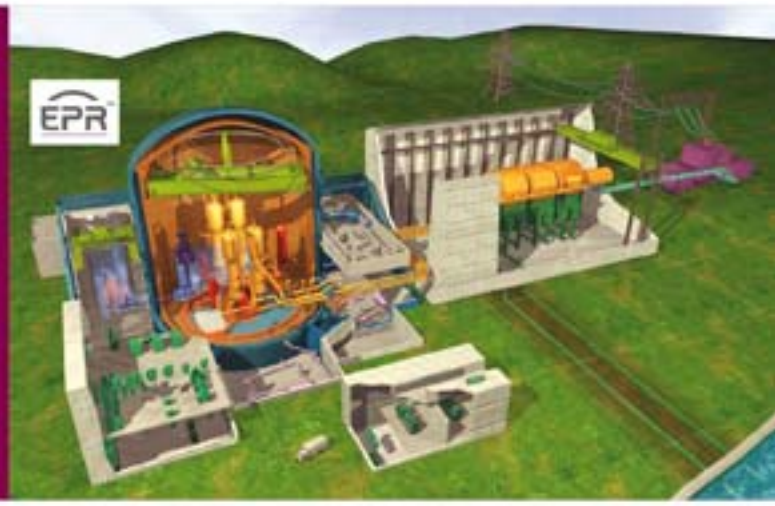
Generic design assessment
UK EPR nuclear power plant design by AREVA NP SAS and Electricité de France SA

Assessment report
Spent fuel



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Published by:

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GEHO0510BSJT-E-E

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UK EPR nuclear power plant design by AREVA NP SAS and Electricité de France SA

Assessment report – Spent fuel

Protective status	This document contains no sensitive nuclear information or commercially confidential information.
Process and Information Document (Environment Agency, 2007)	The following sections of Table 1 in our Process and Information document are relevant to this assessment: Section 1.4 A proposed **waste and spent fuel strategy** based on the expected waste generation and management practices throughout the facility lifecycle Section 2.5 A description of **how spent fuel will be managed** and the quantities that will arise throughout the facility's lifecycle
Radioactive Substances Regulation Environmental Principles (Environment Agency, 2010)	The following principles are relevant to this assessment: RSMDP1 – Radioactive Substances Strategy: A strategy should be produced for the management of all radioactive substances RSMDP3 – Use of BAT to minimise waste: The best available techniques should be used to ensure that production of radioactive waste is prevented and where that is not practicable minimised with regard to activity and quantity. RSMDP10 – Storage: Radioactive substances should be stored using the best available techniques so that their environmental risk and environmental impact are minimised and that subsequent management, including disposal is facilitated. RSMDP14 – Record Keeping: Sufficient records relating to radioactive substances and associated facilities should be made and managed so as: to facilitate the subsequent management of those substances and facilities; to demonstrate whether compliance with requirements and standards has been achieved; and to provide continuing assurance about the environmental impact and risks of the operations undertaken, including waste disposal. RSMDP15 – Requirements and conditions that properly protect people and the environment shall be set out and imposed for disposal of radioactive waste. Disposal of radioactive waste shall comply with imposed requirements and conditions.
Report author	Dr Colette Grundy

Table of contents

1 Summary

1 This report presents the findings of our assessment of the proposals made by EDF and AREVA for spent fuel management based on information submitted in their Pre-Construction Environmental Report (PCER) and supporting documents.

2 The Joint Regulators for GDA, the HSE and the Environment Agency, have worked together closely to review EDF and AREVA's spent fuel management proposals in GDA. HSE are responsible for regulation of storage of spent fuel and the Environment Agency regulate disposals. Our assessment has involved review of EDF and AREVA's GDA submissions and, in particular their Integrated Waste Strategy (IWS), BAT Demonstration report, Solid Radioactive Waste Strategy Report (SRWSR), their mapping document for the Radioactive Waste Management Case, and the NDA RWMD Disposability Assessments, including an EDF and AREVA Critique of the NDA RWMD findings.

3 This assessment aims to establish that EDF and AREVA have an adequate strategy for spent fuel management, and that spent fuel will be managed so that it will be suitable for disposal at a geological disposal facility.

4 We have examined EDF and AREVA's GDA submissions, and found that they give consideration to operating strategies in regard to spent fuel generation. The strategy proposed by EDF and AREVA for managing spent fuel following its removal from the reactor, is to transfer the spent fuel to the spent fuel pool for storage and initial cooling for a period of around 10 years. The fuel is then proposed to be transferred to an interim storage facility (PCER sc6.2s3.4.2) until such time a geological disposal facility becomes available for direct disposal. EDF and AREVA have provided supporting information on longer term storage.

5 We conclude that in their submission, EDF and AREVA describe how spent fuel will arise, be managed and disposed of throughout the facility's lifecycle. EDF and AREVA provide information on the fuel composition and characteristics, and expected fuel burn up, and quantities of spent fuel that will arise. Information is provided in the submission and supporting documents on short and long-term management proposals for spent fuel. EDF and AREVA have obtained a view from the RWMD of the NDA on the disposability of the fuel and have provided their critique to the Regulators.

6 EDF and AREVA provided detailed responses in regard to storage and disposability in February and March 2010. Their response on disposability was considered in our assessment report on disposability of spent fuel.

7 We need more information on the longer term storage of the fuel to understand whether there is any potential for degradation of the fuel over the longer term that might affect its disposability. This is consistent with the HSE requirement for a satisfactory demonstration that spent fuel can be stored safely for the necessary period of time without significant degradation. This information has been provided as noted above. HSE is reviewing this information in its Step 4 assessment. We will continue to work with HSE on these matters, and this work will inform our decision document. Therefore, our conclusion is subject to the potential GDA Issue:

a) Disposability of spent fuel following longer term interim storage pending disposal.

8 Our findings on the wider environmental impacts and waste management arrangements for the UK EPR reactor may be found in our Consultation Document (Environment Agency, 2010a).

2 Introduction

9 We set out in our Process and Information Document (P&ID) the requirements for a Requesting Party to provide a proposed **waste and spent fuel strategy** based on the expected waste generation and management practices throughout the facility lifecycle. This strategy should have regard to:

a) the UK Government's Sustainable Development Strategy (March 2005) Cm 6467;

b) the objectives of the UK strategy for radioactive discharges (DECC, 2009b);

c) the Review of Radioactive Waste Management Policy, Final Conclusions, Cm2919 July 1995 (DETR, 1995);

d) The Decommissioning of the UK Nuclear Industry's Facilities (decommissioning policy) (DTI, 2004); and

e) our Radioactive Substances Regulation Environmental Principles (REPs) (Environment Agency, 2010c).

