UK EPR	Title: PCER – Chapter 7 – Measures for monitoring discharges
	UKEPR-0003-070 Issue 03

Total number of pages: 65	Page No.: I / II
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REVISION HISTORY

Issue	Description	Date
00	First issue.	28.04.08
01	PCER March 2010 update Complementary information included in - sub-chapter 7.1 - sub-chapter 7.3 sections 1.1, 2.1 and 2.2.3	28.03.10
02	PCER Reformatted Version - Minor formatting changes and editorial corrections - References listed under each numbered section or sub-section heading numbered [Ref-1], [Ref-2], [Ref-3], etc	23.12.11
03	Consolidated PCER update: - Replaced Ex [CILWDS] with Ex (0SEK [SiteLWDS]) - Update of reference in Sub-chapter 7.1 - Clarification of text: o in Sub-chapter 7.3 Sections 1.1.3.3, 2.1.3, 2.1.4.1, and 2.1.4.2 o in Sub-chapter 7.4 section 1.3.2 - Clarification and consistency with Sub-chapter 6.4 in Sub-chapter 7.3 sections 2.1.2, 2.2.2 and 2.2.4.1	04.08.12

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CONTENTS CHAPTER 7

SUB-CHAPTER 7.1 – INTRODUCTION

This chapter presents EDF and AREVA's approach to the monitoring of radioactive releases both to water and atmosphere from the EPR. It also describes monitoring of chemical discharges into the sea and the atmosphere. More details can be found in the document "Monitoring of liquid and gaseous discharges: Prospective arrangements for the UK EPR" [Ref-1].

The information presented in this chapter is in direct response to the requirement 2.6 'Methods for determination of discharges' and partially to the requirements 3.2 and 3.3 of the Environment Agency (EA) process and Information (P&I) Document [Ref-2].

Indeed, this chapter identifies the methods, including sampling arrangements, techniques and systems used to measure and assess discharges. In particular, it specifies methods used to determine discharges of groups of radionuclides and substances that are subjected to an authorisation and provides information on the efficiency of abatement plant.

To make sure that statutory requirements are fulfilled the plant operator implements a discharge control and environmental monitoring programme. This programme, established in agreement with the EA, is created under the plant operator's responsibility to undertake and provide for appropriate monitoring. It will be managed under the overall Environmental Management System.

The aim of the monitoring is to check that the values prescribed in the authorisations or permit are respected, notably for water intakes and thermal, chemical and radioactive discharges. Values are defined for each parameter that is subjected to an authorisation request (volume sampled, flows, concentrations, activity, etc.). The nature and frequency of the measurements depends on the flows requested, the installation's characteristics (e.g. planned discharges by tanks or continuous discharges) and the sensitivity of the receiving water body.

In addition to these plant related measurements, the plant operator carries out environmental monitoring measurements, the purpose of which is to evaluate the impact of the installation's operation (see Chapters 11 and 12 of the PCER).

The monitoring procedures take into account the experience acquired from the start in this field. This allows an optimised monitoring system to be proposed based on the most relevant practices and data. The techniques of assessment are kept under review to take account of experience and technical developments to ensure that the Best Available Techniques (BAT) are used to maximise this assessment accuracy provided that they are cost effective.

All of the measurements carried out for monitoring purposes are available for periodic reporting (e.g. monthly and annual information) to the Regulators.

Summary data from these measurements will also be communicated to the public located around the power plant.

In agreement with the EA Technical Guidance on Monitoring: M11 (Monitoring Releases to Atmosphere from Nuclear Facilities) [Ref-3], M12 (Monitoring Releases to Water from Nuclear Facilities) [Ref-4] and M18 (Monitoring of discharges to water and sewer) [Ref-5], the plant operator implements a documented Quality Management System which allows the station to cover all aspects of sampling and analysis of discharges based on the requirements of proven international standards (especially ISO 17025: 2000 and ISO 14001: 2004).

Thus, the plant operator has the following means for carrying out the identified measurements:

- The plant operator takes the necessary measures so that statutory measurements and sampling can be carried out at all time. In particular, an emergency power supply will be available for the radiological protection equipment involved in the statutory measurements;
- The plant operator has a radioactivity measuring environment laboratory and a radioactive waste control laboratory. These two laboratories are separate and exclusively assigned to radiological protection measurements;
- The plant operator has laboratory vehicles which are maintained in a state of readiness for deployment inside and outside of the site regardless of the circumstances;
- The plant operator permanently employs staff skilled and qualified in radiation analysis and chemical analysis;
- The various laboratory measuring devices are subjected to regular maintenance and suitable calibration. The calibration report appears in the appropriate register;
- The plant operator will determine, in agreement with the EA, the technical characteristics of the radiological protection equipment (sampling and measurements), their location, the technical modalities and the measuring methods;
- The original records and analysis or control results are stored for at least the life of the station and are available at any time; and
- The plant operator has a meteorological station that allows wind speeds and directions, atmospheric pressure, hygrometry of the air, temperature and precipitation to be measured permanently and which is equipped with a rainwater sampling station. The wind data is retransmitted to the control room and available in any circumstances.

Overall, the plant operator uses BAT to ensure that the discharge assessment techniques do not underestimate any radioactivity discharged, having taken into account the accuracy of the sampling and analysis methods and the effect of combining these (more details on BAT are provided in Chapter 8 of the PCER).

SUB-CHAPTER 7.1 – 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.

[Ref-1] Monitoring of liquid and gaseous discharges: Prospective arrangements for the UK EPR. UKEPR-0007-001 I03. EDF/AREVA. August 2012. (E)

[Ref-2] Process and Information Document for Generic Assessment of Candidate Nuclear Power Plant Designs. The Environment Agency. January 2007. (E)

[Ref-3] Monitoring of radioactive releases to Atmosphere from Nuclear Facilities. Technical Guidance Note (Monitoring) M11. Environment Agency. 1999. (E)

[Ref-4] Monitoring of radioactive releases to Water from Nuclear Facilities. Technical Guidance Note (Monitoring) M12. Environment Agency. 1999. (E)

[Ref-5] Monitoring of discharges to water and sewer. Technical Guidance Note (Monitoring) M18. Version 1. Environment Agency. 2004. (E)

SUB-CHAPTER 7.2 – LEGISLATIVE BACKGROUND

1. RADIOACTIVE DISCHARGES

1.1. RADIOACTIVE SUBSTANCES ACT 1993

The use, accumulation, storage, disposal and discharge of radioactive material within the UK is regulated via the Radioactive Substances Act 1993 (RSA 93) [Ref-1]. Section 13 of the Act states that:

“no person shall, except in accordance with an authorisation granted in that behalf under this subsection, dispose of any radioactive waste on or from any premises which are used for the purposes of any undertaking carried on by him, or cause or permit any radioactive waste to be so disposed of, if (in any such case) he knows or has reasonable grounds for believing it to be radioactive waste”.

RSA 93 is regulated by the Environment Agency (EA) in England and Wales and the Scottish Environment Protection Agency (SEPA) in Scotland. The regulatory system includes the issuing of authorisations, which set out limits and conditions associated with waste disposals from that site.

Applications are generally made on a multi-media basis covering solid waste arisings and discharges or airborne and liquid effluents. Applications are supported by a document detailing predicted arising and the engineered controls and management arrangements in place to minimise waste arising and the abatement measures in place to minimise discharges. The supporting document will draw on any studies undertaken to support the conclusion that the waste management arrangements represent the Best Practicable Environmental Option (BPEO) and that Best Practicable Means (BPM) have been employed to mitigate the societal effects.

When considering new or varied applications the aim of the EA (or SEPA for Scotland) will be to ensure that the authorisation when granted will adequately protect the public and the environment.

The overall system of regulatory control applied by EA and SEPA [Ref-2] includes:

- Deciding whether new applications or variations to existing authorisations should be granted and setting appropriate limits and conditions in any issued authorisations to ensure the protection of the public and environment;
- Reviewing authorisations and the environmental performance of operators against the limits and conditions set out in the authorisations;
- Carrying out unannounced inspections and audits;
- Carrying out investigations of environmental incidents;
- Using powers of enforcement, where necessary, to ensure compliance with authorisations; and
- Monitoring of waste disposal and effluent discharges and undertaking assessments of associated public radiation exposure.

1.2. MONITORING UNDERTAKEN TO DEMONSTRATE COMPLIANCE WITH AUTHORISATIONS

1.2.1. Monitoring undertaken by Regulators

The EA or SEPA regulates discharges to water and air, under RSA 93 [Ref-1] while the Health and Safety Executive regulates sources of direct radiation. It is also responsible for the exposure of workers to radiation (e.g. staff at nuclear power stations). The Food Standards Agency is responsible for protecting the public from radioactivity in food.

EA and SEPA monitor radioactivity in discharges from nuclear sites to ensure limits are not exceeded and monitor the environment to check dose rates and levels of radionuclides in air, rain, water, mud, sand and soil around nuclear sites. The regulators will also ensure that the quality of operator self-monitoring of radioactive substances and radioactive waste disposals is acceptable, requiring the use of Standards, Auditing and Check Monitoring.

1.2.2. Monitoring undertaken by site Operators

As stated in previous sub-sections, liquid and airborne releases from nuclear facilities are strictly controlled in accordance with limits and conditions laid down in authorisations issued under the RSA 93. In addition to numerical limits on the amounts of radioactivity permitted to be discharged, the authorisations require the operator to use BPM to minimise discharges.

The authorisation also imposes requirements on the operator to undertake sampling, measurements, tests and surveys, to maintain records and to supply the EA or SEPA with relevant information relating to the discharges.

In regulating compliance with authorisations issued under RSA 93 [Ref-1] both EA and SEPA require a lower level of documentation to be produced, which sets out the more detailed arrangements to be employed by operators. This covers, for example, techniques for sampling and analysis, and the form of records to be retained.

The EA has established the objectives of discharge monitoring programmes [Ref-2] [Ref-3] which include:

- Ensuring that potential discharges are known by the site operator to be within authorised limits;
- Providing information to demonstrate that the operations giving rise to the effluent and the use of abatement plant (if any) and all associated control and management systems are performing as planned;
- To rapidly detect, give warning and identify the nature and extent of any unplanned releases to the environment to allow suitable remedial activities to be instigated; and
- To provide a record of the amount of radioactive material discharged to the environment in order to demonstrate compliance with the authorised limits on releases.

A monitoring programme may also:

- Identify trends in discharges, especially those which may indicate a chronic plant or process problem;

- Provide source term data and other information for modelling studies, for example, for radiological impact assessments;
- Indicate requirements for off-site environmental measurements, or a programme of environmental monitoring; and
- Provide public reassurance.

To meet these aims and objectives, a monitoring programme must be planned in advance. Planning should define:

- The nuclides to be included in the programme. This may include not only those nuclides specified in the discharge authorisation but others that may provide additional information on, for example, the efficiency of abatement plant;
- The timing and frequency of sampling of the discharge, and the sampling methods to be used. The aims are to ensure that samples are representative and that sufficient data are available to determine total discharges over the discharge authorisation period and (in some cases) any trends over time; and
- The laboratory analysis programme. This is required to ensure that the final data can be used to establish reliably the cumulative discharge and that trends with time are not masked by poor analytical data.

Planning of the monitoring programme, and the finalised programme, should be fully documented and must be related to a Quality Assurance (QA) system.

1.2.2.1. Monitoring of Airborne Releases

The EA has produced a Technical Guidance Note (TGN) regarding the monitoring of releases to atmosphere [Ref-1]. Airborne discharges are made from defined discharge points specified in the conditions of the authorisation and discharges from these points are monitored to ensure compliance with the limits defined in the authorisation.

Monitoring of airborne releases are undertaken using two main techniques:

a) **Sampling for laboratory analysis** normally provides a retrospective measurement of the amount of radioactive material emitted. Sampling is normally carried out by passing a representative sample of the effluent for a fixed period of time, typically 24 hours, through a collection device. The amount of radioactivity in the collection device is measured and can be related to the amount of gaseous effluent that has passed through the sampling system in the sampling period to give the activity concentration of the effluent. The total amount of radioactivity emitted can then be estimated from the activity concentration multiplied by the total stack flow during the period. Alternatively, given that the ratio of the sampling flow to stack flow is known (or the ratio of the total flow in the sampling period), the amount of radioactivity emitted can be estimated by multiplying this ratio by the total amount of activity in the collection device; and

b) **On-line instrumental measurements** provide a continuous indication to the operator of the quantity of radioactive material in the emission. This enables rapid corrective action to be taken in the event of any deviation from the norm, by use of alarm levels. On-line instrumental measurement systems are usually provided where there is a potential for sudden and significant changes in the level of radioactive material emitted, especially where this could pose a potential off-site hazard, and can provide information for plant control.

Sampling systems provide a more accurate, albeit retrospective, estimate of emissions and are almost invariably used for accounting purposes to demonstrate compliance with authorisation limits. Consequently sampling techniques are used for routine emission assessment and are the most important from the point of view of authorisation requirements.

