short term storage of wastes. Looking at the layout drawings presented during meetings in Lyon and Manchester they were able to show that a UK EPR could provide equivalent space. Again the final decision on the utilisation of the space in the Effluent Treatment Building is for the licensee, so I have not formalised these areas in my assessment report.

283 The information provided in response to TQ-EPR-961 (Ref. 36) shows that the encapsulation of the filters is a process that EDF have experience of successfully implementing.

284 I judge that the information presented is sufficient to show that there are feasible systems for conditioning the waste produced by UK EPR and that there will be sufficient space for short term storage.

4.2.1.2 Spent Fuel

285 Short term storage of spent fuel will be in the at-reactor spent fuel pool; this is discussed in section 2.4.4.1.

286 The information provided by EDF and AREVA on the encapsulation of spent fuel (Ref. 37) is sufficient to show that packaging for disposal should be feasible. As this facility would not be required for several tens of years I do not believe that there is any benefit in pursuing this issue further within GDA.

4.2.2 Findings on Plans for Short Term Storage and Conditioning

287 In the course of my assessment EDF and AREVA have provided sufficient information to satisfy me that the proposed conditioning processes, (Refs 34, 36 and 37), are feasible.

288 During the site visits EDF and AREVA showed the space typically required for short term storage of wastes and fuel and demonstrated that a UK EPR could provide equivalent space.

289 Recognising that EDF and AREVA have demonstrated credible options for short term storage and conditioning I have not required them to go through a process to optimise the process for conditioning wastes, other than spent fuel. This will need to be done. So:

> **AF-UKEPR-RW-06**: *the licensee shall produce a safety report for the processing and long-term storage of the ILW. The report will contain information equivalent to that of a Preliminary Safety Case as defined in Guidance on the Purpose, Scope and Content of Nuclear Safety Cases, (Ref. 60) and be complete prior to the pouring of nuclear island safety related concrete.*

4.3 EDF and AREVA Plans for Long Term Storage

4.3.1 Assessment

290 SAP RW5 indicates that radioactive waste storage should include the following characteristics:

- The need for active safety systems to ensure safety should be minimised.
- The need for monitoring to ensure safety should be minimised.
- There should be no need for prompt intervention to maintain the facility in a safe condition.
- The design, construction standards, construction materials, and maintenance and inspection provisions of the storage facility should take account of the anticipated storage duration (including ageing and degradation) to ensure that the facility continues to meet its safety function.

- The storage environment should avoid degradation that may render the waste unsuitable for long-term management or disposal.
- The storage facility should be designed and operated so that individual packages can be inspected and retrieved within an appropriate period of time. This may include the need for reserve storage space.
- The storage facility should be designed and operated to enable timely intervention in the event of unexpected faults or accidents.
- Appropriate provisions should be available for dealing with radioactive waste or its packaging that shows signs of unacceptable degradation.

291 I have used these requirements to judge the acceptability of the EDF and AREVA proposals for long-term storage.

4.3.1.1 Wastes, Other Than Spent Fuel

292 The information provided by EDF and AREVA on the long term management of wastes, other than spent fuel, (Refs 38 and 39) is to a level of detail broadly in line with our published expectations (Ref. 13). In addition the SRWSR, (Ref. 31) provides alternative processes for storing with these wastes.

293 During the site visits arranged by EDF and AREVA I have observed some of the storage options. This supported the assertions in the documentation that these processes could be undertaken in a safe and environmentally acceptable way.

294 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.

295 My assessment has not sought to identify the optimum storage option. When selecting the option the licensee will need to consider, amongst other things:

- the frequency of all inspections;
- the baseline (to monitor and inspect you need information related to the condition of the package or facility at the starting point);
- the ability to inspect whilst operations are ongoing (imports and exports); and
- the ability to export any package once a GDF is available.

296 It is possible that these requirements could preclude some future store layouts.

297 I have not identified any specific findings for this area. There are findings associated with the timings of the decisions associated with long term storage; these are discussed in Section 4.8.

4.3.1.2 Spent Fuel

298 For GDA the spent fuel is treated as a waste. SAP RW5 states that radioactive waste should be stored in accordance with good engineering practice and in a passively safe condition. For very long term storage, EDF and AREVA indicate that some fuel may have to be cooled for disposal for 100 years; it is challenging to meet the principles of SAP RW5 over this timescale.

299 I have required EDF and AREVA to provide a lot of detail on their proposals for the long term storage of fuel. This is because of the time constraints that RWMD have placed on

their ability to dispose of the fuel and the implications this has on its management. Whilst adopting these consequential timescales as targets I also want EDF and AREVA to demonstrate that safety can be maintained beyond these dates, should it be necessary.

300 The information provided by EDF and AREVA on the long term management of spent fuel, (Refs 38, 40, 41, 42, 43, 44, 45 and 46) is to a level of detail broadly in line with our published expectations (Ref. 13). In addition the SRWSR, (Ref. 31) provides alternative processes for storing these wastes.

301 During the site visits arranged by EDF and AREVA I have observed operational wet and dry storage options. This supported the assertions in the documentation that these processes could be undertaken in a safe and environmentally acceptable way.

302 The work my TSC, National Nuclear Laboratories (NNL) undertook for me (Ref. 19) also supports the EDF and AREVA assertions that if correctly treated the fuel can be stored for the required periods and be suitable for transport after storage.

303 SAP RW 5 is supported by explanatory text. Much of the evidence this explanatory text would require is beyond the requirements of GDA. For GDA the key aspect that I expected EDF and AREVA to show over the totality of the on-site storage period were:

- The waste form and its container should be physically and chemically stable.
- The package should be compatible with the long-term management strategy for the waste, which may include the need for further characterisation, treatment or conditioning, a prolonged period of storage, or disposal.
- The radioactive waste should be immobile.
- The need for active safety systems to ensure safety should be minimised.
- The need for monitoring to ensure safety should be minimised.
- There should be no need for prompt intervention to maintain the facility in a safe condition.
- The design, construction standards, construction materials, and maintenance and inspection provisions of the storage facility should take account of the anticipated storage duration (including ageing and degradation) to ensure that the facility continues to meet its safety function.
- The storage environment should avoid degradation that may render the waste unsuitable for long-term management or disposal.
- The storage facility should be designed and operated so that individual packages can be inspected and retrieved within an appropriate period of time. This may include the need for reserve storage space.
- The storage facility should be designed and operated to enable timely intervention in the event of unexpected faults or accidents.
- Appropriate provisions should be available for dealing with radioactive waste or its packaging that shows signs of unacceptable degradation.
- No external controls are relied upon to prevent criticality.

304 The arguments presented by EDF and AREVA show that these aspects can be met and that fuel can be stored for the required periods.

305 I acknowledge that there remains a small residual risk that after interim storage the fuel is not in a suitable state for transport. To alleviate this risk it will be an important aspect of the storage option selected that:

- the transfer of the fuel from the at-reactor spent fuel pool to the long-term store does not adversely affect the long term performance of the fuel, cladding or support structure;
- the fuel can be monitored so that any detected changes can be acted upon; and
- there is sufficient space for maintenance, repair or replacement of the equipment and the fuel.

306 To compliment the design of the storage facility it will also be important for the licensee to have programmes in place to:

- research the evolution of the fuel, cladding and support structure to build to maintain confidence that it is not undermining the ability to transport the fuel;
- learn from the international experience on the long term management of spent fuel so that any potential remediation can occur early; and
- work with RWMD to optimise the storage periods so that transport can occur as soon as reasonably practical.

307 This is reflected in the finding at the end of this section. Furthermore there are indications of increased international interest in research to underpin cases for long-term fuel storage. This work will be a valuable addition to the topic.

308 The long term storage facility will have to interface with the at-reactor fuel pool. Reference 41 outlines the EDF and AREVA proposals for the interface facility. The proposals appear practical, although I recognise that depending upon the selected long-term management option it may require additional facilities. This should be reflected in the plan discussed in Section 4.8.

4.3.2 Findings on the Plans for Long Term Storage

309 The information provided by EDF and AREVA on the long term management of wastes, other than spent fuel, is to a level of detail broadly in line with our published expectations for GDA. The site visits arranged by EDF and AREVA supported the assertions in the documentation that these processes could be undertaken in a safe and environmentally acceptable way. Therefore I am satisfied that EDF and AREVA have made sound arguments showing their plans for long term storage of radioactive wastes, other than spent fuel, should be safe to implement.

