UK EPR	Title: PCER – Sub-Chapter 6.5 – Interim storage facilities and disposability for UK EPR	
	UKEPR-0003-065 Issue 04	
Total number of pages: 32		Page No.: I / III
Chapter Pilot: C. CAHUZAC *Name/Initials* [signature] *Date* 18.06.2012		
Approved for EDF by: A. PETIT *Name/Initials* [signature] *Date* 19.06.2012		Approved for AREVA by: Gary Craig *Name/Initials* [signature] *Date* 20.06.2012

REVISION HISTORY

Issue	Description	Date
00	First issue.	26.11.08
01	PCSR June 2009 update: - LLWR and NDA assessment progress on disposability added - Figures and reference documents grouped at the end - Clarification of text Update equivalent PCER chapter	19-09-09
02	PCER March 2010 update Complementary information included in sections 3.1, 4.1, 5.1 and 5.2 and 5.3	28-03-10

03	Consolidated PCER March 2011 update
	- Minor editorial changes
	- Clarification of text
	- Addition of information and/or of reference to supporting documents relating to:
	  - Mapping document for UK EPR radioactive waste management case (in section 1);
	  - ILW and spent fuel Interim storage facilities design safety principles, human factors, maintenance, planning and records, and decommissioning (in sections 3, 4 and new section 6);
	  - Spent fuel Interim Storage Facility: safety of wet storage, research and development, transfer of spent fuel assemblies from the fuel building to the Interim Storage Facility (section 4);
	  - Incineration of waste oils (section 5.1)
	  - Encapsulation of spent fuel (section 5.3)
	- Conclusion of the NDA / RWMD's disposability assessment for ILW and spent fuel and work to be performed by a prospective operator in the LOC process (section 5.2 and 5.3)
		28-03-11

Continued on next page

REVISION HISTORY (Cont'd)

Issue	Description	Date
04	Consolidated PCER update: - References listed under each numbered section or sub-section heading numbered [Ref-1], [Ref-2], [Ref-3], etc - Minor formatting changes - Minor editorial change in section 4.2.1 - Text "and solvents" added (§5.1) - Clarification added for evaporator concentrates in section 5.2, and for solvents in section 5.1	20-06-2012

For information address:

AREVA NP SAS
Tour AREVA
92084 Paris La Défense Cedex
France

EDF
Division Ingéniérie Nucléaire
Centre National d'Equipement Nucléaire
165-173, avenue Pierre Brossolette
BP900
92542 Montrouge
France

SUB-CHAPTER 6.5 - INTERIM STORAGE FACILITIES AND DISPOSABILITY FOR UK EPR

1. INTRODUCTION ... 3
2. REGULATORY BASELINE ... 3
3. INTERIM STORAGE FOR ILW ... 4
   - 3.1. DESIGN ASSUMPTIONS ... 4
   - 3.2. DESCRIPTION OF THE FACILITY ... 5
     - 3.2.1. INTRODUCTION ... 5
     - 3.2.2. SINGLE ROOM STORAGE ... 5
     - 3.2.3. MULTIPLE COMPARTMENT STORAGE ... 8
   - 3.3. DECOMMISSIONING OF THE ILW INTERIM STORAGE FACILITY ... 8
4. INTERIM STORAGE FOR SPENT FUEL ... 8
   - 4.1. DESIGN ASSUMPTIONS ... 8
   - 4.2. DESCRIPTION OF THE FACILITY ... 9
     - 4.2.1. INTRODUCTION ... 9
     - 4.2.2. WET INTERIM STORAGE FACILITY ... 10
     - 4.2.3. DRY INTERIM STORAGE FACILITY ... 14
   - 4.3. DECOMMISSIONING OF THE SPENT FUEL INTERIM STORAGE FACILITY ... 15
   - 4.4. RESEARCH AND DEVELOPMENT ... 15
5. DISPOSABILITY ... 16
   - 5.1. OPERATIONAL VLLW / LLW ... 16
   - 5.2. OPERATIONAL ILW ... 16
   - 5.3. SPENT FUEL ... 18
6. RECORDS ... 19

LIST OF FIGURES

SUB-CHAPTER 6.5 - FIGURE 1 : VIEWS OF THE SINGLE ROOM INTERIM STORAGE FACILITY 20

SUB-CHAPTER 6.5 - FIGURE 2 : CASKS UNLOADING FROM BENEATH THE POOL 21

SUB-CHAPTER 6.5 - FIGURE 3 : VIEW FROM ABOVE OF THE INTERIM STORAGE POOL 22

SUB-CHAPTER 6.5 - FIGURE 4 : VIEW OF THE INTERIM WET STORAGE FACILITY 23

1. INTRODUCTION

Sub-chapter 6.5 deals in part with requirements 1.4, 2.1, 2.4 and 2.5 of the EA P&I guidance document [Ref-1].

Initially, designs are discussed for interim storage facilities, for the:

(i) ILW (Intermediate Level Waste) radioactive operational waste, and

(ii) spent fuel, produced during the UK EPR 60 years of operation.

The discussions also address the need for plans to demonstrate when facilities will be developed and constructed, as identified by HSE [Ref-2].

Secondly, the current status of the discussions with NDA, with respect to the disposability of UK EPR solid radioactive waste, and spent fuel arising during the operational period are described.

This sub-chapter and supporting documents provide a basis for a potential UK EPR operator to develop radioactive waste management cases for ILW and spent fuel, in compliance with HSE Guidance [Ref-3], summarised in the document "Mapping Document for RWMC" [Ref-4].

2. REGULATORY BASELINE

The design, construction, operation and decommissioning of the facilities will meet the requirements of the following UK Legislation:

- Nuclear Installations Act 1965 (as amended) (NIA) [Ref-1] relating to the licensing and inspection of nuclear installations;
- Ionising Radiation Regulations 1999 (IRR) [Ref-2];
- Radiation Emergency Preparedness and Public Information Regulations 2001 (REPPIR) [Ref-3];
- Management of Health and Safety at Work Regulations 1999 [Ref-4];
- Nuclear Reactors (Environmental Impact Assessment for Decommissioning) (Amendment) Regulations 2006 (EIADR) [Ref-5];
- Radioactive Substances Act 1993 (RSA93) [Ref-6];
- Management of Radioactive Materials And Radioactive Waste On Nuclear Licensed Sites [Ref-7];
- Provision and Use of Work Equipment Regulations [Ref-8];
- Lifting Operations and Lifting Equipment Regulations [Ref-9];
- Personal Protective Equipment at Work Regulations [Ref-10];

- Pressure Systems Safety Regulations [Ref-11];
- Control of Major Accident Hazards Regulations (as amended) [Ref-12];
- Dangerous Substances and Explosive Atmospheres Regulations [Ref-13];
- Environment Agency or Scottish Environmental Protection Agency Regulations;
- The Office for Civil Nuclear Security (OCNS) Regulations.

3. INTERIM STORAGE FOR ILW

3.1. DESIGN ASSUMPTIONS

The estimated amount of ILW produced by the UK EPR per year of operation is detailed in Sub-chapter 6.3. A rounded amount of 50 m^3 produced during each year of operation is taken into account for the facility design.

Radioactive decay of ILW into LLW (Low Level Waste), which will occur during the interim storage period of time, is taken into consideration in the sections below. Facilities and procedures are available in case the operator wishes to use this waste route.

