Environment Agency

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

Assessment report
Aqueous radioactive waste disposal and limits

We are the Environment Agency. It's our job to look after your environment and make it **a better place** - for you, and for future generations.

Your environment is the air you breathe, the water you drink and the ground you walk on. Working with business, Government and society as a whole, we are making your environment cleaner and healthier.

The Environment Agency. Out there, making your environment a better place.

Published by:

Environment Agency
Rio House
Waterside Drive, Aztec West
Almondsbury, Bristol BS32 4UD
Tel: 0870 8506506

Email: enquiries@environment-agency.gov.uk

www.environment-agency.gov.uk

GEHO0510BSJR-E-E

Generic design assessment

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

Assessment report – aqueous radioactive waste disposal and limits

Protective status	This document contains no sensitive nuclear information or commercially confidential information.
Process and Information Document[1]	The following sections of Table 1 in our Process and Information document are relevant to this assessment: 1.5 – show that the best available techniques will be used to minimise the waste discharged. 2.1 – describe how aqueous waste will arise, be managed and disposed of. 2.2 – design basis estimates for monthly discharges of aqueous waste. 2.3 – proposed annual for aqueous discharges.
Radioactive Substances Regulation Environmental Principles[2]	The following principles are relevant to this assessment: RSMDP3 - Use of BAT to minimise waste RSMDP12 – Limits and levels on discharges
Report author	Roger Green

1. Process and Information Document for Generic Assessment of Candidate Nuclear Power Plant Designs, Environment Agency, Jan 2007.

   http://publications.environment-agency.gov.uk/pdf/GEHO0107BLTN-e-e.pdf

2. Regulatory Guidance Series, No RSR 1: Radioactive Substances Regulation - Environmental Principles (REPs), 2010.

   http://publications.environment-agency.gov.uk/pdf/GEHO0709BQSB-e-e.pdf

Table of contents

1 Summary

1 This report presents the findings of our assessment of aqueous radioactive waste disposals from the UK EPR based on information submitted by EDF and AREVA in their Pre-Construction Environmental Report (PCER) and supporting documents. We compare discharges with other comparable stations across the world and set out our proposed annual disposal limits and quarterly notification levels (QNL).

2 We conclude that overall the UK EPR utilises the best available techniques (BAT) to minimise discharges of aqueous radioactive waste:

a) during routine operations and maintenance;

b) from anticipated operational events.

3 However our conclusion is subject to one other issue:

a) the sizing of filters and the demineralisation system in the Liquid Waste Processing System.

4 We conclude that the aqueous discharges from the UK EPR should not exceed those of comparable power stations across the world.

5 We conclude that the UK EPR should comply with the limits and levels set out below for the disposal of aqueous radioactive waste to the marine environment.

Radionuclides or group of radionuclides	Annual limit GBq	Quarterly notification level GBq
Tritium	75,000	45,000
Carbon-14	95	9
Cobalt-60	1.5	0.12
Caesium-137	0.5	0.04
All other radionuclides (excepting tritium, carbon-14, cobalt-60 and caesium-137)	3	0.24

2 Introduction

6 In addition to using BAT to prevent and, where that is not practicable, minimise the creation of radioactive waste (as discussed in our report EAGDAR UK EPR-03, see Environment Agency, 2010a), we also expect new nuclear power plant to use BAT to minimise the impact of discharges of radioactive waste to the environment.

7 This report assesses the aqueous radioactive waste created and whether the UK EPR uses BAT to minimise the impact of its discharge. We compare discharges with other comparable stations across the world and propose disposal limits and notification levels for those discharges.

8 We set out in our Process and Information Document (Environment Agency, 2007) (P&ID) the requirements for a Requesting Party to provide information that:

a) shows BAT will be used to minimise the discharge and disposal of aqueous radioactive wastes (reference 1.5);

b) describes sources of radioactivity and matters which affect aqueous wastes arising (reference 2.1);

c) gives design basis estimates for monthly discharges of aqueous radioactive waste (reference 2.2); and

d) gives their proposed annual limits with derivation for aqueous radioactive waste (reference 2.3).

9 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, 2010b).

2.1 BAT to minimise discharges of aqueous radioactive waste

10 Statutory Guidance (DECC, 2009) to us in 2009 reinforced the requirement to use BAT, paragraph 23:

> "*In relation to any designs for new nuclear power stations, the Environment Agency should ensure that BAT is applied so that the design is capable of meeting high environmental standards. This requirement should be applied at an early stage so that the most modern or best available technology can be incorporated into the design of the stations, where this would ensure improved standards. The application of BAT should ensure that radioactive wastes and discharges from any new nuclear power stations in England and Wales are minimised and do not exceed those of comparable stations across the world*."

11 In our Radioactive Substances Regulation Environmental Principles (REPs, Environment Agency, 2010c), principle RSMDP3 (Use of BAT to minimise waste) states that:

> "*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.*"

12 The methodology for identifying BAT is given in principle RSDMP4 and the application of BAT is described in principle RSDMP6. We also published in 2009 our Assessment Guide: "Radioactive Substances Regulation: Assessment of Best Available Techniques" (now Environment Agency, 2010d). The Guide says that, for initial clarity:

> "*BAT are the means by which an operator optimises the operation of a practice in order to reduce and keep exposures from the disposal of radioactive waste into the environment as low as reasonably achievable, economic and social factors being taken into consideration (ALARA)*".

13 In this report we assess the techniques EDF and AREVA use in the UK EPR to minimise the discharge and impact of aqueous radioactive wastes and present our conclusions on whether BAT is demonstrated.

14 EDF and AREVA provided their submission to GDA in August 2007. We carried out our initial assessment and concluded we needed additional information. We raised a Regulatory Issue on EDF and AREVA in February 2008 setting out the further information that we needed. In particular we believed P&ID reference 1.5 had not been addressed by the submission and required “a formal BAT assessment for each significant waste stream”.

15 EDF and AREVA completely revised their submission during 2008 and provided a Pre-Construction Environmental Report (PCER) with supporting documents.

16 We assessed information contained in the PCER but found that while much improved from the original submission it still lacked the detail we require to demonstrate BAT is used. We raised two Regulatory Observations (ROs) on EDF and AREVA in May and June 2009 that had actions to provide:

a) a detailed BAT assessment for carbon-14 to demonstrate that its discharges had been minimised, we specifically addressed carbon-14 as its impact was the highest of the discharged radionuclides;

b) more general BAT assessments to show the significance of individual radionuclide arisings and that significant arisings had been minimised.

17 We raised 31 Technical Queries (TQs) on EDF and AREVA during our assessment. Six were relevant to this report:

a) Quantity of carbon-14 in proposed discharge to sea.

b) Liquid radioactive waste filters.

c) Fuel management regimes and their impact on proposed liquid and gaseous radioactive waste discharges.

d) Liquid waste discharge pond.

e) Liquid waste tanks.

f) Discharge of actinides.

18 EDF and AREVA responded to all the ROs and TQs. They reviewed and updated the PCER in March 2010 to include all the relevant information provided by the ROs and TQs. This report only uses and refers to the information contained in the updated PCER and its supporting documents.

2.2 Comparison of discharges with other stations

19 We commissioned a study to help us compare discharges from designs put forward for GDA with currently operating nuclear power plant. Our Science Report SC070015/SR1 "*Study of historic nuclear reactor discharge data*" was published in September 2009 (Environment Agency, 2009a). We used data from this report and our own sources to establish annual discharge ranges for significant radionuclides for "*comparable stations across the world*", see Annex 3 of our Consultation Document.

20 This report compares the aqueous discharges from the UK EPR with the ranges quoted in Annex 3 of the Consultation Document.

Radionuclides or group of radionuclides	UK EPR predicted annual discharge	UK EPR normalised to 1000 MWe	Range for 1000 MWe station
Tritium (TBq)	52	30	2 - 30
Carbon-14 (GBq)	23	13	3 - 45
Iodine radionuclides (MBq)	7	4	10 - 30
Other radionuclides not specifically limited (GBq)	0.6	0.35	<1 - 15

2.3 Discharge limits and levels

2.3.1 Radionuclides on which limits should be set

21 We recommended in the P&ID that RPs should take account of our Science Report SC010034/SR "*Development of Guidance on setting limits on discharges to the Environment from nuclear sites*" (Environment Agency, 2005). The report sets outs that limits should be set on radionuclides and / or groups of radionuclides which:

a) are significant in terms of radiological impact for humans and non human species, including radionuclides that may be taken up in food;

b) are significant in terms of the quantity of radioactivity discharges, whether or not they are significant for radiological impact;

c) have long radioactive half-lives, that may persist and / or accumulate in the environment and that may contribute significantly to collective dose;

d) are good indicators of plant performance and process control; or

e) provide for effective regulatory control and enforcement.

This advice from the report was essentially confirmed in the *Considerations* section of RSMDP12 in our REPs.

22 In addition our Considerations document (Environment Agency, 2009b) recommends the following criteria for identifying radionuclides or groups of radionuclides for which to set plant limits:

a) Critical group dose from the established worst case plant discharges (EWCPD) is greater than 1μSv per year;

b) Collective dose from the EWCPD is greater than 0.1 man Sv;

c) The EWCPD exceeds 1TBq per year;

d) Discharges of the radionuclide are a good indicator of plant performance or process control, or limits are otherwise felt to be necessary for effective regulatory control and enforcement.