The TGN [Ref-1] describes the principles of monitoring of gaseous emissions, system design parameters and nuclide specific techniques.

One of the key issues relating to airborne discharge monitoring is ensuring that a representative sample is taken for analysis under all conditions of operation of the facility. Continuous sampling is normally required on major emission routes and it is important that all factors which could affect sampling are taken into account, such as temperature, pressure, humidity and chemical form of the emission.

In order to obtain a representative sample for compliance monitoring purposes the TGN [Ref-1] identifies several conditions that must be fulfilled.

1.2.2.2. Monitoring of Aquatic Releases

The EA has produced a TGN regarding the monitoring of aquatic releases [Ref-1]. Aquatic discharges are made from defined discharge points specified in the conditions of the authorisation and discharges from these points are monitored to ensure compliance with the limits defined in the authorisation.

Aqueous waste streams discharged from a licensed nuclear site may contain a number of categories of radionuclides. Depending on the exact type of facility (e.g. nuclear power station, isotope preparation laboratory, reprocessing plant), the radionuclides present will include one or more of the following:

- Fission products, of which the most important are caesium-137 (Cs-137), strontium-90 (Sr-90), ruthenium-106 (Ru-106) and technetium-99 (Tc-99). These are gamma and beta emitters. Other fission products such as noble gases appear at much lower levels in liquid waste streams than in gaseous waste streams;

- Activation products formed by neutron activation of reactor materials (most importantly cobalt-60 (Co-60)). These are gamma and beta emitters;

- Actinides (mainly alpha-emitting isotopes of plutonium, uranium and americium), which are formed predominantly in uranium or uranium oxide fuel; and

- Tritium formed as a ternary fission product or by-neutron activation of lithium in a reactor moderator. Tritium is a soft (i.e. low-energy) beta emitter.

In addition to the key radionuclides to be monitored, there may also be a range of non radioactive substances present, which have implications for the monitoring programme. These include suspended solids, suspended and emulsified oil, organic matter, detergents, decontamination solutions (containing complexing agents such as EDTA), etc.

This TGN [Ref-1] also states that the composition of nuclides in a waste stream, in terms of their chemical and/or physical state, also needs to be considered in the planning of a monitoring programme:

- Radionuclides may be present as ions in aqueous solution;
- Radionuclides may also be present in particulate form. These include metal oxides (such as rust or other plant corrosion products), non-metals (such as paint particles) or suspended organic matter (such as oil). Active material may make up a large portion of each particle (e.g. UO_2 fuel particles) or may be a minor constituent in each particle (e.g. Co-60 in plant corrosion products). A few such 'hot' particles can be responsible for a large portion of the total activity in the waste stream;
- Tritium is usually present as tritiated water (HTO), but may be organically bound; and
- Gases will be present in solution. Solubility of gases depends on conditions of temperature and pressure and also on factors such as turbulence.

Discharges of liquid effluent from licensed nuclear sites in the UK take place to surface waters, either the sea, rivers, lakes or in some cases to or via public drainage systems. These discharges take place in two ways that need to be considered in the planning of the monitoring programme, as follows.

a) **Batch discharges.** At most nuclear sites, aqueous wastes are treated in some form of abatement plant on a batch basis. They are then stored temporarily in hold-up ('delay') or sentencing tanks. Once full, the contents of the tanks are normally mixed, sampled and analysed prior to being discharged. Discharges commonly take place over 1 to 20 hours, often at prescribed times, e.g. around high tides. Additional sampling during the discharge itself is also often carried out, with retrospective (and usually more detailed) analysis of these samples.

   Examples of batch discharges are those from nuclear power station active effluent treatment plants. The total activity discharged over any given period will be the sum of the activities of individual batches discharged in that period.

b) **Continuous discharges.** A few sites discharge liquid effluent on a continuous basis. These are confined to very low active wastes generated by, for example, surface runoff or those that are particularly well characterised.

TGN 12 [Ref-1] states that, in order to prevent:

- Inadvertent discharge from the filled tanks prior to sampling and confirmatory analysis (to ensure that the contents of the tank are acceptable to discharge); and
- Discharge of the tank simultaneous to filling of the tank or other operations such as transfers between tanks, re-treatment or recirculation (in the abatement plant), robust engineered and administrative procedures are required on batch discharges.

TGN 12 [Ref-1] notes that there may be changes in the activity concentration during a discharge of aqueous effluent. In a single batch discharge, taking place over a matter of hours, these changes are of relatively little interest. Of greater significance are variations over the whole of the discharge authorisation period. These (and possible causes of variation) are:

a) Random variations, which reflect changes in the original source of waste or in the performance of an abatement plant;

b) Systematic (or cyclic) variations, due to systematic variations in the original waste stream (due to, for example, yearly refuelling in a power station). They may also be due to periodic changes in the performance of the abatement plant (e.g. those taking place over the life of a filter bed); and

c) Trends, i.e. long and short-term upward or downward changes. These may reflect changes in the sources of effluent, the mode of operation of the plant or in the performance of the abatement systems.

As well as establishing the cumulative discharge, a monitoring programme should be designed to detect and provide information on changes.

Once the overall strategy of sampling has been decided, TGN 12 [Ref-1] identifies a number of precautions that need to be taken in the practical execution of the sampling programme. The primary aim is to ensure that the sample reaching the analysis laboratory is fully representative of the waste stream in the period in which it was taken. The main areas of concern are as follows:

a) Samples must be of a size commensurate with that required by the analysis laboratory;

b) There must be no significant preferential sampling of particular phases in the waste stream (especially of particulates which may include those with high activities, so called 'hot' particles). Where information on the relative importance of these phases is of interest, sampling must be carried out to accommodate this requirement;

c) The sample must not become contaminated during or after sampling; and

d) Any changes in the composition of the sample after it has been taken must be minimised. In particular, losses of active material must be avoided. This may require some form of preservation.

1.2.2.3. Quality Assurance

TGN 11 [Ref-1] and TGN 12 [Ref-2] state that the methods used for monitoring emissions should be documented and linked to or be part of a Quality Assurance (QA) system and that such a system should be designed to assure and demonstrate the accuracy of monitoring results. QA systems should be auditable.

Some considerations specific to the monitoring of atmospheric emissions detailed in TGN 11 [Ref-1] and TGN 12 [Ref-2] include the following areas:

- QA policy and management;
- system design;
- procedures;
- calibration;
- audits and checks; and
- records.

2. NON RADIOACTIVE DISCHARGES

2.1. INTRODUCTION

The requirements for the monitoring of discharges would be presented as a condition within the Pollution Prevention and Control (PPC) permit for the area designated as an installation under PPC. A monitoring programme would need to be developed in line with the permit conditions, taking into account the requirements of UK legislation and European Union (EU) directives.

The Integrated Pollution and Prevention Control (IPPC) Practical Guide issued by DEFRA (2005) [Ref-1] indicated that monitoring may be required with respect to the following:

- integrity testing of containment measures such as pipes, bunds and hardstanding; and

- sampling and monitoring of soil and/or water.

All monitoring undertaken must meet the EA quality requirements, in line with the EA Monitoring Certification Scheme (MCERTS) where relevant standards and procedures exist and EDF and AREVA will comply by MCERTS requirements. The scheme provides a framework within which environmental measurements and monitoring are undertaken in line with EA requirements. MCERTS currently applies to emissions to air, water and land (analysis of soil samples).

A number of TGNs have been produced by the EA and include atmospheric stack emissions monitoring, ambient air quality monitoring, monitoring of particulate matter ($PM_{2.5}$ and PM_{10}), monitoring of Volatile Organic Compounds (VOCs) and monitoring discharges to water and sewer.

Further guidance regarding regulation and permitting, and assessment and control for noise (H3), odour (H4) and the protection of land (H7) are provided within the Horizontal Guidance notes produced by the EA.

2.2. POLLUTION PREVENTION AND CONTROL (PPC) REGULATIONS 2000

The PPC Regulations were brought into force on 1st August 2000 and implement the requirements of the EU's IPPC Directive (96/61/EC). The Directive sets out the principle that industrial operators are responsible for undertaking monitoring of emissions from the installation.

IPPC applications must include information regarding the nature, sources and likely emissions to environmental medium defined as *"direct or indirect releases of substances, vibrations, heat or noise …. into the air, water or land"* [Ref-1].

The application must include information on emissions monitoring including the measurement methodology, frequency and evaluation frequency. The permit will outline monitoring requirements under the operating conditions with respect to the different environmental media including monitoring methodologies, required monitoring frequency and any emission limits.

The permit will include Emission Limit Values (ELVs) for all pollutants likely to be emitted in significant quantities. The setting of the ELV will be based on the technical characteristics of the installation, its location and should ensure no breaches of EU environmental quality standards.

2.3. ENVIRONMENTAL PERMITTING REGULATIONS

The Environmental Permitting (England and Wales) Regulations were enacted in December 2007 and came into force in April 2008.

The Environmental Permitting Regulations systems combine the Pollution Prevention Control and Waste Management Licensing systems into a common compliance and permitting systems.

The requirements for the monitoring of discharges remain unchanged [Ref-1]. However, this system means that there will be one (non radiological) permit for the entire site, compared with the previous system which can include additional permits and licences for areas of the site not designated as an installation.

2.4. IPPC REFERENCE DOCUMENT ON THE GENERAL PRINCIPLES OF MONITORING

The document provides information regarding the monitoring requirements of industrial emissions at source. The document indicates that monitoring is required in order to assess compliance with permit conditions and to allow the environmental reporting of emissions.

2.5. ATMOSPHERIC DISCHARGES

2.5.1. National Air Quality Objectives

ELVs for air quality will be set to ensure the achievement of the National Air Quality Objectives (NAQS). Part IV of the Environment Act 1995 [Ref-1] introduced a new framework for ensuring that a number of standards and objectives in reducing and controlling key air pollutants are met. This includes a National Air Quality Strategy first published by the Secretary of State in 1997 and then revised in 2000 with an addendum published in February 2003. A new Air Quality Strategy was published in July 2007 [Ref-2]. The new Strategy replaces the indicative objectives for PM_{10} for 2010, with an exposure reduction approach for $PM_{2.5}$.

National Air Quality Objectives have been established and included in the National Air Quality Strategy based upon the recommendations of work carried out by the Expert Panel on Air Quality Standards (EPAQS) and taking into account the requirements of the EU Air Quality Daughter Directive. Objectives have been established for both the protection of human health and the protection of vegetation for the following pollutants; benzene, 1,3- butadiene, carbon monoxide, nitrogen dioxide, sulphur dioxide, lead and particulate matter (PM_{10} and $PM_{2.5}$).

2.5.2. Technical Guidance Notes

A number of TGNs have been produced by the EA in relation to the monitoring of atmospheric discharges as follows:

- M1 - Sampling Requirements for Stack Emissions Monitoring [Ref-1];
- M2 - Monitoring of Stack Emissions to Air [Ref-2];
- M8 - Ambient Monitoring Strategy [Ref-3];
- M9 - Ambient Monitoring Methods [Ref-4];

- M15 - Monitoring PM_{10} and $PM_{2.5}$ [Ref-5]; and
- M16 - Monitoring Volatile Organic Compounds (VOCs) to air from Industrial Installations [Ref-6].

The guidance notes set out information regarding monitoring techniques and methodologies, selection of sampling points and include reference to other relevant documents including British Standards and International Standards Organisation documents.

2.6. DISCHARGES TO CONTROLLED WATERS

2.6.1. Water Resources Act (WRA) 1991 as partly amended by the Water Act 2003 (England and Wales)

Section 85 of the WRA 1991 states that *"no person shall cause or knowingly permit any poisonous, noxious or toxic material of solid waste to enter a controlled water"* [Ref-1]. Discharge consents are required for releases into controlled waters and would be covered by the requirements of the WRA and the Groundwater Regulations and may be included within the PPC permit. Monitoring would be required to show compliance with the permit conditions.

2.6.2. Groundwater Regulations 1998

The Groundwater Regulations 1998 implement the Groundwater Directive (80/68/EEC), the requirements of which must be implemented via the PPC permit [Ref-1]. The requirements of the Directive are that there is no discharge of List I substances to groundwater and no pollution of groundwater by List II substances. This includes deliberately releasing polluting matter, and causing pollution accidentally. Authorisation for discharges to groundwater are required and would be included as part of the permit conditions.

2.7. THERMAL DISCHARGES

Thermal discharges to coastal waters and freshwater are regulated through the protection afforded by habitat and species legislation and are therefore location dependent, i.e. in relation to the location of designated coastal sites. Thermal discharges may be regulated by the following legislation:

- The Surface Waters (Fishlife) Classification Regulations, 1997 [Ref-1];
- Pollution Prevention and Control Regulations, 2000 [Ref-2];
- The Conservation (Natural Habitats, & C) Regulations, 1994 [Ref-3];
- EC Shellfish Waters Directive (79/923/EEC) implemented by The Surface Waters (Shellfish) (Classification) Regulations, 1997 [Ref-4]; and
- Water Resources Act 1991 (as amended) [Ref-5].