The ILW interim storage facility will be designed to be in operation for up to 100 years.

The safety and design approach and assumptions to be applied for the facility and its auxiliaries will be consistent with those presented in Sub-chapter 3.1 of the PCSR, including the ALARP requirement. The document “ILW Interim Storage Facility” [Ref-1] provides details of the design safety principles and ALARP approach for the design of the interim storage facility for ILW.

The integration of human factors engineering into the overall EPR design process is described Sub-chapter 18.1 of the PCSR. For the ILW Interim Storage Facility, further detail of the design approach to limit the reliance on the operator and how this will facilitate the maintenance of a suitable and sufficient competence baseline over the long term is provided in the document “Human Factors in Long Term Waste Management“ [Ref-2].

Furthermore the BAT approach will be applied in the design regarding the minimisation of the environmental impacts.

The document “Plan for the Development of Waste Management Facilities over the EPR Lifetime” [Ref-3] provides an outline of potential timescales for operation up to decommissioning of an ILW Interim Storage Facility.

3.2. DESCRIPTION OF THE FACILITY

3.2.1. Introduction

ILW generated during the 60 years of UK EPR operation will be conditioned in the EPR Effluent Treatment Building. The packages will be transported into the separate Interim Storage Facility (ISF). The ISF will provide interim storage for ILW pending removal to a final disposal facility, thereby allowing ultimate de-licensing and return of the site to an end state agreed by the regulators and the local planning authority.

The expected lifespan of the ISF is 100 years.

A first design, ("single room storage ISF"), adapted to the ILW conditioning packages of the reference case is summarised in section 3.2.2 below; further details are provided in the supporting document [Ref-1].

An option for other ILW conditioning packages ("multiple compartment storage ISF") is introduced in section 3.2.3 and further described in the Solid Radioactive Waste Strategy Report (SRWSR) [Ref-2].

3.2.2. Single room storage

The single room storage is a storage hall suitable for C1 and C4 packages used in the reference case (see Sub-chapter 6.3).

3.2.2.1. Design requirements

The facility is designed to receive and store packages of ILW waste arising from 60 years of operation of a single EPR nuclear reactor.

The waste will already be conditioned when it is received for interim storage. This will primarily be in one of two types of package:

- C1 packages (Ø 1400 mm, height 1300 mm) encapsulated by qualified high-performance concrete (BHP) and a cap cast using the same formulation. Total parcel mass varies between 4.5 and 6.4 tonnes, of which 10 to 40% is waste;
- C4 packages (Ø 1100 mm, height 1300 mm) of the same nature as the C1 but smaller.

Other packages are also possible.

The facility is designed to store 1200 C1 packages and 600 C4 packages for up to 100 years. Taking into account radioactive decay to LLW, which will no longer need storage; the amount of space required in the ISF would be reduced.

Some space is available for specific requirements, such as over-packaging of a potentially defective package.

Currently, there is no final repository (Geological Disposal Facility) for Intermediate Level Waste in the United Kingdom. As required in the Environment Agency (EA) guidance, the storage facility will be built so as to adapt to all situations at the end of the storage phase, for example the retrieval of the waste packages.

3.2.2.2. Design choices

C1 and C4 are EDF ILW reference packages. EDF uses these packages for the 58 reactors of the current French nuclear fleet.

The interim storage facility design is based on the EDF ICEDA facility: an interim storage facility project for ILW contained in such packages. This project is currently under discussions with the French Nuclear Safety Authority.

All the packages will be stored in a single interim storage hall.

The packages can be stacked on three levels in pyramids (providing better earthquake resistance but using a larger amount of space) or in columns (easier to monitor and move).

The number of waste package handling operations will be minimised through performing package inspection and monitoring tasks with equipment mounted on a travelling crane.

To optimise the use of space, a single shielded containment cell will be used for both waste package inspection and defective waste package over-packing. The sampling and over-packaging cell has been positioned between the interim storage hall and the reception/retrieval hall in order to use the transfer car as the means of handling.

The described facility includes one interim storage hall but can be designed to be extendable to include an additional interim storage hall (in the case of waste management being required for two or more nuclear power plant units).

3.2.2.3. Facility design description

In order to receive, send and inspect the packages, the facility has a reception / retrieval hall (25 m long, 10 m wide and 9 m high), which includes:

- an area suitable for the import and export of waste packages by road or rail transport;
- a temporary storage area, which is also used to inspect the packages;
- a transfer area which is the link between the reception hall and the interim storage hall;
- a storage area for the travelling crane and the handling device for the lifting of packages;
- a travelling crane equipped with a load cell and a camera.

The main storage hall is designed to store the packages and to survey them. This hall, (58 m long, 35 m wide and 9 m high), includes:

- the transfer area which is the link between the reception hall and the interim storage hall;
- waste package storage areas;
- storage area for over-packed non-compliant packages (in case of loss of integrity);
- a cell for monitoring packages and their over-packing if necessary;

- a storage area for the travelling crane and the handling device for the lifting of packages;

- a travelling crane equipped with a camera and a bar code reader.

In order to transfer the packages between the reception/retrieval hall and the interim storage hall, the facility has a transfer car (11 m long, 2.50 m wide and 2 m high).

In order to monitor the packages, and over-pack them in the event of loss of integrity, the facility has a sampling and over-packaging cell. This cell is located between the reception/retrieval and the interim storage halls. Biological shielding ensures that the sampling cell is a low dose rate area.

The facility also requires a number of auxiliary systems and facilities, such as electrical power unit, ventilation system unit, maintenance area and stack. These are not described in this study, but will be similar to those in the EPR plant. The detailed design of these auxiliary systems will be performed at the site specific stage.

A complete diagram of the facility is shown in Sub-chapter 6.5 - Figure 1.

3.2.2.4. Safety aspects

The facility will be designed, constructed and operated to comply with Ionising Radiation Regulations (IRR 99) [Ref-1]. In order to minimise radiation doses to workers and the public, the facility will include the following safety functions:

- the facility will provide containment for radioactive material. In most instances the primary containment will be provided by the waste packages (which have a design life of 300 years) and secondary containment by the facility structure in case of hall contamination;

- the monitoring and inspection cell will provide primary containment for the purpose of reworking out-of-specification waste packages;

- the facility will limit the radiation exposure of workers and the public through the provision of shielding and also the site boundary will be appropriately positioned to minimise gamma doses at the site fence;

- the facility will be maintained at a reduced pressure through the use of a filtered ventilation system to prevent the spread of contamination.

In the unlikely event of loss of containment from a waste package, worker and public exposures must be minimised. 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;

- the facility will be robust against foreseeable external hazards such as earthquake, loss of electrical power and severe weather.

3.2.2.5. Conclusion

Details of the facility are given in the supporting document [Ref-1]. It shows that the design, implementation and operation of a single room interim storage facility are technically feasible in compliance with the environmental and safety requirements of the United Kingdom.

In conclusion, it can be stated that interim storage for ILW in C1 and C4 reference packages is a proven technology, which is able to meet all storage requirements (such as maintaining package integrity and preventing package degradation) through robust engineering of the handling, containment and monitoring functions.

3.2.3. Multiple compartment storage

The Solid Radioactive Waste Strategy Report (SRWSR) [Ref-1] describes a multiple compartment Interim Storage Facility (ISF) to store ILW arising from the operation of a UK EPR, with other types of conditioning packages than those in the reference case.