23 We used the above advice and criteria to determine appropriate radionuclides and groups of radionuclides on which to set limits.

2.3.2 Time basis of limits

24 We decided that the most appropriate limit basis was that of a rolling 12 month period. This provides an element of flexibility for the site operator with respect to normal fluctuation in discharges on a month by month basis whilst exerting a smoothing effect. This encourages operators to ensure that discharges are made, wherever possible, at relatively consistent levels and to avoid short term elevations in the amount of radioactivity discharged which may increase the impact on humans or non humans species.

25 Discharge limits set on a rolling 12 month basis also allow derivation of information about discharges in any calendar year and such information is used to assess impact in terms of dose which is generally expressed in terms of dose in a calendar year. Additionally discharge limits set on a 12 month rolling basis allow reporting on annual discharges required under such things as the OSPAR Convention and in UK publications such as the annual publication on Radioactivity in Food and the Environment.

26 We discarded the concept of discharge limits set in terms of activity discharge per cycle as this adds complexity to the regulatory process as in practice cycle lengths may vary from the operational aims of an 18 month cycle and it is difficult to set limits to take into account any unexpected changes in cycle length.

27 For simplicity we use the term *Annual Limit* later in this report and in the Consultation Document but it should be taken that this would be expressed in a permit as a *12 month rolling limit*.

2.3.3 Limit setting

28 Our limit setting report recommends the use of a formula to determine the headroom which is appropriate to apply to average discharges to give operational flexibility and to take into account other conditions which might change during the period for which the limits would apply. The report recommends the use of the formula to calculate the “worst case annual plant discharge” (WCPD):

29 WCPD = (1.5 x D x T x A x B) + C + L + N – I where:

a) 1.5 is an Environment Agency-established factor which relates ‘worst case’ to average discharges and takes account of the requirement to minimise headroom.

b) D is the representative average 12-month plant discharge. The average excludes discharges due to faulty operation of plant but includes discharges arising from minor unplanned events.

c) T is a factor, which allows for any future increases in throughput, power output etc relative to the review period.

d) A is a factor, which allows for plant ageing – that is, for increases in discharges which result from changes within the plant as it ages that cannot be remedied or controlled by the operator.

e) B is a factor, which allows for other future changes that are beyond the control of the operator.

f) C is an allowance for decommissioning work beyond that carried out in the review period (and included in D).

g) L is an allowance for dealing with legacy wastes, beyond those dealt with in the review period (and included in D).

h) N is an allowance for new plant.

i) I is the reduction in discharges expected as a result of introducing improvement schemes before the new authorisation comes into force.

30 The discharge setting report recommends that WCPD for new plant should be a factor of 2 times the best estimate of discharges of radioactive waste.

31 Subsequent to the report, Statutory Guidance (DECC, 2009) to us states that we should set limits:

a) *based on the use of BAT; and*

b) *at the minimum levels necessary to permit "normal" operation of a facility.*

32 Statutory Guidance also states that "Where the prospective dose to the most exposed group of members of the public from discharges from a site at its current discharge limits is below 10 μSv y^{-1} the Environment Agency should not seek to reduce further the discharge limits that are in place, provided that the holder of the authorisation applies and continues to apply BAT". While this applies to existing sites we consider the 10 μSv y^{-1} is an appropriate benchmark to consider when deciding if BAT are used and an appropriate limit based on the use of BAT.

33 We have assessed that the impact of radioactive discharges from the UK EPR to the most exposed person to be 31 μSv y^{-1} (our report EAGDAR UK EPR-11, see Environment Agency 2010e). This indicates we need to actively challenge the EDF and AREVA BAT assertions. We indicate in our assessment below the impact attributable to each considered radionuclide or group of radionuclides and have targeted our assessment time at those with the highest contribution to the total. Where some radionuclides have only minimal contribution (much less than 10 μSv y^{-1}) to the impact we have reduced our assessment time.

34 Our REPs reiterate the Statutory Guidance in relation to limits in the *Considerations* for principle RSMDP12:

a) *limits should be based on the level of releases achievable by the use of BAT by operators;*

b) *limits should be set such that there is a minimum headroom between actual levels of discharge expected during normal operation and the discharge limit.*

35 EDF and AREVA did not use the methodology of our limit setting guidance. They presented discharge data for radionuclides and groups of radionuclides in the PCER as:

a) "annual expected performance" – the lowest annual discharge expected from a UK EPR with no contingency margin and no allowance for any operational failure;

b) "maximum annual discharge" – combines the "expected performance" with contingencies derived from operation feedback data from predecessor reactors adapted to improvements expected from the UK EPR. The "maximum" may also include contingencies associated with management options. EDF and AREVA use a qualified descriptive justification to get from "expected performance" to "maximum".

36 We have assessed the EDF and AREVA "maximum" proposals and where we believe justified have accepted them. Otherwise we have reviewed the information contained in the PCER and used it as far as possible within our own limit setting guidance to propose limits.

2.3.4 Notification level setting

37 Our REPs state, in the *Considerations* for principle RSMDP12, that advisory levels should be set that:

a) *prompt review of whether the best available techniques are being used; and*

b) *ensure early assessment of the potential impact of increased discharges*.

38 Advisory levels should also require early reporting of:

a) *operational performance issues leading to increases in discharges; and*

b) *events that have given rise to higher than normal short term discharges*.

39 We have in the past set quarterly, weekly or daily advisory levels. We consider that as the radioactivity discharges from the UK EPR are of a relatively low quantity and reasonably even over time that only quarterly notification levels (QNL) should be set.

40 The QNL is defined precisely by a condition in any permit we issue, a typical condition would be:
'*If, in any quarter, the activity in waste discharged of any radionuclide or group of radionuclides specified in (the relevant Table) exceeds the relevant Quarterly Notification Level, the Operator shall provide the Agency with a written submission which includes:*

a) *Details of the occurrence;*

b) *A description of the techniques used to minimise the activity of waste discharged;*

c) *A review of those techniques having regard to the following:*

   i) The operator shall use the best available techniques to minimise the activity of radioactive waste produced on the premises that will require disposal to be disposed of on or from the premises;

   ii) The operator shall use the best available techniques in respect of the disposal of radioactive waste pursuant to this permit to:

      a) minimise the activity of gaseous and aqueous radioactive waste disposed of by discharge to the environment;

      b) minimise the volume of radioactive waste disposed of by transfer to other premises;

      c) dispose of radioactive waste at times, in a form, and in a manner so as to minimise the radiological effects on the environment and members of the public.

Not later than 14 days from making the record which demonstrates such excess.'

41 The exceedence of a QNL set in a permit is not an offence. But it would be an offence for an Operator to fail to notify us of the exceedence of a QNL in accordance with the relevant condition of the permit.

42 Normally we would use operational discharge data over at least 5 years to set QNLs. But as the UK EPR has not yet operated anywhere in the world we cannot do this at GDA. The simplest way to set a QNL would be to take a proportion of the annual limit say 25%. However annual limits have contingency factors built in and we need to get early warning if discharges are above normal (without any contingency) so that we can ensure that BAT are still being used. We have therefore usually taken the "expected performance" figures quoted in the PCER as our start point to set QNLs. The detail of how we set each QNL is given below.

43 It is possible that with operational discharge data from EPRs currently under construction will become available during specific site permitting. We will review this and may need to revise the QNLs for any permit we issue.

3 Assessment

3.1 Assessment Methodology

44 The basis of our assessment was to:

a) read appropriate sections of the PCER and its supporting documents;

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) assess the techniques proposed by EDF and AREVA to minimise the discharge of aqueous radioactive waste using our internal guidance and regulatory experience and decide if they represent BAT;

e) compare aqueous discharges from the UK EPR to ranges quoted in Annex 3 of the Consultation Document (Environment Agency, 2010b);

f) assess the EDF and AREVA proposals for limits, compare with our own methodology and set our own limits and levels;

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

3.2 Assessment Objectives

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

a) have all sources of aqueous radioactive waste been identified?

b) have options for minimising the discharge of significant radionuclides that will be present in aqueous waste been presented?

c) are the options chosen for the UK EPR BAT?

d) are the discharges comparable to operating stations across the world?

e) have annual aqueous disposal limits been proposed by EDF and AREVA?

   i) is the derivation of the limits clear?

   ii) are contingencies acceptable?

   iii) have they taken account of our limit setting guidance (Environment Agency, 2005)?

3.3 EDF and AREVA documentation

46 The Pre-Construction Environmental Report is divided into chapters and sub-chapters (provided as separate documents) and has supporting documents. We referred to the following documents to produce this report:

Document reference	Title	Version number
UKEPR-0003-011	PCER-Sub-chapter 1.1 - Introduction	03
UKEPR-0003-030	PCER – Chapter 3 – Aspects having a bearing on the environment during operation phase	02
UKEPR-0003-061	PCER – Sub-chapter 6.1 – Sources of radioactive materials	03
UKEPR-0003-063	PCER – Sub-chapter 6.3 – Outputs for the Operating Installation	03
UKEPR-0003-064	PCER – Sub-chapter 6.4 - Effluent and waste treatment systems design architecture	03
UKEPR-0003-080	PCER – Chapter 8 – Best Available Techniques	01
UKEPR-0003-110	PCER – Chapter 11 – Radiological impact assessment	02
UKEPR-0011-001	GDA UK EPR-BAT Demonstration	03
UKEPR-0010-001	GDA UK EPR – Integrated Waste Strategy Document	02

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

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

b) BAT Demonstration section 3.2 = EPRBs3.2.

