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REVISION HISTORY

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00	PCSR June 2009 update: – Minor clarification of text (**Note**: Previous issues of this sub-chapter were included in UKEPR-0002-200)	28-06-2009

01	Consolidated Step 4 PCSR update:
	- Minor editorial changes
	- Sub-chapter title changed
	- Incorporation of more detailed information regarding decommissioning:
	  - summary added before §1,
	  - §2.2 (new) “Hazards and challenges” added,
	  - §3 updated to include “Decommissioning logistics”,
	  - §4 “Design principles” updated,
	  - §5 (new) “Baseline principles and objectives” added, and
	  - §6 (new) “Records” added
		27-03-2011

02	Consolidated PCSR update: - References listed under each numbered section or sub-section heading numbered [Ref-1], [Ref-2], [Ref-3], etc	08-06-2012

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SUB-CHAPTER 20.1 – GENERAL DECOMMISSIONING PRINCIPLES – REGULATIONS

Although decommissioning is the final stage in the overall lifecycle of a facility and will be the responsibility of the future UK EPR Licensee, the need for decommissioning must be taken into account at all stages in the lifecycle, starting at the design stage.

This sub-chapter deals with the general principles and regulations related to decommissioning.

1. PHASES

The dismantling of a nuclear facility comprises several technical operations and administrative processes which result in the site regulatory de-licensing.

In most cases, the following sequence applies:

- decision to permanently shut down the facility by the operator;
- removal of fissile materials and radioactive liquids, while the nuclear-side plants are still operational, although in a simplified way;
- depending on the technical requirements, demolition or re-equipment of the non-nuclear plant and possibly a reduction of the perimeter of the facility;
- phased dismantling of the activated and contaminated equipment;
- phased deactivation and decontamination of components;
- after establishing what remains of the facility, partial or total de-licensing;
- a period of safe store, if required.

The waste produced by these operations is removed from the site, possibly after interim storage on the site.

Finally, the remaining structures and the site itself are redeveloped according to the owner's requirements and the obligations to which the owner is bound under the terms of decommissioning.

2. RISK AND HAZARD REDUCTION

2.1. RISK REDUCTION

During the dismantling phase, the required safety functions to be ensured are the containment of radioactive materials and the minimisation of the risk of public external exposure.

The removal of fissile materials and radioactive liquids eliminates the largest part of the radiological hazard. Consequently, only one containment system is required between the radioactive materials and the environment during the subsequent phases.

At the start of dismantling, the original containment system is used; however, some of the ventilation systems may not be used. Nevertheless, the dismantling of the facility involves the ultimate removal of certain protective barriers.

As a result, there may be a temporary increase in residual risk, which is permissible as long as:

- each decommissioning task serves to reduce the remaining risk;
- the ultimate aim of the dismantling works is to eliminate the hazard;
- the level of risk, related to the total radioactive inventory and the thermal and mechanical energy potentially available for uncontrolled release, is far smaller than that during the operating phase of the facility;
- the nuclear safety case requirements are satisfied.

These conditions also apply to the consideration of the consequences of external hazards (e.g. earthquakes, aircraft crashes, etc.). Protection against flooding, provided during the operating phase, remains effective during most of the dismantling phase. The removal of protection provided against external hazards cannot occur before the reduction in the radioactive inventory.

The auxiliary buildings that are erected specifically for the dismantling works must comply with all of the safety requirements in force at the start of work.

The risks to the containment system of the facility related to dismantling operations will be identified and reduced to a very low frequency through appropriate measures, and their consequences will be limited. This particularly applies to:

- the rupture of water and air pipes;
- fires and explosions;
- the dropping of waste containers;
- equipment failure and human error.

2.2. HAZARDS AND CHALLENGES

Hazards management is key in the nuclear industry during all periods of design, construction, operation or decommissioning. As such, identification of all hazards and analysis of the risk that they can present is essential before and during all decommissioning activities. Similarly, feedback and learning from experience is also essential once decommissioning activities are complete, to ensure that all hazards were identified and managed, and that the controls put in place to protect against these hazards were optimised. It is important that learning is gained so that the management of hazards is improved for future projects.

