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REVISION HISTORY

Issue	Description	Date
00	First issue.	28-04-08
01	Updating for complementary submission, with elements related to the PPC application for standby diesel generators (Sub-Chapter 3.3.Section 4.2).	30-06-08
02	PCER March 2010 update Complementary information included in sub-chapter 3.3 sections 4.2.1.1 and 7.3 Minor editorial change in sub-chapter 3.4 section 5.3.2	21-03-10
03	Sub-chapter 3.3 Table 4: Update of “maximum annual activity” discharge values of gaseous C14 and FP/AP Sub-chapter 3.3 Table 5: Update of individual FP/AP “maximum annual activity” discharge values and correction of typos in FP/AP "expected performance" values (these values not used in the environmental impact analyses) Minor editorial changes in sub-chapters 3.3 and 3.4 (mainly "iodine" --> "iodine isotopes")	25-03-11
04	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	12-12-11
05	Consolidated PCER update - Clarifications in Sub-chapters: - 3.2 sections 1.2, 1.3, 1.3.1, 1.3.2, 1.3.3, 1.4, 2.2.2.2 and 2.2.2.3, - 3.3 sections 1.2.1, 2.1, 4.1.1.1.2 , 4.1.2 and 7.2, - 3.4 Sections 1.1.2, 5, 5.1, 5.2.2, 5.2.3, 5.2.4, and 5.4.2. - Alignment with PCSR Sub-chapter 5.5 in Sub-chapter 3.2 section 2.2.2.1, Sub-chapter 3.3 section 4.1.2 and Sub-chapter 3.4 sections 5.2.4, 5.3.1, 5.3.1.1, 5.3.1.2, 5.3.1.3, and 5.3.2	22-08-12

REVISION HISTORY (Cont’d)

Issue	Description	Date
05 (cont’d)	- Replaced SEK tanks [CILWDS] with Ex (0SEK [SiteLWDS]) tanks in Sub-chapter 3.3 section 7.3 and Sub-chapter 3.4 section 5.3.2. - Minor editorial changes in Sub-chapter 3.3 section 2.2.1 and Sub-chapter 3.4 sections 5.2.3, 5.4.1.1, 5.4.1.3 and 5.4.1.4 - Alignment with PCSR Sub-chapter 16.6 (Fukushima) in Sub-chapter 3.3 section 4.2.1.1 and Tables 5 and 9.	22-08-12

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CONTENTS CHAPTER 3

SUB-CHAPTER 3.1 – INTRODUCTION

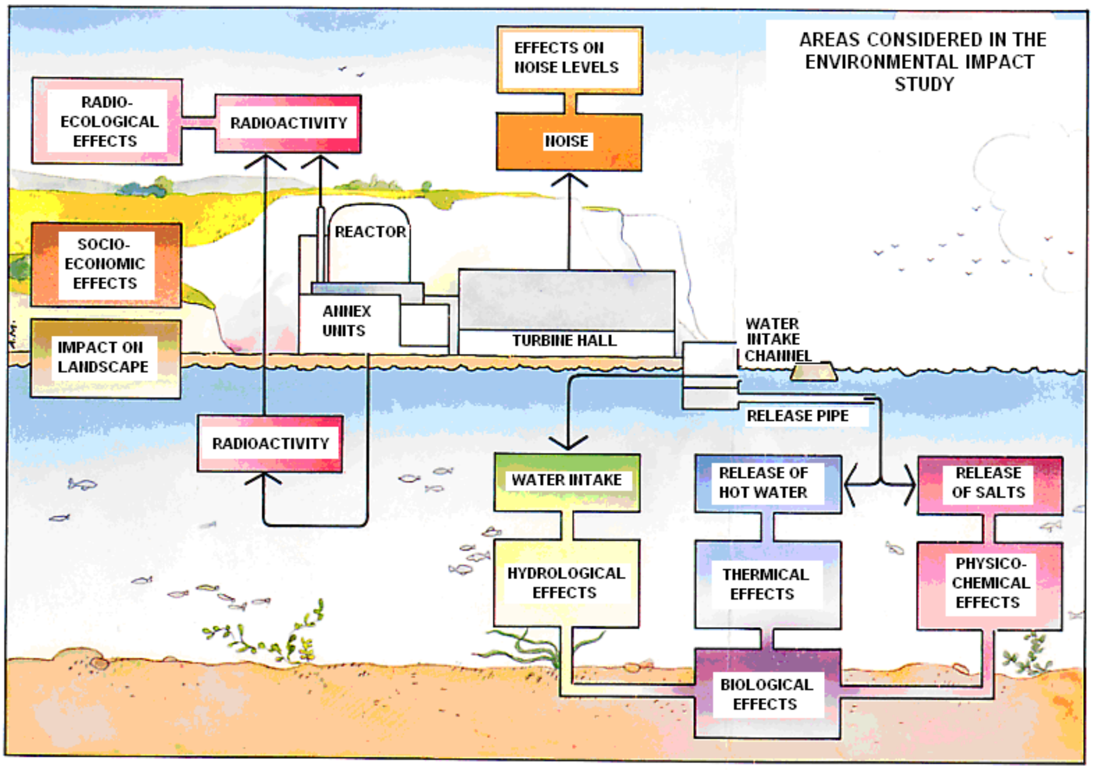
Chapter 3 deals with the requirements 1.2 and in part with 1.4, 2.1, 2.2, 2.3, 2.4, 2.5, 3.1, 3.2, 3.3 and 3.4 of Environment Agency (EA) Process and Information (P&I) Document [Ref-1].

The different phases and activities that will take place during the EPR operation phase are summarised in Sub-chapter 3.2, emphasising those that will potentially have an impact on the environment because they either use natural resources or generate wastes and discharges.

The aspects of the UK EPR, which have a bearing on the environment during the operational phase, are then identified, split into those related to the terrestrial environment (Sub-chapter 3.3) and those related to the aquatic environment (Sub-chapter 3.4).

The diagram below (Sub-chapter 3.1 - Figure 1) illustrates the interfaces of the EPR with the environment, including water, air, and land compartments.

Sub-chapter 3.1 - Figure 1: Areas considered in the environmental impact study for the UK EPR



The PCER considers a generic EPR open cooling unit with a coastal or estuarine site, which is judged as being representative of the development of potential nuclear power station in the UK; thus the design of the cooling system is similar to the design of reference EPR Flamanville 3.

This chapter describes what the needs are of the EPR design, how the wastes and discharges arise and what they are. The assessment of the impacts on the environment is addressed in Chapters 11 and 12 of the PCER.

Potential incidents or accidents are addressed in the PCSR, while the Control of Major Accidents Hazards (COMAH) Regulations requirements linked to hazardous substances stored and/or manipulated on the site are addressed in Sub-chapter 3.3.

Finally, a more detailed description of the EPR systems design related to chemical and radiological wastes and discharges is provided in Chapter 6 of the PCER.

SUB-CHAPTER 3.1 – 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] Process and Information Document for Generic Assessment of Candidate Nuclear Power Designs. The Environment Agency. January 2007. (E)

SUB-CHAPTER 3.2 - GENERAL DESCRIPTION OF THE OPERATIONAL PHASE

The EPR is designed for 60 years of operation.

Plants, systems and processes having a bearing on the environment are those, which use natural resources and/or generate solid wastes, liquid or gaseous discharges in the accomplishment of their function. They operate:

- during one or more of the following phases of the normal operation phase:
  - reactor full power;
  - reactor power changes and shutdown;
  - outage and/or plant maintenance; and
  - periodic tests.
- at any time during these phases:
  - where it is necessary to maintain the temperature and pressure in the various rooms inside the plant buildings within the limits set during the design;
  - where it is necessary to prevent the equipment corrosion and maintain the fluids characteristics within the limits set during the design; and
  - for the use and storage of hazardous substances.

Finally the presence of workforce and staff on the site is also source of environmental impact.

Incident and accident conditions as well as the design of systems necessary to ensure the safe shutdown are treated in the PCSR.

1. NORMAL PLANT OPERATION PHASES

1.1. FULL POWER OPERATION

The reactor produces heat from nuclear fission occurring in the fuel assemblies. The EPR design is such that once the fuel is loaded in the reactor core it can generate energy for at least 12 months (and up to 22 months depending on the fuel management).

During that period of time (or ‘fuel cycle’) the reactor will mainly stay at full power, generating 4500 MW(th) into the primary circuit.

During the fuel cycle the content of the fissile uranium-235 (U-235) isotope of Uranium in the fuel decreases. The fuel consumption is expressed in terms of energy produced, called ‘fuel burn-up’ in GWd per Te of UO_2.

While the burn-up increases, the boron concentration of the primary circuit is reduced by dilution, i.e. addition of non-borated water and removal of borated water from the primary circuit. The removed water is treated in the Coolant Storage and Treatment System (TEP [CSTS]).

1.2. POWER REDUCTIONS AND INCREASES

The power may also be reduced: either for grid requests or for shutting down the reactor for outage. The thermal generation is reduced down to an intermediate level or shutdown for refuelling and/or maintenance (see next section). The changes in the power level require:

- An adaptation of the boron concentration in the primary coolant water by discharging water at the current concentration from the primary circuit and charging with borated or unborated water depending on the objective;

- Water volume adjustment through the Chemical and Volume Control System (RCV [CVCS]): discharged water is recycled and filtered into the water treatment system TEP [CSTS] and stored in RCV [CVCS], TEP [CSTS] or Reactor Boron and Water Make-up System (REA [RBWMS]) tanks, depending on its final boron concentration, for further use in the primary circuit; and

Degassing and/or nitrogen sweeping via TEG [GWPS] in the TEP [CSTS] or in tanks containing primary coolant, such as the TEP [CSTS], RCV [CVCS], Nuclear Vent and Drain System (RPE [NVDS]) tanks. This is a continuous process during all normal operation phases.

1.3. OUTAGE

For the EPR the fuel burn-up reached at the end of a fuel cycle is on average 60 GWd per Te of UO_2. When the end of cycle is reached the reactor must be shutdown, to remove the spent fuel (typically 1/3 of the assemblies depending on fuel management), bring in new assemblies and rearrange them in the core with the remaining assemblies (see PCSR Chapter 4).

About once every 18 months, depending on the planned fuel management, the reactor must be shutdown for the fuel reloading.

Depending on the type of maintenance planned during shutdown, the steam generators may be filled with demineralised water, layed-up with hydrazine with added morpholine, ethanolamine or ammonia to prevent their corrosion and to provide a biological barrier when carrying out work in their vicinity.

Several types of outage are planned during the EPR lifetime and are described below.

1.3.1. Simple fuel reloading shutdown (or ROO: Refuelling Only Outage)

The only operation that takes place is the unloading and reloading of the assemblies from and into the reactor core. This requires the reactor shutdown, filling the reactor pool with borated water during the fuel assemblies' transfer to and from the fuel storage pool; then emptying the reactor pool and starting up the reactor. This type of shutdown will last 11 days.

1.3.2. Partial maintenance (or NRO: Normal Refuelling Outage)

In addition to the core reloading, partial maintenance and in-service inspection, is performed on circuits and components that cannot be maintained at full power. The inspection requires emptying the concerned circuits then filling them up with demineralised water. This type of outage is planned to last 16 days.

1.3.3. ‘Ten yearly’ outage (or ISIO: In-Service Inspection Outage)

Every ten years the reactor shutdown period includes more thorough tests and inspection, such as pressure tests on the containment and circuits, similar to the commissioning tests. This type of outage is planned to last 40 days.

1.4. MAINTENANCE ACTIVITIES

Maintenance activities are performed during the whole fuel cycle, at full power as well as during shutdown state, depending on the equipment concerned and in compliance with the Technical Specifications.

Maintenance activities consist of fixing or replacing equipment and are followed whenever required by tests. Waste and discharges arise from the maintenance activities:

- ‘White clothes’ worn by the workers inside the Nuclear Island buildings are sent after use to the laundry; if they remain contaminated after cleaning, they are treated as solid waste;
- Contaminated tools and parts are sent to the Effluent Treatment Building;
- Flushed water, water from leakage and oily water are collected in the waste liquid systems (such as RPE, SEO, SEH) depending on their origin; and
- Algae and sludge are regularly removed from the seawater treatment structures and treated as waste.

1.5. PERIODIC TESTS

Periodic tests are performed on systems and plant dedicated to management of incident and accident conditions, which are not used under normal operating conditions.

The main periodic tests that may impact the environment are those, which actuate the standby diesel generators one at a time. Details are given in Sub-chapter 3.3.