3.3. DECOMMISSIONING OF THE ILW INTERIM STORAGE FACILITY

Decommissioning of the facility will take place at the end of the lifecycle after the last package has been transported to the Geological Disposal Facility (GDF). Further information is provided in PCER Chapter 5 and document "GDA EPR UK - Decommissioning" [Ref-1].

4. INTERIM STORAGE FOR SPENT FUEL

4.1. DESIGN ASSUMPTIONS

The isotopic composition of the spent fuel depends upon the initial enrichment and the fuel management regime conditions to which it is subject in the reactor. The average reactor region fuel burn-up is less than 65,000 MWd/tU.

For the purpose of sizing the heat removal capacity required for the interim storage facility it is assumed that the spent fuel assemblies are discharged from the reactor and placed into the spent fuel pool to cool and decay for a period of about 10 years before being moved to an interim storage facility. The decay heat generated by an EPR spent fuel assembly, which has undergone four 13 month reactor cycles and 10 years of cooling in the spent fuel pool, is approximately 1,400 Watts at the time of interim storage.

The UK EPR is designed for an operational life of 60 years. At any given time the operational reactor will contain around 127 tonnes of enriched uranium fuel. Reactor refuelling will take place at the end of reactor cycles, which can range between 12 and 22 months depending on the fuel management regime adopted. The quantities of spent fuel discharged from the reactor during refuelling can reach up to 80 assemblies.

A bounding value for the total number of spent fuel assemblies produced at the end of the reactor life is set to 3400 assemblies.

The interim storage facility will be designed to be in operation for up to 100 years.

The safety and design approach and assumptions to be applied for the facility and its auxiliaries will be consistent with those presented in Sub-chapter 3.1 of the PCSR, including the ALARP requirement. The document “Spent Fuel Interim Storage Facility” [Ref-1] provides details of the design safety principles and ALARP approach for the design of the interim storage facility for spent fuel.

The integration of human factors engineering into the overall EPR design process is described in Sub-chapter 18.1 of the PCSR. For the Spent Fuel Interim Storage Facility, further detail of the design approach to limit the reliance on the operator and how this will facilitate the maintenance of a suitable and sufficient competence baseline over the long term is provided in the document “Human Factors in Long Term Waste Management“ [Ref-2].

An overview of the maintenance principles and requirements for the UK EPR is given in Sub-chapter 18.2 of the PCSR. For the Spent Fuel Interim Storage Facility, further detail of the maintenance principles and design requirements, and their application to the different types of long term storage, including examples of maintenance facilities on current plants, is provided in the document “Maintenance of Interim Storage Facilities“ [Ref-3].

Furthermore the BAT approach will be applied in the design regarding the minimisation of the environmental impacts.

The document “Plan for the Development of Waste Management Facilities over the EPR Lifetime” [Ref-4] provides a generic outline plan for design, licensing, construction, and operation of a Spent Fuel Interim Storage Facility. Planning assumptions are given and a baseline plan is developed based on the different authorisations, consents and agreements needed to construct a facility together with a high-level analysis of the duration of the various activities (such as filling and emptying the store). The plan demonstrates, in principle, that the proposals for longer-term management of UK EPR wastes are credible for both wet and dry storage options.

4.2. DESCRIPTION OF THE FACILITY

4.2.1. Introduction

Interim storage for spent fuel is practiced worldwide. Such facilities are based on either wet or dry storage concepts. For the latter, two approaches are of interest to operators: storage of fuel assemblies in metal casks or alternatively in a vault type storage facility.

A description of the wet type interim storage facility is summarised in section 4.2.2 below, and further details are provided in the EPR Interim Storage Facility Report [Ref-1]. The dry storage technologies are introduced in section 4.2.3 and are described in the Solid Radioactive Waste Strategy Report (SRWSR) [Ref-2].

The facilities upstream of interim storage (reactor fuel building spent fuel pool) and downstream (final repository), along with cask transport, are not covered here, either for incoming or outgoing flasks. The design of the UK EPR is consistent with the utilisation of the TN 13/2 transport cask design, or similar, for the transport of spent fuel assemblies from the spent fuel pool to the Interim Storage Facility (ISF). The UK EPR reactor spent fuel pool and cask transfer facility are described in PCSR Sub-chapter 9.1.

4.2.2. Wet interim storage facility

In this facility, spent fuel assemblies are stored in a pool.

This section provides a summary of the requirements for design, construction, and operation of the proposed pool-based interim storage facility (ISF). The facility is designed for spent fuel assemblies coming from an EPR plant; more details are provided in the document EPR Interim Storage Facility Report [Ref-1].

4.2.2.1. Design requirements

The ISF is separate from the EPR plant. It will allow the storage of spent fuel coming from an EPR nuclear plant unit during its 60 years operation. The ISF will be designed to be in operation for up to 100 years.

At the end of the EPR 60 years of operation, around 3400 spent fuel assemblies will be accumulated, all of which will require storage in the ISF following initial cooling in the EPR fuel building spent fuel pool.

The facility can be broken down into a number of functional areas:

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

4.2.2.2. Design options and preferred solutions at the conceptual stage

A number of options for the design and operation of the handling and storage plant have been considered. These options have been reviewed against UK and international legislation and standards, and against UK and international operational experience feedback. The conclusions at the conceptual stage are:

- the interim storage facility described is designed to be extendable to allow sufficient capacity for storage of waste from a second EPR nuclear plant unit;
- for the storage pool, a facility built at ground level is preferable to a semi-embedded one;
- underwater unloading of casks from beneath the pool is preferable to underwater unloading via immersion from above the pool;
- the type of spent fuel storage chosen is a storage pool containing square removable racks (4 x 4 = 16 cells).

Different views of the facility are shown in Sub-chapter 6.5 - Figures 2 to 4.

However, the conclusion of the basic design studies for the spent fuel ISF at the site specific stage may lead to variants to this preferred solution (such as to bury the pool in the ground and to unload the containers in the pool rather than from underneath) due to the site specific safety, security and geographic constraints.

4.2.2.3. Overview of UK policies and guidance

4.2.2.3.1. Legislation

The design, construction, operation and decommissioning of the facility will meet the requirements of UK legislation (see section 2).

4.2.2.3.2. Safety functions

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;
- to ensure the fuel remains sub-critical in all normal and fault conditions.

These safety functions will be a fundamental part of the building and system design. Where possible, risks will be eliminated or minimised by design.

4.2.2.4. Underwater interim spent fuel storage

Spent fuel assembly transfer from the reactor fuel building to the ISF will be based on the design and procedures of existing wet fuel storage facilities. The spent fuel assemblies will be transferred from the fuel building to the ISF in the transport container used to unload the fuel from the spent fuel pool. The design of the ISF docking system will ensure compatibility between the transport container and the storage facilities. Transfer procedures for the UK EPR will be adapted as required following ALARP and BAT principles, incorporating any available feedback experience.

The initial operations (cask reception and preparation) are generic whatever option is used for unloading the spent fuel from the transport container in the ISF. The activities undertaken following cask preparation will depend on the unloading option (dry or wet unloading [Ref-1]) chosen for the UK EPR during the site-specific stage, which will be based on site characteristics and constraints.

4.2.2.4.1. Cask reception

Function:

To receive incoming casks containing spent fuel, and prepare for interface with cask and fuel handling plant.