3.4 Origins of aqueous radioactive waste

48 The PCERsc3.4s5.2.2 (see also Figure 1 reproduced in the Annex of this report) describes three categories of liquid radioactive effluent:

a) liquid associated with the reactor coolant, not chemically polluted;

b) spent liquid comprising polluted reactor coolant, chemical effluent and floor drainage;

c) drainage water from the Turbine Hall including blowdown from the secondary circuit.

49 The PCERsc6.2s1.1.1 gives more detail on the collection of effluents into 3 drain systems:

a) process drain (PD): collects polluted primary coolant that cannot be recycled;

b) chemical drain (CD): collects chemically polluted water from the Nuclear Auxiliary Building, Reactor Building and Fuel Building;

c) floor drains (FD) of 3 types:

   i) FD1: collects potentially contaminated leaks and floor washings from controlled areas;

   ii) FD2: collects normally uncontaminated leaks and floor washings from controlled areas;

   iii) FD3: normally uncontaminated leaks and floor washings from outside controlled areas. FD3 is normally sent directly to a discharge tank for non-radioactive wastes (in the Conventional Island Liquid Waste Discharge System (CILWDS)).

50 The effluents from the PD, CD, FD1 and FD2 are collected in separate buffer tanks before treatment in the Liquid Waste Processing System (LWPS). Effluent from the LWPS is collected in disposal tanks (the LRMDS tanks). The contents of these tanks are analysed before disposal to the sea is allowed under a managed procedure.

51 Drainage from the Turbine Halls is normally sent to the CILWDS except for blowdown water from the secondary circuit. This is normally recycled after treatment, but, if recycling is not possible, blowdown is sent to the LRMDS tanks.

52 An overall diagram of the effluent systems is given in PCERsc6.4s1 Figure 1, reproduced in the Annex of this document.

53 The UK EPR uses filtration and / or demineralisation and / or evaporation in the LWPS to minimise discharges of liquid radioactive waste. These techniques are specifically targeted at the reduction of fission and activation products and are assessed later in this report. PCERsc6.4s2.1 Figure 2, reproduced in the Annex of this report, shows the principle of routing of effluents:

54 PCERsc3.4s5.2.4 Table 1 states that the UK EPR will make radioactive discharges to the sea as given in the Table below. We have added to that Table our proposed annual disposal limits and QNLs, which are explained further later in our report.

Category	Annual expected performance excluding contingency GBq	Maximum annual liquid radioactive discharge GBq	Proposed Environment Agency Disposal Limits GBq	Proposed Environment Agency QNL GBq
Tritium	52,000	75,000	75,000	45,000
Carbon-14	23	95	95	9
Iodine radionuclides	0.007	0.05	None	None
Cobalt-60	0.18	3	1.5	0.12
Caesium-137	0.0567	0.945	0.5	0.04
All other radionuclides (excepting tritium, carbon-14, cobalt-60 and caesium-137)	0.4	6	3	0.24

55 PCERsc3.4s5.2.4 Table 2 gives the distribution of fission and activation products in radionuclides discharged as aqueous waste. The most significant are cobalt-60 and cobalt-58. We are content this lists the significant individual radionuclides that need to be considered.

Radionuclide	Expected performance	Maximum annual activity
Ag 110m	0.0342 GBq	0.57 GBq
Co 58	0.1242 GBq	2.07 GBq
Co 60	0.18 GBq	3 GBq
Cs 134	0.0336 GBq	0.56 GBq
Cs 137	0.0567 GBq	0.945 GBq
Mn 54	0.0162 GBq	0.27 GBq
Sb 124	0.0294 GBq	0.49 GBq
Te 123m	0.0156 GBq	0.26 GBq
Ni 63	0.0576 GBq	0.96 GBq
Sb 125	0.0489 GBq	0.815 GBq
Cr 51 / Others	0.0036 GBq	0.06 GBq

Sub-chapter 3.4 – Table 2: Distribution of fission and activation products in radionuclides discharged in liquid form (expected performance and maximum values)

56 We will set limits and levels on the quantities of radioactivity that can be discharged into the environment where these are necessary to secure proper protection of human health and the environment. We have assessed the information within the PCER against the criteria in our limit setting guidance (Environment Agency, 2005) as follows:

a) critical group dose greater than 1 μSv y^{-1}: carbon-14 at 14 μSv y^{-1} and "all other radionuclides" at 3.27 μSv y^{-1} (total including cobalt-60 and caesium-137);

b) discharge exceeds 1 TBq y^{-1}: tritium;

c) indicator of plant performance:

   i) cobalt-60 indicates effectiveness of corrosion controls and the filter and demineralisation system in the Liquid Waste Processing System;

   ii) caesium-137 is an indicator of fuel cladding failures.

57 We have set out our proposed disposal limits for tritium, carbon-14, cobalt-60, caesium-137 and other radionuclides in the Table above. "All other radionuclides" will be more completely defined in any permit we issue, for example "All other radionuclides means the sum of all radionuclides as measured by the methods defined in this permit except those specified individually in the Table". We do not consider it proportionate to set a limit for iodine radionuclides as discharge levels and impact are low and measured levels may well be below detection thresholds of monitoring methods.

58 EDF and AREVA state that alpha-emitting radionuclides should not be present in detectable amounts in the aqueous discharge and that in-line detectors will operate to prevent any such discharge. We will not include alpha-emitters as a category for disposal limits.

59 PCERsc6.3s6.2 to s6.5 quantifies disposals, these are given as "expected performance" that has no allowance for any contingencies and "maximum" (we have taken as proposed disposal limit) that allows for contingencies to cover situations foreseeable in normal operations but not any incidents. The PCERsc6.2s1.2.2 covers the nature and treatment of the aqueous disposals. We have summarised the PCER information below.

3.5 Specific radionuclides disposals and limits

3.5.1 Tritium

60 Tritium is present as tritiated water in the reactor coolant. EDF and AREVA state there are currently no available techniques to remove tritium from the reactor coolant. Therefore to avoid the build up of tritium in the coolant (to reduce radiological hazard) a portion of the coolant must be discharged (and replaced). This is the main source of tritium for aqueous discharge.

61 Tritium can also be found in the water contained in the secondary circuit if there are leaks in the steam generators. Any water drained from the circuit will enter the LWPS and be contained in storage tanks before monitoring and discharge. This discharge route does not affect the overall discharge of tritium.

62 EDF and AREVA review aqueous abatement techniques (EPRBs3.3) but do not consider any represent BAT:

a) decay by delay is not an option as the half-life of tritium is 12 years;

b) filtration has no effect on tritium in liquid effluents;

c) evaporation is not an option as tritiated water would carry over to the condensate, leaving little in the concentrate for treatment and disposal as solid waste;

d) EDF and AREVA refer to IAEA Technical Report No. 421 that lists some theoretical techniques that may have potential for use in the future, but none are currently technically developed for PWRs;

e) tritiated water could be collected and cemented to solid waste. This would produce large volumes of solid waste for disposal (probably ILW) and the tritium may not be immobilised effectively;

f) isotopic retention is an undeveloped technique.

63 Tritium discharges have a low impact on the environment (see below: 0.018 μSv y^{-1} to an adult). Therefore we agree that the use of any of the aqueous abatement techniques considered is not proportionate for the UK EPR, we conclude that the UK EPR uses BAT to minimise the discharge of aqueous tritium.

64 The “expected performance value” of 52 TBq y^{-1} and “maximum” of 75 TBq y^{-1} were taken from calculations assuming 91% or 100% power production respectively and various reactor chemistry options (PCERsc6.3s6.2.1.4). EDF and AREVA then reviewed operational experience of predecessor plant to validate the calculations.

65 From our examination of historic discharges from European and US PWRs operating over the last 10 to 15 years we consider that the range of discharge to water of tritium is 2 to 30 TBq per year for a 1000 MWe power station. (see Annex 3 of Consultation Document). The “expected performance” aqueous discharge of tritium from UK EPR is 52 TBq, as tritium production is directly related to power we need to correct against the 1735 MWe of the UK EPR to give 30 TBq/1000 MWe. While the UK EPR is at the top of our range we did note that the design minimises gaseous discharge of tritium, this means most tritium will be in the aqueous discharge. We conclude that aqueous discharge of tritium is comparable to other power stations across the world.

66 EDF and AREVA state that monthly discharges are related to the time in the generation cycle. Also contingency is needed to allow operational flexibility to delay discharges for a period to allow for maintenance or faults in the LWPS. Values at 25% of the annual are quoted: 13 TBq/month “expected performance” and 18.75 TBq/month “maximum”.

67 The radiological impact from the “maximum” disposal of tritium to the sea is stated as a dose to adults of 0.018 μSv y^{-1}, to children of 0.0049 μSv y^{-1} and infants of 0.0017 μSv y^{-1} – from PCERsc11.1 Annex 3 Tables E, F and G. We consider these to be of low significance.