10 Our P&ID also requires a description of **how spent fuel will be managed** and the quantities that will arise throughout the facility's lifecycle. This should include:

a) new fuel composition and characteristics;

b) expected fuel burn up and ratings;

c) short and long term management proposals including any for off site management or disposal.

11 If the management options include direct disposal, the requesting party should obtain, and provide, a view from the Nuclear Decommissioning Authority (NDA) (as the UK authoritative source in providing such advice) on the disposability of the spent fuel.

12 We published our Radioactive Substances Regulation Environmental Principles in 2010 and principles on radioactive substance strategy, use of BAT to minimise waste, storage, record keeping and requirements and conditions that properly protect people and the environment are relevant to this topic.

13 This assessment aims to establish that EDF and AREVA have an adequate strategy for spent fuel management, and that spent fuel will be managed so that it will be suitable for disposal at a geological disposal facility. This assessment considers in detail EDF and AREVA's proposals for spent fuel management.

14 The Joint Regulators have worked closely to review EDF and AREVA's proposals for spent fuel management in GDA. Our assessment is performed on a sampling basis and has involved review of EDF and AREVA's GDA submissions including the PCER and key supporting documents namely the Integrated Waste Strategy (IWS), BAT Demonstration report, Solid Radioactive Waste Strategy Report (SRWSR), and the Radioactive Waste Management Case (RWMC, see HSE et al, 2010) mapping report.

15 We assessed information contained in the PCER but found that while much improved from the original submission it still lacked the detail we require including an integrated waste strategy for waste and spent fuel, and detailed proposals for spent fuel management. We raised Regulatory Observations (ROs), some jointly with HSE and some were raised directly by HSE with relevance to this assessment report, on EDF and AREVA that had actions to provide:

a) Integrated Waste Strategy, BAT case and evidence to support a Radioactive Waste Management Case (RO-UKEPR-33);

b) Long Term Storage (RO-UKEPR-39) (HSE);

c) Disposability of Spent Fuel and ILW (RO-UKEPR-48);

16 We raised 31 Technical Queries (TQs) on EDF and AREVA during our assessment. The following TQs, some of which were raised jointly with HSE or directly by HSE, were relevant to this report:

a) TQ-EPR-123 Information on the longer term used fuel storage facility (HSE)

b) TQ-EPR-149 EPR Environment Design Review and Environment Committee

c) TQ-EPR-182 Fuel management regime and proposed liquid and gaseous radioactive waste discharges

d) TQ-EPR-222 EPR Intermediate Level Waste

e) TQ-EPR-231 Discharge of Actinides

f) TQ-EPR-467 Encapsulation of spent fuel prior to disposal (HSE)

g) TQ-EPR-569 Long-term pond storage of spent fuel (HSE)

17 EDF and AREVA responded to all the ROs and TQs. They reviewed and updated the PCER in March 2010 to include relevant information provided by their response to the ROs and TQs.

3 Assessment

3.1 Assessment Methodology

18 The basis of our assessment was to:

a) review appropriate sections of the PCER and its supporting documents including the Integrated Waste Strategy (IWS), BAT Demonstration report, Solid Radioactive Waste Strategy Report (SRWSR), Radioactive Waste Management Case (RWMC) mapping document;

b) hold technical meetings with EDF and AREVA to clarify our understanding of the information presented and explain any concerns we had with that information;

c) raise Regulatory Observations and Technical Queries where we believed information provided by EDF and AREVA was insufficient;

d) decide on any GDA Issues or other issues to carry forward from GDA.

19 Our overall GDA process, including definitions of GDA Issues and other issues is set out in Chapters 3 and 5 of our UK EPR GDA Consultation Document.

3.2 Assessment Objectives

20 We started our assessment with some key questions to answer:

a) Do EDF and AREVA provide an adequate integrated waste and spent fuel strategy?

b) Do EDF and AREVA provide information on new fuel composition and characteristics, and proposed fuel burn up?

c) Do EDF and AREVA provide information on spent fuel quantities and give consideration to operating strategies in regard to spent fuel generation?

d) Do EDF and AREVA provide information on the short and long term management proposals for spent fuel?

e) Are the spent fuel arisings from a UK EPR disposable?

21 We expect new nuclear power plant designs to be developed in line with a radioactive waste and spent fuel strategy that seeks to:

a) minimise the production of radioactive waste;

b) manage unavoidable waste and spent fuel to achieve an optimal level of protection for people and the environment.

22 Our radioactive substances regulation environmental principles (REPs) (Environment Agency, 2010) set out the issues that this type of strategy should take into account. For new nuclear power plant designs, the strategy also needs to be consistent with recent government statements (BERR, 2008) that:

a) the disposal of intermediate level radioactive waste (ILW) to a future geological repository, from any new nuclear power stations, is unlikely to occur until late this century;

b) any nuclear power stations that might be built in the UK should proceed on the basis that spent fuel will not be reprocessed.

23 There are currently no final disposal facilities for spent fuel in the UK. However, the Government has stated (BERR, 2008) that it is satisfied that:

a) a geological disposal facility would provide a possible and desirable mechanism for disposing of higher level wastes (both from a new nuclear programme and existing legacy waste);

b) there are feasible and long-term mechanisms through the MRWS (Defra et al 2008) programme for identifying a suitable site and for constructing a geological disposal facility.

24 Although a permit for final disposal may not be required for a considerable time, we expect EDF and AREVA to show now whether spent fuel:

a) is likely to be suitable for disposal in a geological repository;

b) will be appropriately managed in the interim, so as not to prejudice their ultimate disposal.

25 We expect spent fuel storage to be required for around 100 years until a geological disposal facility is available. The Regulators need to see that spent fuel can be safely stored and managed to avoid degradation over time such that it can remain in a form acceptable for transport to, and disposal in, a repository.

