UK EPR	Title: PCSR – Sub-chapter 12.0 – Radiation protection requirements
	UKEPR-0002-120 Issue 04

Total number of pages: 10	Page No.: I / III
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REVISION HISTORY

Issue	Description	Date
00	First issue for INSA review	14.01.08
01	Integration of technical, co-applicant and INSA review comments	26.04.08
02	PCSR June 2009 update: - inclusion of references, - clarification of text - section 1: compliance of the SDO-3 (Safety Design Objective) with the UK regulation, - section 2: addition of values defining the supervised area and the conventional zone.	23.06.09
03	Consolidated Step 4 PCSR update: - Minor editorial changes	27.03.11
04	Consolidated PCSR update: - References listed under each numbered section or sub-section heading numbered [Ref-1], [Ref-2], [Ref-3], etc - Minor editorial changes	27.09.12

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SUB-CHAPTER 12.0 - RADIATION PROTECTION REQUIREMENTS

The aim of this sub-chapter is to define the regulatory framework relating to radiation protection on which the design of the UK EPR is based.

Chapter 12 concentrates mainly on radiation protection in normal operation. Worker exposure due to accidents is considered in Chapters 15 (PSA) and 17 (ALARP) of this PCSR.

1. REGULATORY REQUIREMENTS

The legislative requirements, taken from international, European and national regulations on which this Chapter is based, are listed in the table below:

International Recommendations	ICRP 60 [Ref-1]	**Effective dose limits:** - Workers: 100 mSv over 5 years and maximum 50 mSv in any given year, - Public: 1 mSv/yr Application of ALARA Principles
European Recommendations	Euratom Directive 96/29 of 13 May 1996 [Ref-2]	**Effective dose limits:** - Workers: 100 mSv over 5 years and maximum 50 mSv in any given year, - Public: 1 mSv/yr
UK Legislation	Radiation Protection in UK is regulated under the following regulations: The Ionising Radiations Regulations (IRR) 1999 [Ref-3] [Ref-4]	**Effective dose limits:** - Individual Worker: 20 mSv/yr - Worker extremities and skin (averaged over 1cm^2): 500mSv/yr - Worker lens of eye: 150mSv/yr - Public: 1 mSv/yr from all sources on a site - Public extremities and skin : 50mSv/yr -Public lens of eye: 15mSv/yr

	Radioactive Substances (Basic Safety Standards) (England and Wales) Direction 2000 [Ref-5] [Ref-6] The Radiation (Emergency Preparedness and Public Information) Regulations 2001 (REPPIR) [Ref-7]	-Public: 0.3mSv/yr from operation of a single unit; 0.5mSv/yr from operation of all units on a site. - Post-accident situations: see Chapter 12.5.

The International Commission on Radiological Protection (ICRP), a non-governmental organisation, draws its recommendations from the work of various scientific authorities who study the effects of ionising radiation on man. Their work is published in numbered publications. The Member States of the European Union are bound by the EURATOM Treaty, from which international recommendations are transposed into Directives published in the Official Journal of the European Union. Member States are required to integrate the provisions of these Directives into their own laws within a set time.

Based on data collected on the surviving population after the Hiroshima and Nagasaki bombings, and the re-estimation of risk factors published by the UNSCEAR in 1986, the ICRP produced new recommendations in 1990, published as number 60. These recommendations were adopted by the European Union on 13th May 1996 with the publication of the Euratom 96/29 Directive.

The UK IRRs aim at ensuring that exposure to ionising radiations from work activities are kept As Low As Reasonably Practicable (ALARP) and do not exceed the specified dose limits. The Radiation Emergency Preparedness and Public Information Regulations 2001 (REPPIR) apply to work with ionising radiation that may lead to a radiation emergency. The IRRs stipulate that a radiation employer should take all necessary measures to restrict as far as is reasonably practicable (ALARP) the extent to which its employees and other persons are exposed to ionising radiations. They also specify lower legal limits for the annual exposure of workers and public, that are, respectively, 20 mSv/year and 1 mSv/year (from all sources). Additional limits are also specified for exposure to the eye lens, for equivalent doses to the skin, the hands, forearms, feet and ankles.

The UK EPR additional safety design objectives that are adopted incorporate UK regulatory requirements into the EPR design framework and also recognise the more restrictive exposure limits stated in HSE Safety Assessment Principles. The overall requirement of UK law for radiation doses to workers and the public to be ALARP is included as a UK EPR safety design objective. The additional safety design objectives are stated in Sub-chapter 3.1 of the PCSR and are summarised in the table below:

UK EPR Safety Design Objectives		**Effective dose limits:**
	UK EPR Safety Design Objective SDO-1	The radiation doses to workers and the general public from an EPR, under normal operating and postulated accident conditions, must be As Low As Reasonably Practicable (ALARP).
	UK EPR Safety Design Objective SDO-2	Individual Worker Maximum Dose: 10 mSv/yr
	UK EPR Safety Design Objective SDO-3	Maximum dose to an individual off-site due to normal operation of an EPR shall not exceed 0.3 mSv/yr due to operation of a single unit and shall not exceed 0.5 mSv/yr for the total site on which the EPR unit is located.