68 EDF and AREVA propose a liquid disposal limit for tritium of 75 TBq per year. The headroom over the “expected performance” of 52 TBq y^{-1} allows for up to 100% production or other management options that may affect tritium discharges. (PCERsc6.3s6.2.2.2)

69 We have accepted above that the UK EPR uses BAT to minimise the liquid discharge of tritium with an “expected performance” value of 52 TBq y^{-1}. We accept the headroom proposed by EDF and AREVA as a reasonable contingency factor and we will set the annual disposal limit at 75 TBq.

70 As tritium production depends on power production rather than abatement techniques we consider that a quarterly notification level based on the maximum disposal (75 TBq y^{-1}) is appropriate in this case. We will take the stated maximum monthly estimate of 25% of annual (18.75 TBq) and add 2 months at the “expected” level of 13 TBq to give (rounded up) 45 TBq per quarter. This should highlight adverse trends in disposals and require an Operator to demonstrate that BAT is still being applied if a QNL is exceeded.

3.5.2 Carbon-14

71 As described in our report EAGDAR UK EPR-03 (Environment Agency, 2010a) 5-20% of carbon-14 produced (444 GBq y^{-1}) will be present in the aqueous or solid wastes. (PCERsc6.3s6.3.1)

72 EDF and AREVA propose no specific techniques for C-14 reduction in aqueous wastes from the UK EPR but have considered (EPRBs3.2):

a) decay by delayed discharge is not an option as the half-life of C-14 is 5710 years;

b) filters and demineralisers do remove some C-14 but this is dependent on the form of the C-14 and these items are optimised for corrosion products removal. Further treatment may be possible by filters and demineralisers but reductions are difficult to calculate and may only affect C-14 in inorganic forms while much may be organic. Further, increasing C-14 content on filter media and resins can give matters for solid waste disposal (current disposal facilities have a strict acceptance criterion for C-14). Further treatments by these techniques are not proposed.

c) evaporation of some liquid effluent is undertaken in the UK EPR. Evaporation of all liquid effluent is possible but would require "*significant amounts of additional energy* [13 GWh to evaporate the predicted 19000 m^3 of liquid effluents from Flamanville units 1 and 2] *whilst conversion* [of the concentrate] *to solid waste would produce large volumes of solid waste*". Further, past operational experience has shown that while much C-14 would be retained in concentrates there is still significant C-14 activity in distillates and these must be discharged (in GDA to the sea). EDF and AREVA do not intend to consider additional evaporation for the UK EPR but offer no formal options assessment.

73 EDF and AREVA claim that while techniques have been used in the UK EPR to minimise the presence of C-14 in aqueous wastes (see EAGDAR UK EPR-03) there are no techniques that are BAT for reduction of the C-14 content of those wastes. We conclude that, at this time, there are no applicable techniques that may be used on the UK EPR to reduce the discharge of carbon-14 to the sea.

74 The "expected performance" value of 23 GBq y^{-1} was estimated from the basic source term of 444 GBq y^{-1} applying operational feedback experience from the predecessor 1300 MWe reactors. This is also about 5% of the source term so equates well to the expected distribution. (PCERsc6.3s6.3.2.1)

75 EDF and AREVA propose a "maximum" value of 95 GBq y^{-1}. This is because:

a) the 444 GBq y^{-1} term was based on reactor availability of 91% and it is hoped the UK EPR will exceed this value;

b) the distribution of carbon-14 between gas and liquid in the UK EPR could be different to existing reactors, operational experience of an EPR is needed to confirm performance;

c) the 444 GBq y^{-1} source term assumed a coolant nitrogen content of 10 ppm, if a higher content is found in operation then the nitrogen source term will increase.

76 From our limited information about PWRs operating over the last 10 to 15 years we consider that the range of discharge to water of carbon-14 is 3 to 45 GBq per year for a 1000 MWe power station (see Annex 3 of Consultation Document). The "expected performance" aqueous discharge of carbon-14 from UK EPR is 23 GBq, (13.3 GBq normalised to 1000 MWe) well within this range. We conclude that aqueous discharge of carbon-14 from the UK EPR is comparable to other power stations across the world.

77 EDF and AREVA state that monthly discharges of carbon-14 are very dependent on power produced and generally unaffected by operating contingencies. However operational management of aqueous discharges, as noted for tritium above, may affect level of discharge in any month. A "maximum" monthly discharge of 24 GBq is proposed based on 25% of the annual "maximum".

78 The radiological impact from the "maximum" disposal of carbon-14 to the sea is stated as a dose to adults of 14 µSv y^{-1}, to children of 4.2 µSv y^{-1} and infants of 1.4 µSv y^{-1} – from PCERsc11.1 Annex 3 Tables E, F and G. This is the most significant contributor to the total dose from a UK EPR.

79 We have accepted that the UK EPR uses BAT to minimise the aqueous discharge of carbon-14 with an "expected performance" value of 23 GBq y^{-1}. While the level of headroom proposed is high, an additional 72 GBq y^{-1} to allow for the uncertainty of split between gas and liquid and level of nitrogen in the coolant, we do recognise the

uncertainties at this time and will set an indicative annual disposal limit at 95 GBq, this gives a pessimistic impact assessment. We will review this limit at the earliest opportunity once operational experience is available.

80 We will set a quarterly notification level based on the "expected performance" to give us early indication if this performance cannot be met in operation. We have allowed for 25% of annual discharge in 1 month (say 6 GBq) and average discharge (say 1.5 GBq) for 2 months. This gives a QNL of 9 GBq.

3.5.3 Iodine radionuclides

81 As described in our report EAGDAR UK EPR-03 (Environment Agency, 2010a) iodine radionuclides are formed in the fuel and are only present in the coolant in the event of fuel cladding defects. Iodines tend to dissolve and are therefore mostly found in liquid effluents. While it is not their primary function, the demineralisers in the Coolant Purification System do absorb significant amounts of iodines. Also effluents are held up in tanks in the Liquid Waste Processing System awaiting treatment or discharge, the delays will allow the shorter half-life iodine radionuclides to decay. (PCERsc6.3s6.4.1.1 and EPRBs3.6)

82 The EDF and AREVA BAT case for iodine radionuclides relies on:

a) improved fuel integrity;

b) removal in the demineralisers.

83 We conclude that the very low levels of discharge and impact (see below) support the case that BAT is employed without a detailed assessment.

84 The "expected performance" is stated as 7 MBq y^{-1}. This is supported by operational feedback from predecessor reactors but results of measurements are often below detection thresholds so that the 7 MBq value is actually a "limit of detection" value.

85 The "maximum" value proposed is 50 MBq y^{-1}. This allows for some 40 MBq headroom over the "expected value" and relates to operational experience of predecessor reactors when this value was achieved on rare occasions. The headroom allows for contingencies of fuel and treatment system failure. (PCERsc6.3s6.4.1.3)

86 From our limited information about PWRs operating over the last 10 to 15 years we consider that the range of discharge to water of iodine radionuclides is 10 to 30 MBq per year for a 1000 MWe power station (see Annex 3 of Consultation Document). The "expected performance" aqueous discharge of iodine radionuclides from UK EPR is 7 MBq (4 MBq normalised to 1000 MWe), below this range. We conclude that aqueous discharge of iodine radionuclides from the UK EPR is comparable to other power stations across the world.

87 Monthly discharges in normal operation are stated as being at detection threshold and equivalent to 0.7 MBq. However a worst case scenario could see almost all the "maximum" annual discharge in 1 month – the "maximum" monthly discharge value is quoted as 50 MBq.

88 The radiological impact from the "maximum" disposal of iodines to the sea is stated as a dose to adults of 7.6×10^{-5} (0.000076) µSv y^{-1}, to children of 3.8×10^{-5} µSv y^{-1} and infants of 2.2×10^{-5} µSv y^{-1} – from PCERsc11.1 Annex 3 Tables E, F and G. We consider this impact to be almost insignificant.

89 We have accepted that BAT is used to minimise the discharge of iodines to the sea with a "predicted performance" of 7 MBq y^{-1}. We have decided that at this level of discharge and bearing in mind the very low impact it is not proportionate to set a limit or quarterly notification level for the discharge of iodine radionuclides to the sea.

3.5.4 Other radionuclides

90 Aqueous wastes can contain other radionuclides in addition to those specifically considered above. These are both particulate and dissolved activated corrosion products (particularly cobalt-58 and cobalt-60) and fission products (particularly caesium-134 and caesium-137). (PCERsc6.3s6.4.2.1) The main source of these is the coolant. The coolant is recycled through filters and demineralisers in the Chemical and Volume Control System (CVCS) where high decontamination factors are achieved. EDF and AREVA say they rely on these systems for primary reduction of these other radionuclides. However low concentrations are still found in managed discharges and minor leaks of coolant reaching the Liquid Waste Processing System (LWPS).

91 PCERsc8.2s3.3.3 lists some available techniques to treat liquid effluents:

a) chemical precipitation;

b) hydro-cyclone centrifuging;

c) cross-flow filtration;

d) ion exchange (demineralisation);

e) reverse osmosis;

f) evaporation.

92 PCERsc8.2s3.3.3.4 discusses some techniques under development for potential use for the treatment of EPR effluents:

a) membrane technologies such as cross-flow, micro- and ultra-filtration might be used to retain particles down to 0.01 micron size;

b) reverse osmosis might be suitable to remove dissolved substances from effluent;

c) electrolysis might be used to remove electro-active materials such as corrosion products;

d) isotopic retention is an electrochemical process using a metallic catalyst that can reduce the concentration of some radionuclides.