3.3 EDF and AREVA documentation

26 We referred to the following documents to produce this report:

Document reference	Title	Version number
UKEPR-0003-62	PCER Sub-Chapter 6.2- Details of the effluent management process, Section 3 Solid Radioactive Waste and Spent Nuclear Fuel Strategy	03
NDA TN 11261814	GDA: Summary of Disposability Assessment for Wastes and Spent Fuel arising from Operation of the UK EPR	Oct 09
NXA/10747397	GDA: Disposability Assessment of Wastes and Spent Fuel arising from Operation of the UK EPR Part 1 Main Report	Jan 10
NXA/10777960	GDA: Disposability Assessment of Wastes and Spent Fuel arising from Operation of the UK EPR Part 2 Data Sheets and Inventory Tables	Jan 10
UKEPR-0010-001	GDA UK EPR – Integrated Waste Strategy Document	02
ELI0800224	Interim storage facility for spent fuel assemblies coming from an EPR plant	A
NESH-G/2008/en/0123	Solid Radioactive Waste Strategy Report (SRWSR)	A
UKEPR-0009-001	Longer Term Spent Fuel Interim Storage Facility	1
UKEPR-0011-001	GDA UK EPR BAT Demonstration	03
UKEPR-0012-001	GDA UK EPR Mapping Document for Radioactive Waste Management Case	01

27 We use short references in this report, for example:

a) ER sub-chapter 6.2 section 1.2.1 = PCERsc6.2s1.2.1.

3.4 Waste and Spent Fuel Strategy

28 EDF and AREVA's integrated waste strategy (IWS) was produced in response to RO-UKEPR-33. The IWS includes the management of both radioactive and non-radioactive wastes arising from construction, operation and decommissioning of the UK EPR. EDF and AREVA claim there is a management strategy for all the waste streams produced by the UK EPR, and that they have been suitably planned for. EDF and AREVA claim that the IWS demonstrates the minimisation of waste via implementation of the waste hierarchy and application of best available techniques (BAT).

29 The IWS states there is a spent fuel interim store to store all spent fuel assemblies generated by the reactor for about 100 years before final disposal. The design of the store will provide adequate space and handling for safe operation, and monitoring of the condition of the spent fuel. The store is designed to be maintained or replaced to last for at least 100 years from when spent fuel is first emplaced in the store.

30 Interim storage may be required potentially beyond 100 years to cover the lifetime of reactor operations (including the final emplacement of fuel to interim storage, following an initial cooling period in a pond after reactor operations cease), the time to reduce the heat generation of the fuel, and the potential for refurbishment of the store(s).

31 The regulators requested further information about long-term storage initially in TQ-EPR-123, and subsequently in RO-UKEPR-39, see later in this report. EDF and AREVA provided a detailed response report to TQ-EPR-123 which provided information on fuel integrity during storage for both wet and dry storage options.

32 EDF and AREVA provided detailed response information in regard to RO–UKEPR-39 in February and March 2010 which was too late for us to consider in our public consultation document, and herein. HSE is reviewing this information in its Step 4 assessment. We will review this information, and continue to liaise with HSE on this, and this work will inform our decision document.

33 EDF and AREVA take account of Government policy in their IWS, noting that spent fuel will be declared as waste and will not be reprocessed, and that spent fuel will be stored on site and then disposed of to the geological disposal facility. The IWS indicates that the UK EPR design allows for spent fuel to be stored in an on site fuel store designed to accommodate the lifetime arisings of spent fuel from the nuclear power station. PCERsc6.2s3.4.2 notes one or more options for spent fuel storage, including an on site interim storage facility and or construction and operation of an interim spent fuel storage facility shared between several sites.

34 EDF and AREVA provided information on the measures incorporated in the design and the use of fuel materials, and reactor controls in order to retain activity in the fuel.

35 EDF and AREVA produced a mapping document in response to RO-UKEPR-33 to demonstrate how they could meet regulatory expectations, and identified the information required to produce the RWMC for spent fuel. The RWMC demonstrates the longer term safety and environmental performance of waste for the planned management from generation to conditioning to a form which will be suitable for storage and eventual disposal. The mapping document identifies the existing documents that form the basis of the RWMC, states the RWMC requirements and identifies where relevant information is provided in the submission and related documents, and provides a justification that the information meets the requirement. It covers spent fuel generated throughout the reactor lifecycle from operation, maintenance, and decommissioning stages.

36 EDF and AREVA present a 'reference case' solid radioactive waste and spent fuel strategy based on the waste and spent fuel management practices and arrangements of the reference plant for the UK EPR, Flamanville 3. This is supported by a BAT analysis in PCERsc8. EDF and AREVA recognise that UK EPR operators may wish to adopt alternative spent fuel arrangements. Other possible options to the reference

case for spent fuel strategy are presented in a solid radioactive waste strategy report (SRWSR). However, the SRWSR does not present respective BAT arguments. EDF and AREVA claim there is a high degree of confidence that such cases can be made by potential EPR operators.

37 Five interim storage solutions are identified in the solid radioactive waste strategy report, SRWSR, including underwater long-term pool storage and four types of dry storage. Wet storage is usual practice in nuclear power plants and is used for initial cooling, and subsequently may be used for interim storage, before final disposal. Dry interim storage for spent fuel is used in Europe and the USA.

38 Of the five options, one wet pool storage, and two dry storage solutions were identified and assessed in more detail for the UK EPR. EDF and AREVA considered the regulatory requirements for interim storage facilities and in particular Environment Agency requirements in relation to BAT and our radioactive substances environmental principles (REPs).

39 EDF and AREVA considered three spent fuel storage technologies, based on available and proven technologies:

a) wet interim pool storage - fuel assemblies stored in a pool;

b) dry interim cask storage - fuel assemblies stored in metal casks;

c) dry interim storage in purpose designed stores - fuel assemblies stored in vault type storage.

40 The dry interim storage facility uses metallic storage flasks technology, the TN DUO flask which is designed for both transport and storage. Information is provided on the building layout and safety features in the SRWSR. The storage facility is designed to operate for 100 years. Visual surveillance is carried out as part of a maintenance programme for flasks in the interim storage facility. A permanent check system is implemented which monitors any pressure drop in the interspace between the primary and secondary lid of the TN-DUO flask.

41 The dry storage vault involves placing fuel assemblies into canisters when they are received. The stainless steel canisters contain aluminium partitions to house fuel assemblies and ensure heat dissipation. Details are provided on the building layout and safety features.

42 These designs allow for retrieval and inspection of the fuel, and for refurbishment. Further information on wet interim storage is provided later in this report.

43 The IWS is consistent with recent government statements (BERR, 2008) as EDF and AREVA have made the following assumptions:

a) Spent fuel will be declared as waste and will not be reprocessed.

b) Spent fuel will be stored on site followed by disposal to a geological disposal facility (GDF) at the appropriate time.