2. CONTINUOUS SERVICING

2.1. HEATING, VENTILATION AND AIR CONDITIONING (HVAC) IN THE BUILDINGS

At any time during the operational phase air temperatures and pressures of the rooms in the various buildings are monitored and controlled so that they stay within the design limits.

Fresh air is taken from air intakes, conditioned by ventilation systems and circulated in the rooms, replacing the air, which is discharged after filtration, at the Nuclear Auxiliary Building stack.

2.2. WATER MANAGEMENT

2.2.1. Water supply

The EPR primary and secondary circuits are filled with demineralised water. Demineralised water is obtained either from freshwater through a demineralisation plant or from seawater through a desalination unit.

At any time during the operational phase, demineralised water may be injected into any circuit to compensate for leakage; demineralised water is also needed periodically to fill the circuits with clean water.

Operations in the Turbine Hall and in the Pumping Station require untreated freshwater.

The water for the tertiary circuit of the UK EPR, e.g. the condenser and Essential Service Water System (SEC [ESWS]), is seawater.

2.2.2. Water treatment and discharge

2.2.2.1. Chemical treatment

At any time during the operational or shutdown phase the water of the various circuits requires the addition of chemicals, in order to maintain the fluid characteristics within the specification limits to avoid material corrosion. The need is determined from monitoring results of the circuits, the water temperature for seawater circuit or the activity (lay-up of steam generators during shutdown).

The criteria defined in Chemical Specifications (see PCSR Sub-chapter 5.5) are periodically checked by the suitable monitoring (sampling and measurement).

2.2.2.2. Discharged water treatment

The water discharged from the primary circuit during the different phases is filtered on resins in the Nuclear Auxiliary Building before being reused in the process. Periodically the resins must be removed and replaced by new resins. The spent resins are treated as radioactive solid waste.

2.2.2.3. Leakage

Leakage from circuits and components are collected in the RPE [NVDS] and treated according to their origin. They are sent, with liquid effluent that cannot be recycled, to the liquid treatment systems where they are treated and then to the discharge tanks. There they are stored and sampled before a monitored and recorded discharge into the sea is performed.

2.3. USE AND STORAGE OF HAZARDOUS SUBSTANCES

2.3.1. Radioactive substances

Fresh fuel and spent fuel are stored in the Fuel Building.

Radioactive liquid effluent is stored and monitored in tanks before being discharged according to the authorised limits.

Radioactive solid wastes are treated and stored prior to transport off site.

2.3.2. Non radioactive substances

Chemical substances, either in gaseous, liquid or solid form needed for the process and its maintenance are stored on the site in accordance with any Control of Major Accident Hazards (COMAH) Regulations requirements.

3. STAFF LIFE IN AND OUT OF SITE

During the normal operational phase about 300 people work around the unit. This number rises during plant shutdown up to 1000 for partial maintenance outage and 1300 for a ‘ten-year’ outage. The main premises for the staff are the Operational Service Centre (which contains offices as well as workshops).

Potable water is used mainly for the laundry, for sanitary reasons, for drinking and in the canteen.

Staff will travel to the site every day typically by car or bus.

These aspects are similar to those described for the construction phase in Chapter 12 of the PCER.

SUB-CHAPTER 3.3 – NEEDS AND OUTPUTS RELATED TO THE TERRESTRIAL ENVIRONMENT

LIST OF TABLES

LIST OF FIGURES

This sub-chapter identifies the aspects of the operational phase, in terms of needs and outputs, which have a bearing on the terrestrial environment for an operating EPR Unit.

1. USE OF NATURAL RESOURCES

1.1. OCCUPATION OF LAND SURFACE

Typically an EPR unit and ancillary facilities requires 70 hectares for construction and operation.

The impact upon land take will be assessed as part of the site environmental impact assessment. As part of the mitigation against impact, the site design will be such that land take will be reduced as far as practicable.

1.2. RAW MATERIALS

1.2.1. Fuel assemblies

As a light water reactor concept, the EPR uses the fission of uranium-235 (U-235) in the uranium dioxide (UO_2) pellets contained in the reactor core assemblies to produce heat that is transferred to the primary coolant water, which in turn generates, via the steam generators, the steam that rotates the turbo generator.

Sustainability of the nuclear fission reaction requires the UO_2 pellets to be slightly enriched in U-235 compared to the natural ratio. The initial enrichment of fresh assemblies is up to 5.0% in weight. In the EPR the enrichment and the fuel cycle have been optimised compared to the previous PWR designs in order to enhance efficiency, thus reducing the fuel needed for the production of the same amount of energy.

The EPR fuel cycle lasts from 12 to 22 months. At the end of each cycle about one third of the 241 fuel assemblies are replaced by fresh fuel assemblies. A fuel assembly contains 527.5 kg of uranium. More information about the fuel is presented in the PCSR Chapter 4.

1.2.2. Other resources

The other resources used during the EPR operational phase are:

- chemicals and gases for the conditioning of circuits;
- boron, to control the reactor core reactivity;
- diesel fuel to run the standby diesel generators during periodic tests; and
- paint for maintenance purposes.

Chemicals and other substances stored on site to be used are identified in Sub-chapter 3.3 - Table 9. All these products are readily available.

2. SOLID WASTES

2.1. RADIOACTIVE WASTES

Radioactive wastes arise from materials that become activated or contaminated through the operating process or maintenance activities.

This section identifies the radioactive waste arising during the operational phase; waste linked to decommissioning is discussed in Chapter 5 of the PCER.

Solid radioactive waste results from normal operation (including maintenance) either in the Nuclear Island or in the Effluent Treatment Building; it includes:

- spent resin from the demineralisers for the various nuclear circuits;
- filters from the various nuclear circuits;
- concentrates from the evaporators in the non-recycled Liquid Waste Processing System (8TEU [LWPS]);
- sludges from the bottom of various tanks and sumps;
- high-concentration chemical effluent from decontamination operations; and
- sundry technological waste that could be contaminated (such as plastics, paper, scrap metals).

The categorisation of radioactive waste between Very Low Level Waste (VLLW), Low Level Waste (LLW) and Intermediate Level Waste (ILW) is described in Chapter 6 of the PCER.

The volume of solid radioactive waste depends on the process and on the management of the systems by the operator. The table below (Sub-chapter 3.3 – Table 1) provides, by volume, the annual estimated production of raw waste (prior to conditioning) for each type of waste for one EPR Unit.

Sub-chapter 3.3 - Table 1: Estimated annual volumes of solid waste produced during operation of the EPR Unit

	Type of waste	Estimated gross annual volume (m^3)
Process waste	Ion exchange resins from the Nuclear Island	3
	Low-activity APG [SGBS] resins (with or without regeneration)	2.5/ 7.5
	Sludge (sumps and tanks)	1
	Water filters from effluent treatment > 2 mSv h^{-1}	5
	Evaporator concentrates	3
Operational waste and process < 2 mSv h^{-1} in contact waste stored in 200 l metal drums	Pre-compacted operational waste (apparent density. 0.5) and non compactable: maintenance (excluding metals), rubble, decontamination operations and insulation	50
	Non-compactable process waste: air and water filters	4
Operational waste > 2 mSv h^{-1} on contact	This waste is stored in concrete containers	1
Special operational waste < 2 mSv h^{-1} on contact	Oils	2
	Metal waste from maintenance	6
TOTAL		**77.5/ 82.5**

Raw solid radioactive waste is sent to the Solid Waste Treatment System (TES [SWTS]) for sorting, storage and treatment. This is presented in detail in Chapter 6 of the PCER.

2.2. CONVENTIONAL SOLID WASTES

2.2.1. Source and type of conventional solid wastes

Conventional solid wastes may arise during the operational phase, from the maintenance of the process (maintenance of pipes and equipment), or in the conventional part of the unit (removal of algae from the water abstraction structure, maintenance of control rooms equipment, activities in the workshops and waste from office work, packaging and from the canteen).

Conventional wastes consist of ‘industrial waste’ (chemical and material additives, effluents and materials), ‘inert waste’ (rubble) and ‘commercial waste’ (canteen and office waste).

With reference to the European Waste Catalogue [Ref-1], wastes arising for UK EPR are likely to be similar in type to the waste found on an existing NPP, and consist mainly of:

Industrial waste (chemical and materials additives, effluents and materials):

06 01 wastes from the manufacture, formulation, supply and use of acids
06 02 wastes from the manufacture, formulation, supply and use of bases
06 04 metal-containing wastes
08 01 wastes from manufacture, formulation, supply and use and removal of paint and varnish
08 03 wastes from manufacture, formulation, supply and use of printing inks
08 04 wastes from manufacture, formulation, supply and use of adhesives and sealants (including waterproofing products)
09 01 wastes from the photographic industry
12 01 wastes from shaping and physical & mechanical surface treatment of metals and plastics
13 01 waste hydraulic oils
13 02 waste engine, gear and lubricating oils
13 03 waste insulating and heat transmission oils
13 05 oil/water separator contents
14 06 waste organic solvents, refrigerants and foam/aerosol propellants
15 02 absorbents, filter materials, wiping cloths and protective clothing
16 01 end-of-life vehicles from different means of transport (including off-road machinery)
16 02 wastes from electrical and electronic equipment
16 05 gases in pressure containers and discarded chemicals
16 06 batteries and accumulators
17 04 metals (including their alloys)
17 05 soil (including excavated soil from contaminated sites), stones and dredging spoil
17 06 insulation materials and asbestos-containing construction materials
18 01 wastes from natal care, diagnosis, treatment or prevention of disease in humans
19 08 wastes from waste water treatment plants not otherwise specified
19 09 wastes from the preparation of water intended for human consumption or water for industrial use

Inert waste and Commercial waste (as a result of minor estates and facilities works, packaging, canteen and office waste):

15 01 packaging (including separately collected municipal packaging waste)
17 01 concrete, bricks, tiles and ceramics
17 05 soil (including excavated soil from contaminated sites), stones and dredgings
20 01 separately collected fractions (except 15 01)
20 02 garden and park wastes
20 03 other municipal wastes

Several of these waste types will be classed as hazardous under the Hazardous Waste (England and Wales) Regulations 2005 (as amended) [Ref-2] and will require special storage and treatment arrangements in accordance with the relevant legislation in order to minimise their impact.

Typically, hazardous wastes carrying a risk of impact upon the environment and human health will comprise of:

- chemical additives;
- detergents, cleaning and decontamination products;
- oils, greases and other lubricants; and
- a wide range of electrical and electronic equipment.

Hazardous wastes include solids (aerosol spray cans), liquids (solvents and oils) and sludge (paint residues). The properties of hazardous wastes are given in the H1 - H14 definitions of the Hazardous Waste Regulation [Ref-2].

2.2.2. Conventional solid waste strategy

The Solid Waste Strategy will be designed to comply with the requirements of the Waste Framework Directive as implemented in the UK by domestic legislation such as the PPC Regulations, Waste Management Licensing Regulations 1994 and subsequently the Environmental Permitting Regulations, together with the Environmental Protection (Duty of Care) Regulations 1991. By ensuring compliance with these regulations in terms of minimising waste production, storing and transferring waste responsibly, the requirements of the Waste Framework Directive will be upheld.

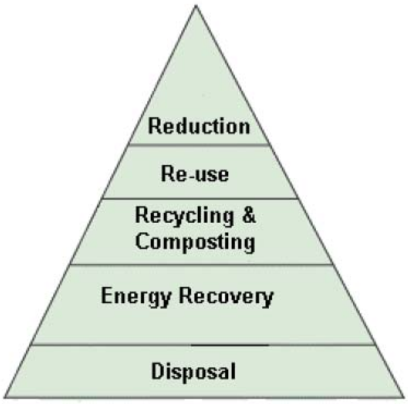
Strict waste management procedures will be implemented for all waste streams through the site Environmental Management System. With these measures in place, the potential impact upon terrestrial ecosystems is considered to be low.

In order to comply with the requirements of the Environmental Permitting Regulations, an appropriate site permit and registrations will be obtained from the regulatory authorities. These may include Hazardous Waste registrations [Ref-1].

The production of waste at the UK EPR will be an inevitable consequence of the operation and management of the site. Where possible, arisings will be reduced at the point of origin by way of careful site management and operational practices, including the careful choice of raw materials.

Conventional wastes will be managed in accordance with the UK hierarchy:

- reduction;
- re-use;
- recycling (and composting);
- energy recovery; and
- disposal.