93 EDF and AREVA claim that only the following techniques are BAT for use in the UK EPR:

a) filtration for removing particulate matter using single-use cartridge filter technology;

b) ion exchange systems for removing dissolved active materials;

c) evaporation for effluents which are incompatible with ion exchange resins, the concentrate is treated for disposal.

94 EDF and AREVA argue that other techniques are not currently developed for use in PWRs while those chosen are in standard use. Further the chosen techniques are adequate to optimise discharges.

95 We conclude that, at this time, filtration by cartridge filter, ion exchange and, for effluents incompatible with ion exchange, evaporation are BAT for use in the UK EPR.

96 A diagram of the LWPS is provided as Figure 5 in the IWSp37 (reproduced in the Annex of this report) and more detailed descriptions are in PCERsc6.2s1.1.3.

97 Effluents are collected at the front end of the LWPS by tanks. Tank contents, depending on their analysis, may be treated by filtration, filtration and ion exchange or by evaporation. After treatment the contents are pumped by way of a final filter to a set of discharge tanks.

98 In the UK EPR, single use cartridge filters are available to select as required by operations in the LWPS. We have not found a BAT case to support the filter pass size chosen: (PCERsc8.2s3.3.3.1)

a) floor drain system – 25 micron;

b) process drain system – 25 followed by 5 micron before demineraliser, 25 micron after (to remove any resin particles);

c) chemical drain system – 25 micron;

d) final filter before discharge tanks – 5 micron.

99 All filters are fitted with instruments to measure the pressure difference over the filter element. The pressure will increase as filters are used and retain particles. EDF and AREVA say they will only change filter elements when a set pressure is exceeded. We accept this is BAT to minimise the volume of solid waste arisings from use of filters.

100 The process drain system contains a demineralisation system with 3 beds (PCERsc8.2s3.3.3.2):

a) strong high-capacity anionic or macro-porous resins;

b) strong high-capacity gel-type cationic resins;

c) mixed-bed-type.

101 EDF and AREVA state that: '*The initial choice retained for the UK EPR is one high-capacity cationic bed and one mixed bed. The third space is left empty and is used if deemed necessary by the operator, for example if there is a problem with one of the beds (filling the third space will allow for maintenance to be carried out on the bed, without interruption of the filtering process); it also allows flexibility in dealing with specific pollutants (silver, tritium…), as it can be used for a specific treatment if necessary.*'

102 We have been unable to find a BAT case to support the design of the demineralisation system.

103 The chemical drain system has an evaporator available. This separates chemically polluted effluents into a distillate (only weakly active / polluted) and a concentrate containing most of the activity / pollution. The distillate is sent to the discharge tanks after monitoring. The concentrate is sent to the Solid Effluent Treatment Unit for treatment before disposal. We conclude that the provision of the evaporator on the UK EPR is BAT to treat otherwise untreatable aqueous wastes.

104 We conclude, in principle, that the Liquid Waste Processing System of the UK EPR is BAT for minimising the discharge of fission and activation products. However as the impact of other radionuclides is greater than 1 μSv y^{-1} we require a complete formal BAT assessment to confirm that the sizing of filters and the demineralisation system is in fact BAT to minimise the discharge to sea of other radionuclides prior to or during site specific permitting.

105 EDF and AREVA claim that the "expected performance" for discharge of other radionuclides (the total including cobalt-60 and caesium-137) is 0.6 GBq y^{-1}. This value is supported by operational data from predecessor reactors with an allowance for improvements in effluent treatment in the UK EPR. This value is without contingency allowances for such issues as leaking fuel. EDF and AREVA expect the UK EPR to discharge 10% less other radionuclides than the predecessor 1300 MWe unit. (PCERsc6.3s6.4.2.2)

106 EDF and AREVA propose a "maximum" annual disposal of 10 GBq. The headroom above "expected performance" is not specifically quantified but allows for contingencies such as fuel cladding defects combined with failure or unavailability of liquid treatment systems. (PCERsc6.3s6.4.2.3)

107 From our examination of historic discharges from European and US PWRs operating over the last 10 to 15 years we consider that the range of discharge to water of fission and activation products is <1 to 15 GBq per year for a 1000 MWe power station (see

Annex 3). The "expected performance" aqueous discharge of other radionuclides from UK EPR is 0.6 GBq (0.35 GBq normalised to 1000 MWe), well within this range. We conclude that the aqueous discharge of other radionuclides from the UK EPR is comparable to other power stations across the world.

108 EDF and AREVA say that monthly discharges are difficult to predict as they are dependent on effluent management policy adopted and operational conditions. The monthly discharge during shutdown could be 6 times higher than other months. In normal operating conditions monthly discharge could be up to 0.3 GBq. In extreme circumstances the whole of the "maximum" detailed above, 10 GBq, could be discharged in 1 month.

109 The radiological impact from the "maximum" disposal of other radionuclides to the sea is stated as a dose to adults of 3.27 µSv y^{-1}, to children of 0.53 µSv y^{-1} and to infants of 0.06 µSv y^{-1} - from PCERsc11.1 Annex 3 Tables E, F and G. The greatest part of the dose is attributable to cobalt-60. We consider that the impact is a significant contribution to dose from a UK EPR.

110 We have provisionally accepted above that the UK EPR uses BAT to minimise the discharge to sea of other radionuclides with an "expected performance" of 0.6 GBq y^{-1}. We set disposal limits based on BAT with minimum headroom to cover expected operational events. We believe that equipment failures should be rectified promptly and should not have a significant impact on annual discharges. We do not accept the EDF and AREVA proposal for "maximum" annual disposal. We have considered past operational data and will allocate an additional 2 GBq y^{-1} above the "expected performance" to allow for increased discharges due to fuel cladding defects or other contingencies. Our predicted maximum is thus 2.6 GBq y^{-1} and we will apply a x2 factor to set a disposal limit of 5 GBq y^{-1}. We wish to set limits separately for cobalt-60 and caesium-137 so will allocate the total 5 GBq as:

a) Cobalt-60 – 1.5 GBq y^{-1};

b) Caesium-137 – 0.5 GBq y^{-1};

c) Other radionuclides not specifically limited – 3 GBq y^{-1}.

111 We wish to set a quarterly notification level based on the "expected performance" to give us early indication if performance cannot be met in operation. We have allowed for 0.3 GBq in 1 month and average discharge for 2 months (say 0.05 GBq). This gives a QNL of 0.4 GBq for a total including Co-60 and Cs-137. We have apportioned this as follows:

a) Cobalt-60 – 0.12 GBq;

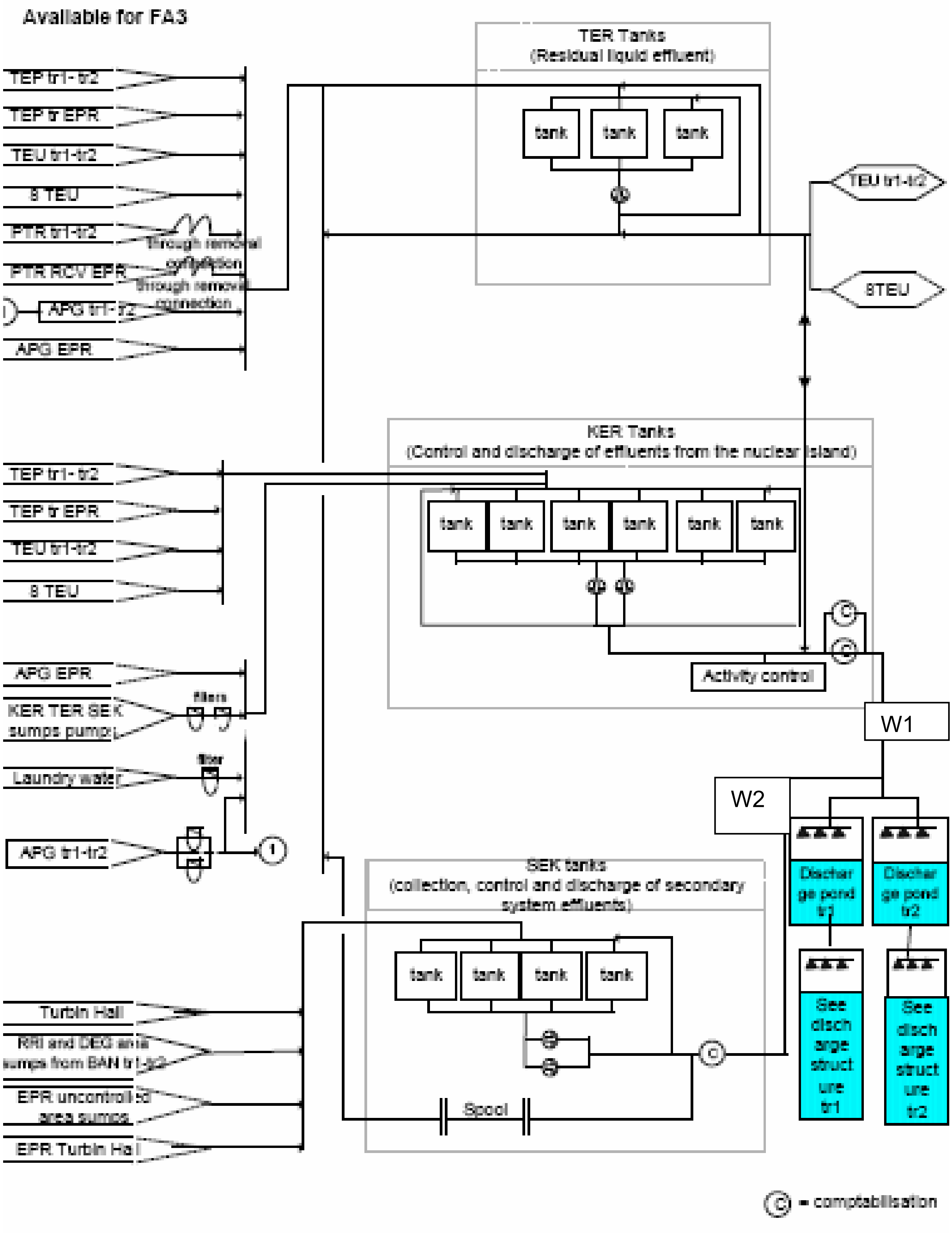
b) Caesium-137 – 0.04 GBq;

c) Other radionuclides not specifically limited – 0.24 GBq.