2. TECHNICAL GUIDELINES

This Chapter also addresses the requirements of the EPR Technical Guidelines document (see section 2 of Sub-chapter 3.1), which defines the basic principles of the EPR design.

3. MAIN RADIATION PROTECTION REQUIREMENTS

As stated in section 1, the radiation protection requirements on which the design of the EPR is based come from:

- the relevant UK national regulatory legislative texts, the IRRs, which address the developments in the international (ICRP 60) and European (Euratom Directive 96/29) regulations and also stipulate that the doses to workers and members of the public should be maintained ALARP.

- paragraphs relating to radiation protection in the Technical Guidelines, notably paragraph A.1.1 "General safety objectives", A.2.7.“Radiation protection for workers and the public” and C.4.1 “Radiation protection during production”.

- additional Safety Design Objectives for radiation protection adopted to comply with UK/HSE Safety Assessment Principles.

Compliance with the radiation protection requirements for workers in normal plant operation is discussed in the different sections of Chapter 12. The radiation doses to the public from normal operation are addressed separately in Chapter 11 of the PCER.

The topics covered in Chapter 12 are:

- the definition of radiation protection zoning:

A supervised area is a zone in which the workers are likely to receive, under normal working conditions, an annual dose between 1 and 6 mSv. They cannot be exposed to more than 7.5 µSv/hr.

If the workers are likely to receive a dose greater than 6mSv in a year, the rooms are classified as being in a controlled area. A controlled area is further divided into four types of zone:

  - Green zone

The area equivalent dose rate may be greater than 7.5 µSv/hr but is always less than 25 µSv/hr.

  - Yellow zone

The area equivalent dose rate may be greater than 25 µSv/hr but is always less than 2 mSv/hr. The working time in this zone is limited to which is strictly necessary.

  - Orange zone

The area equivalent dose rate may be greater than 2 mSv/hr but is always less than 100 mSv/hr. The access procedure is regulated.

  - Red zone:

The area equivalent dose rate may be greater than 100 mSv/hr. Access is prevented by a physical barrier. The doors are double locked. The access procedure is strictly regulated. An individually named authorisation is compulsory for entering a red zone.

- the definition of an annual occupational dose exposure limit, that covers:
  - a requirement for the total effective dose received by a worker from external and internal exposure not to exceed 10 mSv over twelve consecutive months.
  - the implementation of the EPR optimisation strategy including operational feedback from the best French and German nuclear power plants.
  - the definition of the collective dose target.
- the definition of airborne contamination zoning: at the design stage, the airborne contamination risks considered are the iodine and aerosols risks. The associated classification is used to design the ventilation system.
- the definition of surface contamination zoning (see Sub-Chapter 12.0 - Table 1) into:
  - a conventional waste zone (K) where the surface contamination is lower than 0.4 Bq/cm^2 and where no neutron flux exists,
  - nuclear waste zone which is divided into three zones : the nuclear clean zone (NP) where the surface contamination is lower than 0.4 Bq/cm^2, the nuclear low level contamination zone (N1) where the surface contamination is comprised between 0.4 and 4 Bq/cm^2 and the nuclear high level contamination zone (N2) where the surface contamination is likely to exceed 4 Bq/cm^2.

In conventional, nuclear clean and nuclear low level contamination areas, a periodic cleanliness monitoring programme is applied. The rooms in which such a monitoring programme cannot be performed (because of the ambient dose rate for example) are classified as high level contamination zones.

Sub-chapter 12.0 - Table 1 presents this surface contamination zoning.

SUB-CHAPTER 12.0 – TABLE 1

Surface Contamination Zoning

Zone type	Conventional waste zone	Nuclear waste zone		
Waste zoning	Conventional waste: K	Nuclear waste: N		
Cleanliness zoning	Conventional	NP Nuclear Clean	N1 Nuclear low level contamination	N2 Nuclear high level contamination
Surface contamination (Bq/cm^2)	< 0.4 No neutron flux	< 0.4	0.4 < conta.< 4	> 4

SUB-CHAPTER 12.0 – 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. REGULATORY REQUIREMENTS

[Ref-1] 1990 Recommendations of the International Commission on Radiological Protection. ICRP Publication 60. Ann. ICRP 21 (1-3). 1991. (E)

[Ref-2] Council Directive 96/29/EURATOM of 13 May 1996 laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionizing radiation. Official Journal of the European Communities, L159, Vol. 39. June 1996. (E)

[Ref-3] The Ionising Radiations Regulations 1999. Statutory Instrument 1999 No. 3232. HM Stationery Office. ISBN 0-11-085614-7. (E)

[Ref-4] Nuclear Safety Directorate. Ionising Radiations Regulations 1999 on Sites Regulated by NSD. T/INS/037 Issue 1. UK Health and Safety Executive (HSE). (E)

[Ref-5] Radioactive Substances (Basic Safety Standards) (England and Wales) Direction 2000. (E)

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

[Ref-7] The Radiation (Emergency Preparedness and Public Information) Regulations 2001 (REPPIR). Statutory Instrument 2001 No. 2975. HM Stationery Office. ISBN 0-11-029908-6. (E)