Waste production will be minimised through effective site operational techniques. Where possible, waste will be re-used on site. Where it is technically and economically feasible, waste will be recycled if suitably permitted facilities exist locally. Waste may be sent for energy recovery at cement kilns or to energy plants; waste will only be disposed of to landfill or to incinerator as a final option, where no other option for recovery exists.

2.2.3. Quantity of waste and management

The amount of conventional wastes produced by the EPR does not depend entirely on the process itself but also on the way the operator organises the daily operation and maintenance activities.

Since no data are yet available from an EPR unit in operation, typical data are presented in Sub-chapter 3.3 - Table 2 based on yearly review on existing sites.

Sub-chapter 3.3 - Table 2: Breakdown of conventional wastes typically generated by an EPR Unit over one year

Waste type	Annual quantity (tonnes)
Inert waste and commercial waste	470
Hazardous (non radioactive) waste	100
Total arisings (annual)	570

Moreover, Sub-chapter 3.3 - Table 8 presents the details of the wastes, which arose over the year 2006 on the Flamanville site, where two plants are under operation. Sub-chapter 3.3 - Table 8 also presents the way they are stored and whether they have been re-used, recycled incinerated or buried.

3. LIQUID DISCHARGES

Since the UK EPR will be on a coastal or estuarine site no liquid is intended to be discharged to the water courses or on land.

Effluents from transformers, Turbine Hall, oil and grease store, and storage areas that might be contaminated with hydrocarbons are sent to an oil water separation system. This system has an interceptor that collects the oil before it flows into the rainwater drains.

The treatment and discharge of radioactive and/or chemically polluted water resulting from normal operation of the EPR process, of water collected that could contain oil and of water discharged from the output of the purification station are addressed in Sub-chapter 3.4 (Aquatic environment).

4. GASEOUS DISCHARGES

This section describes the different aspects of the EPR operation that are the source of gaseous discharges to air that have a potential impact on the air and/or climate.

It should be noted that the EPR process operation does not release carbon dioxide.

Gaseous emissions are divided into radioactive and non radioactive, as described below.

4.1. GASEOUS RADIOACTIVE DISCHARGES

4.1.1. Source of gaseous radioactive discharges

This section presents a summary of the gaseous radioactive discharges; more details on the treatment systems can be found in Chapter 6 of the PCER.

An EPR unit produces gaseous radioactive effluent, part of which is eventually discharged to the atmosphere through a stack. Discharged radionuclides may be divided into five families:

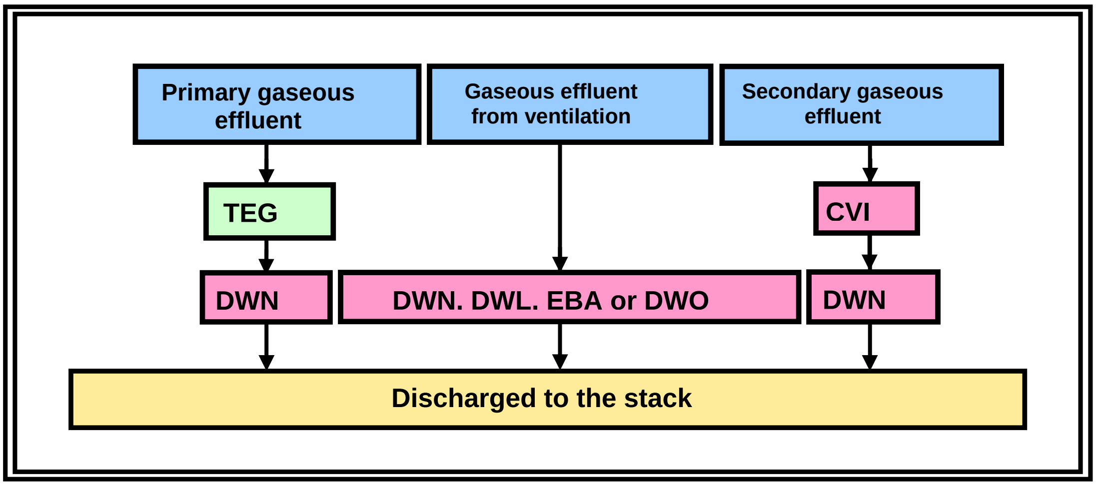
- tritium;
- carbon-14;
- noble gases;
- iodine isotopes; and
- other fission or activation products.

Each of these categories has an expected discharge performance, a realistic assessment with no significant allowance for contingency and a maximum estimated discharge, which includes a margin to allow for normal operating contingencies.

4.1.1.1. Origin of gaseous radioactive discharge

Gaseous radioactive discharge falls into one of three categories, as shown in the following diagram (Sub-chapter 3.3 - Figure 1):

Sub-chapter 3.3 - Figure 1: Nature of gaseous radioactive discharge



These three categories are described in the following sections.

4.1.1.1.1. Gaseous effluent from the primary circuit

This effluent comes from degassing in either the primary effluent degassers in the Coolant Storage and Treatment System (TEP [CSTS]), or in the head spaces in facilities containing primary coolant or primary effluent, such as the Chemical and Volume Control System (RCV [CVCS]), TEP [CSTS] tanks, some Nuclear Vent and Drain System (RPE [NVDS]) tanks and the primary circuit pressuriser tank.

It comprises mainly hydrogen, nitrogen and the gaseous products of fission and activation, and therefore is radioactive.

Nitrogen sweeping is used to maintain low levels of hydrogen and oxygen. Thus hydrogenated or aerated effluent is not found in the gaseous discharge from the EPR Unit’s primary circuit.

Primary gaseous effluent is discharged directly in the Gaseous Waste Processing System (TEG [GWPS]).

4.1.1.1.2. Gaseous effluent from ventilation

Exhaust from ventilating premises may be contaminated or have an iodine risk in the Nuclear Auxiliary Building, Fuel Building, Safeguard Buildings, Reactor Building, Operational Service Centre, Access Building and Effluent Treatment Building.

It is essentially air that may be polluted with radioactive gases.

Exhaust air is collected in the ventilation circuits of the different buildings on the Nuclear Island (Nuclear Auxiliary Building Ventilation System (DWN [NABVS]), Fuel Building Ventilation System (DWK [FBVS]), Controlled Safeguard Building Ventilation System (DWL [CSBVS]), Containment Sweep Ventilation System (EBA [CSVS]), Operating Building Contaminable Room Ventilation System (DWB), Peripheral Room Ventilation System (DWW [ABVS]) and Effluent Treatment Building Ventilation System (8DWQ [ETBVS])), where it is filtered through HEPA filters and discharged through the NAB stack. In the event of iodine contamination being detected, iodine traps are used. It should be noted that, for EBA [CSVS], iodine traps are used at all times during normal power operation.

4.1.1.1.3. Gaseous effluent from the secondary circuit

Gaseous radioactive effluent from the secondary circuit is largely air that may be polluted with radioactive gases, particularly tritium, in the event of leakage from the primary circuit to the secondary circuit at the steam generator tubes level.

Gas is collected in the Condenser Vacuum (CVI) system, then sent to the DWN [NABVS], where it is filtered before being discharged into the stack.

4.1.2. Amount of radioactive gaseous discharge expected

The EPR expected performance for gaseous radioactive discharge, excluding contingency, is estimated from existing 1300 MW(e) Units OEF, and incorporates EPR improvements in the source terms and the abatement plant.

The estimated maximum discharge of radioactive gas from the EPR Unit includes normal operating contingency, and is intended to cover all foreseeable situations that are likely to be encountered in the Unit during normal operation (see Sub-chapter 3.3 - Table 3).

Sub-chapter 3.3 - Table 3: Expected annual performance for gaseous radioactive discharge

Category of radionuclides	Annual expected performance excluding contingency (GBq)	Maximum annual gaseous radioactive discharge (GBq)
Tritium	500	3000
Carbon-14	350	700 (*)
Iodine isotopes	0.05	0.4
Noble gases	800	22,500
Other fission or activation products emitting beta or gamma radiation	0.004	0.12 (**)

(*) As discussed in PCER Sub-chapter 6.3 section 7 it is now considered that a maximum annual discharge value of 700 GBq y^{-1} for gaseous carbon-14 would be more realistic than the previous 900 GBq value. However environmental impact assessment was performed with 900 GBq y^{-1} (see PCER Sub-chapter 1.1). Note that International experience and numerical estimations show the absence of negative impacts on carbon-14 production from zinc acetate injection (see PCSR Sub-chapter 5.5 and [Ref-1]).

(**) As discussed in PCER Sub-chapter 6.3 section 7 maximum annual activity for FP/AP has been re-estimated at the end of 2008 down to 120 MBq instead of 340 MBq. However the impact analysis (PCER Sub-chapter 11.1) has not been re-performed, since the initial maximum activity were conservative values (i.e. Co-58: 86.7 MBq; Co-60: 102.4 MBq; Cs-134: 79.56 MBq and Cs-137: 71.4 MBq).

The overall activity relating to iodine isotopes, noble gases and other fission or activation products is divided between the various radionuclides using the averaged discharges from all EDF French Units existing 1300 MW(e) Units, calculated over the period 2002-2004. Hence, the 1300 MW(e) series has been chosen as the reference, since information is readily available and its design is as close as is available to the EPR (see Sub-chapter 3.3 - Table 4).

Sub-chapter 3.3 - Table 4: Split of activity between iodine isotopes, noble gases and fission and activation products (expected performance and estimated maximum values)

Category of radionuclide	Expected performance	Maximum annual activity
I-131	0.0228 GBq	182.4 MBq
I-133	0.0272 GBq	217.6 MBq
Total iodine isotopes	0.05 GBq	400 MBq
Kr-85	111.2 GBq	3.1275 TBq
Xe-133	504.8 GBq	14.1975 TBq
Xe-135	158.4 GBq	4.455 TBq
Ar-41	23.2 GBq	0.6525 TBq
Xe-131m	2.4 GBq	0.0675 TBq
Total noble gases	800 GBq	22.5 TBq
Co-58	0.00102 GBq	30.6 MBq
Co-60	0.001204 GBq	36.1 MBq
Cs-134	0.000936 GBq	28.1 MBq
Cs-137	0.00084 GBq	25.2 MBq
Total FP/AP	0.004 GBq	120 MBq (**)

(**) As discussed in PCER Sub-chapter 6.3 section 7 maximum annual activity for FP/AP has been re-estimated at the end of 2008 down to 120 MBq instead of 340 MBq. However the impact analysis (PCER Sub-chapter 11.1) has not been re-performed, since the initial maximum activity were conservative values (i.e. Co-58: 86.7 MBq; Co-60: 102.4 MBq; Cs-134: 79.56 MBq and Cs-137: 71.4 MBq).

4.2. CHEMICAL NON RADIOACTIVE GASEOUS DISCHARGES

Potential sources of gaseous non radioactive discharge consist of:

- emissions linked to the process:
    - Sulphur and nitrogen oxides in the exhaust gases from engines of the back-up electricity generators during periodic tests;
    - Formaldehyde, that may in turn produce carbon monoxide, emitted by the thermal decomposition of insulation material when the plant goes back into operation after maintenance (every 18 months at the most); and
    - Ammonia discharged as the temperature rises in the steam generators during start-up.
- other non radioactive emissions that are directly released into the atmosphere come from the use of staff and delivery vehicles around the site.

4.2.1. Process related discharges

4.2.1.1. Back-up generators tests

The reference EPR unit includes four main emergency back-up electricity generators (‘Emergency Diesel Generator (EDG)’ or ‘main diesel generator’), each rated around 7.5 MW(e) (17.6 of thermal input) and two ultimate emergency back-up generators (‘Station Black Out (SBO)’ or ‘ultimate diesel generator’) at around 2.5 MW(e) (6 MW of thermal input)[1]. This is safety equipment, providing back-up power supply in the unlikely case of loss of off-site power when house load operation fails or is not possible, so that the Unit can be secured and the reactor cooled.

These back-up generators normally operate only during periodic tests. The tests aim to ensure the back-up generators and associated equipments are in good working order.

Sulphur dioxides and nitrogen oxides are produced only during these periodic tests, the estimated annual running time per diesel being less than 20 hours.

Data available at the time of the present assessment refers to a fuel with a level of sulphur complying with the European Directive 2003/17/CE [Ref-1]. The annual emissions of sulphur dioxide (SO_2) and nitrogen dioxide (NO_2) have been calculated using data provided by the EDG suppliers for the existing French fleet.

The assumptions for the releases calculation are the following:

- release rate of SO_2: 1.34 kg h^{-1} per MW(e); and
- release rate of NO_2: 14 kg h^{-1} per MW(e).