310 Recognising that EDF and AREVA have demonstrated credible options for long term storage options for wastes, other than spent fuel I have not required them to go through a process to optimise the long term storage option. However, this will need to be done in the future on a site specific basis. So:

> **AF-UKEPR-RW-06**: *the licensee shall produce a safety report for the processing and long-term storage of the ILW. The report will contain information equivalent to that of a Preliminary Safety Case as defined in Guidance on the Purpose, Scope and Content of Nuclear Safety Cases, (Ref. 60) and be complete prior to the pouring of nuclear island safety related concrete.*

311 EDF and AREVA have provided a lot of detail on their proposals on the long term management of spent fuel because of the time constraints that RWMD have placed on their ability to dispose of the fuel. Whilst adopting these consequential timescales as targets I want EDF and AREVA to demonstrate that safety can be maintained beyond these dates, should it be necessary.

312 Therefore I am requiring the licensee to undertake a number of actions associated with the development of the long-term spent fuel interim storage facilities. These include:

> ***AF-UKEPR-RW-10****: the licensee shall produce a safety report for the long-term storage of spent fuel. The report will contain information at least equivalent to that of a Preliminary Safety Case as defined in Guidance on the Purpose, Scope and Content of Nuclear Safety Cases, (Ref. 60). The process optimisation will be against the principles set out in:*
>
> - *Section 2.4.3, Design Safety Principles, of the Longer Term Spent Fuel ISF. UKEPR-0009-001 Issue 00, July 2009 (Ref. 42); and*
> - *Section 3, Design Safety Principles, of the Human Factors in Long Term Waste Management, R10-006(A) Issue 2, February 2010 (Ref. 44).*
>
> *It shall also detail the proactive inspection regime for the spent fuel in on-site storage that builds on existing knowledge and experience, allows the spent fuel to be retrieved and inspected within a reasonable time frame and limits the number of fuel assembly lifts. This will be complete prior to the first fuel load.*

> ***AF-UKEPR-RW-07****: the licensee shall identify the evidence necessary to underpin their spent fuel storage, transport and disposal strategy, the activities needed to secure this evidence and the time needed for these activities. The provision of this evidence and associated activities will be detailed on a plan that will link the evidence needed with the construction activities for all on site facilities required to manage the spent fuel over its lifetime. This will be complete prior to the pouring of nuclear island safety related concrete*

> ***AF-UKEPR-RW-08****: the licensee shall produce a plan, with RWMD input, for the work necessary to reduce the on-site storage period for the spent fuel produced by the reactor so that the fuel can be transported as soon as reasonably practical. This will be complete prior to the first fuel load.*

4.4 Disposability

4.4.1 Assessment

313 In the UK the Environment Agency issues the permits for the disposal of radioactive waste. They assessed the suitability of the wastes produced by a UK EPR for disposal (Ref. 15). I accept their conclusion that the design is not expected to produce wastes for which there is no foreseeable disposal route. As such I have not considered the disposability of the wastes in detail.

314 The disposability of the wastes arising from decommissioning activities is covered in the following section.

4.5 Decommissioning

4.5.1 Assessment

315 I asked EDF and AREVA to base their case on currently available technology but it is likely that techniques will develop as more experience is gained in decommissioning PWRs throughout the world (Ref.22). Indeed, services continue to develop to accommodate a growing international demand e.g. the decontamination and recycling of steam generators (Ref. 61).

316 I was supported in my assessment of the UK EPR by the Radiological Protection Assessor (Ref. 26) and React Engineering Ltd (Ref. 62). The assessment consisted of a presentation by EDF and AREVA on their plans, a visit to their facilities in France and the provision of a detailed decommissioning plan. Based on this information I judge that EDF and AREVA have made adequate provision within the design of the UK EPR to allow the plant to be decommissioned.

317 I did not consider the demolition of the civil structure as this was covered by the Civil Engineering and External Hazards Assessment of the UK EPR (Ref. 24).

318 I based my assessment on the SAPs DC.1 – DC.6 detailed in Table 1. Using these I produced an intervention plan. This was supplied to EDF and AREVA, who subsequently structured their report using the same headings. The individual interventions are discussed below.

4.5.1.1 Principles Underpinning the Design

319 UKEPR-0016-001 (Ref. 54) outlines a number of underpinning decommissioning principles for the UK EPR, as detailed in section 3.1.1. I judge that these are suitable for the design stage in the UK EPR development. EDF and AREVA have also provided details in Ref. 54 of how the design facilitates application of these principles.

320 EDF and AREVA have not provided evidence of the process for incorporating decommissioning into the design. During design a process should be in place to incorporate the decommissioning needs (SAP- DC.1, Table 2). As there was no evidence of the process, the EDF and AREVA decommissioning engineers demonstrated, through detailed exchange, that the UK EPR has features to help decommissioning. I am therefore satisfied that there was an informal process in place during the design of the UK EPR.

4.5.1.2 Decommissioning Logistics

321 Section 2.4 in Chapter 2 of UKEPR-0016-001 (Ref. 54) provides the proposed decommissioning logistics for the UK EPR. This appears logical and well thought through. It shows that large items, such as a steam generator, and complex items, such as the reactor vessel, can be removed.

322 The information contained in the report takes account of the interdependencies on the nuclear island. There is less information on the auxiliary facilities, such as the interim waste storage facilities. However, this is not considered to present significant challenges.

4.5.1.3 Timings of Decommissioning

323 EDF and AREVA state a preference for immediate decommissioning. This is ND's preferred option, subject to the optimisation of doses and discharges. (SAP – DC.3, Table 2).

324 Chapter 3 of UKEPR-0016-001 (Ref. 54) provides a rigorous justification for this preference. Evidence is also provided that a UK EPR could be decommissioned if the decision was taken to delay the start of decommissioning or bring it forward.

325 The NNL report that I commissioned (Ref. 19) indicated that fuel should be cooled before being sent to a dry long term store. The effect of such a requirement has been considered in UKEPR-0016-001 (Ref. 54), which indicates that decommissioning would be delayed if the fuel has to be stored in the at-reactor spent fuel pool. The report also indicates the affect of storing the fuel in the at-reactor fuel pool on the safety systems that need to be operational. I am satisfied that this demonstrates sufficient flexibility in the design to allow the potential demands of long-term spent fuel storage to be accommodated within the final decommissioning strategy.

4.5.1.4 Hazards and Challenges

326 Chapter 4 of UKEPR-0016-001 (Ref. 54) provides an overview of the potential hazards and challenges associated with the decommissioning of a UK EPR. The information provided is sufficiently comprehensive for me to be confident that EDF and AREVA have identified the likely types of hazard and challenge that could be encountered during decommissioning.

327 For me the most important aspects of this chapter are the means that EDF and AREVA identify for controlling the hazards and challenges. These include learning from experience of other decommissioning projects and the potential use of remote technologies, such as robots.

328 I have noted that there is not a commitment for the extensive use of robots, even though these could reduce operator doses. For decommissioning I am satisfied that EDF and AREVA have provided sufficient evidence to show that a licensee could choose to use robots in decommissioning. I have informed the Radiological Protection Assessor of this conclusion as they are considering dose reduction through the use of robots in the operation of the UK EPR.

4.5.1.5 Assumed Plant Status at Decommissioning

329 UKEPR-0016-001 (Ref. 54) outlines the assumed radiological and contamination zoning of areas, stating that these reflect the status of the plant at the point of decommissioning. I accept that this is a reasonable planning assumption.

330 EDF and AREVA have also demonstrated that a UK EPR can be decontaminated prior to decommissioning. This will reduce doses and facilitate prompt decommissioning.

4.5.1.6 Disposability Assessment

331 UKEPR-0016-001 (Ref. 54) provides evidence that the wastes produced during decommissioning, including large items such as steam generators, are broadly similar to those produced during operations. I have discussed this with the Environment Agency,

who are of the opinion that the design is not expected to produce LLW and ILW for which there is no foreseeable disposal route.

4.5.1.7 Decommissioning Plans

332 UKEPR-0016-001 (Ref. 54) includes a decommissioning plan (SAP – DC.4, Table 2). When assessing this I have taken account of all the information in the report.

333 The report indicates that the decommissioning of the facility and the associated plant will result in a brown field site. This is supported by evidence, which demonstrates that decommissioning can be undertaken safely, and that the end-state (and any interim state) can be met.

334 The plan shows that as far as practicable EDF and AREVA has optimised the use of existing facilities and plant during decommissioning and considered any necessary changes to the existing safety systems.

335 The level of detail contained in the plan is commensurate with the information available at this stage in the development of the project.