3.6 Disposal to the environment

112 We have identified 3 effluent release points for the UK EPR from the example diagram for Flamanville 3 provided in PCERsc6.4s2.3 Figure 1 (page 84)):

Section 2.3 FIGURE 1: OVERALL KER [LRMDS]-SEK [CILWDS]-TER [ExLWDS] DIAGRAM



113 We have allocated references to discharge points, as we would in a permit, as below:

a) W1 – combined discharge line from 2 sets of tanks:

   i) from the LRMDS tanks (KER above) in the Liquid radwaste monitoring and discharge system (LRMDS). [6 tanks of 750 m^3]# capacity collect effluent treated by the Liquid Waste Processing System (LWPS).

   ii) from the ExLWDS (TER above) tanks in the Additional liquid waste discharge system (ExLWDS). [3 tanks of 750 m^3]# capacity kept in reserve in case of issues with the LWPS or the LRMDS. The contents of these tanks can be sent back into the LWPS for treatment or discharged, as appropriate.

b) W2 – discharge line from the CILWDS (SEK above) tanks in the Conventional island liquid waste discharge system (CILWDS). [4 tanks of 750 m^3]# capacity collect effluent from radiologically uncontrolled areas such as the Turbine Hall. In normal operation effluents collected by this system are uncontaminated but may show low levels of tritium in the event of any leaks from the primary to the secondary systems.

c) W3 – return line of circulating seawater cooling system. The seawater should be uncontaminated in normal operation. The seawater system serves various systems, each of which should have internal sample points for detection of contamination at point of return to the main system (PCERsc3.4s3.1.1):

   i) circulating water system to main condenser;

   ii) essential services water system;

   iii) service water circuit for conventional auxiliaries;

   iv) ultimate cooling system.

114 # EDF and AREVA say that number and sizing of the LRMDS, ExLWDS and CILWDS tanks is a site specific matter depending on number of reactors on a site and any discharge timing restrictions. The sizes and number of tanks above is from the Flamanville site where the tanks will serve two existing 1300 MWe reactors, one EPR in construction and possibly another EPR in the future. We consider that the size of discharge tanks is an important BAT issue, we need to see that sufficient capacity is available not only to cope with normal operations but also to cope with foreseeable events such as equipment failures. We will not comment on tank sizes at GDA but will expect site specific applications to provide a formal BAT case justifying the number and volumes of discharge tanks proposed.

115 Our permit will allow discharge of liquid radioactive waste through points W1 and W2 under specific disposal limits and conditions. Discharges will not be continuous but on a tank by tank basis, when a tank needs to be discharged its contents will be sampled and analysed. Data on the volume to be discharged and its radioactivity will be used within a management procedure to authorise the time and rate of discharge to ensure compliance with permit conditions. All discharge authorisations will need to be recorded as operational records – a permit condition. We will require the discharge lines to be fitted with MCERTS[1] flowmeters and flow proportional samplers at points W1 and W2 to provide permit compliance data.

116 The returning seawater should be uncontaminated. We will not require flow metering of this, flow will be directly related to pumps in service. We will not require continuous sampling as we consider risk of contamination is very low. However we will require safe and permanent access to the return flow at point W3 for spot sampling to confirm no radioactive contamination or other contamination such as oil or chemicals.

117 The disposal route from points W1 and W2 is initially to join the high volume direct sea water cooling flow (67 $m^3\ s^{-1}$) at the discharge pond. The combined flow is then sent

[1] The Environment Agency's Monitoring Certification Scheme, see www.mcerts.net

to an outfall discharging some distance out from the shore. While we do not accept dilution as a reduction technique, once discharges have been minimised by other techniques pre-dilution in a large flow before discharge to the environment is desirable to reduce initial concentrations before dispersion in the receiving waters.

118 We have not considered at GDA other site liquid discharges such as surface water. The design of such systems will be site specific and there should be no contamination in normal operation. We will review site drainage at site specific permitting and, as a minimum, require accessible sampling points at final discharge locations for confirmation spot sampling.

119 For GDA, EDF and AREVA selected Irish Sea / Cumbrian Waters for predicting dispersion of liquid radioactive discharges using the model PC Cream. They said this would give pessimistic results for the dose impact calculations. The calculated total annual dose impact to the most exposed members of the public from “maximum” discharges was 17 μSv for an adult, 4.7 μSv for a child and 1.5 μSv for an infant. Dose was largely due to eating sea food. The doses are sufficiently low that we conclude that dispersion under GDA conditions is BAT.

120 The design and location of outfalls will be a highly site specific matter. The Operator for each specific site will need to demonstrate by modelling that the outfall proposed will be BAT for adequate dispersion in local waters.

4 Public comments

121 We received no relevant public comments on this topic before the end of 2009. Any comments received after that time will be addressed in our final decision to be published in June 2011.

5 Conclusion

122 We conclude that overall the UK EPR utilises the best available techniques (BAT) to minimise discharges of aqueous radioactive waste:

a) during routine operations and maintenance;

b) from anticipated operational events.

123 However our conclusion is subject to one other issue:

a) the sizing of filters and the demineralisation system in the Liquid Waste Processing System.

124 We conclude that the aqueous discharges from the UK EPR should not exceed those of comparable power stations across the world.

125 We conclude that the UK EPR should comply with the limits and levels set out below for the disposal of aqueous radioactive waste to the marine environment.

Radionuclides or group of radionuclides	Annual limit GBq	Quarterly notification level GBq
Tritium	75,000	45,000
Carbon-14	95	9
Cobalt-60	1.5	0.12
Caesium-137	0.5	0.04
All other radionuclides (excepting tritium, carbon-14, cobalt-60 and caesium-137)	3	0.24

References

(BERR, 2008)	*Meeting the Energy Challenge. A White Paper on Nuclear Power,* BERR, January 2008. http://www.berr.gov.uk/files/file43006.pdf
(DECC 2009)	Statutory Guidance to the Environment Agency concerning the regulation of radioactive discharges into the environment, Department of Energy and Climate Change and Welsh Assembly Government, 2009. http://www.decc.gov.uk/media/viewfile.ashx?filepath=what%20we%20do/uk%20energy%20supply/energy%20mix/nuclear/radioactivity/dischargesofradioactivity/1_20091202160019_e_@@_guidanceearadioactivedischarges.pdf&filetype=4
(Defra, 2010)	Environmental Permitting Guidance, Radioactive Substances Regulation For the Environmental Permitting (England and Wales) Regulations 2010, March 2010, Version 1.1 http://www.defra.gov.uk/environment/policy/permits/documents/ep2010radioactive.pdf
(Environment Agency, 2005)	Development of Guidance on Setting Limits on Radioactive Discharges to the Environment from Nuclear Sites, (Science Report: SC010034/SR, Environment Agency, December 05) http://publications.environment-agency.gov.uk/pdf/SCHO1205BIVK-e-e.pdf
(Environment Agency, 2007)	Process and Information Document for Generic Assessment of Candidate Nuclear Power Plant Designs, Environment Agency, Jan 2007. http://publications.environment-agency.gov.uk/pdf/GEHO0107BLTN-e-e.pdf
(Environment Agency, 2008)	Environment Agency Generic design assessment of new nuclear power plant designs, Statement of findings following preliminary assessment of the submission by EDF and AREVA for their UK EPR design, March 2008. http://www.hse.gov.uk/newreactors/reports/epr.pdf
(Environment Agency, 2009a)	Study of historical nuclear reactor discharge data, Environment Agency Main report http://publications.environment-agency.gov.uk/pdf/SCHO0509BQAM-e-e.pdf Graph Annex http://publications.environment-agency.gov.uk/pdf/SCHO0509BQAN-e-e.pdf
(Environment Agency, 2009b)	Considerations for Radioactive Substances Regulation under the Radioactive Substances Act at Nuclear Sites in England and Wales, Environment Agency, Jan 2009 (version 2). http://publications.environment-agency.gov.uk/pdf/PMHO0106BKDG-e-e.pdf
(Environment Agency, 2010a).	EAGDAR UK EPR-03: Generic design assessment. UK EPR nuclear power plant design by AREVA NP SAS and Electricité de France SA. Assessment report – Best available techniques to prevent or minimise the creation of radioactive wastes.
(Environment Agency, 2010b).	Generic design assessment. UK EPR nuclear power plant design by AREVA NP SAS and Electricité de France SA. Consultation Document.