The regulations provide protection to the various designations and specify frequencies for sampling and analysis.

2.8. DISCHARGES TO SEWER

2.8.1. Water Industry Act 1991

Trade effluent discharges are required for all discharges to sewer covered by the Water Industry Act 1991 with consent provided by the relevant water company. Discharges would also be covered by the IPPC permit. The consent will include conditions in relation to parameters such as flow, permitted pH ranges, and may include stated limits for certain concentrations. Monitoring will be required as specified within the permit conditions to show compliance.

2.8.2. Water Resources Act (WRA) 1991

Consent to discharge sewage effluent into ‘controlled waters’ is required under WRA 1991 and may also be required for discharges into soakaways or self-contained ponds. Monitoring of any discharges will be required to ensure compliance with conditions.

2.8.3. Technical Guidance Note (Monitoring) M18: Monitoring of Discharges to water and sewer

The TGN provides information regarding sampling including the selection of sampling points, sample handling and transportation, sampling procedures and analysis [Ref-1].

SUB-CHAPTER 7.2 – 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. RADIOACTIVE DISCHARGES

1.1. RADIOACTIVE SUBSTANCES ACT 1993

[Ref-1] The Radioactive Substances Act 1993. HM Stationery Office. ISBN 0-10: 0105412937. (E)

[Ref-2] Process and information Document for Applications for New Authorisations issued under the Radioactive Substances Act 1993 to Nuclear Sites in England and Wales. Version 1. Environment Agency. December 2007. (E)

1.2. MONITORING UNDERTAKEN TO DEMONSTRATE COMPLIANCE WITH AUTHORISATIONS

1.2.1. Monitoring undertaken by Regulators

[Ref-1] The Radioactive Substances Act 1993. HM Stationery Office. ISBN 0-10: 0105412937. (E)

1.2.2. Monitoring undertaken by site Operators

[Ref-1] The Radioactive Substances Act 1993. HM Stationery Office. ISBN 0-10: 0105412937. (E)

[Ref-2] Monitoring of Radioactive Releases to Atmosphere from Nuclear Facilities. Technical Guidance Note (Monitoring) M11. Environment Agency. 1999. (E)

[Ref-3] Monitoring of Radioactive Releases to Water from Nuclear Facilities. Technical Guidance Note (Monitoring) M12. Environment Agency. 1999. (E)

1.2.2.1. Monitoring of Airborne Releases

[Ref-1] Monitoring of Radioactive Releases to Atmosphere from Nuclear Facilities. Technical Guidance Note (Monitoring) M11. Environment Agency. 1999. (E)

1.2.2.2. Monitoring of Aquatic Releases

[Ref-1] Monitoring of Radioactive Releases to Water from Nuclear Facilities. Technical Guidance Note (Monitoring) M12. Environment Agency. 1999. (E)

1.2.2.3. Quality Assurance

[Ref-1] Monitoring of Radioactive Releases to Atmosphere from Nuclear Facilities. Technical Guidance Note (Monitoring) M11. Environment Agency. 1999. (E)

[Ref-2] Monitoring of Radioactive Releases to Water from Nuclear Facilities. Technical Guidance Note (Monitoring) M12. Environment Agency. 1999. (E)

2. NON RADIOACTIVE DISCHARGES

2.1. INTRODUCTION

[Ref-1] Integrated Pollution Prevention and Control Practical Guide. Edition 4. DEFRA. 2005. (E)

2.2. POLLUTION PREVENTION AND CONTROL (PPC) REGULATIONS 2000

[Ref-1] Pollution Prevention and Control Regulations 2000. SI No. 1973. The Stationery Office Ltd. ISBN 978-011099621-9. (E)

2.3. ENVIRONMENTAL PERMITTING REGULATIONS

[Ref-1] Environmental Permitting Core Guidance for the Environmental Permitting (England and Wales) Regulations 2007. DEFRA. 2008. (E)

2.5. ATMOSPHERIC DISCHARGES

2.5.1. National Air Quality Objectives

[Ref-1] Environment Act 1995. ISBN 978-010542595-3. The Stationery Office Ltd. (E)

[Ref-2] The Air Quality Strategy for England, Scotland, Wales and Northern Ireland. DEFRA. 2007. (E)

2.5.2. Technical Guidance Notes

[Ref-1] Sampling requirements for stack-emission monitoring. Technical Guidance Note (Monitoring) M1. Version 4, Environment Agency. 2006. (E)

[Ref-2] Monitoring of stack emissions to air. Technical Guidance Note (Monitoring) M2. Version 4.2. Environment Agency. 2007. (E)

[Ref-3] Environmental Monitoring Strategy - Ambient Air. Technical Guidance Note (Monitoring) M8. Environment Agency. 2000. (E)

[Ref-4] Monitoring Methods for Ambient Air. Technical Guidance Note (Monitoring) M9. Environment Agency. 2000. (E)

[Ref-5] Monitoring PM_{10} and $PM_{2.5}$. Technical Guidance Note (Monitoring) M15. Version 1. Environment Agency. 2006. (E)

[Ref-6] The measurement and monitoring of volatile organic compounds to air from industrial installations. Technical Guidance Note (Monitoring) M16. Version 1. Environment Agency. 2005. (E)

2.6. DISCHARGES TO CONTROLLED WATERS

2.6.1. Water Resources Act (WRA) 1991 as partly amended by the Water Act 2003 (England and Wales)

[Ref-1] Water Resources Act,1991. ISBN 978-010545791-6. The Stationery Office Ltd (as amended)..

2.6.2. Groundwater Regulations 1998

[Ref-1] Groundwater Regulations 1998. SI No. 2746. The Stationery Office Ltd. ISBN 978-011079799X. (E)

2.7. THERMAL DISCHARGES

[Ref-1] Surface Waters (Fishlife) Classification Regulations 1997. SI No. 1331. The Stationery Office Ltd. ISBN 0110620518. (E)

[Ref-2] Pollution Prevention and Control Regulations 2000. SI No. 1973. The Stationery Office Ltd. ISBN 978-011099621-9. (E)

[Ref-3] The Conservation (Natural Habitats, & C.) Regulations 1994. SI No. 2716. The Stationery Office Ltd. ISBN 0110457161. (E)

[Ref-4] Surface Waters (Shellfish) Classification Regulations 1997. SI No. 1332. The Stationery Office Ltd. ISBN 0110637089. (E)

[Ref-5] Water Resources Act, 1991. ISBN 978-010545791-6. The Stationery Office Ltd (as amended).

2.8. DISCHARGES TO SEWER

2.8.3. Technical Guidance Note (Monitoring) M18: Monitoring of Discharges to water and sewer

[Ref-1] Monitoring of discharges to water and sewer. Technical Guidance Note (Monitoring) M18. Version 1. Environment Agency. 2004. (E)

SUB-CHAPTER 7.3 – MONITORING GASEOUS AND LIQUID RADIOACTIVE DISCHARGES

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1. MONITORING OF GASEOUS RADIOACTIVE DISCHARGES

1.1. MONITORING OF GASEOUS RADIOACTIVE WASTE DISCHARGED FROM THE STACK OF THE NUCLEAR AUXILIARY BUILDING

1.1.1. Statutory reminder

According to the requirements of the Radioactive Substances Act 1993 (RSA 93) [Ref-1] (see Sub-chapter 7.2), the plant operator must control its gaseous discharges, in order to check that the discharge limit values which will be imposed to it by its authorisation are complied with (see Chapter 6 of the PCER).

Five categories of gaseous radionuclides are subjected to discharge limits: tritium, noble gases, carbon-14, iodine isotopes, and the other beta or gamma emitting activation or fission products. These radionuclides are identified both in the Environment Agency (EA) Guidance for monitoring M11 [Ref-2] (monitoring of radioactive discharges to atmosphere) and in European Union (EU) Commission Recommendation 2004/2/Euratom [Ref-3].

For the gaseous radioactive waste discharged from the stack of the Nuclear Auxiliary Buildings, controls concern compliance with the limit values that will be imposed, i.e.:

- The activity discharged, for the five categories of radionuclides;
- The emission rate at the discharge point, for tritium, noble gases, iodine isotopes, and the other beta or gamma emitting activation or fission products; and
- The activity concentration in the receiving water body, for tritium and artificial aerosols.

1.1.2. Description of the sampling devices and measuring devices

All of the sampling carried out on the Gaseous Waste Processing System (TEG [GWPS]), at the Reactor Building level, and at the stack level are subjected to analysis at the plant 'Effluents' laboratory.

Sampling for the tritium measurement in the gaseous waste is carried out via a bubbler. Sampling for the carbon-14 measurement in the gaseous waste is carried out on a molecular sieve. Analysis of these samples is carried out via liquid scintillation.

The sampling of noble gases is carried out to ensure the measurement is representative. In particular, the noble gases present in the Reactor Building atmosphere are sampled using a sample bottle, and gamma spectrometry analyses allows their composition to be determined. The gross beta measurements of noble gases are continuously carried out either directly in the stack via a gas beta device with a differential chamber (differential chamber gas beta) located on the latter, or directly at the level of the TEG [GWPS] or Reactor Building, via two other differential chamber gas beta devices.

Gaseous halogen sampling is carried out on an activated carbon cartridge and aerosol sampling on a paper filter. Gamma spectrometry analysis allows the composition of these samples to be determined. In addition, to determine the gross alpha, gross beta and gross gamma activities, these samples are analysed with an alpha-beta counter (gross alpha and gross beta activity measurements) and a Sodium Iodide (NaI) device (gross gamma activity measurements).

Gross alpha measurements are expressed in americium-241 (Am-241) equivalent, gross beta measurements in strontium-90 + yttrium-90 (Sr-90 + Y-90) equivalent, gross gamma measurements in caesium-137 (Cs-137) equivalent, and gas beta measurements in krypton-85 (Kr-85) equivalent.

The design of the sampling platforms, sample probe connections, sampling lines and the exact positioning of the Plant Radiation Monitoring System (KRT [PRMS]) channels will be determined during their detailed implementation studies and will allow for inspection. The height of the stack is also site specific. They will take due consideration of any relevant requirements (such as EA guidance M1 and MCERTS) as well as engineering rules regarding space for monitoring operations and maintenance. Sub-chapter 7.3 - Figure 1 shows the principle of the design of the monitoring sampling in the stack for Flamanville 3 EPR.

All the measurements are redundant; therefore it allows continual monitoring even in case of failure of one of the components. This will also allow the provision of an independent sample to the regulator, if requested.

1.1.3. Type of discharges

1.1.3.1. Definitions

Planned discharges concern scheduled batch wise gaseous discharges carried out via the stack. They correspond to the gaseous waste from the ventilation linked to the scavenging for staff access in the Reactor Building (unit in operation), to the iodine trap tests for the various ventilation systems and to the calibration tests for the activity measuring channels.

Continuous discharges concern gaseous discharges permanently released via the stack, i.e. gaseous waste discharges extracted via the ventilation excluding drainage of air from the Reactor Building and gaseous waste discharges from the secondary cooling system.

In addition, there is the primary effluent discharge treated by the TEG [GWPS] which reduces the activity below the discharge limits, the flow rate of which automatically varies between approx. 0.2 m^3 h^{-1} and approx. 100 m^3 h^{-1}.

1.1.3.2. Type of monitoring

Before any planned discharge, effluents from the Reactor Building are subjected to the following analyses, carried out on representative samples:

- tritium activity measurement;
- gross beta activity measurement and gamma spectrometry analysis of noble gases;
- gross gamma activity measurement and iodine gamma spectrometry analysis; and
- check of the absence of gross alpha activity, gross beta activity measurement and gamma spectrometry analysis of the other activation or fission products.

These analyses allow the composition of the effluents to be known prior to discharge, determine whether discharge is possible (compliance with annual and short-term discharge limits) and in this case, determine the discharge rate to ensure emission rates in the stack meet the requirements.

All of the gaseous waste discharged via the stack is subjected to the following analyses for periods to be defined with the Regulators:

- flow rate measurement in the stack (duplicated and recorded measurement);
- gross beta activity measurement in the stack (duplicated and recorded measurement);
- tritium activity measurement;
- analysis of noble gases;
- gross gamma activity measurement and analysis of iodine isotopes; and
- check of the absence of gross activity, gross beta activity measurement and analysis of the other activation or fission products.

In addition, a carbon-14 activity measurement in the stack is carried out.

These analyses allow the report of the activity discharged to be established and the emission rates from the stack to be determined, and therefore ensure that the activities and emission rates are below limits.

1.1.3.3. Discharge conditions

Planned discharges may be carried out only when the controls described in the previous section have been performed and have allowed the discharge rate to be determined (in compliance with the emission rate values). The UK EPR may only carry out one non-planned discharge at a time (discharge from a single Reactor Building).