Thus the total quantities of SO_2 and NO_2 released, due to the periodic tests, amount respectively to 827 kg and 8680 kg per year. Consequently, the estimated release rates are, based on 88 hours per year, the following:

	Sulphur dioxides	Nitrogen dioxides
Release rate (g s^{-1})	2.61	27.40

Following the requirement 3.3 of Environment Agency (EA) Process and Information (P&I) Document [Ref-2], an assessment of the impact of emissions using the IPPC H1 (EA, July 2003) [Ref-3] is provided in Chapter 12 of the PCER.

Since the standby capacity is in excess of 50 MW(th) in total, the standby diesel generators (EDGs and SBOs) will be subject to IPPC application. At the GDA stage, the site, the station Operator and the engines' manufacturers are unknown; it is therefore not possible to submit a complete application. However generic information for UK EPR diesel generators has been prepared [Ref-4] following the IPPC Technical Guidance for the Combustion Sector S1.01 currently in force [Ref-5]. A Non Technical Summary is presented below.

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[1] These power rates are indicative and could be adapted to site specific conditions (especially ultimate heat sink design). Moreover, these values do not include any potential additional diesel as a result of the design changes considered for implementation in the light of lessons learnt from the Fukushima event.

Non Technical Summary

The UK EPR PPC Installation comprises the four emergency diesel generators (EDGs or main diesel generator) and the two ultimate diesel generators (SBOs) described above.

The GDA PPC application [Ref-4] presents details of the plant and its potential impact on the environment. It also explains how the requirement to use Best Available Techniques (BAT) to ensure that an appropriate balance, between costs to the operator and benefits to the environment, will be met at the site specific stage. Improvements are proposed, which should be considered at the generators' procurement stage.

Emissions control

The main emissions to air consist of hot flue gas containing oxides of sulphur, nitrogen and carbon, smoke (particulate matter) and traces of organic compounds.

Flue gases are emitted to air via exhaust stacks, which are about 30 metres in height.

Once in operation, the necessity of installing abatement for emissions to air, will be considered, but is unlikely to be implemented, on the basis of the infrequent usage (0.2% of the year), which would also prevent effective operation of installed abatement.

Emissions to water from the diesel generators installation are a minor component of the total station discharge, which will be consented under the Water Resources Act [Ref-6].

There is abatement in the form of interceptors and bunding where there is significant handling or storage of fuel and lubricating oils, and antifreeze.

Management

It will be the Operator's responsibility to have an integrated management system of documented procedures covering quality, health and safety and environmental management. The environmental aspects of the management system will have to comply with the international standard ISO 14001: 2004, and meet the Indicative BAT requirements of the Guidance [Ref-5].

Raw materials

The main raw material used in the diesel generators is fuel oil. Considering the newly lowered limit for sulphur content in the fuel, no alternative exists offering significant environmental benefit. There is low usage of other raw materials such as lubrication oil and antifreeze.

Usage of fuel oil will be minimised, since the diesel generators will only be run for safety related testing and maintenance required by the manufacturer.

Waste handling, recovery and disposal

Relatively small quantities of waste will be generated by operation of the diesel generators. Waste will be managed as part of the overall arrangements on the site, as described in section 2.2 of this sub-chapter.

Energy

The energy requirement for the diesel generators is supplied by fuel oil. The electricity generated during the test runs will be delivered to the grid. No operation for commercial reasons will be performed.

Electrical consumption by the diesel generators is considered to be trivial and will not be monitored separately from the wider station usage.

Accidents

It will be the Operator's responsibility to maintain a hazard and risk management system, which addresses the potential accidents associated with the diesel generators' installation, such as the spillage of fuel oil.

Noise

Source of noise from the diesel generators (see Sub-chapter 3.3 - Table 7) are not expected to be significant, considering their intermittent operation and location within concrete buildings. This will be confirmed in the noise assessment carried out at the site specific stage.

Monitoring

Monitoring will be defined at the procurement and site specific stage.

Closure

The diesel generators will be taken out of service, when no longer required to support safety related activities on the EPR process. Although it is not practicable to develop a precise decommissioning plan for the standby generators at this time, the approach will be based on existing plant closure and demolition methodologies for diesel fuelled power plants. It is likely that there will be a continuous improvement in these methodologies over the station life, and the best practice at the time of site closure will be employed.

Decisions on re-use of plant items, recycling of materials or their disposal as waste will be made at the time of decommissioning, in the light of the technology then available, economic considerations and legislation.

Emissions

Estimated emissions, from the diesel generators' operation, are compared against the appropriate BAT based benchmarks [Ref-5]. The comparison will be reviewed at the site specific stage, once the actual engines have been chosen and installed, and the level of sulphur in the fuel oil is known.

Impact

An initial assessment of environmental impact for sulphur and nitrogen dioxides, based on the EA H1 screening methodology, is presented in PCER Chapter 12. It shows that the emissions are above the thresholds of significance, thus requiring further assessment, which will be carried out at the site specific stage.

Habitats

Habitats will be addressed at the site specific stage, with the methodology described in PCER Chapters 9 and 10.

4.2.1.2. Heating of new insulating materials

Part of the plant piping in the Reactor Building is insulated using insulating material. When first heated, during the first unit start-up or after renewal, the insulating materials undergo some thermal decomposition and release steam containing formaldehyde, which in turn may produce carbon monoxide.

In order to keep the concentrations of formaldehyde and carbon monoxide in the workplace air below the acceptable exposure limits, the discharged gases are collected by operating the EBA [CSVS], and discharged through the stack.

The quantities of formaldehyde and carbon monoxide discharged as gases into the environment when the Unit is restarted after maintenance have been calculated by considering the worst-case scenario: restarting the installation produces approximately 700 g of formaldehyde and 660 g of carbon monoxide in the containment of the Reactor Building. The operating time required to evacuate these quantities to comply with the average exposure limits depends on the ventilation flow rate in the Reactor Building containment. It is estimated at 8 hours at normal flow rates and 42 hours at low flow rates.

Considering the normal flow rates, the release rates are the following:

	Formaldehyde	**Carbon monoxide**
Release rate (g s^{-1})	2.43×10^{-2}	2.29×10^{-2}

4.2.1.3. Laying-up of the secondary circuit during maintenance

4.2.1.3.1. Source of ammonia discharge

Depending on the type of maintenance planned during shutdown, laying-up the steam generators wet will prevent their fabric corroding and provides a biological barrier (a water shield) while carrying out work in their vicinity. In this case, the steam generators are filled with demineralised water, laid-up with hydrazine with added morpholine, ethanolamine or ammonia in the proportions defined in the chemical specifications for lay-up on shutdown.

Once the outage is over, the solution used for wet lay-up can either be drained into a T (0KER [LRMDS]) storage tank or directly heated in the steam generators as the installation restarts. The gaseous effluent from this process is then evacuated using the turbine bypass to the atmosphere (Main Steam Relief Train (VDA [MSRT])).

The rise in temperature generates gaseous ammonia partly from the wet lay-up solution used in the steam generators mentioned above, and partly from the steam generator Emergency Feedwater System (ASG [EFWS]) water, which comes either from the ASG [EFWS] deaeration tank or from the Condenser and Condenser Extraction System (CEX), and is used as water supply for the steam generators.

It should be noted that all the hydrazine, which is broken down into ammonia by heating, will not in turn be found in the liquid discharge.

4.2.1.3.2. Estimate of ammonia discharge

It is assumed for the calculations that all the hydrazine present in the water is broken down into ammonia.

- Ammonia from ASG [EFWS] or CEX water

  The ammonia discharged from the ASG [EFWS] or CEX water is calculated using the following assumptions:

  - 5000 tonnes of water vapour are discharged per shutdown;
  - the secondary circuit is conditioned to a high pH using ammonia;
  - all the ammonia in the water is discharged into the atmosphere.

  The estimated quantities of ammonia discharged are approximately 1.5 kg from ASG [EFWS] and 17 kg from CEX. Discharge is continuous throughout the VDA [MSRT] valves opening.

- Ammonia from wet conditioning the steam generators

  The ammonia discharged from wet conditioning the steam generators is calculated using the following assumptions:

  - the residual level of hydrazine in the steam generators is around 100 mg l^{-1};
  - 100 tonnes of water are present in the steam generators; and
  - two-thirds of the ammonia present in the water is discharged into the atmosphere.

  The quantity of discharged ammonia is estimated to be approximately 20 kg. The assumption is that this quantity is discharge during the first few hours of operation.

A study has been carried out to determine how much ammonia was released from the evaporation vapour of the steam generators (worst case). For an EPR unit, the maximum release rate for ammonia was estimated to be 0.78 g s^{-1} for each one of the four steam generators. It was also estimated that the ammonia emissions from the entire steam generator were released during 83 hours.

4.2.2. Traffic related emissions

Road traffic will be generated by the existence of the unit during its entire operational phase. Traffic of heavy vehicles will be less important than during the construction phase, even during period of heavy maintenance work every other year for the delivery of materials. The main source of traffic will be the transportation of the site workforce.

The emissions associated with vehicle exhaust are described in Chapter 4 of the PCER. The assessment of impact is detailed in Chapter 12 of the PCER.

Site management may have to issue traffic rules in order to help reduce the overall impact associated with vehicle related emissions.

4.2.3. Odour emission

The only chemical substances discharged from the EPR unit that may produce an odour are formaldehyde, ammonia and diesel exhaust gases during periodic tests.

4.2.4. Conclusion

The discharge of gaseous non radiological emissions is likely to be regulated by a PPC permit or an Environmental Permit.

Such permits will be obtained for the relevant operational processes which give rise to the non radiological emissions of significance.

5. NOISE AND VIBRATION

Nuclear power plants are sources of noise during normal operation coming from systems such as transformers, turbine generator units, Heating, Ventilation and Air Conditioning (HVAC) systems and pumps.

The acoustic characteristics of an EPR Unit are defined by identifying equipment and facilities that might be heard, and by comparing the noise level with the local regulatory and/or background noise levels when they exist. A list of potential sources of noise has been defined for both the EPR Nuclear and Conventional Islands, based on sources normally found in PWRs currently in operation.

The sound sources identified for an EPR Unit are listed in Sub-chapter 3.3 - Table 7. This table shows the location (the building that houses it) and the assumptions used to calculate the acoustic power for each source of noise. Until final manufacturing and test of the equipment for the UK EPR are available, each sound source has been assigned an acoustic power range based on similar sources for which data is available from other PWRs in France.

Noise due to the change in traffic is site specific.

6. VISUAL ASPECTS

An EPR Unit includes buildings of a substantial scale, mainly the Reactor Building (53 m diameter and 62 m high), the stack (its height is site specific but will be at least as high as the Reactor Building) and the Turbine Hall (about 120 m long, 54 m wide and 43 m high).

Lighting of the site at night must be assessed with regard to sky glow that could be perceived from inland and from the sea.

7. INCIDENT OR ACCIDENT RELEASES

7.1. NUCLEAR SAFETY RELATED INCIDENT AND ACCIDENT

The main objective of the plant buildings, systems and I&C design is, besides its operability, to limit the impacts of incidental or accidental transients during all the phases of the operation (in power and during shutdown periods).

Transient analyses and description of the related design aspects are presented in the PCSR.

7.2. UNPLANNED LIQUID DISCHARGES TO LAND

Unplanned discharges as a result of incidents such as spillages or leaks can arise from:

- liquid radioactive effluent treatment and storage; and
- Turbine Hall maintenance and processes.

Structures, and equipment associated with the process are designed to include drains, so that uncontrolled discharges are collected and returned to the liquid treatment system preventing discharges to ground.

Polluted water resulting from incident situations (water from fires, or accidentally polluted with chemicals) will be collected and stored in a containment tank. The liquid in the tanks will be analysed and treated on-site as far as possible, or transferred to another tank for shipping offsite for treatment rather than being discharged to the sanitary sewer.

7.3. CONTROL OF MAJOR ACCIDENT HAZARDS

The unit operation and maintenance require the storage of chemical substances inside some buildings and/or in the various site facilities.

The stored quantities must be at any time sufficient, between their deliveries to the site, to fulfil the site requirements. It is the responsibility of the operator to supply the amount of each substance according to the maintenance schedule, and to remain in compliance with the regulation during the plant lifetime.

An assessment has been performed for the reference EPR, following the requirements of the Control of Major Accident Hazards (COMAH) Regulations schedule [Ref-1] [Ref-2], of the typical amount of chemicals stored for an EPR unit operation based on the values estimated from existing sites feedback.