Details on the hazards and challenges expected to be met during the decommissioning of the UK EPR are provided in Chapter 4 of document "GDA UK EPR – Decommissioning" [Ref-1]. Additional details are provided regarding:

- EDF and AREVA experience of decommissioning, participation in working groups and the type of hazards encountered;
- the potentially significant hazards that could reasonably be anticipated during the decommissioning of an EPR;
- the protection measures implemented, along with the controls that have been (or will be) put in place to protect against these hazards;
- control of the likely radiological and industrial safety hazards;
- the criteria for the use of remote-controlled equipment and techniques in decommissioning tasks.

3. DISMANTLING PROCESS

Before being implemented, the dismantling process chosen by the operator is defined through documents dealing with:

- the scheduling and nature of the dismantling works and the facility final state;
- the origin, characterisation, quantity, treatment, packaging, transportation, disposal and recycling of nuclear waste and other kinds of waste as well as the management of the aforementioned;
- the risks to the public and workers and the measures taken to detect, prevent, limit and progressively reduce such risks;
- the maintenance requirements for the facility and the auxiliary buildings during the dismantling phases;
- the on-site emergency plan;
- the predicted impact of dismantling and the facility final state on the environment.

For the UK EPR, the logistical challenges presented by the reactor design, which will have to be dealt with during decommissioning, need to be understood at the design stage, in order to be able to demonstrate the credibility of the baseline decommissioning strategy and that it will be possible to safely decommission both the reactor and the associated interim waste and spent fuel storage facilities.

Chapter 2 of document "GDA UK EPR – Decommissioning" [Ref-1] presents the strategic options with respect to logistical challenges, envisaged decommissioning sequence and methodology including considerations such as safety, decontamination, space, access and infrastructure requirements. It demonstrates how decommissioning can proceed throughout the plant allowing the most activated and contaminated equipment to be decontaminated and subsequently decommissioned safely, and also provides decommissioning principles and considerations for the ILW and Spent Fuel storage facilities.

4. DESIGN PRINCIPLES

The design of the EPR must ensure that decommissioning of the plant will be possible in a safe and environmentally acceptable way. Moreover the design should include specific features and encourage operational philosophies which will enable suitable decommissioning solution(s).

As Low As Reasonably Practicable' (ALARP) considerations must be applied to the decommissioning aspects of the design and philosophies, including incorporation of key design features to facilitate the application of these principles, such as building layout, choice of component material and equipment design.

The measures included in the EPR design to facilitate the decommissioning of the unit mean that the following two main aims can be fulfilled at an acceptable cost:

- reduction of the radioactive dose received by workers;
- reduction of radioactive waste and hazardous material.

In addition to the information provided in this section, Chapter 1 of document "GDA UK EPR – Decommissioning" [Ref-1] identifies the underpinning principles adopted in the design to allow the plant to be decommissioned and waste to be minimised. This includes design principles and fulfilment of IAEA requirements related to decommissioning.

4.1. DOSE REDUCTION

The collective and individual doses are reduced to As Low As Reasonably Practicable (ALARP). All of the factors which contribute to the dose are considered in fulfilling this aim, in particular:

- the intensity of the sources to which the workers are exposed;
- the time spent close to these sources;
- the maintenance of the contaminated equipment;
- the provision of protective measures such as shielding.

All internal contamination is avoided without relying on measures which involve a large increase in the time spent in controlled areas.

4.2. WASTE REDUCTION

All methods of waste minimisation including decontamination, volume and size reduction of radioactive waste and in the categorisation of such waste are considered, particularly:

- the maximum use of recycling of materials, with or without the need to demonstrate their suitability for re-use;
- minimal production of waste which is difficult to dispose of, particularly, long-lived, high activity waste and fibrous and chemically reactive waste;
- minimal production of 'secondary' waste (equipment used for the decommissioning phase and contaminated during the operations).

Uncertainties in waste characterisation are reduced to a minimum as they could otherwise lead to an unnecessarily high categorisation of waste; this applies, in particular, to the unjustified classification of conventional hazardous waste as radioactive waste.

4.3. DESIGN REQUIREMENTS

Design features which facilitate decommissioning must not interfere with the correct operation of the nuclear facility.