Planned discharges, may therefore be carried out only if the ventilation flow rate via the stack is greater than the value of 120,000 $m^3 h^{-1}$ (value to be refined with the studies – site dependent parameter), and if the gross beta activity concentration via the stack does not exceed a threshold (for example, alarm trigger value for the two activity measurements via the stack).

In addition, planned discharges, other than discharge from the Reactor Building, may therefore be carried out only if the corresponding ventilation system (Nuclear Auxiliary Building Ventilation System (DWN [NABVS])) of the Nuclear Auxiliary, Safeguard and Fuel Buildings is configured on iodine extraction.

The gaseous effluent extracted from the Nuclear Auxiliary Building (NAB), Fuel building (FB), equipment compartment of Reactor Building (RB) and the controlled area of Safeguard Buildings (SB), are processed in the DWN [NABVS]. This system includes extraction units linked directly to the stack in the Nuclear Auxiliary Building (normal extraction units and iodine extraction units).

Discharge from the Reactor Building, as planned discharge, is directly filtered on iodine trap filters via scavenging ventilation on shutdown of the low flow rate EBA [CSVS].

EBA [CSVS] ventilate the Reactor Building when the reactor is shutdown. Effluent from this system is processed in the DWN [NABVS] described previously.

Also, meteorological measurements at the discharge level must be available and in the equipment in operation. Where possible, to guarantee good atmospheric dispersion, discharges are carried out outside of periods with ‘calm’ winds.

If, during planned discharge, one of these conditions is not met, then the non-planned discharge is interrupted and may only be resumed once these conditions are once again met.

If, during planned or continuous discharge, the gross beta activity concentration exceeds the alarm threshold (for example, alarm trigger value for the two activity measurements in the stack), then discharging is immediately interrupted by the Operator.

1.1.4. Evaluation of the activities discharged and emission rates

The evaluation of the activities discharged and the emission rates is presented in this section in a simplified way. The formulae explaining the calculations made are presented in Sub-chapter 7.3 - Table 1.

1.1.4.1. Activity discharged

For each category of radionuclides, the activity discharged is determined as being the result of the activity concentration for the category of radionuclides considered multiplied by the volume of air discharged into the stack, during a period considered.

For each category of radionuclides, the report of the activity discharged is established for every period defined.

The volume of air discharged into the stack during a period is determined as being the result of the average flow rate in the stack over the period multiplied by the duration of the period.

1.1.4.2. Activity concentration

The activity concentration for each of these categories is determined as follows:

- For tritium, from the tritium activity measured on the sample and the volume of effluent flowing through the sampling device during the sampling time;
- For noble gases, from the spectrometric analysis results and the volume of effluent sampled;
- For iodine isotopes and other activation or fission products, from the spectrometric analysis results and from the volume of effluent flowing through the sampling device during the period; and
- For carbon-14, from the carbon-14 activity measured on the sample and the volume of effluent flowing through the sampling device during the period.

1.1.4.3. Emission rate

For each category of radionuclides, the average emission rate in the stack over a period is determined as being the result of the activity concentration for each category of radionuclides over the period multiplied by the average flow rate via the stack over the same period.

1.1.5. Measuring techniques used and detection limits associated

The Sub-chapter 7.3 - Table 2 presents the measuring techniques corresponding to the Best Available Techniques (BAT) for industrial measurements (more details on sampling equipment and methods are presented in PCER Chapter 8). The equipment that will be used for analysis in the UK EPR will achieve detection of very low levels of radioactivity and will reach the best possible detection limits.

The determination of detection limits, decisions thresholds, and the expression of results will comply with international standard (EU Commission Recommendation 2004/2/Euratom [Ref-1]).

The monitoring of noble gases, iodine isotopes and radioactivity associated with particulate matter is based on continuous sampling. The devices to be implemented on the UK EPR will comply with the M11 guidance for monitoring of gaseous effluents and with the MCERTS requirements.

1.1.6. Monitoring of the equipment and measuring devices

The following controls and checks will be carried out:

- The good condition of all of the gaseous radioactive waste transfer pipes between the various buildings;
- Installation start-up devices such as iodine traps will be subjected to a maintenance programme and their correct operation will be checked; and
- The correct operation of the devices and associated alarms located in the stack. Calibration of these devices is carried out periodically.

1.2. MONITORING OF OTHER GASEOUS RADIOACTIVE DISCHARGES

1.2.1. Monitoring of rooms that are likely to being contaminated

No rooms exist on the EPR unit that are likely to being contaminated and not connected to the stack.

1.2.2. Monitoring of diffused discharges

Any micro-leaks in the steam generator tubes cause tritium to be transferred to the secondary cooling system. Where such leaks exist, the activity concentration due to tritium in the steam from the steam generators does not exceed a few thousand Bq per litre. Some normal operating conditions can therefore lead to steam with low levels of tritium being released to the atmosphere, via the system for atmospheric discharge.

Atmospheric emissions associated with the diffused discharges are subjected to a periodic assessment, aiming to ensure their marginal character in relation to the annual tritium limit. The assessment concerns the activities discharged and is established from the EPR units operating data (volumes discharged during the month and activity concentrations).

In addition, feedback data from Units with steam generator tubes that leak has never identified any iodine isotopes in the water in the secondary cooling system; so no iodine isotopes are discharged in this way.

2. MONITORING OF THE LIQUID RADIOACTIVE DISCHARGES

The various processes producing effluent emissions are outlined in Chapter 6 of the PCER.

It should be noted that measurements of the activity and the volume of the radioactive liquid effluents from the EPR are carried out before transfer to the shared storage tanks to provide feedback on the discharges (see Chapter 6 of the PCER). These provisions are implemented as soon as the EPR is started up, which will be adapted as and when required, once the profile of the discharges has been validated (effluent volume, radionuclide spectrum and chemical elements discharged).

2.1. MONITORING OF THE LIQUID RADIOACTIVE EFFLUENTS FROM THE T (0KER [LRMDS]) AND S (0TER [EXLWDS]) TANKS

2.1.1. Statutory reminder

According to the requirements of the RSA 93 [Ref-1], the plant operator must control its liquid discharge, in order to check that the discharge limit values which will be imposed to it by its authorisation are complied with.

Four categories of liquid radionuclides are subjected to discharge limits following the French practices: tritium, carbon-14, iodine isotopes, and the other beta or gamma emitting activation or fission products. These radionuclides are identified both in the EA Guidance for monitoring M12 [Ref-2] (monitoring of radioactive discharges to water) and in EU Commission Recommendation 2004/2/Euratom [Ref-3].

For the liquid radioactive effluents from the T (0KER [LRMDS]) and S (0TER [ExLWDS]) tanks, controls concern compliance of the limit values that will be requested, i.e.:

- The activity discharged every year, for the four categories of radionuclides;
- The emission rate at the discharge point, for tritium, iodine isotopes, and the other beta or gamma emitting activation or fission products;
- The activity concentration in the receiving water body, for tritium and the other beta emitting activation or fission products; and
- The flows and concentrations of the chemical parameters present in the effluents and subjected to an effluent discharge permit request (see Sub-chapter 7.4). The associated controls are presented in Sub-chapter 7.4.

2.1.2. Functions and role of T (0KER [LRMDS]) and S (0TER [ExLWDS]) Tanks

The functions and the role of T (0KER [LRMDS]) and S (0TER [ExLWDS]) storage tanks have been detailed in Chapter 6 of the PCER. This section provide a brief summary of them.

Role of T (0KER [LRMDS]) storage tank

The 0KER [LRMDS] collects liquid radioactive effluent from the Nuclear Island of each unit and from certain site facilities, monitors and accounts for its activity and its chemical and physical composition, and discharges it in a controlled fashion to the environment via the sea outlet.

The flow rate of the discharge to the environment depends on the level of activity of the effluent and the dilution capacity of the environment, so as to meet the limits set by discharge authorisation.

The various functions are as follows:

- storage for control of the activity and recording of the volume of effluent from the various 0KER [LRMDS] upstream systems; and
- monitored and controlled discharge to the environment via a dilution system.

Monitoring and recording procedures before discharge check compliance with regulations (water uptake and effluent discharge orders).

In the event of pollution of the 0KER [LRMDS] tanks, it is possible to treat the contents by transferring them via the 0TER [ExLWDS] to the 8TEU [LWPS] in the EPR Effluent Treatment Building.

Role of S (0TER [ExLWDS]) storage tank

This system is normally not used. It is kept empty in reserve.

The ***0TER [ExLWDS***] system may be used exceptionally when, for example:

- Dilution in the natural environment cannot be performed by normal discharge methods due to the unavailability of the 0KER [LRMDS] or 0SEK [SiteLWDS] tanks; and
- An unexpected operating incident disrupts the normal operation of a unit preventing direct discharge via normal means.

The role of the 0TER [ExLWDS] system is thus to store the site liquid radioactive effluent:

- either to retreat it using the Liquid Waste Processing System (8TEU [LWPS]);
- or to discharge it later to the environment.

In the event of pollution of the 0TER [ExLWDS] tanks, it is possible to treat the contents by transferring them to the 8TEU [LWPS] in the Effluent Treatment Building.

2.1.3. Description of the sampling devices and measuring devices

All of the sampling carried out on the T (0KER [LRMDS]) or S (0TER [ExLWDS]) storage tanks is subjected to analysis at the plant 'Effluents' laboratory.

A sampling system allows a sample to be taken that is representative of the contents of the T (0KER [LRMDS]) or S (0TER [ExLWDS]) tank to be discharged, obtained once the latter has been mixed. Tritium and carbon-14 analyses are carried out via liquid scintillation and the sample's composition is determined by gamma spectrometry. Gross alpha, gross beta and gross gamma activity measurements are carried out with an alpha-beta counter (gross alpha and gross beta activity measurements) and a gamma counter with NaI detector (gross gamma activity measurements).

Proportional samplers during discharges will be used for retrospective assessment and statutory reporting. Separate proportional samplings will be arranged as required by the Regulator to enable an independent sample to be collected.

Gross alpha measurements are expressed in americium-241 (Am-241) equivalent, gross beta measurements in strontium-90 + yttrium-90 (Sr-90 + Y-90) equivalent, and gross gamma measurements in caesium-137 (Cs-137) equivalent.

2.1.4. Monitoring of the discharges from the T (0KER [LRMDS]) and S (0TER [ExLWDS]) tanks

2.1.4.1. Analyses carried out before discharge

Some of the radioactive parameters for the effluents from the T (0KER [LRMDS]) and S (0TER [ExLWDS]) tanks need to be checked before being discharged into the sea: a sample is taken from each tank and analyses are carried out before discharging from the tank.

Before any discharge, liquid radioactive effluents from the T (0KER [LRMDS]) and S (0TER [ExLWDS]) tanks are subjected to the following analysis:

- tritium activity measurement;
- check of the absence of gross alpha activity;
- gross beta activity measurement;
- gross gamma activity measurement; and
- gamma spectrometry analysis.

The gross gamma activity is measured using a NaI detector whose global output is based on a caesium-137 standard source (100 KeV to 2 MeV window). The equipment purchased for the UK EPR will follow MCERTS requirements and will be selected in such a manner that the measuring range, the accuracy and other relevant features are consistent with the range and amplitude of the variation expected from the measured process parameters and its intended use.

These analyses allow the composition of the effluents to be discharged to be known and determine whether discharge is possible (compliance with annual and any short-term activity limits imposed). In this case, they will also allow to determine the discharge rate to ensure that the emission rates and activity concentrations into the receiving water body half way through the discharge process meet the legal requirements. These analyses also allow the activity discharged (excluding nickel-63 and carbon-14) to be determined and therefore ensure that the annual activity limits (excluding carbon-14) are not exceeded.

2.1.4.2. Analyses carried out after discharge

The other radioactive parameters for the effluents from the T (0KER [LRMDS]) and S (0TER [ExLWDS]) tanks are checked after their discharge. These retroactive controls are carried out:

- either on the sample taken from each tank before its discharge, as the results of the analyses are only known after the discharge;

- or on an aliquot sample representative of all of the discharges from the tanks over one period.

The sample taken from the T (0KER [LRMDS]) or S (0TER [ExLWDS]) tank before its discharge is subjected to a carbon-14 measurement, the result of which is known retroactively. It allows the carbon-14 activity discharged to be determined, and therefore ensures that the annual carbon-14 activity limit is not exceeded.

An aliquot sample representative of all of the discharges from T (0KER [LRMDS]) or S (0TER [ExLWDS]) tanks is prepared periodically. The remaining part of this sample is used to check for the presence of gross alpha activity. This check, although already undertaken before each tank discharge, is however, carried out on the aliquot sample. In actual fact, this analysis on the aliquot sample is more refined (the detection limit for this analysis is lower on the aliquot sample than on the sample taken from the tank before discharge).

The sample is also subjected to specific determination of the activity caused by nickel-63. In actual fact, as this radionuclide is a pure beta emitter, it is not detected during the gamma spectrometry analysis and is not discriminated by α-β counter. This determination is carried out on the aliquot sample because it concerns a complex chemical separation analysis which takes a long time to conduct. This analysis allows the report of the activities discharged to be completed.