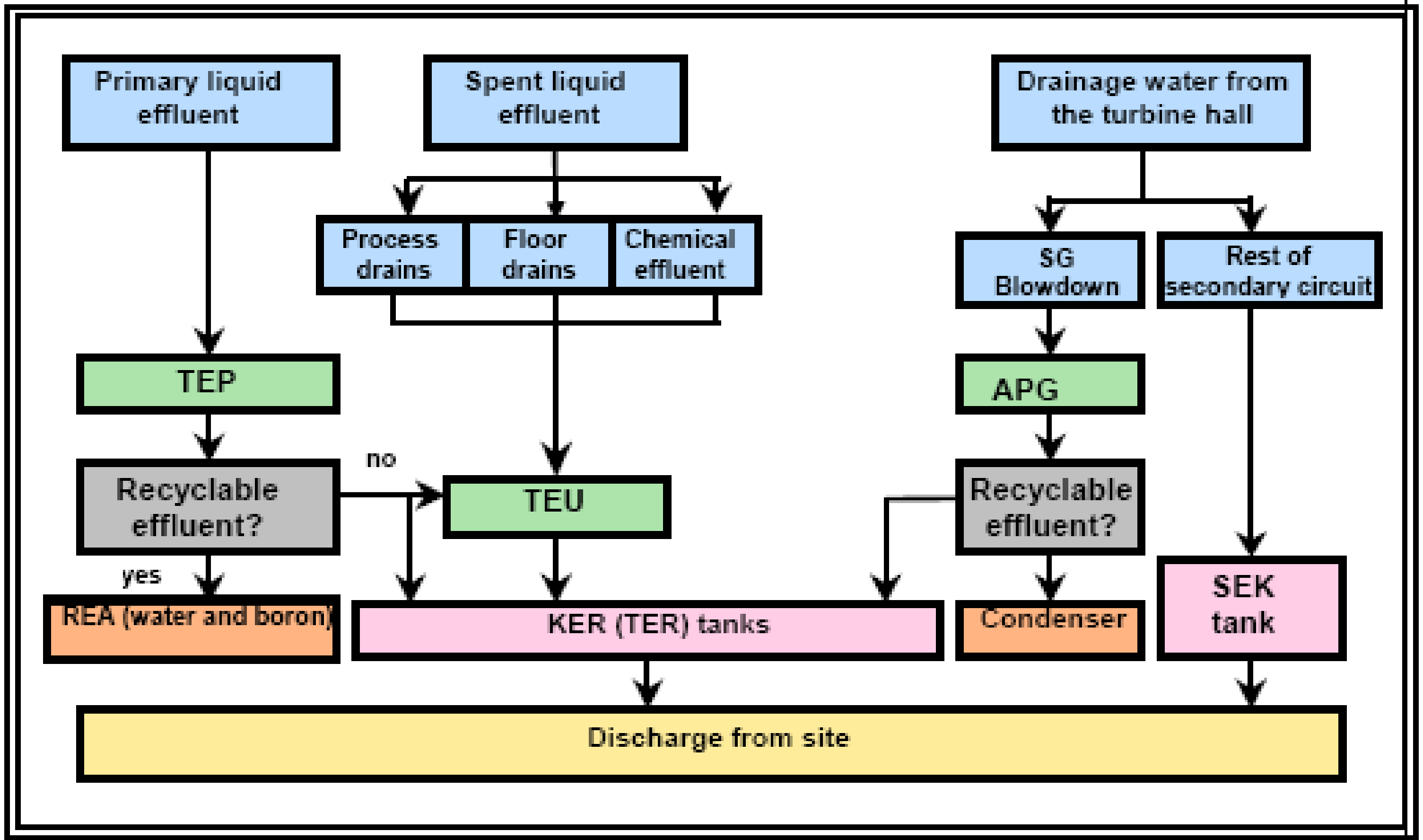
(Environment Agency, 2010c)	Regulatory Guidance Series, No RSR 1: Radioactive Substances Regulation - Environmental Principles (REPs), 2010 http://publications.environment-agency.gov.uk/pdf/GEHO0709BQSB-e-e.pdf
(Environment Agency, 2010d)	Regulatory Guidance Series, No RSR 2: The regulation of radioactive substance activities on nuclear licensed sites, 2010 http://www.environment-agency.gov.uk/static/documents/Business/GEHO0310BSGF-E-E.pdf
(Environment Agency, 2010e)	EAGDAR UK EPR-11: Generic design assessment. UK EPR nuclear power plant design by AREVA NP SAS and Electricité de France SA. Assessment report – Radiological impact on members of the public.

Abbreviations

BAT	Best available techniques
C&I	Control and Instrumentation
CILWDS	Conventional island liquid waste discharge system
CSTS	Coolant Storage and Treatment System
CVCS	Chemical and Volume Control System
EPR 10	Environmental Permitting (England and Wales) Regulations 2010
EPRB	GDA UK EPR – BAT demonstration, document UKEPR-0011-001
EPRB 3.5s1.2	EPRB form 3.3 section 1.2 (example reference)
ETB	Effluent Treatment Building
ExLWDS	Additional liquid waste discharge system
FAPs	Fission and Activation Products
GDA	Generic design assessment
GWPS	Gaseous Waste Processing System
HSE	Health and Safety Executive
HVAC	Heating, ventilation and air conditioning system
IWS	GDA UK EPR – Integrated Waste Strategy Document UKEPR-0010-001 Issue 00
JPO	Joint Programme Office
LRMDS	Liquid radwaste monitoring and discharge system
LWPS	Liquid Waste Processing System
NVDS	Nuclear Vent and Drain System
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
QNL	Quarterly Notification Level
RCS	Reactor Coolant System
REPs	Radioactive substances regulation environmental principles
RI	Regulatory Issue
RO	Regulatory Observation
RSA 93	Radioactive Substances Act 1993
SG	Steam Generator
TQ	Technical Query
VCT	Volume Control Tank
WCPD	Worst Case Annual Plant Discharges