The following table (Sub-chapter 3.3 - Table 5) compares estimated storage quantities of chemicals against threshold limits in Columns 2 and 3 of Part 2, Schedule 1 of the COMAH Regulations.

Sub-chapter 3.3 - Table 5: Typical quantities of chemical storage against Column 2 & 3 Chemical Storage Thresholds (in tonnes)

Chemical	Storage Quantity (tonnes)	Column 2 Threshold (tonnes)	Column 3 Threshold (tonnes)
Acetylene	0.11	5	50
Chlorine	0.01804	10	25
Hydrogen	0.38	5	50
Hydrazine hydrate	1.5	0.5	2
Oxygen	0.450	200	200
Petrochemicals[2] (Diesel for back-up generation)	770	2500	25,000
Petrochemicals (Oils for plant lubrication)	38	2500	25,000

The expected quantity of hydrazine hydrate to be stored on site for one EPR unit exceeds lower tier threshold for that substance in column 2 while remaining below the upper tier threshold in column 3. Therefore the COMAH Regulations will apply on an actual site.

Since the COMAH Regulations concern the storage on an entire site, the study will have to be performed for the selected site to take into account any existing facilities on that site.

The use of hydrazine hydrate is essential for conditioning of the secondary circuit to consume residual oxygen. It is usually delivered to site as a solution in drums or Intermediate Bulk Containers and transferred as required to buffer storage tanks in the injection system. Hydrazine is a named carcinogen in the COMAH Regulations and its main risk is to the workforce. It must be used in a closed system to guarantee worker safety.

Hydrazine is classified as dangerous to the environment and is toxic to aquatic organisms. However its toxicity diminishes in line with concentration, it is not very bio-cumulable and tends to decompose in the aquatic environment.

The main preventive and corrective measures taken to avoid accidental pollution of the aquatic environment are:

- a bund under each container and storage tank;
- the recovery of any effluent on the floor in the rooms by the SEK [CILWDS] draining system, itself directed into the Ex (0SEK [SiteLWDS]) storage tank; discharge is then monitored and dilution is performed before any discharge into the sea; and
- automatic shut-offs for hydrazine systems in event of failure.

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[2] These values do not include potential additional storage of fuel as a result of the design changes considered for implementation in the light of lessons learnt from the Fukushima event.

Given the preventive and mitigation measures implemented, the risks of hydrazine hydrate reaching the environment are very low, and the consequences would be very limited. Therefore Major Accidents To The Environment (MATTE) are highly unlikely, should an accidental spillage of hydrazine hydrate occur during storage or transfer.

An assessment has also been performed, following the requirements of Part 3, Schedule 1 of the COMAH Regulations, on the risks set by the storage of other generic categories (see Sub-chapter 3.3 - Table 6), such as toxic and flammable substances, that might affect the environment. The risks addressed are:

- fire;
- onsite explosion (overpressure);
- toxic cloud derivative;
- explosive cloud derivative (overpressure);
- toxic cloud derivative following a fire;
- liquid chemical pollution; and
- projectile ejection.

Sub-chapter 3.3 - Table 6: COMAH Regulations – Categories of Substances and Preparations

Category	Column 2 Threshold (tonnes)	Column 3 Threshold (tonnes)
Toxic	5	20
Very Toxic	50	200
Oxidising	50	200
Explosive*	50	200
Explosive*	10	50
Flammable	5000	50,000
Highly Flammable*	50	200
Highly Flammable*	5000	50,000
Extremely Flammable	10	50
Dangerous to the Environment:		
R50 – Very toxic to aquatic organisms	100	200
R51 / 53 - Toxic to aquatic organisms	200	500
Any classification:		
R14 - Reacts violently with water	100	500
R29 - In contact with water, liberates toxic gas	50	200

* for these categories, there are two different classifications and definitions given in the COMAH Regulations.

Sub-chapter 3.3 - Table 9 presents risk against its possible origins and the quantity of the concerned substances, as they will be stored on the reference EPR site. Some substances present more than one risk, therefore they are presented several times in the table.

Again a site specific assessment of compliance with the COMAH Regulations will be required for the selected site to take into account any existing facilities on that site.

Sub-chapter 3.3 - Table 7: Characteristics of the EPR noise and vibration sources

	Building		Noise sources	Power of equipment (dB(A))	No. of sources
NUCLEAR ISLAND	Nuclear Auxiliary Building	HN	Chilled water group DER	102.1 per unit	2
			Hopper HNX	87.7	1
	Fuel Building	HK	Chimney - Chimney stack - Chimney opening	104.9, made up of: 91.3 104.7	1
	Electrical building	HLA	Hopper	91.3	1
		HLB	Air inlet	89.9	1
		HLC	Air inlet	89.9	1
		HLD	Hopper	88.9	1
			Air outlet	95	1
		HLA & HLD	Refrigerant group DEL	101.4 per unit	2
		HLB & HLC	Hopper	96.3	1
	Diesel Building	HDA & HDB	Hopper 01VB	89.4 per opening	3
			Hopper 01VB	87.7 per opening	3
			Hopper 03VB	105 per opening	3
		HDC & HDD	Hopper 01VB	89.4 per opening	3
			Hopper 01VB	87.7 per opening	3
			Hopper 03VB	105 per opening	3
	Above the Electrical Buildings		Steam piping Division 1	82.6	1
			Steam piping Division 2	82.4	1
			Steam piping Division 3	82.4	1
			Steam piping Division 4	82.6	1
CONVENTIONAL ISLAND	Turbine Hall	HM	Turbine hall	96.2	1
	Unclassified Electrical Building	HF	Refrigerant group	88.8 per unit	4
	Pumping Station	HP	Pumping station	90.3	1
	Main transformer	HT	Pole TP	105.2 per unit	3
			Ventilation TP	88.2 per unit	3
	Step down transformer		Pole TS	98 per unit	2
			Ventilation TS	88.7 per unit	4
	Auxiliary transformer	HJ	Pole TA	98	1
			Ventilation TA	88.7 per unit	2
	Operational Service Centre	POE	Refrigerant group	101.4 per unit	4

Sub-chapter 3.3 - Table 8: Conventional wastes

Output and disposal for the 2 x 1300 MW(e) units at Flamanville site for the year 2006

1.1. Definition of waste type and treatment used in the Table below

Non-Hazardous waste:	Inert waste (rubble) - (as a result of minor estates and facilities works, packaging); and Commercial waste (canteen, office waste)
Hazardous waste:	Industrial waste; including solids (aerosol spray cans), liquids (solvents oils) and sludge (paint residues) chemical and material additives, effluents, materials.
Turbine Gland System (CET) 1, 2 or 3:	Buried
IE:	Incineration with energetic recovery
IW:	Incineration without energetic recovery
VAL:	Recovery (recovery of material, recycling)

1.2. Production

858 tonnes of conventional solid waste have been produced in 2006:

- 769 tonnes of non-hazardous waste; and
- 88 tonnes of hazardous waste.

Details are presented in the Table below.

Sub-chapter 3.3 - Table 8: Conventional wastes (continued)

Type, quantity and treatment of waste					
Nature	**European Code**	**Quantity (kg)**	**Hazardous/ non-hazardous**	**Intermediate Storage**	**Final Disposal**
Aerosols	16 05 04	143.2	Hazardous	Drum	IE
Biodegradable waste	20 02 01	45,640	Non-hazardous	Skip	VAL
Bulky waste	20 03 07	13,880	Non-hazardous	Skip	CET2
Contaminated packaging	15 01 10	3277	Hazardous	Leaktight bin	IE
Demolition waste (mixture)	17 01 07	84,520	Non-hazardous	Skip	CET3
Demolition waste with asbestos	17 06 05	39.4	Hazardous	Big bag	IW
Discarded computer equipment	16 02 13	2610	Hazardous	Box	VAL
Discarded screens	16 02 15	1193	Hazardous	Box	VAL
Dredging spoil	17 05 06	85,970	Non-hazardous	Tank	CET3
Dredging spoil	17 05 06	7300	Non-hazardous	Skip	CET2
Edible oil and fat	20 01 25	229.8	Hazardous	Drum	IE
Empty paint cans	08 01 12	475.2	Hazardous	Leaktight bin	IE
End-of-life tyres	16 01 03	13,750	Non-hazardous	Skip	VAL
Expired acids	06 01 06	362.6	Hazardous	Leaktight bin	IE
Expired bases	06 02 05	1795	Hazardous	Leaktight bin	IE
Fire extinguisher powder	16 05 09	1682	Hazardous	Drum	IE
Flammable liquid	15 02 02	506.2	Hazardous	Box	IE
Flammable substances	08 04 15	23	Hazardous	Leaktight bin	IE
Fluorescent tubes	20 01 21	410.4	Hazardous	Box	VAL
Insulating (Laine céramique)	17 06 03	287	Hazardous	Big bag	IW
Insulating (rock wool)	17 06 04	13,400	Non-hazardous	Skip	CET2
Insulating and heat transmission oils (water glycol)	13 03 10	940	Hazardous	Tank	IE
Insulating with asbestos (EPI VINYLS)	17 06 01	293	Hazardous	Big bag	IW
Insulating with asbestos (Fire damper)	17 06 01	380	Hazardous	Big bag	IW
Ion exchange resins	19 09 05	567	Non-hazardous	Leaktight bin	IE
Laboratory chemicals	16 05 06	1	Hazardous	Leaktight bin	IE
Lead batteries	16 06 01	966	Hazardous	Box	VAL
Machining oil	12 01 07	626	Hazardous	Drum	IE
Mercury-containing batteries	16 06 03	411.2	Hazardous	Drum	VAL
Mixed metals	17 04 07	94,160	Non-hazardous	Skip	VAL
Mixed municipal waste (canteen)	20 03 01	110,830	Non-hazardous	Skip or other	CET2
Ni-Cd batteries	16 06 02	128	Hazardous	palette	VAL
Non-chlorinated hydraulic oil	13 01 10	510	Hazardous	Drum	IE

Sub-chapter 3.3 - Table 8: Conventional wastes (continued)

Type, quantity and treatment of waste					
Nature	**European Code**	**Quantity (kg)**	**Hazardous/ non-hazardous**	**Intermediate Storage**	**Final Disposal**
Oil contaminated soil	17 05 03	3540	Hazardous	Skip	CET 1
Oily water	13 05 07	55,320	Hazardous	Tank	VAL
Other batteries and accumulators	16 06 05	61.4	Hazardous	Drum	VAL
Paint & glue	08 01 11	358.2	Hazardous	Box	IE
Paints	08 01 17	279	Hazardous	Box	IE
Paper & Cardboard packaging	15 01 01	12,920	Non-hazardous	Skip	VAL
Paper and cardboard	20 01 01	32,220	Non-hazardous	Skip	VAL
Photographic fixer solutions	09 01 04	785	Hazardous	Drum	IE
Plastic packaging	15 01 02	580	Non-hazardous	Skip	VAL
Residues from sandblasting	08 01 17	4060	Hazardous	Leaktight bin	IE
Residues from sandblasting	08 01 17	63	Hazardous	Leaktight bin	IE
Sealant (mastic)	08 04 15	118.8	Hazardous	Drum	IE
Seals containing asbestos	17 06 01	125	Hazardous	Big bag	IW
Silica gel	15 02 02	176.2	Hazardous	Leaktight bin	IE
Silicon	08 04 15	303	Hazardous	Leaktight bin	IE
Sludges from waste water treatment	19 08 14	4000	Non-hazardous	Skip	VAL
Solids contaminated (with oil, solvent or Cresyl phosphate)	15 02 02	5110	Hazardous	Drum	IE
Solvents and solvent mixtures	14 06 03	117	Hazardous	Leaktight bin	IE
Spent waxes and fats	12 01 12	267.2	Hazardous	Drum	IE
Toxic substances	20 01 19	38.2	Hazardous	Leaktight bin	IE
Waste containing mercury	06 04 04	17.3	Hazardous	Leaktight bin	IE
Waste from health care	18 01 03	35.7	Hazardous	Box	IE
Waste paint	08 01 11	170	Hazardous	Leaktight bin	IE
Waste printing toner	08 03 18	426.4	Non-hazardous	Cardboard box	VAL
Water with edible oil and fat	20 01 25	28,970	Non-hazardous	Tank	VAL
Weeds from seawater filtration	19 09 01	53,300	Non-hazardous	Skip	CET2
Weeds from seawater filtration	19 09 01	96,770	Non-hazardous	Skip	VAL
Wooden packaging	15 01 03	52,220	Non-hazardous	Skip	VAL

Sub-chapter 3.3 - Table 9: Facilities presenting a risk - using the reference EPR data (Some facilities are shared by other units on site)

Risk	Origin	Quantity[3]	Location and/or Facility
Fire	Storage in tanks manufactured from flammable liquids	1 x 2 m^3 tank/channel (Ceq = 1.6 m^3)	A and B channel Diesel generator building
		1.5 m^3 tank of diesel (Ceq = 300 litres)	Oil works annex (shared by site)
		Firewall cabinets (Ceq = 0.74 m^3)	General warehouse (shared by site)
		Chemical products (Ceq = 2.48 m^3)	Next to Pumping Station (shared by site)
		1 x 100 m^3 buried tank of kerosene (Ceq = 4 m^3)	TAC enclosure (shared by site)
		1 x 10 m^3 buried tank of fuel and 1 dripping tank (0.25 m^3) (Ceq = 0.13 m^3)	BDS (shared by site)
		2 x 2 tanks of 180 m^3 of diesel in bunded room	Diesel generator buildings
		3 wagons of 38 m^3 of oil per unit (Ceq = 15.2 m^3)	Outside Turbine Hall
		1 x 2 tanks of 25 m^3 of diesel in bunded room	Diesel generator buildings
		8 x 6.3 m^3 tanks of oil + 60 x 25 litre drum of oil + 31 x 200 + 800 kg drums of grease (Ceq = 3.7 m^3)	Site's oil works (shared by site)
		morpholine – 1 x 6 m^3 tank	Demineralisation Station (shared by site)
		morpholine – 1 x 1 m^3 tank	Turbine Hall

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[3] These values do not include potential additional storage of fuel as a result of the design changes considered for implementation in the light of lessons learnt from the Fukushima event.