Safety Objectives:

- To remove residual heat when the cask is vertical.
- To maintain two barriers, and keep the fuel shielded and contained.
- To minimise the possibility of a cask being dropped or lowered uncontrollably, and to minimise the consequences if this does occur.
- To minimise the possibility of collision during handling that could lead to damage to the fuel.
- To maintain fuel integrity in normal operations and during internal and external hazards including seismic events.

4.2.2.4.2. Cask preparation

Function:

To prepare the cask and interface with the pool and fuel handling equipment.

Safety Objectives:

- To remove residual heat when the cask is vertical.
- To maintain two barriers.
- To ensure the fuel is shielded at all times.
- To maintain the integrity of the structures which contain water (i.e. the fuel pool).

4.2.2.4.3. Cask unloading and handling into racks

Function:

- To transfer the fuel from the transport cask to an available storage rack.
- To transfer any defective fuel to an available replacement fuel cylinder.
- To remove fuel from a storage rack.
- To transfer the fuel into the transport cask.

Safety Objectives:

- To minimise the possibility of fuel being dropped or lowered uncontrollably and to minimise the consequences if this does occur.
- To minimise the possibility of collision during handling that could lead to damage to the fuel.
- To maintain adequate shielding of the fuel at all times.
- To minimise the spread of contamination.
- To maintain fuel integrity during normal operation and during internal and external hazards including seismic events.

4.2.2.4.4. Rack movements

Function:

- To move the racks from the loading position to the storage positions in the pool.
- To move the racks from the stored positions to the unloading position (at the end of the interim storage period time).

Safety Objectives:

- To minimise the possibility of racks being dropped or lowered uncontrollably and to minimise the consequences if this does occur.
- To minimise the possibility of collision during handling that could lead to damage to a rack.
- To maintain adequate shielding of the fuel at all times.
- To minimise the spread of contamination.
- To ensure adequate cooling.
- To maintain fuel integrity in normal operations and during internal and external hazards including seismic events.

4.2.2.4.5. Long-term pool storage

Function:

To safely and securely store the spent fuel underwater for up to 100 years.

Safety Objectives:

- To ensure a 100 years lifetime for the facility.
- To maintain shielding.

- To preserve the fuel cladding.
- To minimise contamination.
- To cool the fuel.
- To maintain sub-criticality.
- To protect the fuel assemblies from mechanical damage.

4.2.2.4.6. Preliminary hazard assessment

Hazards and initiating faults have been identified and appropriate safety features incorporated into the preliminary design [Ref-1].

4.2.2.4.7. Safety assessment

Wet storage is a proven technology, used worldwide. Safety analysis demonstrates that spent nuclear fuel can be stored safely in a long-term storage pool. The pool water chemistry and low storage temperatures ensure that the cladding integrity is maintained, which in turn guarantees the retrievability of stored assemblies at any time during storage. The large water volume provides significant thermal inertia ensuring that any increase in temperature is sufficiently slow to allow intervention by the operator long before the fuel integrity is compromised. Monitoring and inspection of the assemblies ensure that safety parameters are maintained within acceptable limits. Other systems such as ventilation, filters or make-up water contribute to the safety of the facility [Ref-1].

4.2.2.4.8. Conclusion

This section gives an overview of the proposed pool-based interim storage facility for spent fuel assemblies coming from an EPR plant. It lists the UK legislation and safety requirements, which will be met by the facility. More details are provided in the document in the EPR Interim Storage Facility Report [Ref-1].

None of the features are novel; they all employ proven technology. Cask loading, unloading and handling, fuel handling and pool storage all have a long and successful history both in the UK and abroad. Long-term pool storage of fuel has been successfully used at a large number of sites without significant degradation of the cladding. It has shown that there is nothing in the proposed design that will not conform to UK legislation and standards.

It is therefore concluded that the proposed interim storage will be suitable for licensing, construction and operation in the UK.

4.2.3. Dry interim storage facility

The Solid Radioactive Waste Strategy Report (SRWSR) [Ref-1] describes dry storage technologies (metal cask and vault) for the spent fuel arising from one or more EPR units.

Out of the four main dry storage technologies most widely used, only the vault-type dry storage is provided with an unloading hot cell. The vault-type facility unloading cell is fully compatible with the reference transport cask TN 13/2, or equivalent. The hot cell, located in the process building, can be adapted during the design stage to a range of casks used for transferring the fuel. It is based on existing dry unloading facilities implemented in France and the Netherlands, and is designed with tight docking systems (specifically designed to reduce operator radiation exposure).

The metal cask dry long-term storage technologies (TN DUO, NUHOMS, TN NOVA [Ref-1]) would require further study to determine the optimum transfer and loading/unloading processes. As the TN DUO, NUHOMS and TN NOVA casks have different geometrical features to the TN 13/2 cask, it would need to be determined whether these casks could be directly connected to the current UK EPR spent fuel pool loading pit configuration, or whether adaptations would be required. Until detailed studies of adaptations to the storage containers and/or modifications to the UK EPR spent fuel pool loading pit have been performed, an additional Dry Transfer Facility would be required for the purpose of transferring spent fuel from the TN 13/2 transport cask (or equivalent) into these long-term storage systems, using a dry unloading cell.

The different dry interim storage solutions presented in the SRWSR [Ref-1] are all based on existing and proven technologies operating worldwide. The solution selected for the UK EPR storage facility will follow ALARP and BAT principles in order to minimise the radiation dose received by workers and the general public, taking account of available operating experience feedback from similar facilities, and site specific details.

4.3. DECOMMISSIONING OF THE SPENT FUEL INTERIM STORAGE FACILITY

Decommissioning of the facility will take place at the end of the lifecycle after the last assembly has been transported to the Geological Disposal Facility (GDF). Further information is provided in PCER Chapter 5 and document "GDA EPR UK - Decommissioning" [Ref-1].

4.4. RESEARCH AND DEVELOPMENT

Interim storage for spent fuel is practiced worldwide, with storage facilities that are based on both wet and dry storage concepts. Significant operating experience has therefore been accumulated by the nuclear industry over a period of decades of both wet and dry spent fuel storage technologies and transportation. Additionally, a number of research and development (R&D) programmes have been performed worldwide to define spent fuel storage acceptance criteria and to support licensing activities.

The document “Current French and International Research and Development Programmes for Interim Storage of Spent Fuel” [Ref-1] provides details of the R&D work already performed on fuel storage, including national and international programmes, and discusses potential future R&D required to meet new requirements. It also discusses the requirements for inspection and the specific aspects of criticality, failed fuel and fuel characterisation. The document demonstrates that there is a comprehensive amount of knowledge on the long-term behaviour of wastes that a future operator could draw upon.

5. DISPOSABILITY

This section contains information about the disposability of UK EPR solid radioactive waste and spent nuclear fuel (should it be declared to be waste) in response to requirements 2.4 and 2.5 of the EA P&I Document [Ref-1]. This takes into account the UK EPR solid radioactive waste and spent fuel characteristics, and the government and NDA policies for the assessment of the disposability of radioactive waste.