2.1.4.3. Discharge conditions

Liquid radioactive effluent discharges may be carried out only when the controls described in section 2.1.4.1 have been carried out and have allowed the discharge rate to be determined (in compliance with the emission rates and activity concentration values *semi-discharged* into the receiving water body). In addition, two T (0KER [LRMDS]) or S (0TER [ExLWDS]) tanks cannot be discharged at the same time.

Radioactive liquid effluent discharges from the T (0KER [LRMDS]) and S (0TER [ExLWDS]) tanks may therefore be carried out only if the gross gamma activity concentration on the discharge line does not exceed a threshold (for example, alarm appearance value for the continuous radioactivity monitoring device located on the discharge line, an alarm which results in automatic shutdown of the discharge in progress).

If, during discharge, special situations are reported (such as, non-compliance of discharge conditions, the non-availability of monitoring devices on the discharge line), discharging is interrupted, the activity discharged is evaluated, and analyses are carried out to determine the cause of the special situation.

2.1.4.4. Discharge monitoring

Discharge monitoring for the T (0KER [LRMDS]) and S (0TER [ExLWDS]) tanks is provided by the control room, close to the KER-TER-SEK valve room, thanks to the retransmission of discharge rate measurements, level measurements and two alarm thresholds (low level and high level).

2.1.5. Evaluations of the activities discharged: Calculating radioactive parameters

The evaluation of the activities discharged and the emission rates is presented in this section in a simplified way. The formulae explaining the calculations made are presented in Sub-chapter 7.3 - Table 3.

2.1.5.1. Activity discharged

For each category of radionuclide, the activity discharged is determined as being the result of the activity concentration for the category of radionuclide considered multiplied by the volume of effluents discharged via the discharge line during the discharge period.

2.1.5.2. Activity concentration

The activity concentration for each category is determined as follows:

- For tritium, from the tritium activity measured on the sample taken before discharge and the volume of this sample;
- For iodine isotopes and other activation or fission products, from the spectrometric analysis results carried out on the sample taken before discharge and the volume of this sample, and the results from the specific nickel-63 determination on the monthly aliquot; and
- For carbon-14, from the carbon-14 activity measured on the sample taken and the volume of this sample.

2.1.5.3. Emission rate

For tritium, iodine isotopes, and other beta or gamma emitting activation or fission products, the average daily emission rate over a period is determined as being the sum of the activity discharged over a day divided by the number of seconds in a day (i.e. 86,400 seconds).

2.1.6. Measuring techniques used and associated detection limits

The measuring techniques presented in Sub-chapter 7.4 - Table 4 correspond to BAT for industrial measurements (more details on sampling equipment and methods are presented in Chapter 8 of the PCER). The equipment that will be used for analysis in the UK EPR will achieve detection of very low levels of radioactivity and will reach the best possible detection limits.

The determination of detection limits, decision thresholds, and the expression of results will comply with international standard (EU Commission Recommendation 2004/2/Euratom [Ref-1]).

2.1.7. Monitoring of the equipment and the measuring devices

The following controls and checks will be carried out:

- The leak tightness of each of the liquid radioactive effluent storage tanks (T (0KER [LRMDS]) and S (0TER [ExLWDS]) tanks);
- Discharge piping for the T (0KER [LRMDS]) and S (0TER [ExLWDS]) tanks to visually check the absence of leaks;
- The correct operation of the devices, the process relay controls and the associated alarms located on the discharge piping (flow rate measurement, gross gamma measurement, automatic closing of the isolation valve); and
- The various sampling devices and measuring devices will be subjected to maintenance and a check of their correct operation. The measuring devices are also subjected to calibration.

2.2. MONITORING OF THE WATER DRAINED FROM THE TURBINE HALLS

2.2.1. Statutory reminder

According to the requirements of the RSA 93 [Ref-1], the plant operator must control its liquid discharge, in order to check that the discharge limit values which are imposed to it by its authorisation are complied with.

The tritium and gross beta activity concentration limits set are defined so that water drained from the Turbine Hall to the Ex (0SEK [SiteLWDS]) tanks may be discharged without the constraints associated to the T (0KER [LRMDS]) and S (0TER [ExLWDS]) tanks (see Sub-chapter 7.4).

For the water drained from the Turbine Hall to the Ex (0SEK [SiteLWDS]) tanks, controls concern compliance with the limit values that will be imposed, i.e.:

- the tritium and gross beta activity concentration; and
- the flows and concentrations of the chemical parameters present in the effluents and subjected to an effluent discharge permit request (see Sub-chapter 7.4). The associated controls are presented in Sub-chapter 7.4.

2.2.2. Functions and role of Ex (0SEK [SiteLWDS]) storage tanks

The role of the 0SEK [SiteLWDS] system is as follows:

- to collect waste water from the following:
  - sumps in the uncontrolled area of the plant; and
  - systems in the Turbine Hall and the auxiliary buildings which may be slightly contaminated in the event of primary and/or secondary leaks in the steam generators.
- to record the volume of effluent received and monitor its level of activity; and
- to discharge this effluent to the environment.

Monitoring and recording procedures before discharge check compliance with regulations and discharge authorisations.

In the event of pollution of the 0SEK [SiteLWDS] tanks, it is possible to treat the contents by transferring them via the 0TER [ExLWDS] to the TEU [LWPS] of the existing units and the 8TEU [LWPS] in the EPR Effluent Treatment Building.

2.2.3. Description of the sampling devices and measuring devices

All of the samples taken from the Ex (0SEK [SiteLWDS]) storage tanks are subjected to analyses at the plant ‘Effluents’ laboratory, which will have to be accredited in accordance with the UK regulation.

A sampling system allows a sample to be taken that is representative of the contents of the Ex (0SEK [SiteLWDS]) tank to be discharged. The sample is obtained once the tank content has been mixed. On this sample, tritium analysis is carried out via liquid scintillation, and the gross beta activity measurement is carried out with an alpha-beta counter.

An aliquot sample representative of all of the discharges from the tanks over one period is also prepared. This sample is monitored to check the absence of gross alpha activity using an alpha-beta counter and the composition of the samples is determined using gamma spectrometry.

2.2.4. Monitoring of the discharges from the Ex (0SEK [SiteLWDS]) tanks

2.2.4.1. Analyses carried out before discharge: Controlled radioactive parameters

Some of the radioactive parameters for the effluent stored in the Ex (0SEK [SiteLWDS]) tanks need to be checked before being discharged into the sea: representative one-off sampling is carried out in each tank and analyses are carried out before discharge of the tank.

Before any discharge, the effluent stored in the Ex (0SEK [SiteLWDS]) tanks is subjected to the following analyses, carried out on a representative sample:

- tritium activity measurement; and
- gross beta activity measurement.

These analyses allow the gross beta and tritium activity concentrations to be known, and therefore determine whether the effluent contained in the Ex (0SEK [SiteLWDS]) tanks may be discharged without the constraints associated with T (0KER [LRMDS]) and S (0TER [ExLWDS]) tanks. In addition, tritium analyses also allow the report of the tritium activity discharged by this channel to be established, and therefore to ensure that the annual tritium activity limit is not exceeded.

If the gross beta activity concentration exceeds the limit value set for this discharge route, then the effluents contained in the Ex (0SEK [SiteLWDS]) tanks are considered as T (0KER [LRMDS]) and S (0TER [ExLWDS]) radioactive effluents: they undergo the same controls as the latter (see section 2.1.4.1) and are discharged and calculated in the same discharge conditions (see sections 2.1.4.3 and 2.1.5).

2.2.4.2. Analyses carried out after discharge: Controlled radioactive parameters

The other radioactive parameters for the water drained from the Turbine Halls are checked after discharge to the Ex (0SEK [SiteLWDS]) tanks. These retroactive controls are carried out on an aliquot sample representative of all of the discharges from the tanks over one period.

This aliquot sample is subjected to a check for the absence of gross alpha activity and gamma spectrometry analysis. These checks are only carried out on the aliquot sample, retroactively, when the effluents from the Ex (0SEK [SiteLWDS]) tanks are, in principle, not radioactive or low activity effluents.

2.2.4.3. Discharge monitoring

Discharge monitoring for the Ex (0SEK [SiteLWDS]) tanks is carried out remotely in the control room. This is achieved by retransmission of discharge rate measurements, level measurements of each tank and two alarm thresholds (low level and high level).

2.2.4.4. Evaluations of the activities discharged: Calculating the radioactive parameters

The evaluation of the activities discharged and the emission rates is presented in this section in a simplified way. The formulae explaining the calculations made are presented in Sub-chapter 7.3 - Table 3.

The tritium activity discharged is determined as being the result of the tritium activity concentration multiplied by the volume of effluents discharged by the discharge line during the discharge period. The tritium activity concentration is determined from the tritium activity measured on the sample taken before discharge and the volume of this sample.

If the gross beta activity measured before discharge is lower than the limit and if the analysis of the aliquot sample does not demonstrate significant activity, then the activity of the tank is considered as zero and therefore is not calculated. In the opposite case, the effluents contained in the Ex (0SEK [SiteLWDS]) tank are controlled, discharged and calculated like the radioactive effluents from the T (0KER [LRMDS]) or S (0TER [ExLWDS]) tanks (see sections 2.1.4.1, 2.1.4.2, 2.1.4.3 and 2.1.5).

2.2.4.5. Measuring techniques used and detection limits associated: Radioactive parameters

The techniques presented in Sub-chapter 7.3 - Table 5 correspond to BAT for industrial measurements (more details on sampling equipment and methods are presented in Chapter 8 of the PCER). The equipment that will be used for analysis in the UK EPR will achieve detection of very low levels of radioactivity and will reach the best possible detection limits.

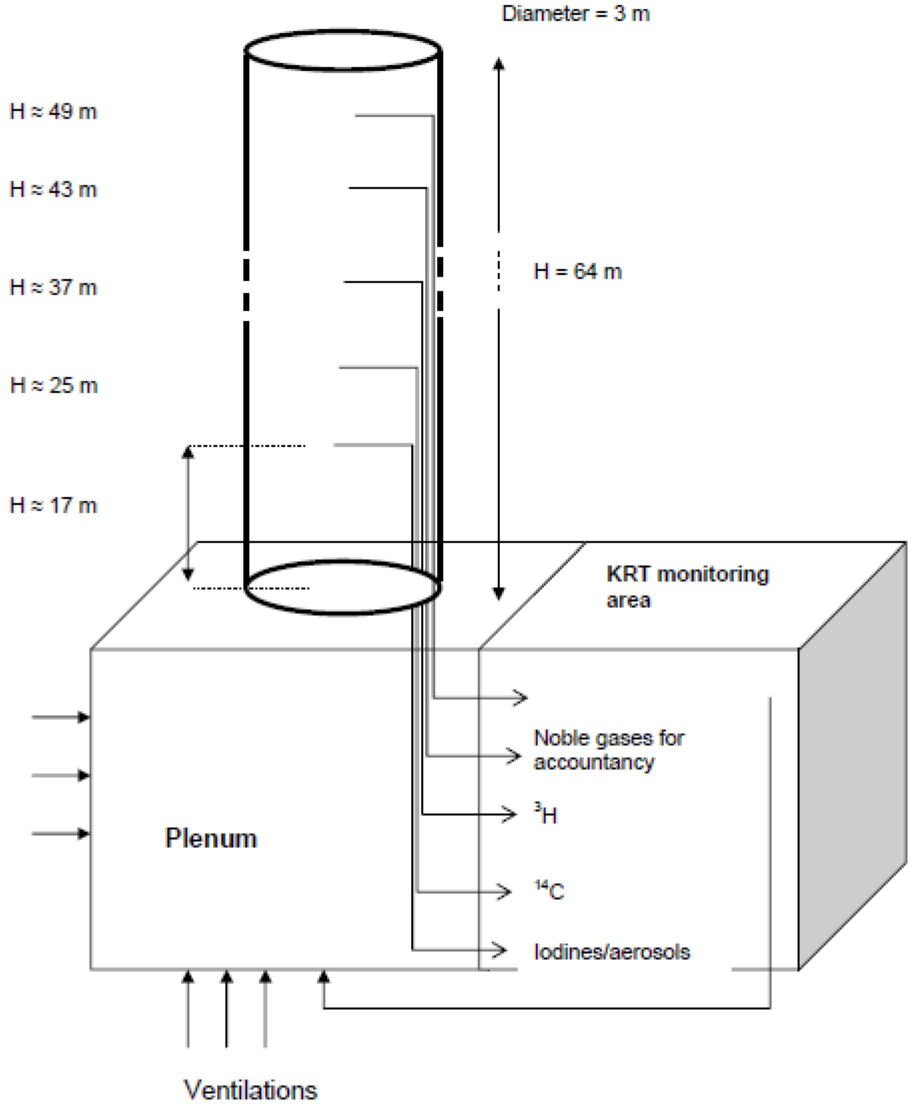
The determination of detection limits, decisions thresholds, and the expression of results will comply with international standard (EU Commission Recommendation 2004/2/Euratom [Ref-1]).