4.5.2 Findings on Decommissioning

336 The information provided by EDF and AREVA is sufficient to meet the requirements of a generic design. The decommissioning information will need to be revisited by the licensee before the first fuel load of the reactor, so that they can take account of the site specific features. These features will include:

- the space available on the site and how this could affect the proposed strategy;
- the chosen long-term management arrangements for the wastes;
- any applicable research; and
- the licensee's processes and procedures.

337 There is no specific finding associated with the updating of the decommissioning information. It is an explicit requirement of Licence Condition 35 that a licensee shall make arrangements for the production and implementation of decommissioning programmes for each plant. Therefore a licensee will have to update the information as part of their process for implementing arrangements for Licence Condition 35.

338 As EDF and AREVA could only show an informal process for incorporating decommissioning into the design I am requiring:

> ***AF-UKEPR-RW-02****: the licensee shall review the construction activities to identify any actions that could be taken during construction that would be beneficial to the decommissioning process. (For example is it appropriate to leave lifting lugs on vessels?). This will be complete prior to the pouring of nuclear island safety related concrete*

4.6 Knowledge Management

4.6.1 Assessment

339 SAP RW.7 requires information that might be required now and in the future for the safe management of radioactive waste to be recorded and preserved.

340 The AREVA report on the Management of Records (Ref. 55) explains the requirement for the production, long-term management, maintenance and preservation of records for spent fuel and ILW.

341 UKEPR-0016-001 (Ref. 54) provides details of how institutional knowledge of the facility will be generated and maintained throughout its life-cycle so that it is accessible during decommissioning. (SAP – DC.4 and DC.6, Table 2).

342 I judge that these reports provide a basis for a licensee to develop a suitable system for recording and preserving information. I also welcome the commitment to the use of the BRIMS^{TM} database.

4.6.2 Findings on Knowledge Management

343 I have agreed with the Management for Safety and Quality Assurance Assessor that there should be a specific finding in my report about the management of information for waste and decommissioning.

> ***AF-UKEPR-RW-03****: the licensee shall implement a records management procedure for waste management and decommissioning that incorporates the principles established in the AREVA report on the Management of Records (Ref. 55) and UKEPR-0016-001 (Ref. 54). This will be complete prior to the pouring of nuclear island safety related concrete*

4.7 The Radioactive Waste Management Case

4.7.1 Assessment

344 I was supported in my assessment of EDF and AREVA by Babcock Ltd (Ref. 63). The assessment consisted of a presentation by EDF and AREVA on their plans and the provision of a detailed mapping document. Based on this information I judge that EDF and AREVA have provided sufficient information on the life cycle of the waste to be able to produce a comprehensive RWMC.

345 I agreed with Babcock that their review would be against a number of questions. My assessment is structured using these questions.

4.7.1.1 Can RWMCs be Created for All Streams When a Site is Selected?

346 I agree with Babcock's assessment that there is sufficient information within the EDF and AREVA GDA submission to generate a comprehensive set of RWMCs for a site. I also note that the mapping document is sufficiently specific to allow a licensee to identify exactly where information is recorded.

347 Given the breadth of information provided by EDF and AREVA in their submission there can be more than one reference for any of the requirements specified in the joint regulatory guidance (Ref. 57). As the licensee will need to go through an optimisation step in the development of their waste management processes I see this as one of the strengths of the mapping document.

4.7.1.2 Are All ILW/Spent Fuel Streams Covered?

348 The EDF and AREVA mapping document covers the operational wastes in detail.

349 Babcock notes that the decommissioning wastes have not been addressed to the same level of detail. I have reviewed the decommissioning submission from EDF and AREVA, see Section 4.5 and judge that this covers the information necessary to produce an RWMC. So I conclude that this is an acceptable omission for GDA.

4.7.1.3 Does It Show the Interrelationships Between Relevant Documents?

350 As a result of EDF and AREVA choosing to look at a number of waste management options the relationship between the different documents is complex. Therefore the interrelationships between the documents are not well reflected in the mapping document. Given the advantages of having different options identified in the EDF and AREVA submission I judge that this complexity is acceptable.

4.7.1.4 Does It Show Key Interrelationships Between Facilities/ Operations?

351 The mapping document reflects the interrelationships described in EDF and AREVA documentation, the illustrative diagrams/flowcharts are informative and could be included in the site specific RWMC.

4.7.1.5 Are All Stages of Waste Management Considered at an Appropriate Level?

352 The joint position statement on the RW&D assessment (Ref. 13) clarifies that for facilities not on the nuclear island the emphasis is less on the specific design details and more on the evidence to show that the chosen route is suitable. As a result the mapping document references are clearer on the management of waste on the nuclear island. This is a suitable position for GDA.

4.7.1.6 Does It Present a Clear Picture of the Waste Management Process Steps?

353 As discussed above EDF and AREVA have identified a number of options for dealing with the wastes produced by a UK EPR. This is acceptable if EDF and AREVA are clear in their plan when choices have to be made. My assessment of the plans produced by EDF and AREVA is contained within Section 4.8, which concludes that the plans are credible. I therefore foresee no reason why a licensee should not have sufficient information available to produce a clear picture of the process management steps within a site specific RWMC.

4.7.1.7 Are the Responsibilities of Different Organisations Clear?

354 The project team is clearly described for the current, GDA, stage. There is also recognition in some cases that final choices will be made by a licensee.

4.7.1.8 Are Future Actions Required to Resolve Information Gaps Identified?

355 It is disappointing that the mapping document does not reference the EDF and AREVA response to RO-UKEPR-048.A2, (Ref. 58). Together the RWMC and the plan for implementing waste management arrangements for a UK EPR provide a robust demonstration that there is a credible route for the management of wastes.

356 In my assessment I have looked at both documents. Whilst they show some shortfalls in identifying the actions required to resolve current information or technology gaps, they are generally comprehensive.

4.7.2 Findings on the Radioactive Waste Management Case

357 The information on the life cycle of the waste provided by EDF and AREVA should be sufficient to produce a comprehensive RWMC.

358 Given the breadth of information provided there can be more than one reference for any of the requirements specified in the joint regulatory guidance (Ref. 57). Whilst the breadth of information can lead to some complexity in the mapping document, it will help the licensee when they optimise their waste management processes. I therefore foresee no reason why a licensee should not have sufficient information available to produce a site specific RWMC early in the Site Licence Phase.

359 The RWMC and the plan for implementing waste management arrangements for a UK EPR provide a robust demonstration that there is a credible route for the management of wastes.

360 Therefore:

> ***AF-UKEPR-RW-01****: the licensee shall produce an RWMC for all of the wastes that their UK EPR will produce. This will be complete prior to the pouring of nuclear island safety related concrete*

4.8 The Production of a Credible Plan for the Waste Management Facilities

4.8.1 Assessment

361 In May 2009 the Environment Agency, Department for Transport and ND published a joint strategy that detailed the anticipated outcomes for the GDA of radioactive waste proposals (Ref. 13). This proposed that for those storage facilities not on the nuclear island EDF and AREVA should develop a strategy that included a detailed plan with key milestones. The plans would be underpinned by descriptions of:

- the types of facility that could be used;
- when facilities will be developed and constructed; and
- the research needs that are required to ensure the waste and spent fuel can be safely managed on sites, transported and disposed of.

362 Whilst the plan is a very simple document it is important to EDF and AREVA, licensees and the Regulators as it provides a baseline to the implementation of the proposed waste management strategy. So for the plan to be credible the underpinning documentation, identified in the bullets above has to be substantive, logical and plausible.

363 It would also be acceptable for a licensee to adopt an alternative strategy than that presented in the plan. Where a licensee chooses to do this they would need to show that the baseline they had established in their plan was broadly equivalent to or better than, that presented here and could be realised in a suitable timescale.

364 Where a substantive item or activity has not been included in the plan I have accepted that the item or activity will be available prior to the first fuel loading. If the licensee

wishes to delay the implementation beyond this date they will need to agree the revised date with the Regulator.

365 This section of the assessment report deals with the plan provided by EDF and AREVA in their response to RO-UKEPR-048.A2, (Ref. 58). This was the culmination of a process that had been developed across the whole of GDA, which includes work on storage, conditioning and disposal of the wastes produced by a UK EPR.

366 The Environment Agency reviewed the RWMD disposability assessment and the response to RO-UKEPR-48.A2 (Ref. 58) and concluded that interactions through the course of the GDA process have identified a range of issues that will need to be addressed in the future programmes of EDF and AREVA and/or licensees. The Environment Agency noted the provisional plan as to how these issues will be addressed through future work. In due course, the Environment Agency will want to see more definitive assessments to confirm how all of the ILW and spent fuel will be conditioned for disposal, that the selected conditioning methods represent the application of BAT and that in their conditioned forms the ILW and spent fuel will continue to be disposable.