44 **We have concluded that:**

a) **EDF and AREVA have provided a reasonable strategy for managing spent fuel that will be produced by the UK EPR.**

b) **The spent fuel strategy is consistent with recent government statements (BERR, 2008), and our REPs (Environment Agency, 2010).**

45 **The radioactive waste strategy is a 'reference case' based on the waste and spent fuel management practices and arrangements of the reference plant for the UK EPR, Flamanville 3. The reference case is reasonable, however our conclusion is subject to the following condition:**

a) **The changes to the 'reference case' for the site-specific strategy and evidence that the site-specific strategy achieves the same objectives shall be provided at site-specific permitting.**

3.5 BAT for Fuel Design

46 The BAT Demonstration report was prepared by EDF and AREVA to provide evidence that best available techniques have been used to prevent, and where that is not practicable to minimise the production of radioactive waste at source in the EPR design.

47 Carbon-14 is produced by the neutron activation of nitrogen-14 and oxygen-17. The two main sources of nitrogen and oxygen are the coolant and the fuel.

48 Zircaloy cladding of fuels is the dominant source of carbon-14 and contains 40-50% of its total. This type of fuel cladding is used in all light water reactors. The production of carbon-14 in fuel is mainly caused by nitrogen impurities in the fuel. This carbon-14 is confined in the fuel cladding and is removed from the reactor with the fuel.

49 Carbon-14 from fuel would only usually be discharged during major fuel cladding failure. Increased discharge in fission products such as caesium-137 and noble gases such as krypton and xenon would indicate a problem with fuel cladding. Also the liquid discharge monitoring of carbon-14 would indicate any increase in discharge of carbon-14 into the primary coolant.

50 Tritium may also be produced from fuel as a result of ternary fission reactions. Evidence is that only a small amount is released through the fuel cladding. The Zircaloy cladding provides an effective barrier in preventing the release of tritium such that releases from the fuel are very low compared to other sources. Production of tritium from helium used to pressurise the fuel rods is a small source and less significant than from the fission process.

51 Further information on radionuclide production mechanisms is available in both our Environment Agency GDA Assessment Report UK EPR-03 on 'creation', and Annex 4 of the UK EPR GDA Consultation Document.

3.6 Creation of spent fuel

52 The UK EPR reactor core comprises 241 fuel assemblies that contain bundles of fuel rods held in place by space grips and top and bottom fittings. The fuel assembly is a 17x17 square array comprising 265 fuel rods and 24 guide thimbles. The thimbles are joined to the grids and the top and bottom nozzles. The thimbles may also hold rod cluster control assembles (RCCAs) which are used to control the reactivity of the core and power distribution, and for reactor shutdown, and neutron source rods, or in core instrumentation. The fuel is in the form of uranium dioxide (UO_2) pellets that are stacked in a zirconium alloy cladding tube to form fuel rods. Some fuel assemblies also include a neutron poison, gadolinium oxide, which is mixed with the fuel and depletes slowly with burn up. EDF and AREVA claim it is also possible to use mixed oxide (MOX) fuel pellets in the EPR but this is not proposed for the UK EPR in GDA.

53 The initial enrichment of new fuel is up to 5 per cent in weight uranium-235 in order to sustain the nuclear fission reaction. The UK EPR is designed for an operational life of 60 years during which time the operational reactor will contain around 127 tonnes of enriched uranium fuel. Reactor refuelling takes place at the end of each reactor fuel cycle. The UK EPR fuel cycle lasts from 12-22 months depending on the fuel management regime adopted by the future operator. At the end of the fuel cycle, approximately one third of the 241 fuel assemblies are replaced by new fuel assemblies. The isotopic composition of the spent fuel depends on the initial enrichment, the uranium source and the fuel management conditions in the reactor.

The average core region fuel burn up is less than 65,000 MWd/tU, which is the maximum burn up proposed.

54 The Regulators requested further information from EDF and AREVA in TQ-EPR-182 on the fuel management regime since this might impact on the radionuclide fingerprint and activity for liquid and gaseous discharges. EDF and AREVA's response confirmed that the fuel management regime will be dependent on the operator. PCSRsc3.1 indicates the possibility for different fuel management techniques has been left open to allow flexibility for the future operator. The information EDF and AREVA provided suggests that benchmark regimes are based on a uranium oxide core with a cycle of 12, 18 or 22 months. The type of fuel management regime impacts mainly on tritium production through boron concentration, but the differences between the tritium produced for the various fuel management conditions are said to be small. EDF and AREVA claim that the maximum discharges presented in the GDA submission will be applicable for benchmark fuel management regimes that may be implemented by the operator.

55 Both new fuel and spent fuel are stored on the reactor site in the fuel building. PCERsc1.2 describes the fuel building, which includes the spent fuel pool, the loading pit for casks, the transfer station, and storage and inspection compartments for new fuel assemblies. It also includes filtration units to filter air escaping in accident conditions and ventilation systems. The roof of the fuel building supports the evacuation stack for discharge of gaseous effluent from the nuclear auxiliary building.

3.7 Management and Disposal of Spent Fuel

56 In PCERsc6.2, EDF and AREVA provide information on radioactive waste and spent fuel produced by the UK EPR. A fuel assembly is spent and must be discharged after producing energy in the reactor for a period of 3 to 5.5 years depending on the fuel cycle adopted by the operator. The fuel assembly is then transferred from the reactor building to the fuel building through the containment penetration formed by the fuel transfer tube. The UK EPR spent fuel reactor pool and transfer facility are described in PCSR chapter 9.1. Decay heat generated from the irradiated fuel assemblies is removed by the fuel pool cooling system.

57 Spent fuel assemblies are discharged from the reactor and placed into the spent fuel pool to cool and decay for a period of approximately 10 years before being moved to an interim storage facility. The UK EPR design allows a storage capacity in the fuel pool for 10 years electricity generation.

58 The quantities of spent fuel discharged from the reactor during refuelling can be up to 80 spent fuel assemblies each refuelling operation. A bounding value for the total number of spent fuel assemblies produced at the end of reactor life is set to 3400 units.

59 Core components used to control or measure neutron activity such as rod cluster control assemblies (RCCAs) and in core instrumentation (aeroball finger tubes) may be replaced during outages. The components are highly activated when they are removed from the reactor (because of their exposure to neutron radiation in the reactor core) and are transferred to the spent fuel pool where they are left to radiologically decay.

60 One wet pool storage, and two dry storage solutions were identified and assessed in detail for the UK EPR, based on available and proven technologies. More information on the options is presented in an earlier section on strategy.

61 PCERsc6.5s4.1 describes the arrangements for interim storage for spent fuel. An interim wet storage facility is described with supporting review information in a report (ELI0800224).

62 The interim wet storage pool facility is designed to be in operation to safely and securely store the spent fuel underwater for up to 100 years. A UK EPR will generate approximately 3400 assemblies that will require storage during its 60 year operating life. The lifetime of the store is about 100 years with stated objectives to maintain shielding, preserve the fuel cladding, minimise contamination, cool the fuel, maintain the sub-criticality, and to protect the fuel assemblies from mechanical damage.