2.2.5. Monitoring of the radioactivity in the SEO systems

Several collection points marked will allow samples to be taken from the secondary outfalls to check the absence of radioactivity.

Sampling will be carried out periodically and analysed in the laboratory. Filtered water will be subjected to gross beta analysis, a tritium activity measurement and a potassium measurement. Total suspended solids will be subjected to a gross beta analysis.

Sub-chapter 7.3 - Figure 1: Principle of the design of the monitoring sampling in the stack for Flamanville 3 EPR



Sub-chapter 7.3 - Table 1: Determination of the activities discharged, activity concentration and emission rates for each category of radionuclide – Gaseous radioactive discharges

<table>
<tr><th></th><th>Activity discharged</th><th>Volume discharged</th><th>Activity concentration</th><th>Emission rate</th></tr>
<tr><td>Noble gases</td><td rowspan="5">For each period:
$Act._{RN\ period} = Act.Vol._{RN} \times V_{R\ period}$
Over the year:
$Act._{RN\ year} = \sum_{year} Act._{RN\ periods}$</td><td rowspan="4">For each period:
$V_{R\ period} = Q_{av\ period} \times T_{period}$</td><td rowspan="5">For each period:
$Act.Vol._{RN} = \frac{Act._{RN\ sampling}}{V_{sampling\ RN}}$</td><td>Everyday:
$Q_{Act.Noble\ gases} = Act.Vol._{av\ beta\ gas} \times Q_{daily\ av}$</td></tr>
<tr><td>Tritium</td><td rowspan="3">For each period:
$Q_{Act.RN} = Act.Vol._{RN\ period} \times Q_{av\ period}$</td></tr>
<tr><td>Iodine isotopes</td></tr>
<tr><td>Others FP or AP</td></tr>
<tr><td>Carbon-14</td><td>For each period:
$V_{R\ period} = \sum_{period} V_{R\ periods}$</td><td></td></tr>
</table>

Key

RN: radionuclide (category)

Act.: activity (Bq)

Act.Vol.:activity concentration (Bq m^{-3})

V_R: volume discharged via the stack (m^3)

Q: rate discharged via the stack ($m^3\ s^{-1}$)

T: time (s)

$Q_{Act.}$: emission rate (Bq s^{-1})

Sub-chapter 7.3 - Table 2: Measuring techniques carried out on gaseous radioactive waste

Radionuclides	Type of sampling	Measurement
Tritium	Bubbler	Liquid scintillation
Iodine isotopes	Activated carbon cartridge	Gross gamma
		Gamma spectrometry
Other fission or activation products	Paper filter	Gross beta
		Gamma spectrometry
		Gross alpha
Noble gases	Differential chamber (fixed or mobile)	Gross beta
	SG500G or SG3000G aluminium capacity with outline geometry	Gamma spectrometry
Carbon-14	Molecular sieve hydraulic unit	Liquid scintillation

Sub-chapter 7.3 - Table 3: Determination of the activities discharged, activity concentrations and emission rates for each category of radionuclide – Liquid radioactive discharges (T (0KER [LRMDS]), S (0TER [ExLWDS]) or Ex (0SEK [SiteLWDS]) tanks)

<table>
<tr><th></th><th>Activity discharged</th><th>Volume discharged</th><th>Activity concentration in the tank</th><th>Emission rate</th></tr>
<tr><td>Tritium</td><td rowspan="4">During each discharge:
$Act._{RN\ discharged} = Act.Vol._{RN} \times V_R$

Over the year:
$Act._{RN\ year} = \sum_{year} Act._{RN\ alldischarge}$</td><td rowspan="4">During each discharge:
$V_R = Q \times T$</td><td rowspan="4">$Act.Vol._{RN} = \frac{Act._{RN\ sample}}{V_{sample}}$

Special case of Ex (0SEK [SiteLWDS])
If the gross beta activity concentration measured is lower than 10 Bq l^{-1} and if the periodically aliquot analysis does not demonstrate significant activity, then only the tritium activity discharged is calculated. In the opposite case, the effluents contained in the Ex (0SEK [SiteLWDS]) tanks are treated and calculated like the radioactive effluents from the T (0KER [LRMDS]) and S (0TER [ExLWDS]) tanks.</td><td rowspan="3">$Q_{Act.} = \frac{Act._{RN\ discharged\ daily}}{86\,400}$</td></tr>
<tr><td>Iodine isotopes</td></tr>
<tr><td>Others FP or AP</td></tr>
<tr><td>Carbon-14</td><td></td></tr>
</table>

Key

RN: radionuclide (category)

Act.: activity (Bq)

Act.Vol.: activity concentration (Bq m^{-3})

V_R: volume discharged in the discharge pond (m^3)

Q: Discharge rate in the 0KER [LRMDS] line (m^3 s^{-1})

T: discharge time (s)

Q_{Act}: emission rate (Bq s^{-1})

Sub-chapter 7.3 - Table 4: Measurement techniques carried out on liquid radioactive effluents

Radionuclides	Location of sampling	Measurement
Checking the absence of alpha emitters	T (0KER [LRMDS]) and S (0TER [ExLWDS]) tanks	Gross alpha
Beta and gamma emitting activation or fission products		Gross beta
		Gross gamma
Tritium		Tritium
-		Gamma spectrometry
Carbon-14 (retroactive)		-
Checking the absence of alpha emitters	Periodic aliquot of the T (0KER [LRMDS]) and S (0TER [ExLWDS]) tanks	Gross alpha
Nickel-63		Nickel-63

Sub-chapter 7.3 - Table 5: Measuring techniques carried out on the water drained from the Turbine Halls

Radionuclides	Location of sampling	Measurement
Beta emitting activation or fission products	Ex (0SEK [SiteLWDS]) tanks	Gross beta
Tritium		Tritium
-	Periodic aliquot of the Ex (0SEK [SiteLWDS]) tanks	Gamma spectrometry
Checking the absence of alpha emitters		Gross alpha

SUB-CHAPTER 7.3 – 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. MONITORING OF GASEOUS RADIOACTIVE DISCHARGES

1.1 MONITORING OF GASEOUS RADIOACTIVE WASTE DISCHARGED FROM THE STACK OF THE NUCLEAR AUXILIARY BUILDING

1.1.1. Statutory reminder

[Ref-1] The Radioactive Substances Act 1993. HM Stationery Office. ISBN 0-10: 0105412937. (E)

[Ref-2] Monitoring of radioactive discharges to Atmosphere from Nuclear Facilities. Technical Guidance Note (Monitoring) M11. Environment Agency. 1999. (E)

[Ref-3] Official Journal of the European Union, Commission Recommendation of 18 December 2003 on standardised information on radioactive airborne and liquid discharges into the environment from nuclear power reactors and reprocessing plants in normal operation. (E)

1.1.5 Measuring techniques used and detection limits associated

[Ref-1] Official Journal of the European Union, Commission Recommendation of 18 December 2003 on standardised information on radioactive airborne and liquid discharges into the environment from nuclear power reactors and reprocessing plants in normal operation. (E)

2. MONITORING OF THE LIQUID RADIOACTIVE DISCHARGES

2.1. MONITORING OF THE LIQUID RADIOACTIVE EFFLUENTS FROM THE T (0KER [LRMDS]) AND S (0TER [EXLWDS]) TANKS

2.1.1. Statutory reminder

[Ref-1] The Radioactive Substances Act 1993. HM Stationery Office. ISBN 0-10: 0105412937. (E)

[Ref-2] Monitoring of radioactive discharges to Water from Nuclear Facilities. Technical Guidance Note (Monitoring) M12. Environment Agency. 1999. (E)

[Ref-3] Official Journal of the European Union, Commission Recommendation of 18 December 2003 on standardised information on radioactive airborne and liquid discharges into the environment from nuclear power reactors and reprocessing plants in normal operation. (E)

2.1.6. Measuring techniques used and associated detection limits

[Ref-1] Official Journal of the European Union, Commission Recommendation of 18 December 2003 on standardised information on radioactive airborne and liquid discharges into the environment from nuclear power reactors and reprocessing plants in normal operation. (E)

2.2. MONITORING OF THE WATER DRAINED FROM THE TURBINE HALLS

2.2.1. Statutory reminder

[Ref-1] The Radioactive Substances Act 1993. HM Stationery Office. ISBN 0-10: 0105412937. (E)

2.2.4. Monitoring of the discharges from the Ex (0SEK [SiteLWDS]) tanks

2.2.4.5. Measuring techniques used and detection limits associated: Radioactive parameters

[Ref-1] Official Journal of the European Union, Commission Recommendation of 18 December 2003 on standardised information on radioactive airborne and liquid discharges into the environment from nuclear power reactors and reprocessing plants in normal operation. (E)

SUB-CHAPTER 7.4 – MONITORING CHEMICAL DISCHARGES TO THE AQUATIC ENVIRONMENT AND THE ATMOSPHERE

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Substances associated with liquid radioactive discharges (lithium hydroxide and boron for example) or derived from the operation of conventional facilities of the installation (conditioning amines from the secondary system for example), chemical discharges are subject to both control optimisation to reduce emissions and monitoring to demonstrate compliance with emissions standards.

All chemical substances associated with the EPR process are considered below. However, it is important to emphasise that discharges from water treatment or the production of filtered and demineralised water are non generic features as they are site-specific (the assumption of a site adjacent to a marine or estuarine environment is made (see Chapters 3 and 6 of the PCER).

1. MONITORING CHEMICAL DISCHARGES ASSOCIATED WITH LIQUID RADIOACTIVE EFFLUENTS

Chemical concentrations and volume are measured before transfer to the storage tanks to provide information on the discharges relating to this unit. These provisions will be implemented from the beginning of commissioning, and are likely to be amended once the chemical characteristics of the discharges has been determined (effluent volume and chemical substances discharged).

1.1. STATUTORY REQUIREMENTS

According to the requirements of the Radioactive Substances Act 1993 [Ref-1] and of the Pollution Prevention and Control Regulations 1999, as described in the Environment Agency (EA) Guidance [Ref-2] and the Integrated Pollution and Prevention Control Practical Guide issued by DEFRA (2005) [Ref-3], the plant operator must control liquid emissions, in order to comply with the discharge limits imposed by the authorisations and permits.

For chemicals associated to liquid radioactive effluents from the T (0KER [LRMDS]), S (0TER [ExLWDS]) and Ex (0SEK [SiteLWDS])) tanks, controls concern compliance with the limit values that will be requested, i.e. the flow and concentrations of chemical parameters present in the effluents and subjected to an effluent discharge permit.

1.2. MONITORING AND CALCULATION PROCEDURES

1.2.1. Sampling and monitoring equipment

All of the samples taken from T (0KER [LRMDS]), S (0TER [ExLWDS]) and Ex (0SEK [SiteLWDS]) storage tanks will be analysed at the on site ‘Effluents’ laboratory. To accord with the requirements of the EA, the effluent laboratory may be MCERTS accredited.

The sampling system allows for a sample to be taken that is representative of the contents of the T (0KER [LRMDS]), S (0TER [ExLWDS]) and Ex (0SEK [SiteLWDS]) once the contents of the tanks have been mixed.

All sampling and monitoring equipment will be subject to a programme of preventive maintenance, involving a daily check of their operation and a periodic calibration. Records of all maintenance and calibration will be kept secure and made available to the Regulators when required.

1.2.2. Measuring techniques used

The monitoring techniques presented in Sub-chapter 7.4 - Table 1 are considered to be appropriate for the processes and emissions investigated. Monitoring will be undertaken in accordance with the relevant best available technique standards (see Chapter 8 of the PCER).

1.2.3. Calculation procedures

The composition calculations for the analysis of each ‘tank’ and ‘aliquot’ will be carried out with the following provision: for all of the flow calculations (2 hours, 24 hours, monthly, annually) and cumulative totals for quantities discharged, the concentrations which are measured below the detection limit are considered to be zero for all of the substances concerned.

1.3. MONITORING DISCHARGES FROM THE T (0KER [LRMDS]) AND S (0TER [EXLWDS]) TANKS

1.3.1. Analyses prior to discharge

The physico-chemical parameters of the effluents from the T (0KER [LRMDS]) and S (0TER [ExLWDS]) tanks will be analysed prior to discharge: representative one-off sampling will be carried out in each tank with laboratory analysis undertaken prior to the effluents being discharged from the tank.

Before any discharge, the liquid radioactive effluents from the T (0KER [LRMDS]) and S (0TER [ExLWDS]) tanks are subjected to the following analyses, carried out on a representative one-off sample:

- Boric acid (H_3BO_3) concentration measurement;
- Hydrazine (N_2H_4) concentration measurement;
- Morpholine (C_4H_9ON) concentration measurement only on the tanks that have received conditioning water from the steam generators, in the case of morpholine steam generator conditioning (only situation where the tanks are likely to contain a high concentration of morpholine); and
- Ethanolamine (C_2H_7ON) concentration measurement only on the tanks that have received conditioning water from the steam generators, in the case of ethanolamine steam generator conditioning (only situation where the tanks are likely to contain a high concentration of ethanolamine).