367 The response to RO-UKEPR-48.A2 (Ref. 58) includes a single plan for all wastes. Using this I have discussed the EDF and AREVA proposed approach to ILW and the approach to spent fuel separately below.

368 The plans do not include actions associated with LLW. This is acceptable because EDF and AREVA have obtained evidence that LLW can be sent promptly for disposal.

4.8.1.1 Plan for Dealing with ILW Wastes

369 The plan produced by EDF and AREVA is at a high level. For GDA this is acceptable. The information provided indicates that the timescales quoted are reasonable for the work that will need to be completed.

370 EDF and AREVA has indicated that potential licensees can work with RWMD to gain a interim stage LoC for the ILW waste produced by a UK EPR prior to the first fuel load. Given that the disposability assessment for this waste indicates that it is broadly equivalent to wastes in the baseline inventory for a future repository this appears straightforward. For this waste I believe that it is feasible for a licensee to gain a final stage LoC on the same time scales. So at first fuel load I would expect the licensee to be able to show that there were no substantive outstanding issues associated with the disposal of this waste.

371 I note that the plan does not include any of the actions identified in the disposability assessment (Ref. 49) and the EDF and AREVA review of this (Ref. 52). I would therefore expect these actions to be complete before first fuel load, as required in the subsequent findings. Where this isn't possible then the licensee would have to prepare a robust justification for the delay and agree this with the Regulator.

372 I conclude that EDF and AREVA have produced a credible plan for the implementation of their proposed ILW strategy, subject to the findings below.

4.8.1.2 Plan for Dealing with Spent Nuclear Fuel

373 The plan produced by EDF and AREVA is at a high level. For GDA this is acceptable.

374 EDF and AREVA have indicated that potential licensees can work with RWMD to gain a final stage LoC for the spent fuel produced by a UK EPR. However, the response to RO-

UKEPR-48.A2 (Ref. 58) argues that EDF and AREVA cannot commit a licensee to specific timescales for gaining LoC as this is outside of their direct control. Given the information provided by the RWMD to me and the disposability assessment supplied by EDF and AREVA I don't accept this argument. The subsequent findings therefore reflect the timescales I would expect a licensee to meet.

375 The disposability assessment for the spent fuel indicates that it is broadly similar to other fuels in the baseline inventory for a future repository. We accept this analysis and the assurance that we have received from the Environment Agency that the spent fuel should be disposable.

376 Given that this will be a significant addition to the baseline inventory used for planning the repository by RWMD, we have looked for additional evidence that the fuel can be sent for disposal and that the associated risks are being actively addressed. For me this means that actions are in place to reduce the timescales over which spent fuel would be stored before it can be sent for disposal. I believe that there is a simple correlation between the length of storage and the risk of fuel failure, so reducing the time reduces the risk.

377 I have checked this through the work I commissioned NNL to undertake (Ref. 19). Their report indicated that the fuel should remain in a stable state where it is suitable for transport and disposal providing it is adequately cooled once it is removed from the reactor. At the time of disposal I would expect a licensee to be able to show that the fuel can be safely transported to a repository. This means that they would have to show that the fuel, in its transport package, could withstand a worst case transport accident as indicated by the IAEA transport regulations (Ref. 64).

378 In the original disposability assessment the RWMD indicated that they expect fuel to be cooled for 100 years before it could be sent for disposal. Since then they have produced a report for the Nuclear Industries Association (NIA) (Ref. 53). This report indicates that there are potential ways of reducing the timeframe over which spent fuel is cooled before it can be sent for disposal. This demonstration of RWMD and potential licensees working together to address an issue is welcome.

379 On the 13 December 2010 the RWMD provided representatives of the Department of Energy and Climate Change (DECC) and the Regulators a briefing on the development of their plans for the disposal of spent fuel. The information that I gained from this meeting has provided me assurance that RWMD have in place plans for developing the underpinning needed to validate the more detailed proposals that will come forward from licensees.

380 It also identified short-comings that a potential licensee would have to work closely with RWMD to address. The most significant of these was that new build fuel is not part of the baseline inventory and, as such, RWMD would not consider new build fuels in generic research. However, RWMD would undertake specific research funded by a licensee that supports disposal of its spent fuel.

381 I conclude that EDF and AREVA have produced the basis for the development of a credible plan for the implementation of their proposed spent fuel strategy. The plan still has areas that need to be revised or extended; these are identified in the finding detailed below.

4.8.2 Findings on the Production of a Credible Plan for the Waste Management Facilities

382 I conclude that EDF and AREVA have produced a credible plan for the implementation of their proposed ILW strategy.

383 The plan produced by EDF and AREVA is at a high level. For GDA this is acceptable. The information provided indicates that the timescales quoted are reasonable for the work that will need to be completed.

384 I note that the plan associated with the wastes, other than spent fuel, does not include any of the actions identified in the disposability assessment (Ref. 49) and the EDF and AREVA review of this (Ref. 52). I would therefore expect these actions to be complete by a future licensee (see action **AF-UKEPR-RW-05** below).

> ***AF-UKEPR-RW-05****: the licensee shall identify the evidence necessary to underpin their ILW storage and disposal strategy, the activities needed to secure this evidence and the time needed for these activities. The provision of this evidence and associated activities will be detailed on a plan that will link the evidence needed with the construction activities for all on site facilities required to manage the ILW over its lifetime. This will be complete prior to cold operations.*

> ***AF-UKEPR-RW-06****: the licensee shall produce a safety report for the processing and long-term storage of the ILW. The report will contain information equivalent to that of a Preliminary Safety Case as defined in Guidance on the Purpose, Scope and Content of Nuclear Safety Cases, (Ref. 60). This will be complete prior to the pouring of nuclear island safety related concrete.*

385 EDF and AREVA have indicated that a licensee could work with RWMD to gain a final stage Letter of Compliance for the spent fuel produced by a UK EPR. They also argue that EDF and AREVA cannot commit a licensee to specific timescales. I don't accept this argument (see action **AF-UKEPR-RW-11** below).

386 On the 13 December 2010 the RWMD provided me assurance that plans are in place for developing the underpinning information needed to validate the more detailed proposals that will come forward from a licensee. It also identified short-comings that a potential licensee would have to work closely with RWMD to address (see action **AF-UKEPR-RW-08** below).

387 I conclude that EDF and AREVA have produced the basis for the development of a credible plan for the implementation of their proposed spent fuel strategy. The plan still has areas that need to be revised or extended on a site specific basis, so:

> ***AF-UKEPR-RW-07****: the licensee shall identify the evidence necessary to underpin their spent fuel storage, transport and disposal strategy, the activities needed to secure this evidence and the time needed for these activities. The provision of this evidence and associated activities will be detailed on a plan that will link the evidence needed with the construction activities for all on site facilities required to manage the spent fuel over its lifetime. This will be complete prior to the pouring of nuclear island safety related concrete.*

> ***AF-UKEPR-RW-08****: the licensee shall produce a plan, with RWMD input, for the work necessary to reduce the on-site storage period for the spent fuel produced by the reactor so that the fuel can be transported as soon as reasonably practical. This will be complete prior to first fuel load.*

> ***AF-UKEPR-RW-10****: the licensee shall produce a safety report for the long-term storage of spent fuel. The report will contain information at least equivalent to that of a Preliminary Safety Case as defined in Guidance on the Purpose, Scope and*

Content of Nuclear Safety Cases, (Ref. 60). The process optimisation will be against the principles set out in:

- *Section 2.4.3, Design Safety Principles, of the Longer Term Spent Fuel ISF. UKEPR-0009-001 Issue 00, July 2009 (Ref. 42); and*
- *Section 3, Design Safety Principles, of the Human Factors in Long Term Waste Management, R10-006(A) Issue 2, February 2010 (Ref. 44).*

It shall also detail the proactive inspection regime for the spent fuel in on-site storage that builds on existing knowledge and experience, allows the spent fuel to be retrieved and inspected within a reasonable time frame and limits the number of fuel assembly lifts. This will be complete prior to first fuel load.