5.1. OPERATIONAL VLLW / LLW

A series of discussions have been held with LLW Repository Ltd (LLWR), who operate the Drigg facility on behalf on the NDA, regarding UK EPR LLW. In accordance with their customer arrangements, Form D1s (Request for Agreement in Principle to dispose of radioactive waste at the Low Level Waste Repository) have been completed for each of the UK EPR LLW streams, except for oils and solvents which are expected to be incinerated. These forms describe the nature of the process giving rise to the waste and the type of radioactive waste generated; the physical and chemical form of the waste and its radiological characteristics are also described, thereby allowing an assessment against the LLWR Conditions for Acceptance and verification of the acceptability of the UK EPR LLW streams to the LLWR.

LLWR technical experts have performed their review of the information provided on the D1 forms before the end of 2008, and have provided a letter confirming in principle the acceptability of the UK EPR LLW waste streams for treatment / disposal through LLWR [Ref-1].

For waste oils and solvents, a comparison against the conditions for acceptance of a UK incinerator has provided confidence that EPR waste oils and solvents would be acceptable for incineration in the UK.

In order to minimise the inventory of waste consigned to LLWR, where the characteristics of LLW streams or packages are such that they could be treated as VLLW (Very Low Level Waste), LLWR have confirmed that they will offer services to dispose of such wastes. This will be in accordance with guidance that EA will produce in support of the DEFRA policy of using specified landfill sites for VLLW. Their newly re-issued Conditions for Acceptance also highlight the need for increased segregation of metallic and combustible components, thereby allowing future treatment in alternative facilities and extending the lifetime capacity of LLWR.

5.2. OPERATIONAL ILW

The assessment of disposability is performed by the Nuclear Decommissioning Authority (NDA). The NDA currently assesses the disposability of ILW through their Letter of Compliance (LoC) process [Ref-1]. As part of the GDA process, the NDA has undertaken a Disposability Assessment for ILW arising from the operation and decommissioning of a UK EPR. In order to assess the disposability of ILW, a datasheet for each of the UK EPR ILW streams was submitted to the NDA to obtain a view from them (as the UK authoritative source in providing such advice) on the disposability of ILW.

Each datasheet included information on the nature of the waste stream, rate of arising, proposed matrix, package type, physical and chemical composition and radionuclide inventory, package heat output and external dose rate.

Note: there are no datasheets for the reference case for evaporator concentrates since these are LLW.

The NDA’s three step assessment covered waste package (nature and quantity) assessment, repository design impact, and repository safety cases impact, and culminated in a Disposability Report supported by a detailed Assessment Report. A regular dialogue was held with the NDA throughout their assessment process in order to provide any necessary clarifications and supplementary information.

The NDA Disposability Assessment Report ([Ref-2] to [Ref-4]) was published in October 2009. The Disposability Report concluded that "ILW and spent fuel from operation and decommissioning of an EPR should be compatible with plans for transport and geological disposal of higher activity wastes and spent fuel". It has also concluded that, "compared with legacy wastes and existing spent fuel, no new issues arise that challenge the fundamental disposability of the wastes and spent fuel expected to arise from operation of a reactor such as the UK EPR". This conclusion is supported by the similarity of the wastes to those expected to arise from the existing UK PWR at Sizewell B.

The document “The case for disposability of spent fuel and ILW” [Ref-5] defines when in the lifecycle of the EPR the three stages of the LoC process will be applied to each waste stream. The plan also identifies the stage in the LoC process when the information required for further assessment in the Disposability Assessment will be addressed. The document sets out a proposed potential work programme which a prospective operator could utilise to demonstrate disposability of operational ILW. This plan has since been further updated with regard to the process for demonstration of disposability [Ref-6].

It is proposed that a prospective operator could achieve an interim stage LoC prior to operation with the waste conditioning strategy and packages determined by the operator. For ILW, the UK geological disposal facility concept is well developed and there is a mechanism for the Radioactive Waste Management Directorate (RWMD) of the NDA to assess operator’s waste package proposals against published safety assessments for transport, repository operations and repository post-closure. The submission of 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 operation.

During operation, small volumes of heat producing wastes are generated (i.e. activated core components such as Reactor Cluster Control Assemblies (RCCAs)) which will be placed into the spent fuel pool to cool prior to packaging, storage and disposal. This is in accordance with the practice at existing PWR plants.

Several options are available for the packaging of these wastes, such as canisters (similar to spent fuel casks) concrete containers or cast iron containers. It is anticipated that these wastes would be accepted into a Geological Disposal Facility (GDF) and that a prospective operator would obtain a conceptual stage LoC prior to operations. As stated above for ILW the UK geological disposal facility concept is well developed and there is a mechanism for RWMD to assess operator’s waste package proposals against published safety assessments. The Interim stage LoC would not be completed until more detailed information is available on the levels of activation products (e.g. based on the reactor operational history and the expected future reactor performance).

Note: Should evaporator concentrates be ILW they would not be incinerated but packaged for disposal as ILW.

5.3. SPENT FUEL

A similar disposability assessment was performed by the NDA to assess the disposability of spent fuel (should it be declared to be waste); detailed information was submitted to the NDA to obtain a view from them on the disposability of UK EPR spent fuel.

The information provided to the NDA included:

- a summary of the UK EPR reactor core and fuel assemblies;
- the main geometrical characteristics of the fuel assemblies and individual fuel rods;
- chemical compositions;
- radiological and thermal characteristics; and
- expected quantities of spent fuel.

The inventory information provided covers the UO_2 and cladding and assembly structural materials and considers enhancements to the radionuclide inventory from impurities in these components. Where requested the radionuclide inventories have been provided at cooling times of 25, 1,000 and 100,000 years through the use of inventory code calculations.

A regular dialogue was held with the NDA throughout their assessment process in order to provide any necessary clarifications and supplementary information.

The NDA assessment led to a Disposability Report ([Ref-1] to [Ref-3]) published in October 2009. The Disposability Report concluded that "ILW and spent fuel from operation and decommissioning of an EPR should be compatible with plans for transport and geological disposal of higher activity wastes and spent fuel". It has also concluded that, "compared with legacy wastes and existing spent fuel, no new issues arise that challenge the fundamental disposability of the wastes and spent fuel expected to arise from operation of a reactor such as the UK EPR".

The NDA RWMD Disposability Report considered that spent fuel is encapsulated in a copper canister following a suitable cooling period; however, discussions are currently ongoing to address the encapsulation processes and location of encapsulation facilities for spent fuel from new build reactors. The document “Encapsulation Facilities for Spent Fuel” [Ref-4] provides an overview of international practice and on-going development on spent fuel encapsulation and concludes that the encapsulation of UK EPR spent fuel for disposal is technically feasible.

The document “The case for disposability of spent fuel and ILW” [Ref-5] defines when in the lifecycle of the EPR the three stages of the LoC process will be applied to each waste stream. The plan also identifies the stage in the LoC process when the information required for further assessment in the Disposability Assessment will be addressed. This plan has since been further updated with regard to the process for demonstration of disposability [Ref-6].