The means used to achieve this are as follows:

- the choice of materials with a minimal propensity to become radioactive through activation, by avoiding in particular the use of materials containing high concentration levels of additives or impurities which are likely to generate gamma emitters and long-lived radionuclides after irradiation;
- the use of shielding and barriers which minimise the activation and contamination of equipment in normal and accident conditions;
- the choice of materials and design of systems and rooms which aim to minimise the creation, transportation and deposition of contamination;
- design of access points in nuclear areas, handling equipment and access routes, and use of equipment which is easy to disassemble and protective devices which are easy to clean, with the objective of reducing the expected duration of exposure of workers to radioactivity and contamination;
- complete design and construction documentation, providing with the operating instructions an accurate inventory and location of the radioactive materials and other hazardous materials at the end of reactor operation, and a decommissioning plan.

The designers will make use of international experience from previous decommissioning activities as well as the studies under way and the initial feedback from significant decommissioning projects in France and worldwide.

The experience gained in the replacement of large components in the operating nuclear plants during shutdown for annual and ten-yearly outages of these facilities have identified the causes of high doses to maintenance staff. Except for those associated with the presence of a neutron flux or very short-lived radionuclides, most of the causes, and particularly those which extend the time spent by workers close to irradiated equipment elements, will apply during decommissioning. The design measures taken to facilitate maintenance will therefore have a positive effect on the decommissioning operations.

5. DECOMMISSIONING PRINCIPLES AND OBJECTIVES

During the plant operation and maintenance period, the licensee should adopt principles which will support the baseline decommissioning approach. Examples include updating of the decommissioning plan, collection of records, measurements, decontamination, radiation and contamination surveys, collection of lessons learned and operational experience feedback, and anticipation of future needs.

The baseline principles and objectives that should then be adopted during decommissioning, to enable adequate management of the decommissioning process and preparation of plans and proposals for the decommissioning of an EPR, include items such as:

- safety of the public, and staff;
- safety of the plant;
- protection of the environment;
- waste management;
- financial provisions;
- maintenance of resources and records;
- periodic review of strategy;
- organisation of the activities.

Other principles are those which facilitate the operator to learn from experience, to adopt industry good practice and follow guidance. This includes maintaining knowledge of best practice in all aspects of decommissioning, for example through membership of suitable professional organisations or bodies, and employment of Suitably Qualified and Experienced Personnel.

This is further developed in Chapter 1 of document “GDA UK EPR – Decommissioning” [Ref-1].

6. RECORDS

Whilst record information (baseline data, operational records etc), including that relevant to decommissioning, will be the responsibility of the Licensee, it is recognised that information pertinent to decommissioning should be specifically identified and recorded at the generic design stage of the life-cycle, in order to capture the design features which underpin the baseline decommissioning plans. Systems to facilitate knowledge transfers from all stages of the life-cycle need also to be defined.

Chapter 8 of document “GDA UK EPR – Decommissioning” [Ref-1] identifies the types of information and knowledge, which will be required to be preserved from the initial design stages for the EPR and associated facilities through their operational life and the decommissioning phase itself, so as to ensure that decommissioning may be undertaken safely and efficiently.

Differentiation is made between information which the designer will be required to generate and retain through the design process and operational information and knowledge which the Site Licensee will be required to generate and retain.

SUB-CHAPTER 20.1 – 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.

2. RISK AND HAZARD REDUCTION

2.2 HAZARDS AND CHALLENGES

[Ref-1] GDA UK EPR – Decommissioning. Chapter 4 - Hazards and Challenges. UKEPR-0016-001 Issue 01. EDF/AREVA. March 2011. (E)

3. DISMANTLING PROCESS

[Ref-1] GDA UK EPR – Decommissioning. Chapter 2 – Decommissioning Logistics. UKEPR-0016-001 Issue 01. EDF/AREVA. March 2011. (E)

4. DESIGN PRINCIPLES

[Ref-1] GDA UK EPR – Decommissioning. Chapter 1 – Principles underpinning the design. UKEPR-0016-001 Issue 01. EDF/AREVA. March 2011. (E)

5. BASELINE PRINCIPLES AND OBJECTIVES TO BE ADOPTED DURING DECOMMISSIONING

[Ref-1] GDA UK EPR – Decommissioning. Chapter 1 – Principles underpinning the design. UKEPR-0016-001 Issue 01. EDF/AREVA. March 2011. (E)

6. RECORDS

[Ref-1] GDA UK EPR – Decommissioning. Chapter 8 – Knowledge Management. UKEPR-0016-001 Issue 01. EDF/AREVA. March 2011. (E)