***AF-UKEPR-RW-11**: the licensee shall produce a disposability assessment for the spent fuel produced from the operation of their reactor. This will be complete prior to first fuel load.*

***AF-UKEPR-RW-12**: the licensee shall substantiate why a conceptual stage Letter of Compliance is suitable and sufficient for the start of reactor operations. This will be complete prior to first fuel load.*

388 In addition THE EDF/AREVA response to TQ-EPR-874, (Ref. 41) identifies the possible need for studies to determine whether some long-term storage containers can be directly connected to the current at-reactor spent fuel pool loading pit configuration. Therefore I am requiring:

AF-UKEPR-RW-09: *the licensee shall produce a safety case for the adaptations on the storage containers and/or modifications of the UK EPR at-reactor spent fuel pool pit loading systems for dry storage containers or develop a pre-construction safety report, (Ref. 60) for an additional dry transfer facility for the purpose of spent fuel transfer from the transport container into the long term storage systems. This will be complete prior to the pouring of nuclear island safety related concrete.*

4.9 Overseas Regulatory Interface

389 HSE's Strategy for working with Overseas Regulators is set out in (Ref. 65) and (Ref. 66). In accordance with this strategy, HSE collaborates with Overseas Regulators, both bilaterally and multinationally.

4.9.1 Bilateral Collaboration

390 ND has formal information exchange arrangements to facilitate greater international co-operation with the nuclear safety regulators in a number of key countries with civil nuclear power programmes. These include:

- the US Nuclear Regulatory Commission, (NRC);
- the French L'Autorité de Sûreté Nucléaire, (ASN); and
- the Radiation and Nuclear Safety Authority of Finland, (STUK).

4.9.2 Multilateral Collaboration

391 ND collaborates through the work of the International Atomic Energy Agency (IAEA) and the Organisation for Economic Co-operation and Development-Nuclear Energy Agency (OECD-NEA). ND also represents the UK in the MDEP - a multinational initiative taken by national safety authorities to develop innovative approaches to leverage the resources and knowledge of the national regulatory authorities tasked with the review of new reactor power plant designs. This helps to promote consistent nuclear safety assessment standards among different countries.

392 In the RW&D assessment information has been shared with the following overseas regulators through a series of interface meetings:

- we have looked at different aspects of the long term management of spent fuel with the NRC;
- we have considered the approach to the long term management of wastes with SSM; and
- we have discussed the development of the new reactor at Okiluoto with STUK.

393 In September 2010 I attended a meeting on radiological protection under the auspices of MDEP. The meeting was attended by representatives from the NEA, STUK, NRC, and ASN. I was joined by the Radiological Protection Assessor and the members of the Environment Agency. Radioactive Waste was one of the key aspects of this meeting.

394 The outputs of these interactions have given me the confidence that the issues we are addressing on RW&D in the UK are broadly similar to those in other countries. Whilst the way of dealing with the issues is influenced by the regulatory regime of a country, it is clear that all the Regulators are working towards similar means of resolving the identified RW&D issues.

4.10 Interface with Other Regulators

395 I have worked very closely with the Environment Agency through the whole of the GDA. Future operators of the UK EPR will require a permit from the Environment Agency to make discharges of radioactivity to the environment and dispose of radioactive wastes. Therefore the interests of the Environment Agency are complimentary to my interests on radioactive wastes.

396 This is an efficient and effective approach as there are a number of similar but distinct lines of enquiry. For example the liquid processing treatments will dictate the radioisotopes discharged and those consigned via solid waste processing. With both Regulators working together we are sure that all aspects are covered and that EDF and AREVA is asked one set of questions relative to both disciplines.

397 In this case close working means running joint intervention plans; raising joint Technical Queries, Regulatory Observations and Regulatory Issues; holding joint meetings with EDF and AREVA; undertaking a number of benchmarking visits and reviewing our respective assessments. I have ensured that my TSC's, React Engineering and Babcock Limited, are aware of the Environment Agency's requirements when undertaking their work.

398 My assessment report is laid out to answer a number of questions. An overview of the specific interactions that I have had with the Environment Agency is detailed below.

4.10.1 Have the Wastes That a UK EPR Will Produce Been Identified?

399 EDF and AREVA responded to Environment Agency requests for a BAT assessment (Ref. 30) and an IWS (Ref. 33). I worked closely with the Environment Agency during their interaction with EDF and AREVA to agree these. This process showed that EDF and AREVA had identified all waste streams that a UK EPR will typically produce.

400 Subsequently I obtained assurances from EDF and AREVA that these wastes streams are not affected by any demands arising from decontamination or decommissioning processes (Ref. 54).

4.10.2 Are There Suitable Plans for Conditioning and Storage?

401 The Environment Agency has looked in detail at the management and disposal of LLW. We have agreed that there are no issues with the management of these wastes.

402 I have kept the Environment Agency informed of my assessment of these aspects for other wastes and the associated benchmarking visits that I have undertaken. I have been able to advise the Environment Agency that EDF and AREVA have provided evidence giving confidence that wastes can be maintained in a suitable condition during on-site storage such that they will remain acceptable for disposal.

4.10.3 Are Wastes Disposable?

403 The Environment Agency asked EDF and AREVA to obtain a disposability assessment for the higher activity wastes, i.e. ILW and spent fuel, produced by a UK EPR. I have used the outputs from the disposability assessment to inform my assessment of the conditioning and storage proposals.

404 The Environment Agency has said that the UK EPR is not expected to produce waste for which there is no foreseeable disposal route. I have told the Environment Agency that I judge that a licensee should be able to manage their higher activity wastes in a manner that meets the requirements set out in the disposability assessment.

4.10.4 Can a UK EPR Be Safely Decommissioned?

405 React Engineering Ltd, has undertaken a detailed assessment of the submission on decommissioning made by EDF and AREVA. The contract technical specification with React Engineering Ltd was agreed with the Environment Agency before it was placed and reflects ND’s and the Environment Agency’s interests. React Engineering Ltd produced a final report that has informed my assessment of the EDF and AREVA submission and the Environment Agency’s assessment.

4.10.5 Can a Radioactive Waste Management Case Be Produced for a Uk EPR?

406 I have contracted Babcock Ltd to assess the Radioactive Waste Management Case Mapping Document (Ref. 56) produced by EDF and AREVA. This assessment is against the requirements of the joint regulatory guidance, (Ref. 17). I have provided a copy of the report produced by Babcock Ltd to the Environment Agency to inform their assessment of the Radioactive Waste Management Case Mapping Document.

407 The Environment Agency and I have shared the outputs of our assessment of the document and they support the associated finding, **AF-UKEPR-RW-01**, that we will make.

4.10.6 Is There a Credible Plan for the Waste Management Facilities?

408 EDF and AREVA have produced a consolidated plan for the development of the waste management facilities and the eventual sending of the waste to the disposal site. This plan addresses the Environment Agency's requirements and those of the HSE.

409 In the assessment of the plan I have had a number of meetings with the Environment Agency assessors on how the plan addresses our expectations. Consequently they support the associated finding, **AF-UKEPR-RW-07**, that we will make.

5 CONCLUSIONS

410 This report presents the findings of the Step 4 Radioactive Waste and Decommissioning Assessment of the EDF and AREVA UK EPR reactor.

411 I am satisfied that EDF and AREVA have provided a sufficient level of evidence against each of the questions identified in Section 2.4 for my assessment to be meaningful. The questions were:

- 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?
- Have EDF and AREVA shown that wastes are disposable?
- Can a UK EPR be safely decommissioned?
- Are there suitable proposals for knowledge management?
- Can a Radioactive Waste Management Case be produced for a UK EPR?
- Is there a Credible Plan for the Development of Waste Management Facilities?

412 I have worked with colleagues in ND on the following issues:

- The design of the at-reactor spent fuel pool.
- Material selection.Information on the Source Terms.
- The suitability of the liquid and gaseous waste processing systems.

413 Again I am satisfied that EDF and AREVA have provided a sufficient level of evidence to show there are no significant issues for RW&D in these areas.

414 Using the AMEC report correlating public concerns against specific industrial incidents (Ref. 22) I have reviewed my assessment findings. This has not identified any additional areas that need to be addressed in my assessment.

415 To conclude, I am broadly satisfied with the claims, arguments and evidence laid down within the PCSR and supporting documentation listed in the Submission Master List (Ref. 67) for the RW&D. I consider that from a RW&D view point, the EDF and AREVA UK EPR design is suitable for construction in the UK. However, this conclusion is subject to satisfactory implementation, on a site specific basis, of the proposed plan for the development of waste management facilities (Ref. 58) put forward in GDA. The plan will need to be updated as the GDA Design Reference is supplemented with additional details on a site-by-site basis.

5.1 Key Findings from the Step 4 Assessment

416 The findings from my assessment of the EDF and AREVA proposals for RW&D fall into three broad categories: generic findings; findings for ILW and those for spent fuel.

417 The first generic finding is to produce a RWMC, as set out in the joint regulatory guidance (Ref. 57), for all of the wastes that the reactor will produce.