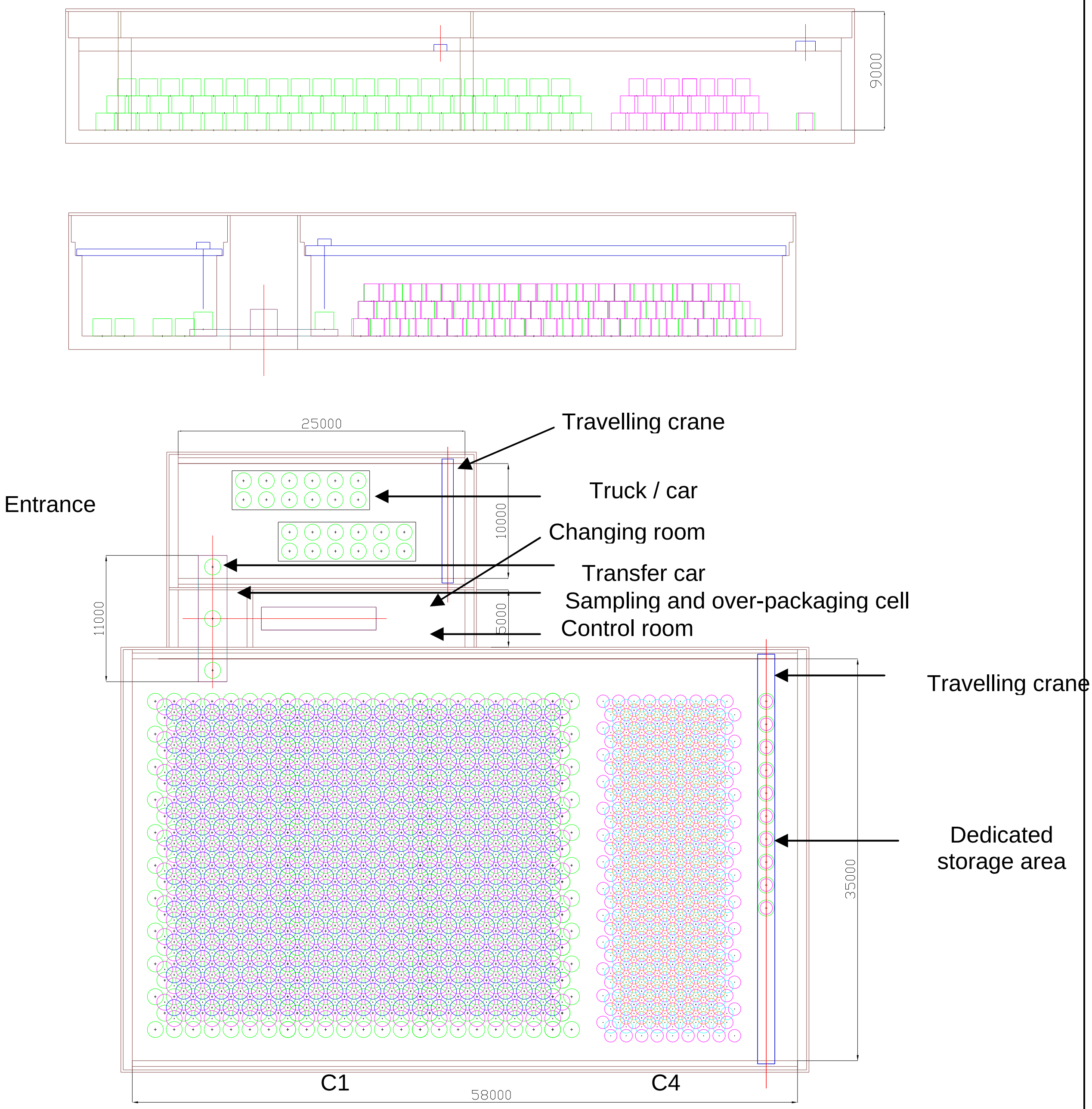
The document sets out a credible timescale for achieving a final stage LoC for spent fuel, which includes submission of a conceptual stage LoC prior to operation. The response stated that a conceptual stage LoC submission could be made by a prospective operator approximately 6 years prior to site operation. This would establish that a safe and effective means of managing spent fuel was available and that this was being taken forward with the site specific design aspects of the Nuclear Power Station.

6. RECORDS

Records of EPR spent fuel and ILW accepted into, stored in and exported from the interim storage facilities will be retained in accordance with the requirements of the Nuclear Site Licence Conditions. The retention and preservation of records will be undertaken in accordance with modern standards of good practice in line with the guidance given in IAEA and NDA reports on record retention and maintenance. The document “Management of Records for Long Term Management of Spent Fuel and ILW” [Ref-1] details the type of information that will be maintained and the means of ensuring the information is retained. Records generated over the lifetime of the plant will be integrated into the British Radwaste Information Management System (BRIMS), which provides an integrated computerised system for the management of a diversity of records and data associated with radioactive waste materials of all categories.