1.3.2. Analyses carried out after discharge

The other physico-chemical parameters of liquid radioactive effluents from the T (0KER [LRMDS]) and S (0TER [ExLWDS]) tanks are controlled after discharge from the tanks. These retrospective controls are carried out:

- either on the representative one-off sample taken from each tank before its discharge, as the results of the analyses are known after tank discharge;
- or on an aliquot sample representative of all of the discharges from the tanks over an appropriate period.

The sample taken from the T (0KER [LRMDS]) and S (0TER [ExLWDS]) tanks before discharge is subjected to the following analyses, the results of which may be known after discharge:

- phosphate concentration measurement (PO_4^{3-});
- nitrogen (N) concentration measurement, excluding hydrazine, morpholine and ethanolamine: this analysis (measurement of the ammonium ions, nitrates and nitrites) is carried out retrospectively because the nitrogen concentration does not exceed a few mg l^{-1}; and
- detergent concentration measurement (only for tanks collecting effluent from laundry).

The aliquot sample representative of all of the discharges from the T (0KER [LRMDS]) and S (0KER [ExLWDS]) tanks is subjected to the following analyses:

- Morpholine (C_4H_9ON) concentration measurement: this analysis is carried out only in the case of morpholine conditioning of the secondary system. Analysis is carried out on the aliquot sample because the morpholine concentration in the effluents is expected to show little variation;
- Ethanolamine (C_2H_7ON) concentration measurement: this analysis is carried out only in the case of ethanolamine conditioning of the secondary system. Analysis is carried out on the aliquot sample because the ethanolamine concentration in the effluent is expected to show little variation;
- Total metals (zinc, copper, manganese, nickel, chromium, iron, aluminium, lead) concentration measurement: this analysis is carried out on the aliquot sample because the metals that originate from the abrasion of materials that make up the systems, are parameters which vary little in the effluents;
- Total suspended solids (TSS) concentration measurement: this analysis is carried out on the aliquot sample (paying special attention to the conservation of the sample) because the TSS flow added remains low in relation to the TSS flowing through the installation via the raw cooling water sampled; and
- Chemical oxygen demand (COD) measurement: this analysis is carried out on the aliquot sample because the compounds that are mainly responsible for the COD are already monitored on each tank.

These analyses allow nitrogen, phosphate, boric acid, morpholine, ethanolamine, total metals, total suspended solids and chemical oxygen demand concentrations to be determined in the T (0KER [LRMDS]) and S (0TER [ExLWDS]) tanks.

Sub-chapter 7.4 - Table 2 summarises all of the analyses of the physico-chemical parameters carried out on effluents from the T (0KER [LRMDS]) and S (0TER [ExLWDS]) tanks.

1.4. MONITORING DISCHARGES FROM THE EX (0SEK [SITELWDS]) TANKS

1.4.1. Analyses carried out before discharge

Some of the physico-chemical parameters of the effluents from the Ex (0SEK [SiteLWDS])] tanks will be checked before being discharged into the sea: representative one-off sampling from each tank will be carried out prior to discharge, consists of:

- measuring the hydrazine concentration.

1.4.2. Analyses carried out after discharge

The other physico-chemical parameters of the liquid radioactive effluents from the Ex (0SEK [SiteLWDS]) tanks are controlled after discharge from the tanks. These retrospective controls are carried out:

- either on the representative one-off sample taken from each tank before its discharge, as the results of the analyses are known after tank discharge;
- or on an aliquot sample representative of all of the discharges from the tanks over an appropriate period.

The sample taken from the Ex (0SEK [SiteLWDS]) tank before discharge is subjected to the following analyses, the results of which may be known after discharge:

- nitrogen (N) concentration measurement, excluding hydrazine, morpholine and ethanolamine on each Ex (0SEK [SiteLWDS]) tank because the nitrogen concentration may fluctuate according to the discharges from the condenser vacuum system (CVI) containers: this analysis is carried out retrospectively; and
- phosphate concentration measurement (PO_4^{3-});

The aliquot sample representative of all of the discharges from the Ex (0SEK [SiteLWDS]) tanks is subjected to the following analyses:

- Boric acid (H_3BO_3) concentration measurement: this analysis is carried out only if boric acid is injected into the secondary system. Analysis is therefore carried out on the aliquot sample because the boric acid concentrations in the effluents from the secondary system vary little and are very low in relation to those in the T (0KER [LRMDS]) and S (0TER [ExLWDS]) tanks;
- Morpholine (C_4H_9ON) concentration measurement, only if the secondary system is conditioned with morpholine: this analysis is carried out on the aliquot sample because the morpholine concentration varies little in the effluents;
- Ethanolamine (C_2H_7ON) concentration measurement, only in the case of conditioning the secondary system with ethanolamine: this analysis is therefore carried out on the aliquot sample because the concentration in the effluents is expected to show little variation;

- Total metals (zinc, copper, manganese, nickel, chromium, iron, aluminium, lead) concentration measurement: this analysis is carried out on the aliquot sample because the metals that originate from the abrasion of materials that make up the systems are parameters which vary little in the effluents;

- Total suspended solids (TSS) concentration measurement: this analysis is carried out on the aliquot sample because the TSS flow added normally remains low in relation to the TSS flowing in the raw cooling water; and

- Chemical oxygen demand (COD) measurement: this analysis is carried out on the aliquot sample because the compounds that are mainly responsible for this chemical oxygen demand are already monitored on each tank.

These analyses allow nitrogen, phosphate, boric acid, morpholine, ethanolamine, total metals, total suspended solids and chemical oxygen demand concentrations to be determined in the Ex (0SEK [SiteLWDS]) tanks.

Sub-chapter 7.4 - Table 3 summarises all of the analyses of the physico-chemical parameters carried out on effluents from the Ex (0SEK [SiteLWDS]) tanks.

1.5. COMPLIANCE MONITORING

A programme of monitoring effluents against discharge limits imposed by the relevant authorisations will be implemented. The programme may involve a range of compliance tests including flow, concentrations, volumes and flow rate.

Assessment of the effluents against authorisation limits for flow concentrations over specified periods (24 hours, annual, etc.) will be undertaken by calculation according to the following equation:

$$\text{Flow added}_{\text{over a period}} = [\text{concentration measured}] \times (\text{volume discharged})_{\text{over a period}}$$

2. MONITORING EFFLUENTS FROM DEMINERALISED WATER PRODUCTION

At the raw water treatment level in the decanter, iron (III) chloride will be added as a flocculent to coagulate the TSS present in the water. Iron chloride is then precipitated in the form of iron hydroxide, an insoluble solid waste compound.

Periodic sampling of the effluent from the Demineralisation Station outlet will be undertaken. It allows for the TSS concentration to be determined before dilution, then the corresponding flow added to the environment can be calculated using the equation presented in section 1.5.

Concerning the chlorides injected via the iron (III) chloride, no authorisation limit is anticipated and no control is planned given their natural content in the marine environment.

Periodic sampling will be carried out at the Demineralisation Station outlet when sludge is discharged. This sampling is used to determine the iron flow required for controlling substances with several origins.

To reduce waste arising from the demineralised water production process, ion exchange resins may be regenerated using either sodium based compounds or sulphuric acid (depending on the type of resin subject to recharge). The effluents from the regeneration process are transferred to the neutralisation pit for treatment via pH adjustment.

The regeneration effluents are neutralised in the neutralisation pit by using sulphuric acid (H_2SO_4) and sodium (NaOH). Further details of the neutralisation process is given in Chapters 3 and 6 of the PCER. The pit is then drained into the SEO system. The neutralisation process results in discharges of sulphates and sodium. Due to the low quantities of discharged sulphate and sodium, and the background concentrations in seawater, there is unlikely to be an authorisation limit on the discharge of these substances.

Concerning sulphates, periodic sampling will be carried out at the Demineralisation Station outlet when sludge is discharged. It allows the sulphate concentration to be determined before dilution and the corresponding flow assessed.

The detergents from the desalination unit are subjected to a flow calculation, which is required for controlling substances with several origins. The flow from the desalination unit is calculated via material assessment during membrane scrubbing by multiplying the concentration of the scrubbing solution by the volume of effluents produced.

Due to the alkalinity and/or acidity of the reagents present in the neutralisation pit, pH will be measured prior to draining the pit.

These measurements and calculations allow compliance against the authorisation limits to be checked.

Measurement method

The methods for measuring TSS, sulphate and iron concentrations are presented in Sub-chapter 7.4 - Table 4. Monitoring is considered a best available technique standard.

3. MONITORING WATER COLLECTED IN THE SEO SYSTEMS

3.1. MONITORING WASTEWATER PURIFICATION STATION

Effluents from the wastewater purification stations may affect $BOD_{5:}$ five-day biological oxygen demand. Determinations of BOD_5 are carried out on composite samples taken periodically downstream of the installation.

Measurement method

The measurement method for the BOD_5 determination is presented in Sub-chapter 7.4 - Table 5, and is considered to be a best available technique standard.

The wastewater purification stations will be subjected to a programme of self-monitoring allowing the efficiency of the drainage system and compliance of discharge limits to be checked. The parameters monitored may include pH, flow rate, BOD_5, COD and TSS.

3.2. HYDROCARBON MONITORING

Rainwater from the site surface water drainage system (car parks, highways, platform, roofs) may contain trace amounts of hydrocarbons.

Each drainage system outfall will be equipped with a permanent flow measuring device and an automatic sampling device programmed over 24 hours to obtain representative data on the drainage effluent. The hydrocarbon concentration will be monitored.

Measurement method

The method for monitoring hydrocarbon concentration is presented in Sub-chapter 7.4 - Table 6, and is considered to be a best available technique standard.

4. MONITORING WATER COLLECTED IN THE SEH SYSTEM CONTAINING OIL

Water containing oil from the plant will be collected in a specific system called the SEH (hydrocarbon effluents system).

Water containing oil from the EPR is treated by an oil separator before rejoining the main drain upstream of the containment tank that allows any eventual pollution to be contained.

Sampling of the water will inform the level of control requried on the content of hydrocarbons in the effluent.

The same sampling regime that is carried out on rainwater is used here. The method for hydrocarbon concentration measurement at the outfall outlets is the same as that described for the rainwater measurement (see section 3.2).

5. MONITORING CHLORINATION IN THE COOLING SYSTEMS

The EPR seawater cooling systems are protected against the development of biofilms and the proliferation of biological fouling organisms via the in situ production and addition of sodium hypochlorite, which destroys biological organisms.

Sodium hypochlorite is produced in situ by seawater electrolysis.

The addition of sodium hypochlorite produces residual oxidants and bromoform wastes.

During the chlorination period:

- The chlorine concentration required in the cooling systems is limited by the size of the installations, by constant monitoring of the current applied to the electrolysers and by periodic measurement of the hypochlorite concentration produced;
- The residual oxidant concentration is measured in the discharge pond. This measurement, together with the volume of water discharged, allows the flow of residual oxidants to be calculated; and

- The bromoform concentration in the discharge pond is calculated from the concentration of chlorine injected. The bromoform concentration together with the volume of water discharged, allows the bromoform flow to be calculated.

Measurement method

The method for monitoring the residual oxidant concentration is presented in Sub-chapter 7.4 - Table 7 and represents a best available technique standard.

6. MONITORING CHEMICAL DISCHARGES INTO THE ATMOSPHERE

The non radioactive gases discharged into the atmosphere comprise:

- Sulphur and nitrogen oxides discharges present in the exhaust gases from the back-up electricity generator sets;
- Methanol and carbon monoxide emitted by the glass wool insulation during the initial temperature increase; and
- Ammonia as a result of the thermal decomposition of the steam generator lay-up solution on restarting.

The air quality assessment set out in Chapter 12 of the PCER will identify the significant emissions to air from the installation. The PPC permit will specify the continuous emission monitoring and extractive test monitoring that is required, in accordance with EA guidance, including:

- Technical Guidance Note M1 – Sampling requirements for monitoring stack emissions to air from industrial installations, Version 2, Environment Agency 2002
- Technical Guidance Note M2 – Monitoring of stack emissions to air, Version 2, Environment Agency, 2003

The type of monitoring required (which can range from occasional extractive sampling to continuous emission monitoring) will be determined in accordance with this guidance and the quantities and frequency of pollutant releases. Initial assessments indicate that none of the above emissions will be continuous or substantial in quantity.

7. MONITORING SUBSTANCES WITH SEVERAL ORIGINS

7.1. MORPHOLINE, ETHANOLAMINE AND PHOSPHATES

Morpholine, ethanolamine and phosphates originate from the T (0KER [LRMDS]), S (0TER [ExLWDS]) and Ex (0SEK [SiteLWDS]) tanks and the SEO system.