418 The second generic finding is to review the construction activities to identify any actions that could be taken during construction that would be beneficial to the decommissioning process. This is necessary as EDF and AREVA were only able to show an informal process for incorporating decommissioning into the design, so I am not convinced that simple actions, which could be taken during construction have been considered.

419 The third generic finding is on knowledge management. Successful waste management and decommissioning requires accurate information to be available to the operator and the decommissioning team. This is explicitly recognised in Licence Condition 32 that requires records to be kept of radioactive wastes accumulated on Nuclear Licensed Sites. The finding requires the licensee to develop the necessary systems to achieve this.

420 The Reactor Chemistry Assessors, the Environment Agency and I recognise that the wastes and discharges from the reactor will be a function of the way that the reactor is operated. So the second category includes a finding to optimise the operation of the chemical volume control system and the liquid, gaseous and solid waste management processes to ensure that the risks associated with their operation and the management of the resulting wastes are as low as reasonably practicable.

421 The remaining findings are similar for the ILW and spent fuel categories. The findings are for the continued development of the technical basis for the long term management. This includes the development of the specific facilities for the processing and long term storage of wastes and access to research to show waste remains suitable for continued storage, transport and disposal. As some of these activities will stretch over a number of decades the findings also call for the development of a number of associated plans.

422 I conclude that the detailed Assessment Findings listed in Annex 1 should be programmed during the forward programme of this reactor as normal regulatory business.

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Table 1

Relevant Safety Assessment Principles for Radioactive Waste and Decommissioning Considered During Step 4

SAP No.	SAP Title	Assessed Category *	WENRA **	IAEA ***
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 paras (7) is for Licence Applicants

Table 2

Key Learning Points from Site Visits

Ref.	Description	Key Learning Points
A	A review of spent fuel facilities associated with an operational reactor.	The conditions of acceptance of the disposal facilities drive particular waste management practices at a plant. The plants location (infrastructure, policies, etc.) will influence the approach to waste management.
B	A review of the waste management facilities associated with an operational reactor. This also allowed access to the proposed ILW waste packages.	Flexible processing systems allow the plant to use best practice that is developed over its lifetime. Waste processing and management is simpler if there is a defined end point. A countries waste management infrastructure significantly influences the approach adopted by the plant.
C.	A review of the waste management and spent fuel facilities associated with an operational reactor.	The plants location (infrastructure, policies, etc.) will influence the approach to waste management. Evaporators designed for specific effluent types can be used successfully. They can be operated safely and effectively to reduce the quantity of radioactive waste for disposal. A countries waste management infrastructure significantly influences the approach adopted by the plant. There is a lot of experience of operating spent fuel dry stores with techniques well developed.

Table 2

Key Learning Points from Site Visits

Ref.	Description	Key Learning Points
D	A review of the waste management and spent fuel facilities associated with an operational reactor.	There should be good segregation of liquid waste streams. The discharge tanks should have some contingency. Flexible processing systems allow the plant to use best practice that is developed over its lifetime. Modern waste water reduction and abatement techniques can help reduce fresh water demands. Systems need to take account of realistic fault scenarios. Reducing the number of discharge points makes their management easier. Don't underestimate the complexity of dealing with hydrogen gas streams. Waste containers, their contents and the associated processes need to be shown to produce a product that can be disposed of in the UK. Abatement systems need to reflect progressive discharge reduction. Sampling regimes should be tailored to the time needed for response.
E	A review of the waste management and spent fuel facilities associated with an operational reactor.	The conditions of acceptance of the disposal facilities drive particular waste management practices at a plant. The plants location (infrastructure, policies, etc.) will influence the approach to waste management.
F	A reactor actively being decommissioned	Staged risk reduction based on pre-planned decommissioning stages is a good approach to decommissioning. Early planning for decommissioning will allow the re-use of equipment used in operations and maintenance. Parallel workfaces and cross-over operations allow for prompter decommissioning. Early consideration should be given to waste reduction, decontamination, segregation and recycling. International operational experience feedback should be actively sought when developing decommissioning methodologies.

Table 2

Key Learning Points from Site Visits

Ref.	Description	Key Learning Points
G	A review of the operation of the spent fuel facilities at an operational reactor.	There is a lot of experience of operating spent fuel pools with techniques well developed. The fuel pool can be designed to minimise the lifts of heavy items and the need for large scale decontamination of transfer flasks. Even with innovative designs it is possible to minimise the potential for leaks.
H	A review of PWR training and maintenance facilities.	Robots have been developed and used for repetitive jobs in high dose environments, such as steam generator inspection and maintenance. Plant mock ups aid training and therefore reduce potential doses. Complex fuel handling tasks of long fuel assemblies can be achieved.
I	A review of the radiological protection and waste management facilities associated with an operational reactor and the plans for decommissioning.	It is good practice to have a waste plan, which identifies the disposal route for all wastes. A standard identification system that allows waste to be traced back to its originator and identifies the waste type helps onward processing and records management. A central storage facility for fuel and the use of a ship to transport it can be publicly acceptable. Waste processing and management is simpler if there is a defined end point. A countries waste management infrastructure significantly influences the approach adopted by the plant. A single fixed facility can operate effectively and deal with the waste from a number of reactors. To have confidence in the decommissioning approach the plant needs to be characterised. For example, the operator needs to know the level of contamination in concrete or the background doses. The mapping of the radiological condition of the plant can take significant resource.

Table 2

Key Learning Points from Site Visits

Ref.	Description	Key Learning Points
J	A review of the waste management and spent fuel facilities associated with an operational reactor.	Flexible processing systems allow the plant to use best practice that is developed over its lifetime. The relevant legal requirements drive particular behaviours or practices at a plant, these can change over time. Evaporators designed for specific effluent types can be used successfully. They can be operated safely and effectively to reduce the quantity of radioactive waste for disposal. The minimisation of Stellite^{TM} reduces doses to workers and appears to be practical from an engineering point of view. Drying materials can be achieved with minimal effects on the off-site discharges, but giving a significant reduction in solid volume. There is a lot of experience of operating spent fuel dry stores with techniques well developed. With a suitably shielded design, access into containment can be achieved with minimal dose. Waste management facilities do not need to be in a single complex, it can be successfully implemented on island sites around the plant. Space is needed in the waste management facilities to provide flexibility in dealing with the waste items a plant may produce over its operating life. The amount of space needed in the health physics laboratories needs to be sufficient to provide adequate separation between different activities, processes and samples.
K	A review of waste management and maintenance facilities.	Waste containers, their contents and the associated processes need to be shown to produce a product that can be disposed of in the UK. It is important that the ion exchange resin contains no other objects. Where work is on a campaign basis, with long periods between campaigns, doses can be managed effectively by the use of a dedicated team who work frequently with the equipment on different sites. Contamination traps can be designed out of mobile decontamination machines. Items with high doses that require maintenance can be designed with quick release fixings.

Figure 1: Table 4 Out of the PCSR Chapter 11.3 (Ref. 32)

	Type of waste	Estimated gross annual volume (m3 of raw waste)		Average Density mass activity (GBq/te of raw waste)	Density	Estimated Treatments gross annual activity (GBq)	Treatments	Packaging on NPP before shipment	Number of packages to be shipped to interim storage (>ILW) or to Drigg and WAMAC (LLW)	Volume of initial packages per year (m³)	Types of final packages to be stored or disposed of	Ratios V. package/ V. raw waste	Volume of final packages (m³)	Number of packages to be stored or disposed of per year upper value
Process waste	Ion-exchange resins from the nuclear island	3		500	1	1500	Embedding	Concrete block 2m³	7.5 (30 each 4 years)	15	Concrete block 2m³	5.18	15.5	8
	SGBS ion-exchange resins (without regeneration)	7.5		0.06	1	0.45	Incineration	Plastic drums 0,2 m³	38	7.6	Heavy metallic drums 0,45 m³	0.04	0.3	1
	Wet sludge (sumps, tanks)	0.5		15	1.2	9	Cementation	Concrete block 2m³	2	4	Concrete block 2m³	6.45	3.2	2
		0.5		< 12		<7.2	Cementation	Metallic drums 0,2 m³	8	1.6	1/3 Height Disposal container	5.54	2.8	1
	Water filters from effluent treatment	5	2.5	4800	0.3	3600	Cementation	Concrete block 2m³	6	12	Concrete block 2m³	4.55	11.4	6
			2.45	1650	0.3	1200	Cementation	Concrete block 1,23m³	9	11.1	Concrete block 1.23m³	4.9	12	9
			0.05	< 12	0.3	<0.18	Cementation	Metallic drums 0,2 m³	1	0.2	1/3 Height Disposal container	3	0.2	0
	Evaporator concentrates	3		2.67	1	8	Incineration	Tank on truck 5 m³	1	5	No incinerated residue	0	0	0