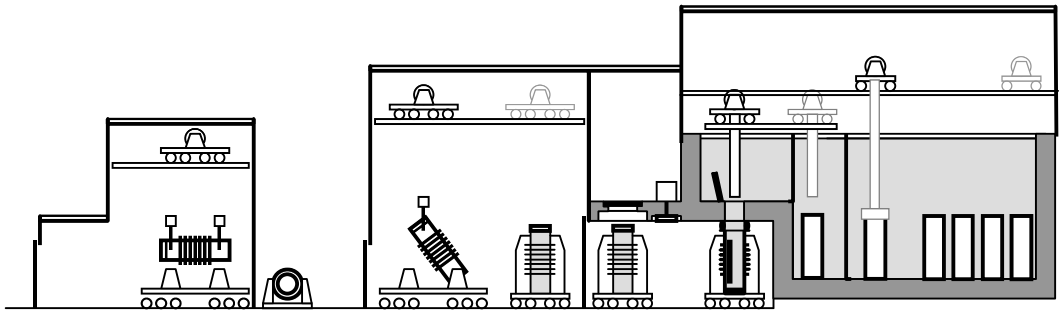
SUB-CHAPTER 6.5 - FIGURE 1

Views of the Single Room Interim Storage Facility



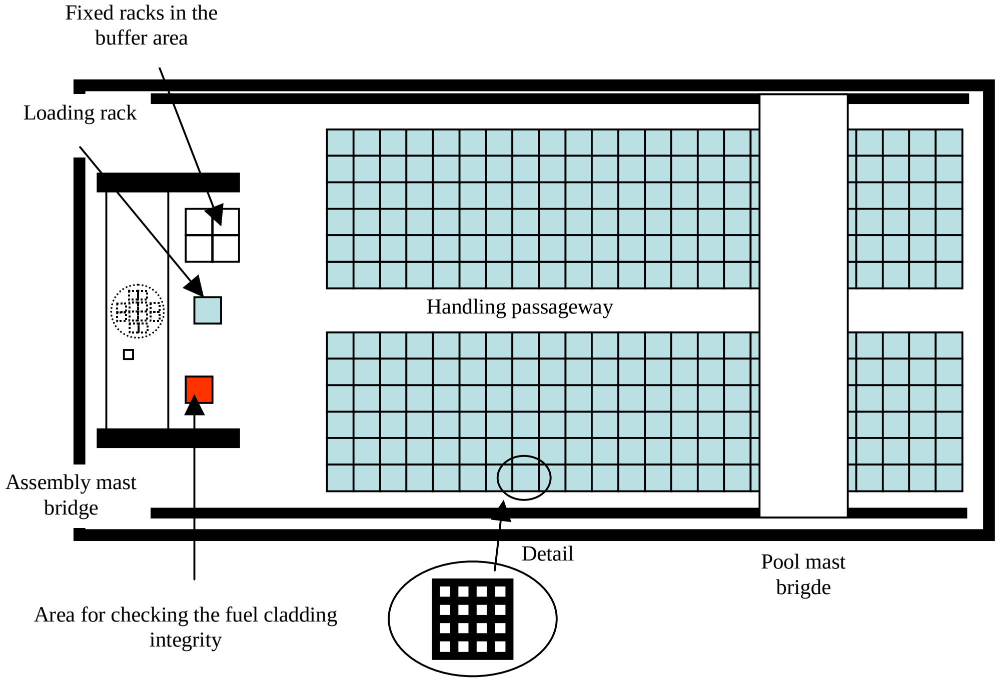
SUB-CHAPTER 6.5 - FIGURE 2

Casks Unloading From Beneath the Pool



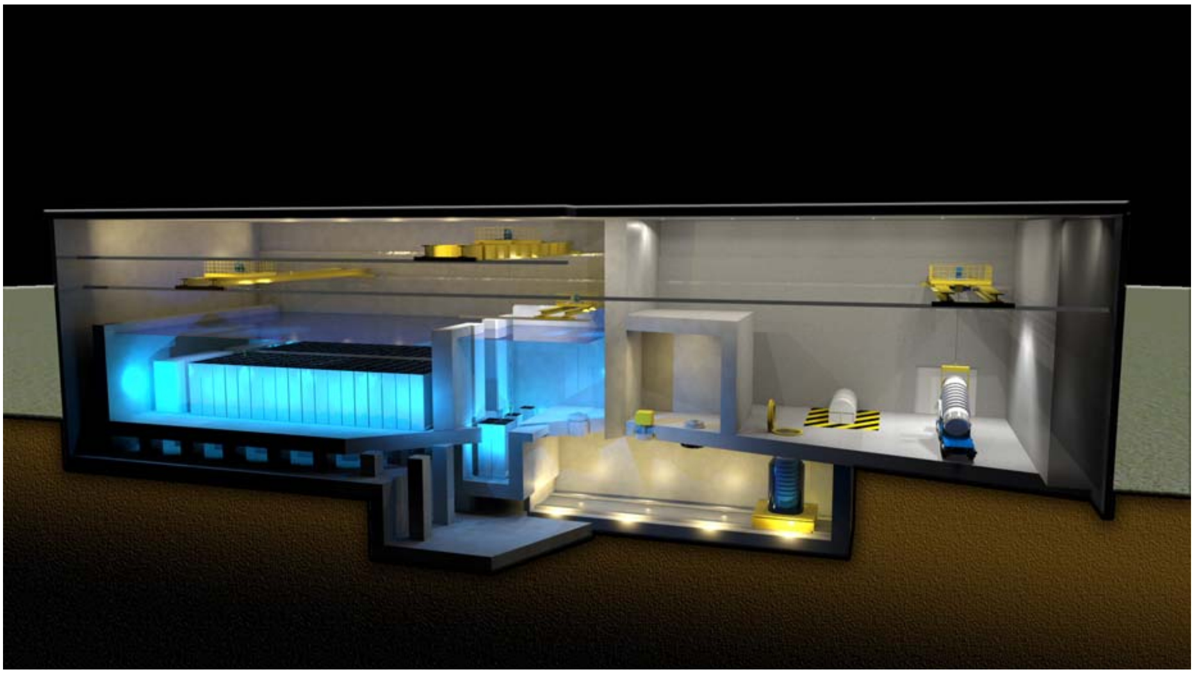
SUB-CHAPTER 6.5 - FIGURE 3

View From Above of the Interim Storage Pool



SUB-CHAPTER 6.5 - FIGURE 4

View of the Interim Wet Storage Facility



SUB-CHAPTER 6.5 – REFERENCES

External references are identified within this sub-chapter by the text [Ref-1], [Ref-2], etc at the appropriate point within the sub-chapter. These references are listed here under the heading of the section or sub-section in which they are quoted.

1. INTRODUCTION

[Ref-1] Process and Information Document for Generic Assessment of Candidate Nuclear Power Plant Designs. The Environment Agency. January 2007. (E)

[Ref-2] The required level of design of waste plants for new build reactors in the Generic Design Assessment. May 2009. (http://www.hse.gov.uk/newreactors/wasteplants.pdf) (E)

[Ref-3] The management of higher activity radioactive waste on nuclear licensed sites, radioactive waste management cases, Guidance from the Health and Safety Executive, the Environment Agency and the Scottish Environment Protection Agency to nuclear licensees. February 2010. (http://www.hse.gov.uk/nuclear/wastemanage/RWM-part2.pdf) (E)

[Ref-4] GDA UK EPR - Mapping Document for Radioactive Waste Management Case. UKEPR-0012-001 Issue 02. EDF/AREVA. March 2011. (E)

2. REGULATORY BASELINE

[Ref-1] The Nuclear Installations Act 1965 (as amended). HM Stationery Office. ISBN 0108502163. (E)

[Ref-2] The Ionising Radiations Regulations 1999. Statutory Instrument 1999 No. 3232. HM Stationery Office. ISBN 0-11-085614-7. (E)

[Ref-3] The Radiation (Emergency Preparedness and Public Information) Regulations 2001 (REPPIR). Statutory Instrument 2001 No. 2975. ISBN 0-11-029908-6.HM Stationery Office. The Stationery Office Ltd. (E)

[Ref-4] Management of Health and Safety at Work Regulations 1999. ISBN 0-11-085625-2. The Stationery Office Ltd. (E)

[Ref-5] The Nuclear Reactors (Environmental Impact Assessment for Decommissioning) (Amendment) Regulations 2006 (EIADR) (SI 2006 No. 657). ISBN 978-0110742427. The Stationery Office Ltd. (E)

[Ref-6] The Radioactive Substances Act 1993. HM Stationery Office. ISBN 0-10: 0105412937. (E)

[Ref-7] Management of Radioactive Materials And Radioactive Waste On Nuclear Licensed Sites. (http://www.hse.gov.uk/nuclear/waste1.pdf) (E)

[Ref-8] Provision and Use of Work equipment Regulations 1998 (PUWER). ISBN 0-11-079599-7.The Stationery Office Ltd. (E)

[Ref-9] Lifting Operations and Lifting Equipment Regulations 1998. ISBN 0-11-079598-9. The Stationery Office Ltd. (E)

[Ref-10] The Personal Protective Equipment at Work Regulations 1992. ISBN 0-11-025832-0. The Stationery Office Ltd. (E)

[Ref-11] The Pressure Systems Safety Regulations 2000 (PSSR). Statutory Instruments 2000 No. 1281. ISBN 0-11-085836-0. The Stationery Office Ltd. (E)

[Ref-12] Control of Major Accident Hazards (Amendment) Regulations 2005 (COMAH). ISBN 0-110-72766-5. The Stationery Office Ltd. (E)

[Ref-13] Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR). ISBN 0-11-042957-5. The Stationery Office Ltd. (E)

3. INTERIM STORAGE FOR ILW

3.1. DESIGN ASSUMPTIONS

[Ref-1] ILW Interim Storage Facility. UKEPR-0008-001 Issue 01. EDF/AREVA. November 2009. (E)

[Ref-2] Human Factors in Long Term Waste Management. R10-006 (A) Issue 2. AREVA. February 2010. (E)

[Ref-3] Plan for the Development of Waste Management Facilities over the EPR Lifetime. ELIDC0902019 Revision B. EDF. March 2010. (E)