63 The review report of interim wet storage (ELI0800224) is based on more than 30 years experience from EDF in underwater storage of spent fuel. The review also considers international design and operating experience for interim storage facilities in Sweden, Finland, UK (Sellafield Site) and Russian Federation Facilities. EDF and AREVA conclude that long term pool storage of fuel has been successfully used at a large number of sites without significant degradation of the cladding.

64 DECC considered UK and international experience of managing higher activity waste in developing their preliminary conclusions on new build waste. A range of evidence on the arrangements for the management and disposal of the waste from new nuclear power stations was reviewed and summarised in a paper published by DECC. For example, for interim storage of spent fuel, evidence was reviewed from OECD Nuclear Energy Agency (NEA), and the US Nuclear Regulatory Commission (NRC). NRC evidence indicates that spent fuel can be stored safely and securely without significant environmental impact for at least 100 years. Evidence from OECD member countries is that spent fuel has been safely and securely stored for several decades and such storage may continue for many more decades with proper control and supervision, as well as repackaging of some wastes and periodic refurbishment of stores. The NEA also noted that stores of modern design have typically been licensed for periods of decades. The DECC paper also noted that considerable international experience exists for dry fuel stores that give confidence that similar stores can be constructed and licensed for operation in the UK.

65 The SRWSR indicates that the design of the wet storage facility for UK EPR spent fuel is based on the last generation of La Hague complex storage pools, and detailed information is presented in the interim wet storage report on the arrangements for receipt of transport containers, handling and loading of fuel assemblies, cooling of the fuel pool, together with details of the building layout, safety and other relevant features.

66 The interim wet storage facility will be able to receive and store defective fuel assemblies associated with cladding failures. This damage may have been detected in the reactor pool or it may have occurred during spent fuel transfer or during interim storage. Defective assemblies can be inserted into over-packing replacement fuel cylinders and stored in the interim wet store.

67 TQ-EPR-123 was issued by the Regulators requiring further information on interim longer term spent fuel storage. The interim store is required potentially to operate beyond 100 years to cover the lifetime of reactor operations (including the final emplacement of fuel to interim storage, following an initial cooling period in a pool after reactor operations cease), the time to reduce the heat generation of the fuel, and the potential for refurbishment of the store(s).

68 EDF and AREVA prepared a report (UK EPR-0009-001) in response to TQ-EPR-123 containing detailed information on proposals for longer term storage of spent fuel, in addition to information provided in the SRWSR. They assumed that the interim store would have capacity for all spent fuel arising over the 60 year operational life of the UK EPR. The lifetime of the interim storage facility is assumed to be 100 years from receipt of the first spent fuel assembly for storage. The report considered both wet and dry interim storage facilities, as detailed in the SRWSR, and specifically interim wet storage as considered in report ELI0800224.

69 The potential for spent fuel assemblies to degrade over time was considered in response, to TQ-EPR-123 and monitoring and mitigation options were provided.

Inspection and maintenance activities were considered. Maintenance of integrity during storage was reviewed including potential mechanisms for fuel damage to occur, and the potential for degradation of other containment structures such as stainless steel and concrete structures designed to provide containment of spent fuel. The design philosophy takes into account the extended period for operation of the facility, and the need for maintenance, refurbishment and replacement. For example, the replacement on a periodic basis of equipment.

70 The potential for damaged fuel to occur was considered, and the means for detection of damaged fuel and options for longer term interim storage of damaged fuel were considered.

71 Plans for retrieval and inspection of fuel were considered, with details of an inspection and monitoring regime. Also plans for spent fuel retrieval were set out. Plans for final fuel retrieval prior to final disposal were detailed.

72 The Regulators found the report provided in response to TQ-EPR-123 (UKEPR-0009-001) to be a good quality response. Evidence from operating experience was provided in several parts of the response. However there were some remaining issues, particularly with regard to longer term wet storage. The Regulators required further information, in particular evidence that fuel will remain robust over the storage period for retrieval, transport and disposal. We also required information on how the future operator will manage and implement arrangements to deal with changes in the size and skills of the workforce over the lifetime of storage, that is the change from operations to a quiescent phase when operations end. This will affect the reliance that can be placed on the workforce. The storage designs and plans for retrieval need to be robust in regard to these changes.

73 The Regulators required the Requesting Parties for GDA to provide information to demonstrate the facility for long term interim storage of spent fuel can be designed for the total expected lifetime. Long term interim storage is required until a Geological Disposal Facility is available for direct disposal of spent fuel. The long term provision of services, for example to a storage pond for spent fuel, after a reactor has been shut down is required to be considered. A paper was issued in GDA '*The required level of design of waste plants for new build reactors in the Generic Design Assessment*' (HSE, 2009). The paper sets out requirements for a Requesting Party to provide sufficient levels of design to justify credibility of the proposed storage options; understanding how waste streams and their packaging evolve during the storage period, the need for data and records management, knowledge of the constraints placed on the wastes by the disposal facility, identification of knowledge gaps and a supporting research programme to address the gaps, and robust estimates of the required capacity.

74 The Regulators issued RO-UKEPR-39 requesting further information on long term storage. The actions associated with the RO outline the requirement for a plan showing when facilities for long term storage should be operational, and the research needed to underpin these plans to ensure that spent fuel can be stored transported and disposed of. Other actions required EDF and AREVA to show how they will manage records over the lifecycle of the waste, to show how human factors have been built into longer term waste management plans and to show how facilities will be maintained over an extended storage period. EDF and AREVA provided a number of reports in regard to their response in February and March 2010.

75 The reports provided in response to RO-UKEPR-39 included:

a) "Plan for the development of waste management facilities over the EPR lifetime" (ELIDC0902019).

b) "Management of Records for Long Term Management of Spent Fuel and ILW" (R10-002).

c) "Human Factors in Long Term Waste Management" (R10-006).

d) “Maintenance of Interim Storage Facilities” (SGN NT 100330 20 0004A).

e) “Current French and International Research and Development Programmes for Interim Storage of Spent Fuel” (SGN NT 100330 20 005A).

This information will be reviewed by Environment Agency, and we will continue to work with HSE on this issue. This work will inform our decision document.

76 The HSE has commissioned the National Nuclear Laboratory to carry out work to identify mechanisms that could lead to early failure of the fuel cladding or the fuel assembly during storage. This work will be reviewed in HSE’s Step 4 and the findings will be taken into account in our decision document.