Sub-chapter 3.3 - Table 9: Facilities presenting a risk - using the reference EPR data (some facilities are shared by other units on site) (continued)

Risk	Origin	Quantity[4]	Location and/or Facility
Fire	Flammable liquids (mixing or usage installations) with the exception of single cold mix installations	2 tonnes - resin coating equipment (MERCURE)	Effluent Treatment Building
	Covered warehouse storage of materials, products or burnable substances in Quantity > 500 tonnes	73 tonnes	General warehouse (shared by site)
		14 tonnes	Operational Service Centre
		11 tonnes	Demineralisation Station (shared by site)
		1 tonne	FERRIER warehouse (shared by site)
	Flammable liquids distribution or filling installation	1500 litre tank of diesel fuel (Qeq = 0.5 m^3 h^{-1})	Oil works annex (shared by site)
	Oil tank	oil	Turbine Hall
	Oil trough		
	GHE room and degassing tank		
	GGR room		
	Transformers (TS/TP/TA and HT/HJ)	oil (30 m^3)	Transformers outside of the Turbine Hall

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[4] These values do not include potential additional storage of fuel as a result of the design changes considered for implementation in the light of lessons learnt from the Fukushima event.

Sub-chapter 3.3 - Table 9: Facilities presenting a risk - using the reference EPR data (some facilities are shared by other units on site) (continued)

Risk	Origin	Quantity[4]	Location and/or Facility
Fire	Waste from basic nuclear installations	Conventional waste transit area	Area in front of Demineralisation Station (shared by site)
		Oily and Cresyl phosphate waste	Bungalows behind oil works (shared by site)
		Effluent Treatment Building	Effluent Treatment Building
		Interim storage area	Area at the top of the cliff (shared by site)
Onsite explosion (overpressure)	Deposits of flammableliquids in manufactured tanks	1 x 2 m^3 tank/channel	A and B channel diesel generator rooms
		1.5 m^3 tank of diesel fuel	Oil works annex (shared by site)
		1 x 100 m^3 buried tank of kerosene (Ceq = 4 m^3)	TAC enclosure (shared by site)
		1 x 10 m^3 buried tank of fuel + 1 x 0.25 m^3 dripping tank (Ceq = 0.13 m^3)	BDS (shared by site)
		2 x 2 tanks of 180 m^3 of diesel in bunded room	Diesel generator buildings
		1 x 2 tanks of 25 m^3 of diesel in bunded room	Diesel generator buildings
	Transformers	oil (30 m^3)	Outside of the Turbine Hall
	Propane Storage or use liquefied gas deposits	328 kg	Operational Service Centre
		15 kg	BH Gas storage (shared by site)
		80 kg	Material reception hall (shared by site)
		163 kg	Gas storage close to BAC (shared by site)

Sub-chapter 3.3 - Table 9: Facilities presenting a risk - using the reference EPR data (some facilities are shared by other units on site) (continued)

Risk	Origin	Quantity[4]	Location and/or Facility
Onsite explosion (overpressure)	Storage or use of hydrogen	2 kg	Nuclear Auxiliary Building
		380 kg per unit	Gas platform (FLA 3)
	Acetylene storage or use	100 kg	Warehouse gas storage (shared by site)
		50 kg	Operational Service Centre
		11 kg	BH gas plant (shared by site)
		55 kg	Gas storage (FLA 3)
	Flammable liquid distribution or filling installation	1500 litre tank (diesel fuel)	Oil works annex (shared by site)
Toxic cloud derivative	Use or storage of liquefied ammonia	7 kg	Demineralisation Station (shared by site)
		14 kg	Turbine Hall
		28 kg	Nuclear Auxiliary Building
Explosive cloud derivative (overpressure)	Propane Storage or use (liquefied gas deposit)	328 kg	Operational Service Centre
		15 kg	BH Gas storage (shared by site)
		80 kg	Equipment reception hall (shared by site)
		163 kg	Gas storage close to BAC (shared by site)
	Storage or use of hydrogen	2 kg	Nuclear Auxiliary Building
		380 kg	Gas platform (FLA 3)

Sub-chapter 3.3 - Table 9: Facilities presenting a risk - using the reference EPR data (some facilities are shared by other units on site) (continued)

Risk	Origin	Quantity[4]	Location and/or Facility
Explosive cloud derivative (overpressure)	Acetylene storage or use	110 kg	Warehouse gas storage (shared by site)
		50 kg	Operational Service Centre
		11 kg	BH gas plant (shared by site)
		55 kg	Gas storage (FLA 3)
Toxic cloud derivative following a fire	Use or storage of toxic liquid preparations or substances	10 tonnes - resin coating equipment (MERCURE)	Effluent Treatment Building
	Industrial manufacturing of chlorine	< 16 kg of available chlorine per unit (normal operation)	Pumping Station
		< 2.4 tonnes for exceptional situations treatment	
	Storage, use, industrial manufacturing,formulation and conditioning of particulartoxic substances and preparations	1 tank per 2 m^3 unit of 24% hydrazine hydrate - 300 kg	Turbine Hall
		6 x 1 m^3 containers of 24% hydrazine hydrate - 900 kg	Operational Service Centre
		1 x 5 m^3 tank per unit of hydrazine hydrate diluted to 7% volume	Turbine Hall
		1 x 3 m^3 tank per unit of 24% hydrazine hydrate	Turbine Hall
	Use or storage of toxic or highly toxic preparations or substances in a laboratory	24% hydrazine hydrate -12 kg per unit	Operational Service Centre

Sub-chapter 3.3 - Table 9: Facilities presenting a risk - using the reference EPR data (some facilities are shared by other units on site) (continued)

Risk	Origin	Quantity[4]	Location and/or Facility
Toxic cloud derivative following a fire	Storage and use of substances that are dangerous for the environment	2 tanks: 3 m^3 and 10 m^3 of 47-50 chlorometric sodium hypochlorite - 2 tonnes of available chlorine	Bleaching rooms located at the top of the cliffs (shared by site)
		1 x 2 m^3 tank of 24% sodium bisulphite in SO$_2$ - 640 kg	Demineralisation Station (shared by site)
		6 x 800 litre container of 28% ammonium hydroxide - 1210 kg	Operational Service Centre
		2 x 1.2 m^3 tanks (28% ammonium hydroxide)	Turbine Hall
		2 x 0.8 m^3 tanks (28% ammonium hydroxide diluted to 50% in volume)	
		404 kg per unit	
		1 x 3 m^3 tanks of 28% ammonium hydroxide diluted to 15% in volume - 114 kg	Demineralisation Station (shared by site)
	Waste from basic nuclear installations	Conventional waste transit area	Area in front of Demineralisation Station (shared by site)
		Oily and Cresyl phosphate waste	Bungalows behind oil works (shared by site)
		Radioactive wastes	Effluent Treatment Building
		Storage area for VLW - VVLW	Area at the top of the cliff

Sub-chapter 3.3 - Table 9: Facilities presenting a risk - using the reference EPR data (some facilities are shared by other units on site) (continued)

Risk	Origin	Quantity[4]	Location and/or Facility
Toxic cloud derivative following a fire	Use or storage of 50% acetic, 20% hydrochloric, 25% sulphuric, 20% nitric acid but with – 70% in weight of acid	30 litre canister of nitric acid (57% in weight) - 300 kg	Operational Service Centre
		30 litre canister of nitric acid (57% in weight) - 120 kg	Nuclear Auxiliary Building
		Nitric acid buffer tank (57% in weight) - 630 kg	Nuclear Auxiliary Building
		2 x 15 m^3 at tanks of sulphuric acid 98% in weight - 54 tonnes	Demineralisation Station (shared by site)
	Usage or storage of sodium or potassium hydroxide (+ 20% of NaOH or KOH)	30 litre containers of 30.5% sodium hydroxide - 150 kg	Operational Service Centre
		800 litre buffer tank - 325 kg	Nuclear Auxiliary Building
		30 litre containers of 30.5% sodium hydroxide - 65 kg	Nuclear Auxiliary Building
		2 x 30 m^3 tanks of 50% sodium hydroxide - 46 tonnes	Demineralisation Station (shared by site)
		12 m^3 tanks of 25-32% sodium hydroxide - 10 tonnes	Electrical building
		Laundry	Warehouse (laundry)

Sub-chapter 3.3 - Table 9: Facilities presenting a risk - using the reference EPR data (some facilities are shared by other units on site) (continued)

Risk	Origin	Quantity[4]	Location and/or Facility
Liquid chemical pollution	Storage, use, industrial manufacturing,formulation and conditioningof particular toxic preparations	1 x 2 m^3 tank per unit of 24% hydrazine hydrate - 300 kg	Turbine Hall
		1 m^3 containers of 24% hydrazine hydrate - 900 kg	Operational Service Centre
		1 x 5 m^3 tank per unit of hydrazine hydrate diluted to 7% in volume	Turbine Hall
		1 x 3 m^3 tank per unit of 24% hydrazine hydrate	Turbine Hall
	Use or storage of toxic or highly toxic preparations or substances in a laboratory	24% hydrazine hydrate - 12 kg per unit	Operational Service Centre
	Industrial manufacturing of chlorine	< 16 kg of available chlorine per unit (normal operation)	Pumping Station
		< 2.4 tonnes in case of variables	

Sub-chapter 3.3 - Table 9: Facilities presenting a risk - using the reference EPR data (some facilities are shared by other units on site) (continued)

Risk	Origin	Quantity[4]	Location and/or Facility
Liquid chemical pollution	Storage or use of substances that are dangerous for the environment	2 tanks: 3 m^3 and 10 m^3 of 47-50 chlorometric sodium hypochlorite - 2 tonnes of available chlorine	Bleaching rooms located at the top of the cliffs (shared by site)
		18 m^3 of commercial sodium hypochlorite (2 tonnes)	Pumping Station
		1 x 2 m^3 tank of 24% sodium bisulphite in SO_2 - 640 kg	Demineralisation Station (shared by site)
		6 x 800 l containers of 28% ammonium hydroxide - 1210 kg	Operational Service Centre
		2 x 1.2 m^3 containers (28% ammonium hydroxide)	Turbine Hall
		2 x 0.8 m^3 tanks (28% ammonium hydroxide diluted to 50% in volume) - 404 kg per unit	
		1 x 3 m^3 tank of 28% ammonium hydroxide diluted to 15% in volume - 114 kg	Demineralisation Station (shared by site)
	Storage and use of substances that are dangerous for the environment and toxic for aquatic organisms	4000 litre of Cresyl phosphate (5 tonnes)	Oil works (shared by site)

Sub-chapter 3.3 - Table 9: Facilities presenting a risk - using the reference EPR data (some facilities are shared by other units on site) (continued)