3.2. DESCRIPTION OF THE FACILITY

3.2.1. Introduction

[Ref-1] Dry Interim Storage facility for ILW. ELI0800226 Revision A. EDF. November 2008. (E)

[Ref-2] Solid Radioactive Waste Strategy Report (SRWSR). NESH-G/2008/en/0123 Revision A. AREVA NP. November 2008. (E)

3.2.2. Single room storage

3.2.2.4. Safety aspects

[Ref-1] The Ionising Radiations Regulations 1999. Statutory Instrument 1999 No. 3232. HM Stationery Office. ISBN 0-11-085614-7. (E)

3.2.2.5. Conclusion

[Ref-1] Dry Interim Storage facility for ILW. ELI0800226 Revision A. EDF. November 2008. (E)

3.2.3. Multiple compartment Storage

[Ref-1] Solid Radioactive Waste Strategy Report (SRWSR). NESH-G/2008/en/0123 Revision A. AREVA NP. November 2008. (E)

3.3. DECOMMISSIONING OF THE ILW INTERIM STORAGE FACILITY

[Ref-1] GDA UK EPR Decommissioning. UKEPR-0016-001 Issue 01. EDF/AREVA. March 2011. (E)

4. INTERIM STORAGE FOR SPENT FUEL

4.1. DESIGN ASSUMPTIONS

[Ref-1] Spent Fuel Interim Storage Facility. UKEPR-0009-001 Issue 01. EDF/AREVA. November 2009. (E)

[Ref-2] Human Factors in Long Term Waste Management. R10-006 (A) Issue 2. AREVA. February 2010. (E)

[Ref-3] Maintenance of Interim Storage Facilities. SGN NT 100330 20 0004 Revision A. AREVA. February 2010. (E)

[Ref-4] Plan for the Development of Waste Management Facilities over the EPR Lifetime. ELIDC0902019 Revision B. EDF. March 2010. (E)

4.2. DESCRIPTION OF THE FACILITY

4.2.1. Introduction

[Ref-1] Interim storage facility for spent fuel assemblies coming from an EPR plant. ELI0800224 Revision A. EDF. November 2008. (E)

[Ref-2] Solid Radioactive Waste Strategy Report (SRWSR). NESH-G/2008/en/0123 Revision A. AREVA NP. November 2008. (E)

4.2.2. Wet interim storage facility

[Ref-1] Interim storage facility for spent fuel assemblies coming from an EPR plant. ELI0800224 Revision A. EDF. November 2008. (E)

4.2.2.4. Underwater Interim Spent Fuel Storage

[Ref-1] Interim storage facility for spent fuel assemblies coming from an EPR plant. ELI0800224 Revision A. EDF. November 2008. (E)

4.2.2.4.6. Preliminary hazard assessment

[Ref-1] Interim storage facility for spent fuel assemblies coming from an EPR plant. ELI0800224 Revision A. EDF. November 2008. (E)

4.2.2.4.7. Safety assessment

[Ref-1] The safety of long-term spent fuel storage in pools. ELIDC1000094 Revision A. EDF. April 2010. (E)

4.2.2.4.8. Conclusion

[Ref-1] Interim storage facility for spent fuel assemblies coming from an EPR plant. ELI0800224 Revision A. EDF. November 2008. (E)

4.2.3. Dry interim storage facility

[Ref-1] Solid Radioactive Waste Strategy Report (SRWSR). NESH-G/2008/en/0123 Revision A. AREVA NP. November 2008. (E)

4.3. DECOMMISSIONING OF THE SPENT FUEL INTERIM STORAGE FACILITY

[Ref-1] GDA UK EPR Decommissioning. UKEPR-0016-001 Issue 01. EDF/AREVA. March 2011. (E)

4.4. RESEARCH AND DEVELOPMENT

[Ref-1] Current French and International Research and Development Programmes for Interim Storage of Spent Fuel. SGN NT 100330 20 005 Revision A. AREVA/EDF. February 2010. (E)

5. DISPOSABILITY

[Ref-1] Process and Information Document for Generic Assessment of Candidate Nuclear Power Plant Designs. The Environment Agency. January 2007. (E)

5.1. OPERATIONAL VLLW / LLW

[Ref-1] Form D1 Application: UK EPR Project, from LLW Repository Ltd. 320.L.027. December 2008 (E)

5.2. OPERATIONAL ILW

[Ref-1] Disposability Assessment of Solid Waste Arisings from New Build. NDA. Radioactive Waste Management Directorate. April 2008 (E)

[Ref-2] Generic Design Assessment: Summary of Disposability Assessment for Wastes and Spent Fuel arising from Operation of the UK EPR. NDA. Radioactive Waste Management Directorate. Technical Note no. 11261814. (https://www.nda.gov.uk/documents/upload/TN-17548-Generic-Design-Assessment-Summary-of-Disposability-Assessment-for-Wastes-and-Spent-Fuel-arising-from-Operation-of-the-EPWR.pdf). October 2009. (E)

[Ref-3] Generic Design Assessment: Disposability Assessment for Wastes and Spent Fuel arising from Operation of the UK EPR. Part 1: Main Report. NXA/10747397 Issue 2. January 2010. (E)

[Ref-4] Generic Design Assessment: Disposability Assessment for Wastes and Spent Fuel arising from Operation of the UK EPR. Part 2: Data Sheets and Inventory Tables. NXA/10777960 Issue 2. January 2010. (E)

[Ref-5] The case for disposability of spent fuel and ILW. R10-017 (A) Issue 1. AREVA. February 2010. (E)

[Ref-6] Letter dated 14th January 2011 from EDF/AREVA to HSE/EA, “Consolidation of the Plan for the Disposability of Waste and Spent Fuel”, REG EPR00637R. (E)

5.3. SPENT FUEL

[Ref-1] Generic Design Assessment: Summary of Disposability Assessment for Wastes and Spent Fuel arising from Operation of the UK EPR. NDA. Radioactive Waste Management Directorate. Technical Note no. 11261814. (https://www.nda.gov.uk/documents/upload/TN-17548-Generic-Design-Assessment-Summary-of-Disposability-Assessment-for-Wastes-and-Spent-Fuel-arising-from-Operation-of-the-EPWR.pdf) October 2009. (E)

[Ref-2] Generic Design Assessment: Disposability Assessment for Wastes and Spent Fuel arising from Operation of the UK EPR. Part 1: Main Report. NXA/10747397 Issue 2. January 2010. (E)

[Ref-3] Generic Design Assessment: Disposability Assessment for Wastes and Spent Fuel arising from Operation of the UK EPR. Part 2: Data Sheets and Inventory Tables. NXA/10777960 Issue 2. January 2010. (E)

[Ref-4] Technical note. Encapsulation Facilities for Spent Fuel. NT 100330 00 0003 Revision B. AREVA./EDF September 2010. (E)

[Ref-5] The case for disposability of spent fuel and ILW. R10-017 (A). Issue 1. AREVA. February 2010. (E)

[Ref-6] Letter dated 14th January 2011 from EDF/AREVA to HSE/EA “Consolidation of the Plan for the Disposability of Waste and Spent Fuel”, REG EPR00637R

6. RECORDS

[Ref-1] Management of Records for Long Term Management of Spent Fuel and ILW. R010-002 (A) Issue 3. AREVA. February 2010. (E)