Figure 1: Table 4 Out of the PCSR Chapter 11.3 (Ref. 32)

<table>
<tr><th></th><th>Type of waste</th><th colspan="2">Estimated gross annual volume (m3 of raw waste)</th><th>Average Density mass activity (GBq/te of raw waste)</th><th>Density</th><th>Estimated Treatments gross annual activity (GBq)</th><th>Treatments</th><th>Packaging on NPP before shipment</th><th>Number of packages to be shipped to interim storage (>ILW) or to Drigg and WAMAC (LLW)</th><th>Volume of initial packages per year (m^3)</th><th>Types of final packages to be stored or disposed of</th><th>Ratios V. package/ V. raw waste</th><th>Volume of final packages (m^3)</th><th>Number of packages to be stored or disposed of per year upper value</th></tr>
<tr><td></td><td>Non compactable : air and water filters (85%/15%)</td><td colspan="2">4</td><td>0.64</td><td>0.4</td><td>1</td><td>Dismantling</td><td>Metallic drums 0,2 m^3</td><td>20</td><td>4</td><td>1/3 Height Disposal container</td><td>1.38</td><td>5.5</td><td>1</td></tr>
<tr><td rowspan="6">Operational waste</td><td rowspan="2">Pre compacted operational waste (plastics, clothes, small items…)</td><td rowspan="2">50</td><td>12.5</td><td rowspan="2">0.62</td><td rowspan="2">0.4</td><td rowspan="2">12.4</td><td>Pre compaction on site</td><td>Metallic drums 0,2 m^3</td><td>63</td><td>12.6</td><td>WAMAC disposal container</td><td>0.91</td><td>11.4</td><td>1</td></tr>
<tr><td>37.5</td><td>Incineration</td><td>Plastic drums 0,2 m^3</td><td>188</td><td>37.5</td><td>Heavy metallic drums 0.45 m^3</td><td>0.1</td><td>3.8</td><td>9</td></tr>
<tr><td>Oils</td><td colspan="2">2</td><td>0.003</td><td>0.9</td><td>0.005</td><td>Incineration</td><td>Tank on truck 5 m^3</td><td>1</td><td>5</td><td>No incinerated residue</td><td>0</td><td>0</td><td>0</td></tr>
<tr><td>Scraps</td><td colspan="2">6</td><td>4.64</td><td>0.5</td><td>14</td><td>Melting</td><td>Metallic boxes 1 m^3</td><td>6</td><td>6</td><td>Ingots 0.2 m^3</td><td>0.08</td><td>0.5</td><td>3</td></tr>
<tr><td rowspan="2">Operational waste</td><td colspan="2">0.9</td><td>153</td><td>0.4</td><td>55</td><td>Cementation</td><td>Concrete block 2m^3</td><td>3</td><td>6</td><td>Concrete block 2m^3</td><td>4.55</td><td>4.1</td><td>3</td></tr>
<tr><td colspan="2">0.1</td><td>< 12</td><td>0.4</td><td><0.48</td><td>Incineration</td><td>Metallic drums 0,2 m^3</td><td>1</td><td>0.2</td><td>Heavy metallic drums 0.45 m^3</td><td>0.1</td><td>0</td><td>1</td></tr>
<tr><td colspan="2">Total</td><td colspan="2">82.5 m^3</td><td></td><td></td><td>6.4 TBq</td><td></td><td></td><td></td><td>128 m^3</td><td></td><td>Total</td><td>71 m^3</td><td>45</td></tr>
</table>

Figure 2: EDF and AREVA Radioactive Waste Stream Flow Diagram

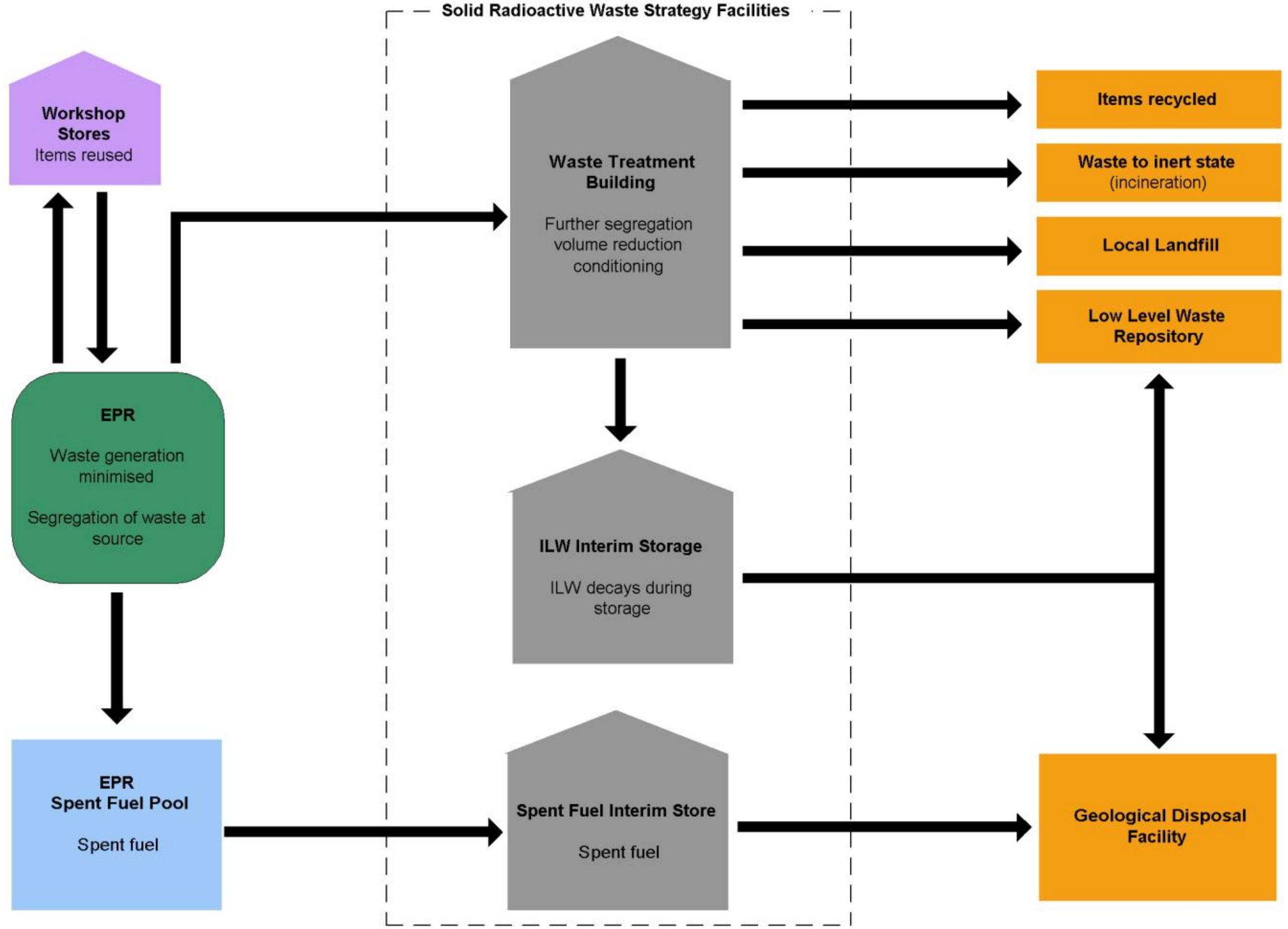
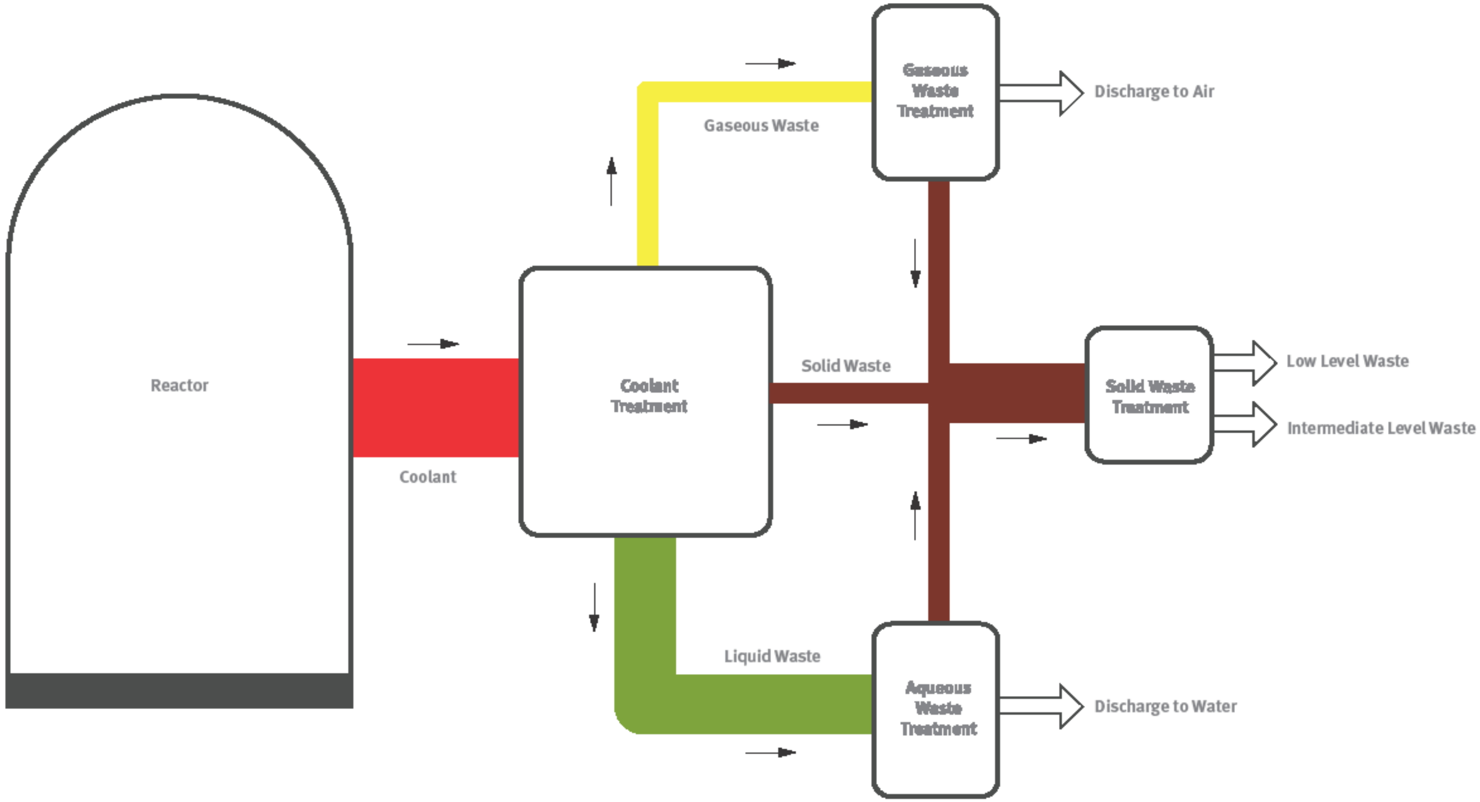