77 For transportation considerations for the transfer of spent fuel offsite, an IAEA type B transport container is required. EDF and AREVA propose to use the TN-DUO for both storage and transport of UK EPR spent fuel if a dry interim storage option is chosen for spent fuel (SRWSR). The UK EPR adopts a proposed burn up of up to 65,000 MWd/tU and the TN-DUO is designed to accommodate this.

78 The PCERsc5.2 provides information on design aspects in relation to decommissioning; the Environment Agency asks the requesting party to consider the whole lifecycle from design to decommissioning in their waste and spent fuel strategy. Improving the strength of fuel cladding materials significantly impacts the classification of waste by limiting the release of alpha and beta emitters. The SRWSR refers to the improvement of fuel cladding integrity to further reduce the likelihood of fuel leakages which EDF and AREVA claim are low.

79 EDF and AREVA have obtained and provided a view from the Radioactive Waste Management Directorate (RWMD) of the Nuclear Decommissioning Authority (NDA) (as the UK authoritative source) on the disposability of their proposed arisings of spent fuel.

80 RWMD assume that the spent fuel will be delivered to the disposal facility packaged in robust disposal canisters, made from copper or steel which would contain up to 4 spent fuel assemblies in a cast iron inner vessel. It is also assumed that the spent fuel will be delivered to the GDF packaged in the disposal canisters.

81 RWMD concluded that EDF and AREVA supplied comprehensive inventory data sufficient to provide confidence in the conclusions of the GDA disposability assessment. The principal radionuclides in the wastes and spent fuel are the same as those present in existing UK legacy wastes and spent fuel. In particular, to the anticipated arisings from the existing PWR at Sizewell B. The design of the UK EPR and the PWR at Sizewell are similar and it is expected that the operating regimes will be similar.

82 The comparison of UK EPR and Sizewell B spent fuel inventories compared the UK EPR maximum fuel assembly average burn up inventory with the batch average fuel burn up inventory for Sizewell B. RWMD recognised it would have been more appropriate to compare either the two maximum fuel assembly average burn up or two batch average fuel burn up inventories. The information was not available to do this at the time of the RWMD assessment.

83 RWMD evaluated the implications of constructing a single EPR and a fleet of UK EPRs. A fleet of 6 UK EPRs was chosen to represent a generating capacity of approximately 10GW(e), equivalent to the capacity of the existing nuclear reactors in the UK which will cease to be operational over the next 20 years.

84 The disposability assessment for the UK EPR undertaken by RWMD assumes that 90 fuel assemblies will be generated every 18 months of reactor operation, which, for an assumed 60 year operating life results in a total of 3600 assemblies requiring disposal which is equivalent to 900 canisters.

85 The potential impact of the disposal of UK EPR spent fuel on the size of the geological disposal facility has been assessed. The area required represents approximately 8%

of the area required for legacy HLW and spent fuel per UK EPR reactor and approximately 50% for the illustrative fleet of 6 UK EPRs. This is in agreement with previous estimates from Nirex for potential new build reactor designs.

86 RWMD undertook an assessment which considered the spent fuel disposal packages against the waste package standards and specifications developed by RWMD and the supporting safety assessments for a geological disposal facility. The safety of transport operations, handling and emplacement at a Geological Disposal Facility, and the longer term performance of the system have been considered, together with the implications for the size and design of the GDF. The potential disposability of spent fuel from the UK EPR was considered with existing assessments of RWMD reference disposal concepts. These assessments provide the basis for judging the potential disposability of UK EPR wastes and spent fuel. One important consideration for the assessment of spent fuel from the UK EPR is that increased burn up and irradiation of the fuel will result in an increased concentration of fission products and higher actinides which causes the fuel assemblies to have a higher thermal output and dose rate.

87 A reference disposal concept is used for the disposability assessment based on the KBS-3V concept developed by SKB for the disposal of spent fuel in Sweden. Spent fuel will be over-packed into durable, corrosion-resistant canisters manufactured from suitable materials that will provide containment for the radionuclides associated with the spent fuel. The assessment has considered the performance of both copper and steel canisters with a cast iron inner vessel used to hold and locate the spent fuel canisters. The canisters would be emplaced in disposal holes lined with a buffer made from compacted bentonite which swells following contact with water.

88 The disposability assessment undertaken by RWMD also considered for spent fuel, estimates of risks from migration of radionuclides to the biosphere following closure of the GDF, with risks considered for the groundwater pathway.

89 Three potential power histories were considered by EDF and AREVA. The power history adopted was one of four short cycles with constant high specific power and considered to be the most challenging.

90 RWMD concluded that compared with legacy waste and existing spent fuel, no new issues arise that challenge the fundamental disposability of the waste and spent fuel expected to arise from operation of the UK EPR. (NDA Document TN 11261814 October 2009)

91 RWMD indicated that the disposal route for rod cluster control assemblies (RCCAs) will need to be clarified. The RWMD assessment indicates they will not represent a major addition to the overall inventory, and that they could be conditioned separately as ILW or disposed of with the rest of the fuel assembly. TQ-EPR-222 EPR Intermediate Level Waste was issued by the regulators requiring further information from EDF and AREVA in regard to these wastes, including evidence that they will be disposable.

92 The activated core components are considered intermediate level waste (ILW), although they generate heat when they are removed from the reactor. These include RCCAs, the stationary core component assemblies, and core instrumentation. As they are exposed to radioactivity in the reactor core, the RCCAs are highly activated by the time they are replaced; they are placed in the spent fuel pool to cool, as is the practice in existing PWR plants. EDF and AREVA claim that these wastes should be accepted for disposal in a Geological Disposal Facility.

93 EDF and AREVA provided the Regulators with a critique of the RWMD disposability assessment, considering the impact of RWMD disposability assessment on their plans for conditioning, storing and dispatching the waste to a repository (GDF). The critique raised a number of issues. EDF and AREVA identified that the principal issues were in relation to fuel burn up, assessment inventories, serious fuel cladding failures, interim storage of spent fuel, the use of supplementary data by RWMD, and the

chloride impurity assumption. The Regulators requested further information from EDF and AREVA on how they will address the issues raised in their critique and those issues raised by RWMD in their disposability assessment.

94 Our report EAGDAR UK EPR-08 Disposability of ILW and Spent Fuel considers both EDF and AREVA's critique and the RWMD assessment. It concludes that subject to a satisfactory demonstration that spent fuel can be stored safely for the necessary period of time without significant degradation, there should be no reason at this stage to believe that any spent fuel will not be disposable in a suitably designed and located GDF. Please refer to this report for more information.