Risk	Origin	Quantity[4]	Location and/or Facility
Liquid chemical pollution	Storage of flammable liquids in manufactured tanks	see fire risk details	see fire risk details
	Flammable liquid distribution or filling installation		
	Use or storage of 50% acetic, 20% hydrochloric, 25% sulphuric, 20% nitric acid but with –70% in weight of acid		
	Use or storage of sodium or potassium hydroxide (+ 20% of NaOH or KOH)		
Projectile ejection	Use or storage of oxygen	360 kg	Operational Service Centre
		11.5 kg	Sick bay BH (shared by site)
		1 kg	Nuclear Auxiliary Building
		0.4 kg	Nuclear Auxiliary Building
		83 kg	Gas storage close to the BAC (shared by site)
	Storage or use of oxidising agent preparations and substances(dinitrogen oxide)	50 kg	Gas storage BH (shared by site)
		80 kg	Gas storage (shared by site)
		45 kg	BH gas storage (shared by site)

Sub-chapter 3.3 - Table 9: Facilities presenting a risk - using the reference EPR data (some facilities are shared by other units on site) (continued)

Risk	Origin	Quantity[4]	Location and/or Facility
Projectile ejection	Propane Storage or use (liquefied gas deposit)	328 kg	Operational Service Centre
		15 kg	Gas storage BH (shared by site)
		80 kg	Equipment reception hall (shared by site)
		163 kg	Gas storage close to BAC (shared by site)
	Storage or use of hydrogen	2 kg	Nuclear Auxiliary Building
		380 kg per unit	Gas platform (FLA 3)
	Acetylene storage or use	110 kg	Warehouse gas storage (shared by site)
		50 kg	Operational Service Centre
		11 kg	BH gas plant (shared by site)
		55 kg	Gas platform (FLA 3)
		10 m^3	BH gas storage (shared by site)
		26 cylinders	Gas storage close to the BAC (shared by site)
	Argon	51 cylinders	Gas storage close to the BAC (shared by site)
		11 m^3	BH gas storage (shared by site)
		12 cylinders	BAC/SEK storage (shared by site)
	Helium	2 cylinders	Gas storage close to the BAC (shared by site)
		3 x 9 m^3	BH gas storage (shared by site)
	Turbine generator unit	Low pressure rotor component	Turbine Hall

SUB-CHAPTER 3.3 – 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.

2. SOLID WASTES

2.2. CONVENTIONAL SOLID WASTES

2.2.1. Source and type of conventional solid wastes

[Ref-1] The List of Wastes (England) Regulations 2005. The Stationery Office Ltd. SI No. 895. ISBN0110726847. (E)

[Ref-2] Hazardous Waste (England and Wales) Regulations 2005. ISBN 978-011072685-4. The Stationery Office Ltd. (E)

2.2.2. Conventional solid waste strategy

[Ref-1] Hazardous Waste (England and Wales) Regulations 2005. ISBN 978-011072685-4. The Stationery Office Ltd. (E)

4. GASEOUS DISCHARGES

4.1. GASEOUS RADIOACTIVE DISCHARGES

4.1.2. Amount of radioactive gaseous discharge expected

[Ref-1] Zinc Injection claims, arguments and evidences: overall balance for UK-EPR. ECEF110139. Revision A. EDF. March 2011 (E)

4.2. CHEMICAL NON RADIOACTIVE GASEOUS DISCHARGES

4.2.1. Process related discharges

4.2.1.1. Back-up generators tests

[Ref-1] Directive 2003/17/EC of the European Parliament and of the Council of 3 March 2003 amending Directive 98/70/EC relating to the quality of petrol and diesel fuels. (E)

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

[Ref-3] Pollution Prevention and Control Regulations 2000. SI No. 1973. The Stationery Office Ltd. ISBN 978-011099621-9. (E)

[Ref-4] GDA UK EPR - PPC application - Generic information for UK EPR diesel generators. UKEPR-0004-001. Issue 00. EDF/AREVA. June 2008. (E)

[Ref-5] IPPC Technical Guidance for the Combustion Sector S1.01. V2.03. Environment Agency & Environment and Heritage Service & Scottish Environment Protection Agency. July 2005 (E)

[Ref-6] Water Resources Act 1991. ISBN 978-0105457916. The Stationery Office Ltd. (E)

7. INCIDENT OR ACCIDENT RELEASES

7.3. CONTROL OF MAJOR ACCIDENT HAZARDS

[Ref-1] The Control of Major Accident Hazards Regulations 1999 (COMAH) ISBN 978-011082192-4. The Stationery Office Ltd. (E)

[Ref-2] Control of Major Accident Hazards (Amendment). Regulations 2005. ISBN 01-10-72766-5. The Stationery Office Ltd. (E)

SUB-CHAPTER 3.4 – NEEDS AND OUTPUTS RELATED TO THE AQUATIC ENVIRONMENT

LIST OF TABLES

LIST OF FIGURES

This sub-chapter identifies the aspects of the operational phase, in terms of needs and outputs, which have a bearing on the aquatic environment for a coastal or estuarine operating EPR Unit.

1. FRESHWATER

Since the UK EPR is a coastal or an estuarine site there is no need to assess freshwater needs for heat sink purposes. During operation of the UK EPR, freshwater will be required to meet process needs and sanitary and other requirements.

1.1. NEEDS FOR FRESHWATER

1.1.1. Needs for demineralised water

The needs for demineralised freshwater for an EPR unit are estimated to be 410 m^3 per day during normal operations and 1110 m^3 per day during start-up after a plant shutdown.

Considering 354 days of normal operation at full power, 11 days for simple outage and 29 hours of start-up, this amounts to a nominal volume of 147,000 m^3 per year. The demineralised water consumption of the fire circuit Conventional Island Demineralised Water Distribution System (SER) is estimated to be 3000 m^3 per year.

Thus the annual required volume of demineralised water is 150,000 m^3.

1.1.2. Needs for untreated freshwater

Untreated (raw) freshwater will be used during the EPR operation for the following purposes:

- to supply the Industrial Water System (SEI), mainly used in the Turbine Hall to wash the floors and reduce in particular overheating in the Conventional Island Liquid Discharge System (SEK [CILWDS]). The need is estimated to be 75,000 m^3 per year; and
- in the Pumping Station for spraying the Circulation Water System (CRF) pumps stuffing boxes; the need is estimated to be 40,000 m^3 per year.

The annual requirement for untreated freshwater is therefore estimated at 115,000 m^3.

1.1.3. Total needs for freshwater

In total, the annual required volume of freshwater for the process is 265,000 m^3.

If the 150,000 m^3 of demineralised water are produced in a demineralisation plant, an additional amount of 36,000 m^3 of filtered freshwater is needed for washing the sand filters, and regenerating and flushing the ion exchangers of the demineralisation plant.

1.2. NEEDS OF POTABLE WATER

Supply of potable water will be required for sanitation needs (lavatories and showers), catering and drink dispensers, as well as for a number of industrial uses, which include:

- laundry;
- hydraulic seal on settling tank in the Demineralisation Station;
- flushing the electrolysers at the end of a cycle;
- Effluent Treatment Building (sealing the concrete cells);
- packing glands for the CRF water circulation pumps (back-up);
- firewater (in addition to the fire fighting network, i.e. Fire Fighting System For Non-Classified Buildings (JPD));
- refrigeration equipment, air-conditioners; and
- laboratory work.

Based on the average annual potable consumption at an existing French unit, the EPR Unit average potable water consumption is estimated to be 30,600 m^3 per year.

1.3. SUPPLY OF FRESHWATER

Freshwater may be provided (via the necessary abstraction and treatment infrastructure) by surface water sources such as rivers or groundwaters, or from a desalination unit depending on the site characteristics. When a possible site location is confirmed, an assessment of the water resource availability will be made by the Water Authorities, in order to define the most sustainable means of sourcing the water both for raw (untreated) water and for drinking quality water.

If freshwater is planned to be abstracted from a surface water source, such as a river or a lake, an Abstraction Licence, granted under the Water Resource Act 1991, may be required before any abstraction can take place.

If it becomes necessary to impound freshwater in a temporary or permanent reservoir, an Impoundment Licence, granted under the Water Resources Act 1991, may be required before work to construct the impoundment takes place.

2. OCCUPATION OF MARITIME DOMAIN

Once construction is complete (see Chapter 4 of the PCER), the operation of the EPR may require access for maintenance purposes to the water inlet and outlet points.

3. SEAWATER NEEDS AND TREATMENT

3.1. USE OF SEAWATER

3.1.1. Cooling water

For the operational phase, seawater is abstracted for cooling the steam turbine condenser (CRF), and plant auxiliary systems. The seawater pumps are installed in a Pumping Station, the design and location of which are site dependant.

The most important part of the cooling water flow rate depends on the CRF design. This flow rate value must be large enough to cool the secondary water at the condenser level, but must also be such that the temperature increase at the discharge point is acceptable.

Typically, with an envelope value of 26ºC for the seawater temperature and a temperature increase of 12°C at the discharge point, the total flow rate of seawater for cooling must be around 67 $m^3 s^{-1}$.

The Pumping Station's nominal intake, of approximately 67 $m^3 s^{-1}$, is distributed as follows:

- 61 $m^3 s^{-1}$ for the CRF, via two pumps with a nominal flow rate of 30.5 $m^3 s^{-1}$;
- 2 $m^3 s^{-1}$ for the Essential Service Water System (SEC [ESWS]) supplying the nuclear steam supply system auxiliaries, via four pumps with a nominal flow rate of 1 $m^3 s^{-1}$ (only two pumps operate at any one time);
- 2.80 $m^3 s^{-1}$ for the service-water circuit for the conventional auxiliaries (Auxiliary (Raw Water) Cooling System (SEN)), comprising four pumps, each with a nominal flow rate of 1.4 $m^3 s^{-1}$. In normal circumstances, only two operate at any one time;
- 0.04 $m^3 s^{-1}$ for the system which treats the circulating water system water by injecting sodium hypochlorite from seawater electrolysis (Circulation Water Treatment (CTE)), via one pump with a nominal flow rate of 0.04 $m^3 s^{-1}$;
- 0.56 $m^3 s^{-1}$ for the circuit supplying the pumps washing the drum and chain filters (two pumps for the drum filters and two for the chain filters) (Circulation Water Filtration System (CFI [CWFS]));
- 0.14 $m^3 s^{-1}$ for the water in the Ultimate Cooling Water System (SRU [UCWS]), via one pump with a nominal flow rate of 0.14 $m^3 s^{-1}$.

The annual volume of seawater used for cooling is therefore around 2.1 billion m^3.

3.1.2. Seawater desalination

Depending on freshwater resources at the site, a seawater desalination and treatment unit may be implemented to produce the 265,000 m^3 of freshwater required per year by the process, as presented in section 3.1.1 above.

The annual volume of seawater involved in the production of this volume of freshwater by means of desalination is around 680,000 m^3.

3.2. SEAWATER TREATMENT

Prior to use in the process, seawater must be filtered and chemically purified, to avoid corrosion and deposits in the primary and secondary systems, as described below.

3.2.1. Filtration

The filtration unit CFI [CWFS] ensures filtration of the seawater before it cools the condenser. CFI [CWFS] is located near the Pumping Station. The filtration is a two stages process: pre-filtration (using fixed grids and trash rakes) for removing large debris, followed by fine filtration (using drum and chain filter). The filtration system comprises four independent channels.

3.2.2. Electrochlorination

The cooling circuits of the EPR unit are protected against the growth of biofilm and biological fouling by injecting sodium hypochlorite into the circulating water. Sodium hypochlorite is produced in situ from electrolysis of seawater.

The plant producing sodium hypochlorite (CTE) for the EPR unit will be situated in the Pumping Station.

3.3. PERMITTING

Since more than 50 m^3 of seawater will be treated per day by chemical, physical or biological means, prior being discharge back into sea the process may require to be permitted in accordance with a relevant permit obtained under the Water Resources Act 1991 and/or the Pollution Prevention and Control Regulations 1999.

4. COOLING WATER DISCHARGES

4.1. THERMAL DISCHARGE

In the case of an UK EPR on a coastal or estuarine site, the cooling system is an open circuit: the cooling water is discharged back into the sea after use. The degree to which the seawater is heated depends on the unit power level, the number of pumps in use on the process side, and on the tide and currents around the water release point.

The water cooling system and the water intake and discharge structures are designed so that under normal operating conditions the rise between the inlet water temperature and the outlet temperature will not exceed a certain increase under normal conditions, while during extreme conditions, when the tide is low and the pumps are fouled, the rise will be slightly greater due to a smaller flowrate in the condenser.