Figure 3: Simplified Flow Diagram of the Liquid and Gaseous Waste Routes



Annex 1

Assessment Findings to be Addressed During the Forward Programme as Normal Regulatory Business

Radioactive Waste and Decommissioning – UK EPR

Finding No.	Assessment Finding	MILESTONE (by which this item should be addressed)
AF-UKEPR-RW-01	The licensee shall produce a site specific Radioactive Waste Management Case for all of the wastes that their UK EPR will produce.	The site specific Radioactive Waste Management Case will be submitted to the regulators prior to milestone 3, nuclear island safety related concrete.
AF-UKEPR-RW-02	The licensee shall review the construction activities to identify any actions that could be taken during construction that would be beneficial to the decommissioning process.	A copy of the written review will be submitted to the regulators prior to milestone 3, nuclear island safety related concrete.
AF-UKEPR-RW-03	The licensee to implement a records management procedure for waste management and decommissioning that incorporates the principles established in the AREVA report on the Management of Records (Ref. 55) and UKEPR-0016-001 (Ref. 54).	A copy of the procedure will be submitted to the regulators prior to milestone 3, nuclear island safety related concrete.
AF-UKEPR-RW-04	The licensee shall optimise the operation of the chemical volume control system and the liquid, gaseous and solid waste management processes to ensure that the risks associated with their operation and the management of the resulting wastes are as low as reasonably practicable.	A copy of the report on the optimisation process and outcomes will be submitted to the regulators prior to milestone 13, fuel load.
AF-UKEPR-RW-05	The licensee shall identify the evidence necessary to underpin their ILW storage and disposal strategy, the activities needed to secure this evidence and the time needed for these activities. The provision of this evidence and associated activities will be detailed on a plan that will link the evidence needed with the construction activities for all on site facilities required to manage the ILW over its lifetime.	The plan will be submitted to the regulators prior to milestone 10, cold operations.
AF-UKEPR-RW-06	The licensee shall produce a safety report for the processing and long-term storage of the ILW. The report will contain information equivalent to that of a Preliminary Safety Case as defined in Guidance on the Purpose, Scope and Content of Nuclear Safety Cases, (Ref. 60).	The safety report will be submitted to the regulators prior to milestone 3, nuclear island safety related concrete.

Annex 1

Assessment Findings to be Addressed During the Forward Programme as Normal Regulatory Business

Radioactive Waste and Decommissioning – UK EPR

Finding No.	Assessment Finding	MILESTONE (by which this item should be addressed)
AF-UKEPR-RW-07	The licensee shall identify the evidence necessary to underpin their spent fuel storage, transport and disposal strategy, the activities needed to secure this evidence and the time needed for these activities. The provision of this evidence and associated activities will be detailed on a plan that will link the evidence needed with the construction activities for all on site facilities required to manage the spent fuel over its lifetime.	The plan will be submitted to the regulators prior to milestone 3, nuclear island safety related concrete.
AF-UKEPR-RW-08	The licensee shall produce a plan, with RWMD input, for the work necessary to reduce the on-site storage period for the spent fuel produced by the reactor so that the fuel can be transported as soon as reasonably practical.	The plan will be submitted to the regulators prior to milestone 13, fuel load.
AF-UKEPR-RW-09	The licensee shall produce a safety case for the adaptations on the storage containers and/or modifications of the UK EPR at-reactor spent fuel pool pit loading systems for dry storage containers <u>or</u> develop a pre-construction safety report, (Ref. 60) for an additional dry transfer facility for the purpose of spent fuel transfer from the transport container into the long term storage systems.	The safety case will be submitted to the regulators prior to milestone 3, nuclear island safety related concrete.
AF-UKEPR-RW-10	The licensee shall produce a safety report for the long-term storage of spent fuel. The report will contain information at least equivalent to that of a Preliminary Safety Case as defined in Guidance on the Purpose, Scope and Content of Nuclear Safety Cases, (Ref. 60). The process optimisation will be against the principles set out in: section 2.4.3, Design Safety Principles, of the Longer Term Spent Fuel ISF. UKEPR-0009-001 Issue 00, July 2009 (Ref. 42); and section 3, Design Safety Principles, of the Human Factors in Long Term Waste Management, R10-006(A) Issue 2, February 2010 (Ref. 44). It shall also detail the proactive inspection regime for the spent fuel in on-site storage that builds on existing knowledge and experience, allows the spent fuel to be retrieved and inspected within a reasonable time frame and limits the number of fuel assembly lifts.	The safety report will be submitted to the regulators prior to milestone 13, fuel load.

Annex 1

Assessment Findings to be Addressed During the Forward Programme as Normal Regulatory Business

Radioactive Waste and Decommissioning – UK EPR

Finding No.	Assessment Finding	MILESTONE (by which this item should be addressed)
AF-UKEPR-RW-11	The licensee shall produce a disposability assessment for the spent fuel produced from the operation of their reactor.	The disposability assessment will be submitted to the regulators prior to milestone 13, fuel load.
AF-UKEPR-RW-12	The licensee shall substantiate why a conceptual stage Letter of Compliance is suitable and sufficient for the start of reactor operations.	The written substantiation will be submitted to the regulators prior to milestone 13, fuel load.

Note: It is the responsibility of the Licensees / Operators to have adequate arrangements to address the Assessment Findings. Future Licensees / Operators can adopt alternative means to those indicated in the findings which give an equivalent level of safety.

For Assessment Findings relevant to the operational phase of the reactor, the Licensees / Operators must adequately address the findings during the operational phase. For other Assessment Findings, it is the regulators' expectation that the findings are adequately addressed no later than the milestones indicated above.

Annex 2

GDA Issues – Radioactive Waste and Decommissioning – UK EPR

There are no GDA Issues for this topic area.