95 The Regulators requested further information from EDF and AREVA in TQ-EPR-467 on the encapsulation process for disposal for spent fuel since this was not considered in the RWMD assessment. EDF and AREVA provided further information in February 2010 in a technical note "Encapsulation Facilities for Spent Fuel UK EPR Project" but we received it too late to consider it in our public consultation, and this assessment report.

96 EDF and AREVA gave a presentation to the Regulators on the UK EPR fuel route in November 2009. The Regulators requested a document providing the evidence and arguments to support the proposals for long-term pond storage in TQ-EPR-569 issued in January 2010. EDF and AREVA provided further information in March 2010, which was too late for us to consider in this document.

97 The Regulators requested further information from EDF and AREVA on the disposability of spent fuel and ILW in RO-UKEPR-48. With particular regard to EDF and AREVA's critique of the RWMD disposability assessment, the Regulators needed more detail from EDF and AREVA when considering the impact of the RWMD review on its plans for conditioning, storing and dispatching the waste to a repository (GDF). EDF and AREVA were asked to make a case for the disposability of spent fuel and ILW to ensure it can be stored, transported and disposed of. The case should include consideration of the issues identified in the RWMD disposability assessment, and in EDF and AREVA's critique of the RWMD assessment, and should include a plan showing how and when the issues will be addressed. Information was received from EDF and AREVA in late February 2010 in a report "The Case for Disposability of Spent Fuel and ILW" (R10-017). This response was considered in EAGDAR UK EPR-08 Disposability of ILW and Spent Fuel which found that the plans proposed to address outstanding disposability issues to be adequate at this stage. Please refer to this report for further information.

98 HSE wrote to us in March 2010 in regard to their Step 4 assessment, including those aspects that could affect disposability of spent fuel. Regulatory Observations have been raised by the regulators on long term storage of waste and disposability of spent fuel as discussed in the preceding paragraphs. The responses to most of the actions associated with these Regulatory Observations were received from EDF and AREVA at the end of February 2010 and in early March 2010. A report from EDF and AREVA on the ability to encapsulate spent fuel for disposal was received at the end of February 2010. HSE, in its Step 4 of GDA, will review the information supplied by EDF and AREVA as they finalise the information contained in their submissions on long-term storage and disposability. We will continue to work closely with HSE on these issues and this work will inform our decision document.

3.8 BAT to minimise disposals of spent fuel

99 EDF and AREVA have used a step-by-step approach to apply BAT. The UK EPR reference plant is Flamanville 3, which was designed to take into account experience and feedback from operating PWRs in France and Germany. This allowed improvements to be identified and incorporated as a result of learning from experience. There was an EPR environment design review in 2004, and an action plan and task force was set up. The scope and findings of the design review was

discussed at the Joint Regulators' inspections in December 2007 and April 2009, and presented in the published Joint Regulators' inspection report in 2009. TQ-EPR-149 was issued by the Environment Agency to request the provision of documentation from the 2004 design review. TQ-EPR-149 also requested minutes of the Environment Committee referenced in the PCER.

100 It is understood from the TQ response that the aim of the environmental design review meeting was to assess the aspects of the design that had the potential for significant environmental impact that need to be addressed at the design stage, rather than through reliance upon operational management arrangements.

101 The review considered radioactive and non-radioactive solid wastes, liquid and gaseous discharges. This was based on operational experience feedback from the 58 operating EDF plants, the German KONVOI reactors, and the periodic assessment of discharges and releases for operating plants. The review was carried out to define outstanding environmental issues which required further studies, as preparation for the environmental report to be submitted for the construction permit, and to prepare answers for the public debate in France once a site was chosen. The review jury made recommendations which included requirements for further studies. Information regarding implementation of the recommendations was presented at the Joint Regulators Team Inspection in April 2009, and at a waste topic meeting with the Regulators in March 2009.

102 EDF and AREVA claim the improvements in environmental performance of the UK EPR project with regard to waste and fuel include:

a) a more efficient use of natural uranium resources;

b) a significant reduction in the quantity of long lived radioactive waste resulting from the fuel and its cladding owing to its:

   i) neutronic design (large core, neutron reflector);

   ii) the fuel management performance (high burn up).

103 PCERsc8 describes the use of BAT in the UK EPR design with regard to spent fuel, namely the improved overall use of the fuel material compared with existing plants, as a result of increased operating and safety margins and more efficient use of the neutrons produced. EDF and AREVA claim there is less use of nuclear materials to produce the same amount of energy, and that it is possible to reduce both the consumption of natural uranium and the quantity of waste produced by irradiation, for the same amount of energy produced. They also claim that high burn up of the fuel optimises the use of the fuel and saves approximately 7 per cent of the natural uranium resource required compared with current fuel for a given amount of energy produced.

104 EDF and AREVA claim the UK EPR design has three design features which directly contribute to reducing natural uranium consumption and spent fuel production:

a) the use of a large core with 241 fuel assemblies compared to 205 fuel assemblies for the N4 reactor operating units; the N4 is a predecessor design to the EPR. There is a reduction in neutron leakage due to the larger size of the core. Adopting a larger core with a smaller refuelling fraction enables 7 per cent savings in natural uranium;

b) using a solid steel reflector, the heavy reflector. The reduction in radial neutron leakage leads to savings of 2 - 3 per cent natural uranium;

c) the improvement in overall thermal efficiency and the enhanced turbine efficiency, contributes 5 per cent to the reduction in consumption of natural uranium.

105 EDF and AREVA indicate that the reduction of solid waste arising from fuel and its cladding is linked to the UK EPR's neutronic design, capability for improved burning of the fuel used and the capability of the nuclear power plants in operation to reuse all or

part of the spent fuel. EDF and AREVA claim the increased burn up rate leads to a reduction in radiotoxic materials of around 14 per cent and a reduction of high activity long lived waste such as cladding of around 30 per cent.

106 EDF and AREVA note that the improvement in fuel reliability is a major objective for the UK EPR in their response to TQ-EPR-231 Discharge of actinides. This TQ issued by the Regulators required EDF and AREVA to quantify the actinide content of gaseous and liquid discharges and solid wastes arising from reasonably foreseeable events during the lifecycle of the UK EPR. This included the potential for fuel to contain tramp uranium, that is traces of uranium on the outside of the cladding left over from fuel manufacture, and potentially for fuel failure to occur. Information provided indicates that the current EPR fuel design is based on improvements in manufacturing and quality, and research and development. There is a worldwide programme of research and development, including manufacturing and human aspects. The current EPR fuel AFA 3G assemblies have shown consistent high operational reliability as a result of the improvements in manufacturing and quality as above.