With reference to the quantities originating from the T (0KER [LRMDS]), S (0TER [ExLWDS]) and Ex (0SEK [SiteLWDS]) tanks, it is anticipated that the only regulatory control will be that associated with the flow of these substances. Compliance with the authorisation limit will be checked using the calculation, as described in section 1.5.

With reference to the quantities originating from the SEO system, no authorisation limit is anticipated. The quantities will be calculated so that the limit on the concentration added into the discharge pond, which results from discharges from the T (0KER [LRMDS]), S (0TER [ExLWDS]) and Ex (0SEK [SiteLWDS]) tanks and SEO discharges, can be checked.

7.2. SODIUM, CHLORIDES, TSS, TOTAL METALS AND DETERGENTS

7.2.1. Sodium and chlorides

Due to the background concentrations of sodium and chloride present in seawater, it is unlikely that the discharge of these substances will be regulated.

7.2.2. Total suspended solids

Total suspended solids originate from the T (0KER [LRMDS]), S (0TER [ExLWDS]) and Ex (0SEK [SiteLWDS]) tanks and the Demineralisation Station.

With reference to the quantities originating from the T (0KER [LRMDS]), S (0TER [ExLWDS]) and Ex (0SEK [SiteLWDS]) tanks, the authorisation limit will likely concern flow only. Compliance against the limit will be checked via calculation, as described under section 1.5 above.

With reference to the quantities originating from the Demineralisation Station, the authorisation limit will likely concern the concentration in the effluent. Compliance with the authorisation limit will be checked by measuring, as described in section 2. The flow from the Demineralisation Station will be calculated (see section 2) so that the limit on the concentration added into the discharge pond, which is caused by discharges from the T (0KER [LRMDS]), S (0TER [ExLWDS] and Ex (0SEK [SiteLWDS]) tanks and discharges from the Demineralisation Station, may be checked.

7.2.3. Total metals

Heavy metals discharges (measured as total metals) will be from the T (0KER [LRMDS]), S (0TER [ExLWDS]) and Ex (0SEK [SiteLWDS]) tanks and the Demineralisation Station.

With reference to the quantities originating from the T (0KER [LRMDS]), S (0TER [ExLWDS]) and Ex (0SEK [SiteLWDS]) tanks, the authorisation limit will likely concern the flow of these substances. Compliance with the limit will be checked via calculation, as described in section 1.5.

With reference to the quantities originating from the Demineralisation Station (for iron only), no authorisation limit is anticipated, however the quantities will be calculated (see section 2) so that the limit on the concentration added into the discharge pond, which is caused by discharges from the T (0KER [LRMDS]), S (0TER [ExLWDS]) and Ex (0SEK [SiteLWDS]) tanks and discharges from the Demineralisation Station, may be checked.

8. SUMMARY OF THE MONITORING REGARDING LIQUID CHEMICAL DISCHARGES

8.1. DIAGRAM OF THE MONITORING ASSOCIATED TO CHEMICAL DISCHARGES FROM THE EPR UK

The Sub-chapter 7.4 - Figure 1 presents a summary of the monitoring associated with chemical discharges from the UK EPR.

Sub-chapter 7.4 - Table 1: Measuring techniques used for measuring chemical substances associated to liquid radioactive effluents

<table>
<tr><th colspan="2">Parameters</th><th>Measurement method</th></tr>
<tr><td colspan="2" rowspan="2">Boric acid (H_3BO_3)</td><td>Titrimetry</td></tr>
<tr><td>Molecular absorption spectrometry</td></tr>
<tr><td colspan="2">Hydrazine (N_2H_4)</td><td>Molecular absorption spectrometry</td></tr>
<tr><td colspan="2">Morpholine (C_4H_9ON)</td><td>Capillary electrophoresis</td></tr>
<tr><td colspan="2">Ethanolamine (C_2H_7ON)</td><td>Capillary electrophoresis</td></tr>
<tr><td rowspan="4">Nitrogen (N)</td><td rowspan="2">Ammonium</td><td>Specific ion electrode</td></tr>
<tr><td>Capillary electrophoresis</td></tr>
<tr><td>Nitrites</td><td>Molecular absorption spectrometry</td></tr>
<tr><td>Nitrates</td><td>Molecular absorption spectrometry with deconvolution</td></tr>
<tr><td colspan="2" rowspan="2">Phosphate</td><td>Molecular absorption spectrometry with bismuth phosphomolybdate</td></tr>
<tr><td>Molecular absorption spectrometry with ammonium molybdate</td></tr>
<tr><td colspan="2">Detergents</td><td>Molecular absorption spectrometry with deconvolution</td></tr>
<tr><td colspan="2">Total metals</td><td>Atomic absorption spectrometry</td></tr>
<tr><td colspan="2">Total suspended solids (TSS)</td><td>Filtering</td></tr>
<tr><td colspan="2">Chemical oxygen demand (COD)</td><td>Molecular absorption spectrometry</td></tr>
</table>

Sub-chapter 7.4 - Table 2: Measurement frequencies for the chemical substances associated with the liquid radioactive effluents from the T (0KER [LRMDS]), and S (0TER [ExLWDS]) tanks

Parameters measured (T (0KER [LRMDS]), and S (0TER [ExLWDS]) tanks)	Measurement frequencies		
	Before discharge	After discharge	
	On each tank	On each tank	Periodic aliquot
Boric acid (H_3BO_3)	✓		
Hydrazine (N_2H_4)	✓		
Morpholine (C_4H_9ON) only on the tanks receiving conditioning water from the steam generators, in the case of steam generator conditioning with morpholine	✓		
Morpholine (C_4H_9ON) only in the case of conditioning of the secondary system with morpholine			✓
Ethanolamine (C_4H_9ON) only on the tanks receiving conditioning water from the steam generators, in the case of steam generator conditioning with ethanolamine	✓		
Ethanolamine (C_2H_7ON) only in the case of conditioning of the secondary system with ethanolamine			✓
Nitrogen (N) excluding hydrazine, morpholine and ethanolamine		✓	
Phosphate (PO_4^{3-})		✓	
Detergents		✓	
Total metals zinc, copper, manganese, nickel, chromium, iron, aluminium, lead			✓
Total suspended solids (TSS)			✓
Chemical oxygen demand (COD)			✓

Sub-chapter 7.4 - Table 3: Measurement frequencies for the chemical substances associated with the water drained from the Turbine Hall's Ex (0SEK [SiteLWDS]) tanks

Parameters measured (Ex (0SEK [SiteLWDS]) tanks)	Measurement frequencies		
	Before discharge	After discharge	
	On each tank	On each tank	Periodic aliquot
Boric acid (H_3BO_3) only if boric acid is injected into the secondary system			✓
Hydrazine (N_2H_4)	✓		
Morpholine (C_4H_9ON) only in the case of conditioning of the secondary system with morpholine			✓
Ethanolamine (C_2H_7ON) only in the case of conditioning of the secondary system with ethanolamine			✓
Nitrogen (N) excluding hydrazine, morpholine and ethanolamine		✓	
Phosphate (PO_4^{3-})		✓	
Total metals zinc, copper, manganese, nickel, chromium, iron, aluminium, lead			✓
Total suspended solids (TSS)			✓
Chemical oxygen demand (COD)			✓

Sub-chapter 7.4 - Table 4: Measurement methods for suspended solids, sulphate and iron concentrations at the Demineralisation Station outlet

Parameter	Requirement	Sampling location	Measurement method
Suspended Solids	Maximum concentration at the Demineralisation Station outlet before dilution	Demineralisation Station outlet	Filtering
Sulphates	Maximum concentration at the Demineralisation Station outlet before dilution	Demineralisation Station outlet	Molecular absorption spectrometry with barium chloride
Iron	Maximum concentration at the Demineralisation Station outlet before dilution	Demineralisation Station outlet	Molecular absorption spectrometry

Sub-chapter 7.4 - Table 5: Measurement method for BOD_5 determination at the wastewater purification station outlet

Parameter	Requirement	Sampling location	Measurement method
BOD_5	Concentration increase	Downstream of the wastewater purification stations	Dissolved oxygen measurement

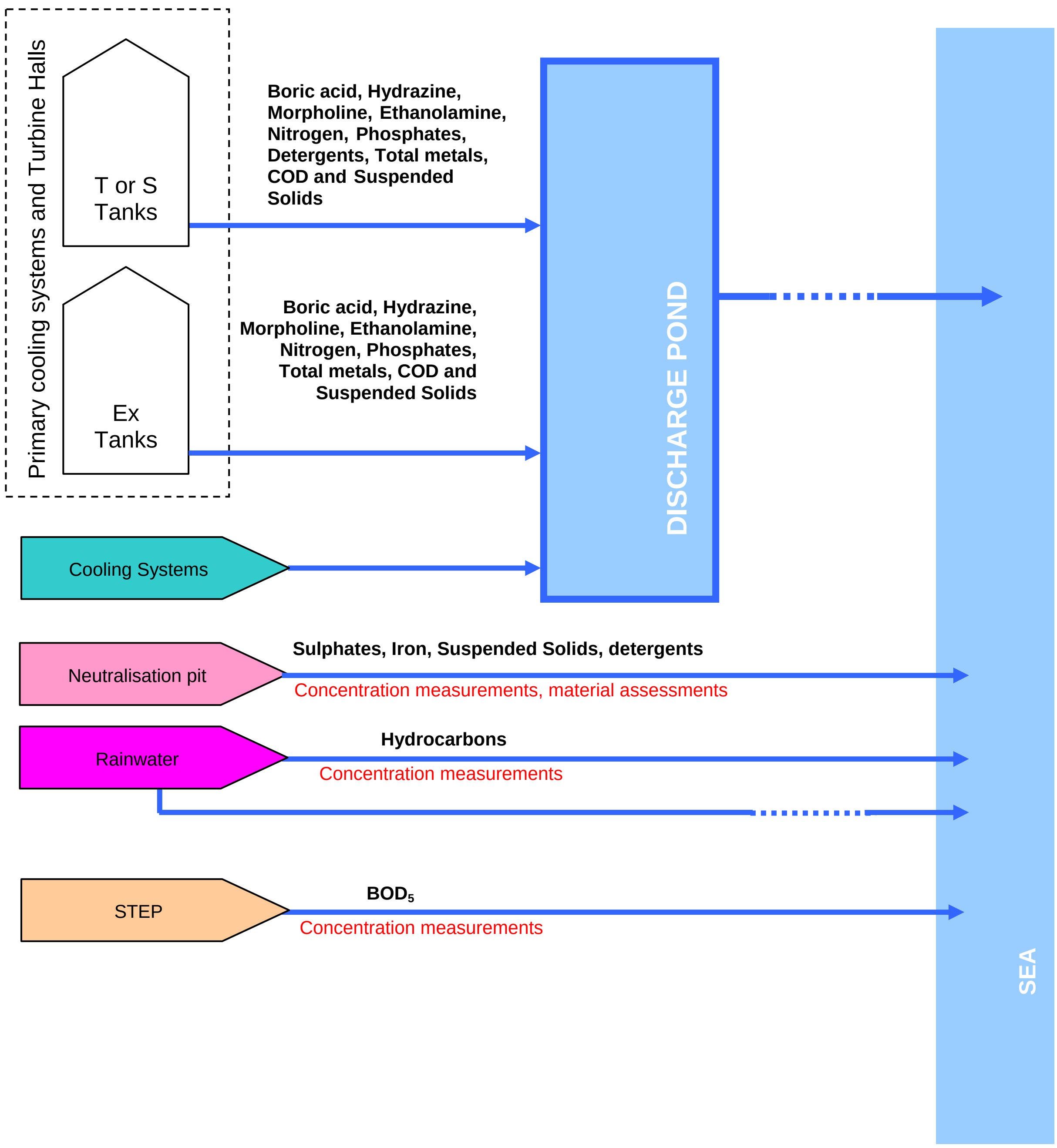
Sub-chapter 7.4 - Table 6: Hydrocarbon concentration measurement

Parameter	Requirement	Sampling location	Measurement method
Total hydrocarbons	Maximum immediate concentration	Output from all of the SEO outfalls	Gas Chromatography

Sub-chapter 7.4 - Table 7: Measurement methods for additional parameters

Parameter	Requirement	Sampling location	Measurement method
Residual oxidants	Concentration increase	In each discharge pond	Colorimetry
Chlorine produced	-	Electrolyser output	Titrimetry

Sub-chapter 7.4 - Figure 1: Diagram of the monitoring associated with chemical discharges from the site



SUB-CHAPTER 7.4 – 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. MONITORING CHEMICAL DISCHARGES ASSOCIATED WITH LIQUID RADIOACTIVE EFFLUENTS

1.1. STATUTORY REQUIREMENTS

[Ref-1] The Radioactive Substances Act 1993. HM Stationery Office. ISBN 0-10: 0105412937. (E)

[Ref-2] Monitoring of discharges to water and sewer, Technical Guidance Note (Monitoring) M18. Version 1. Environment Agency. 2004. (E)

[Ref-3] Integrated Pollution prevention and Control Practical Guide. Edition 4. DEFRA. 2005. (E)