Annex 1 Figures from PCER

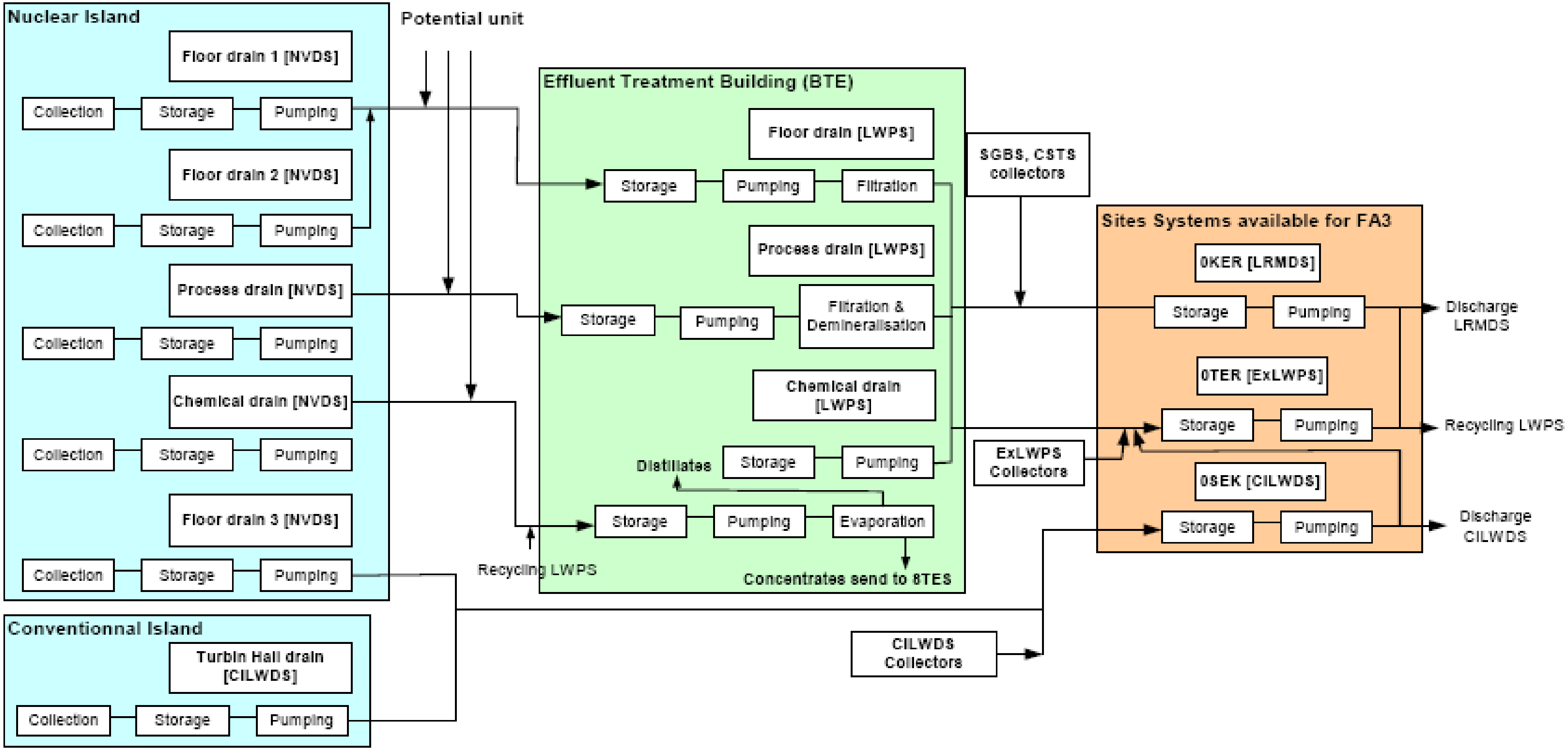
PCERsc3.4 Figure 1



Sub-chapter 3.4 - Figure 1: Nature of liquid radioactive discharge

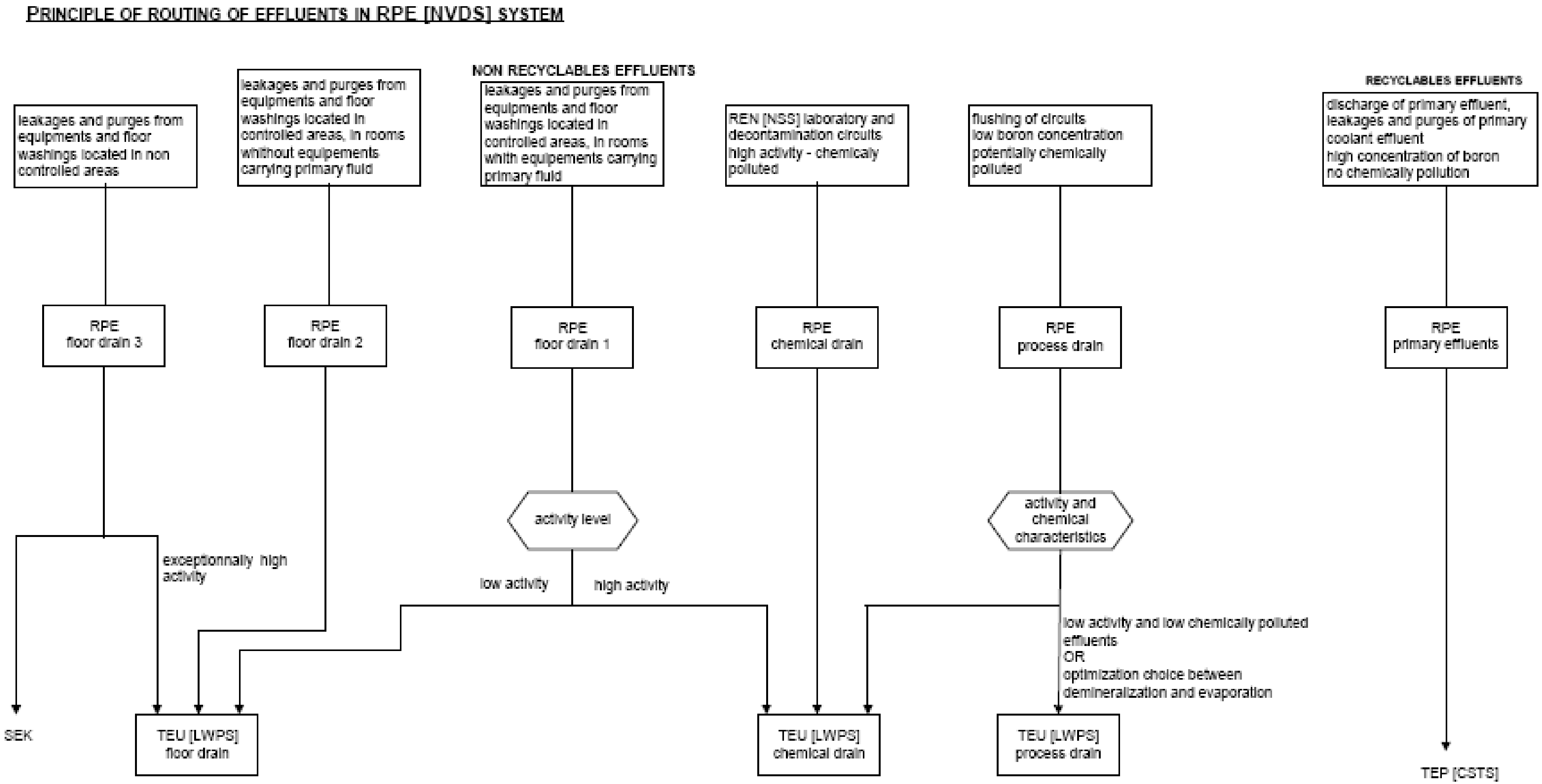
PCERsc6.4s! Figure 1

Section 1 FIGURE 1 : OVERALL DIAGRAM FOR NON RECYCLED LIQUID EFFLUENT



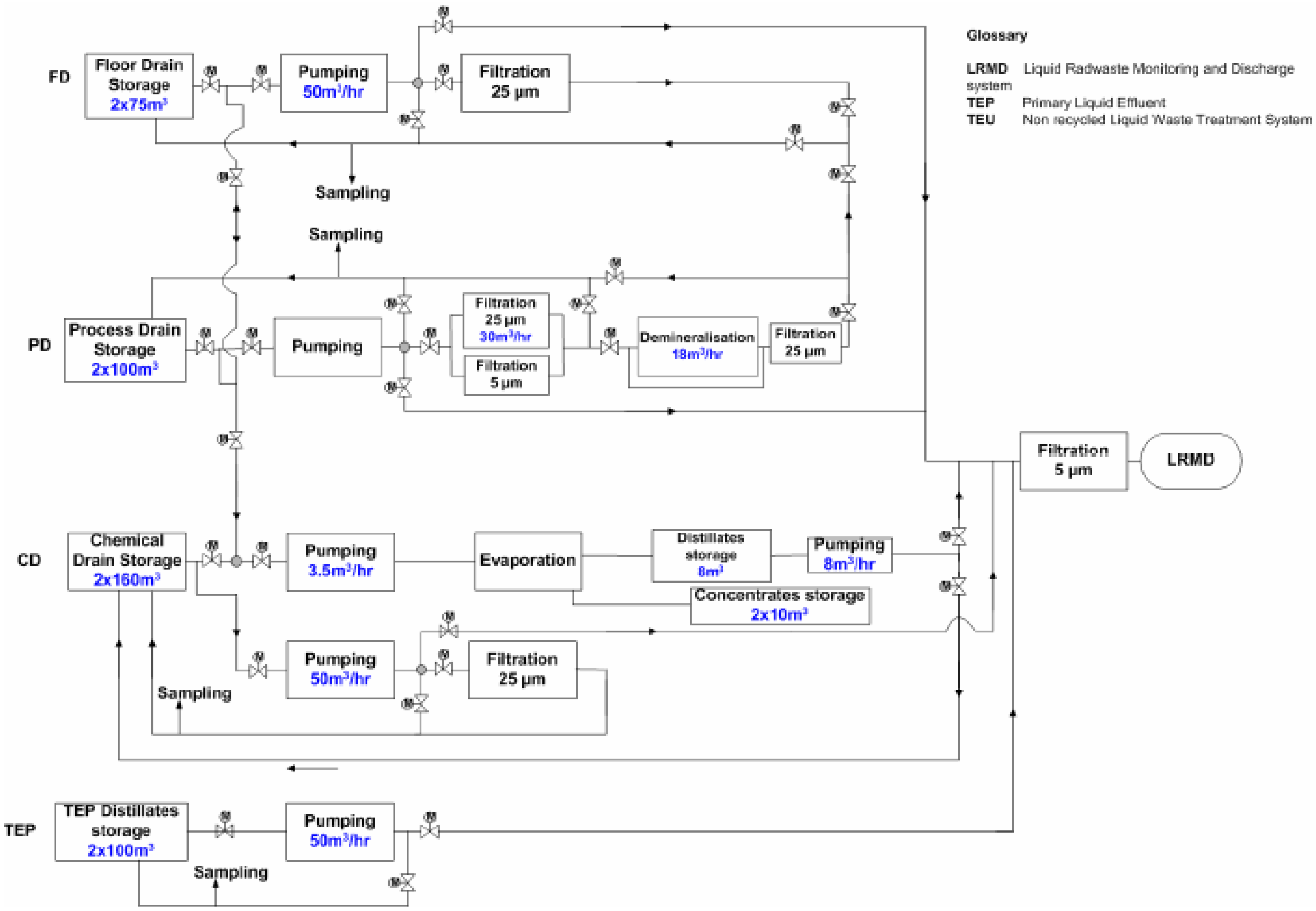
PCERsc6.4s2.1 Figure 2

Section 2.1 FIGURE 2: RULES FOR CHANNELING EFFLUENT IN THE RPE [NVDS]



IWS Figure 5

Figure 5: The Treatment of Non-Recycled Liquid Effluents



Would you like to find out more about us, or about your environment?

Then call us on

08708 506 506* (Mon-Fri 8-6)

email

enquiries@environment-agency.gov.uk

or visit our website

www.environment-agency.gov.uk

incident hotline 0800 80 70 60 (24hrs)

floodline 0845 988 1188

***Approximate calls costs: 8p plus 6p per minute (standard landline). Please note charges will vary across telephone providers**

Environment first: This publication is printed on paper made from 100 per cent previously used waste. By-products from making the pulp and paper are used for composting and fertiliser, for making cement and for generating energy.