107 EDF and AREVA have not provided detailed information on discharges from spent fuel storage. EDF and AREVA provided some generic information in regard to discharges from the spent fuel pool in their response to TQ-EPR-123 on longer term interim storage of spent fuel in the report “Spent fuel interim storage facility” (UKEPR-0009-001). Aerial discharges via the ventilation system will be generated under wet and dry interim storage options. In both cases, solid wastes are anticipated from the filtration of these discharges. However, for wet storage, additional wastes are anticipated from the treatment of the spent fuel pool water. Both solid and liquid wastes may be generated. EDF and AREVA confirm no liquid wastes will be released directly to the environment from the storage facility under any option. Any solid or liquid wastes will be transferred to dedicated treatment and assay facilities.

108 EDF and AREVA anticipate that aerial discharges will be very small under normal operating conditions for both dry and wet storage options. Abatement will be provided using HEPA filtration upstream of the discharge point. For wet storage, in regard to liquid effluent discharges, some abatement will be provided by passive filtration. However, chemical treatment such as ion exchange will also be required.

109 We would not expect discharges from interim spent fuel storage to be significant, and unless evidence is provided by EDF and AREVA to the contrary, we propose any discharges would be within the limits and levels proposed in Chapters 9 and 10 of our Consultation Document for the UK EPR.

4 Public comments

110 Comments on spent fuel received from the public involvement process relating to the EPR design by 4 January 2008 were addressed in our preliminary assessment report (Environment Agency, 2008). Public comments on this subject were received during our detailed assessment stage. One comment requested information about the type of spent fuel cask that would be used to transport spent fuel for processing or disposal. The response from EDF and AREVA confirmed that the TN type family of casks such as the transport cask TN24TM or others with comparable characteristics would be used to transport spent fuel in the UK, and provided information about the casks. The TN cask is a dual purpose cask that can be used to store and to transport spent fuel.

111 A public comment was received in regard to storage of spent fuel following the closure of reactor operations, and the need for ongoing secure power supplies to service the spent fuel storage ponds, water treatment systems, waste treatment systems and storage facilities. The comment also queried whether the design of the dry storage casks would take into account the varying enrichment levels of the fuel elements. The response from EDF and AREVA confirmed that the technology for longer term spent fuel management is not chosen although several options are available such as dry cask or dry vault storage, or long term pool storage. The response also confirmed the design of the storage facilities will take into account the enrichment and residual heat of the spent fuel elements, whatever technology is chosen. With regard to the ongoing availability of electrical power for services following reactor closure, it was confirmed that it is the aim of the UK national energy policy to ensure security of supply, together with the integrity of back up power supplies to provide power in the event of loss of grid supplies. The latter is considered specifically in GDA.

5 Conclusion

112 We conclude that, in their submission, EDF and AREVA describe how spent fuel will arise, be managed and disposed of throughout the facility's lifecycle. EDF and AREVA provide information on the fuel composition and characteristics, and expected fuel burn up, and quantities of spent fuel that will arise. Information is provided in the submission and supporting documents on short and long-term management proposals for spent fuel. The strategy proposed by EDF and AREVA for managing spent fuel following its removal from the reactor, is to transfer the spent fuel to the spent fuel pool for storage and initial cooling for a period of around 10 years. The fuel is then proposed to be transferred to an interim storage facility (PCER sc6.5) until such time a geological disposal facility becomes available for direct disposal.

113 The strategy is consistent with our REP, RSMDP1 Radioactive Substances Strategy. The evidence provided for BAT for the EPR fuel design and to minimise disposals satisfies RSMDP3 use of BAT to minimise waste. Information has recently been provided on record keeping, together with further information on longer term storage. This will be assessed and considered in our decision document for compliance with our REPs, in particular RSMDP14 record keeping, and RSMDP10 storage.

114 EDF and AREVA have obtained a view from the RWMD of the NDA on the disposability of the fuel and have provided their critique to the Regulators.

115 EDF and AREVA's proposals for storage of spent fuel are based on current practice. EDF and AREVA have provided supporting information on longer term wet storage (ELI0800224) based on 30 years operating experience worldwide in underwater storage of spent fuel. The Regulators requested further information about the proposed storage facilities to support the safe long-term storage of the spent fuel and to ensure that the fuel does not degrade over the long storage period.

116 EDF and AREVA provided detailed responses in regard to storage and disposability in February and March 2010. HSE is reviewing this information in its Step 4 assessment. We will continue to work with HSE on these matters, and this work will inform our decision document.

117 We need more information on the longer term storage of the fuel to understand whether there is any potential for degradation of the fuel over the longer term that might affect its disposability. This is consistent with the HSE requirement for a satisfactory demonstration that spent fuel can be stored safely for the necessary period of time without significant degradation. This information has been provided as noted above. HSE is reviewing this information in its Step 4 assessment. We will continue to work with HSE on these matters, and this work will inform our decision document. Therefore, our conclusion is subject to the potential GDA Issue:

a) Disposability of spent fuel following longer term interim storage pending disposal.

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Abbreviations

AREVA	AREVA NP SAS
ASN	the French Nuclear Safety Authority, Autorité de Sureté Nucléaire
BAT	Best available techniques
CEA	Commissariat à l'énergie atomique
EDF	Electricité de France SA
GDA	Generic design assessment
GDF	Geological Disposal Facility
HSE	Health and Safety Executive
IAEA	International Atomic Energy Agency
JPO	Joint Programme Office
NDA	Nuclear Decommissioning Authority
NEA	Nuclear Energy Agency (of the OECD)
OECD	Organisation for Economic Cooperation and Development
P&ID	Process and information document
PCER	Pre-Construction Environmental Report
PCERsc3.3s4.1	PCER sub-chapter 3.3 section 4.1 (example reference)
PCSR	Pre-Construction Safety Report
PWR	Pressurised water reactor
RCCAs	Rod cluster control assembles
REPs	Radioactive substances environmental principles
RGN	Regulatory Guidance Note
RGS	Regulatory Guidance Series
RO	Regulatory Observation
RWMC	Radioactive Waste Management Case
RWMD	Radioactive Waste Management Directorate of the Nuclear Decommissioning Authority
SODA	Statement of Design Acceptability
SNF	Spent nuclear fuel. That is fuel that has been irradiated in and permanently removed from a reactor core (IAEA)
SRWRS	Solid Radioactive Waste Strategy Report
TQ	Technical Query
US NRC	United States Nuclear Regulatory Commission

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