The temperature increase is a site specific issue. For example, for the Flamanville 3 EPR, the water temperature increase at the discharge point is 12°C for a nominal flowrate of 67 $m^3 s^{-1}$, and 14°C for a reduced flowrate of 58 $m^3 s^{-1}$.

On site measurements and computer modelling will be used to evaluate the thermal impact of discharge on the chosen site (see Chapter 12 of the PCER).

4.2. RATE OF DISCHARGE

The water discharge rate is the same as the abstraction flowrate. In the case of the Flamanville 3 EPR the maximum discharge flowrate is 67 $m^3 s^{-1}$, and the water speed at the diffuser level is typically around 4 $m s^{-1}$.

Therefore the specific location of the discharge point and the local seabed, fauna and flora will be taken into consideration (at the site specific stage) during the design of the discharge and its infrastructure.

5. PRODUCTION AND DISCHARGE OF LIQUID EFFLUENT

More details on the liquid treatment and discharge systems, above that presented in the sections below may be found in Chapter 6 of the PCER.

5.1. TYPES OF LIQUID EFFLUENT

The operation of the EPR generates liquid effluent linked to the process itself, i.e. the conditioning and maintenance of the circuits, leaks and maintenance of the premises and the site area.

The liquid effluent may be divided into two types:

- liquid radioactive effluent containing chemicals from the reactor process, which is treated, stored and monitored before discharge;
- non radioactive liquid effluent from the conventional part of the unit, which includes sewage from the site, mainly comprises of:
    - freshwater and/or seawater demineralisation process;
    - seawater chlorination and/or sodium hypochlorite production;
    - effluent from biological fouling treatments (seawater chlorination);
    - water collected from rainwater drains and black and grey wastewater (effluent from the Purification Stations);
    - water contaminated with oil and water from the processes collected in the Turbine Hall.

This section provides estimates of what these discharges are likely to be for an UK EPR, although the actual amount of discharges also depends on the management by the operator of the liquid treatment and discharge systems, and of the way the demineralised water is produced.

5.2. LIQUID RADIOACTIVE DISCHARGE

5.2.1. Origin of activity

Radioactivity in liquid effluent is the result of:

- corrosion of the steam generator tubes, giving rise to activated corrosion products;
- activation of chemical species in the primary coolant; and
- leaks of volatile fission product from non-leaktight fuel assemblies (defects in the cladding).

5.2.2. Collecting, treating and storing radioactive liquid effluent

As shown in Sub-chapter 3.4 - Figure 1, there are three categories of radioactive liquid effluent to be processed.

- Primary liquid effluent

  This comprises liquid leaked or drained from the primary coolant water, not chemically polluted, and water from circuits containing the primary coolant, discharged when the concentration of boric acid in the primary water changes.

- Spent liquid effluent

  This comprises three kinds of drained liquid:

  - process drains from polluted primary coolant drained or leaked from equipment after flushing;
  - chemical effluent or drains produced in the Nuclear Auxiliary Building which are more polluted than process drains; and
  - floor drains from leaks and floor washing in different rooms.

- Drainage water from the Turbine Hall

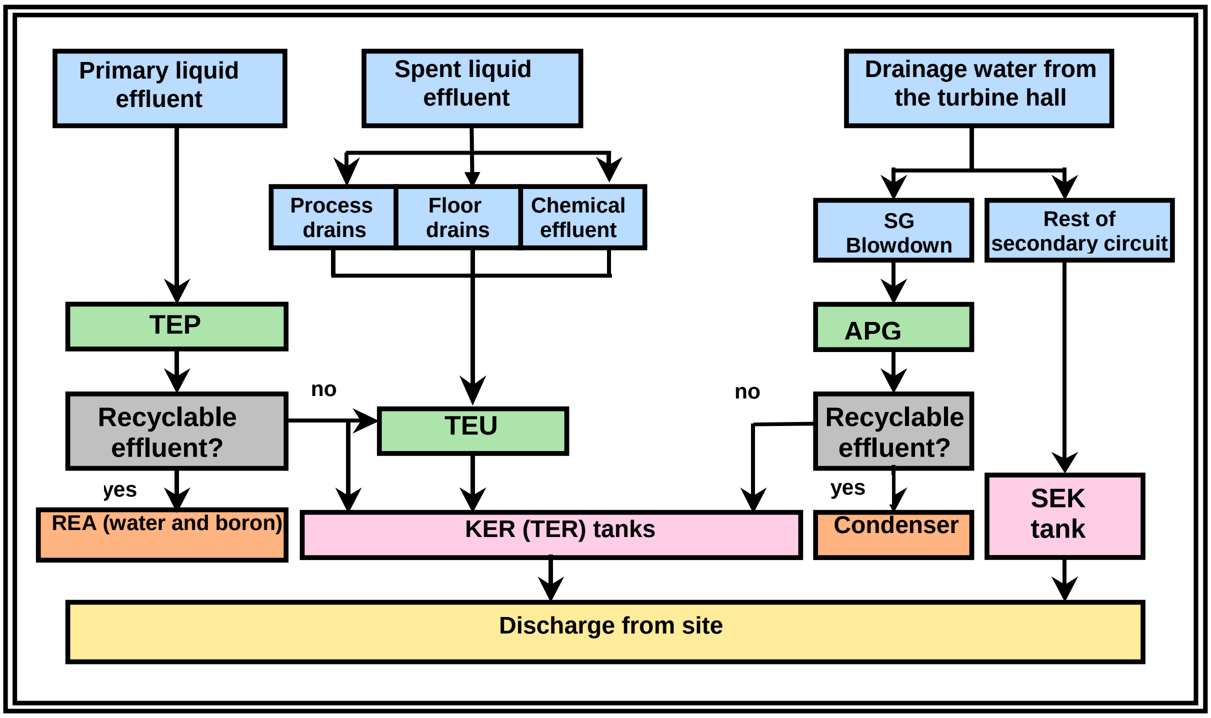
  The sources are:

  - blowdown water from the steam generators;
  - water drained from the Turbine Hall coming from leakage; and
  - effluent from draining and emptying the secondary circuit.

The systems and equipments, used to treat and store radioactive liquid effluent (filters, demineralisers, evaporators, degassers and tanks) help limit the radioactivity, which is eventually released into the environment when discharged into the sea.

Discharges from the tanks into the sea are performed in a monitored way, as described in Chapter 7 of the PCER.

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



5.2.3. Liquid radioactive effluent discharge

After storage in tanks, liquid radioactive effluent is discharged into sea. The discharged radionuclides belong to one of the following four groups:

- tritium;
- carbon-14;
- iodine isotopes; and
- other fission or activation products.

For each of these groups, Sub-chapter 3.4 - Table 1 shows the expected performance (realistic assessment excluding contingency) and maximum estimated discharge (including a margin to allow for normal operating contingencies).

5.2.4. Expected performances and maximum discharges

Sub-chapter 3.4 - Table 1 below presents the expected performance (excluding contingencies) in terms of radioactive liquid discharge, estimated from current French units OEF and taking into account the improvements brought to the PWR process by the EPR design.

The second column presents the estimated maximum discharge of radioactive liquids from the EPR Unit including normal operating contingency, and is intended to cover all foreseeable situations that are likely to be encountered in the Unit during normal operation.

Sub-chapter 3.4 - Table 1: Expected annual performance (excluding contingency) for liquid radioactive discharge & Maximum annual liquid radioactive discharge

Category of radionuclides	Expected annual performance (excluding contingency) for liquid radioactive discharge (GBq)	Maximum annual liquid radioactive discharge (GBq)
Tritium	52,000	75,000
Carbon-14	23	95
Iodine isotope	0.007	0.05
Other fission or activation products emitting beta or gamma radiation	0.6	10

Note that International experience shows the absence of negative impacts of zinc acetate injection on carbon-14 production (see PCSR Sub-chapter 5.5 and [Ref-1]).

The distribution of the expected overall activity of 0.6 GBq (maximum 10 GBq) between the different radionuclides in “Other fission or activation products” is presented in Sub-chapter 3.4 - Table 2. It has been determined using the averaged discharges from all 1300 MW(e) French PWR units, calculated over the period 2002-2004. The 1300 MW(e) category has been chosen as the reference, since information about it is readily available, and its design is close to that of the EPR (though the EPR is expected to show improvements in a number of respects).

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

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

5.3. CHEMICALS ASSOCIATED WITH RADIOACTIVE DISCHARGE

This section discusses the chemicals associated with liquid radioactive discharge that are released into the marine environment.

It gives the purpose of each substance and the proposed maximum amounts discharged. The systems used to treat and discharge these chemicals are the same as for radioactive effluent; and are described in Chapter 6 of the PCER.

5.3.1. Source of discharges

The chemicals associated with liquid radioactive effluent derive from various lay-up processes within the primary circuit, the secondary circuit and the nuclear and conventional auxiliary circuits. For various operational and maintenance reasons, the chemicals cannot be retained within those systems. PCSR Sub-chapter 5.5 provides details about the conditioning of the different circuits.

5.3.1.1. Lay-up in the primary circuit

The primary circuit is conditioned with:

- boric acid for its neutron-absorbing properties;
- lithium hydroxide to offset the acidity of the boric acid, to keep the pH slightly alkaline and prevent equipment corrosion;
- zinc acetate to reduce the material corrosion and replace the cobalt of oxides deposited on ex-core surfaces;
- hydrogen peroxide during shutdown in order to favour the dissolution of corrosion products and increase their removal via the demineralisers; and
- hydrazine during shutdown and start-up in order to eliminate the oxygen.

5.3.1.2. Lay-up in the secondary circuit

In order to obtain a pH where minimum levels of corrosion occur, a basic compound must be injected into the secondary circuit. Compounds used for this lay-up include ammonia, morpholine and/or ethanolamine, each having its advantages and drawbacks.

Lay-up is supplemented with hydrazine to eliminate oxygen in the feedwater and to prevent fouling of the steam generators caused by corrosion products (mainly iron oxides). Hydrazine decomposes when heated to produce ammonia.

Whichever lay-up compound is used to maintain the pH for minimum corrosion, ammonia is always present in the secondary circuit:

- where the conditioning uses ammonia, the quantity of ammonia produced by the decomposition of hydrazine is not sufficient to maintain the pH for minimum corrosion, and it is therefore supplemented; and

- where the conditioning uses morpholine or ethanolamine, the thermal decomposition of hydrazine means that ammonia is present in the secondary circuit. Ammonia can also be added to ethanolamine if needed.

5.3.1.3. Lay-up of the secondary circuit during shutdown

The feedwater plant for the secondary circuit is kept dry during shutdown.

The steam generators are potentially treated during shutdown with:

- hydrazine; and
- morpholine, ammonia and/or ethanolamine .

5.3.1.4. Lay-up in the nuclear and conventional auxiliary circuits

Trisodium phosphate is used for the lay-up in the cooling and heating circuits. This type of compound is used to inhibit corrosion in circuits in contact with air, where an all-volatile treatment cannot be used. It may be discharged into the environment during the plant operation.

5.3.1.5. Laundry

Detergents are used in the laundry to clean the working clothes. The detergents are sent together with the water that can be contaminated to the T (0KER [LRMDS]) tanks.

The detergents used in the EPR will be biodegradable commercial products, from which EDTA (Ethylene Diamine Tetra-acetic Acid) and phosphates will be absent.

5.3.1.6. Wear in the circuits

Metals arising from wear in the circuits are found in the discharged liquids associated with radioactive effluent. These metals are those used to manufacture either the circuits or some of the equipment (aluminium, copper, chromium, iron, manganese, nickel, zinc, copper, aluminium and lead). Proper chemical conditioning is a major factor in limiting the amount produced. Although the effluent is filtered and treated with ion-exchange resins, small quantities of these metals are found in the discharge tanks.

Suspended solids come largely from collected effluent that may be polluted either by dust or by the raw water used to cool overheated effluent from the auxiliary installations in the secondary circuit. There are only limited suspended solids in the T (0KER [LRMDS]) storage tanks, because the effluent is filtered.

The Chemical Oxygen Demand (COD) comes from most of the organic compounds (particularly detergents) and also from oxidisable mineral salts in the water analysed.

5.3.2. Amount of discharges expected

The maximum values of the additional annual flux of chemical discharges are determined to enable:

- the conditioning policies required by the circuits chemical specifications;

- the installations to operate normally, and under the transient conditions that are inherent to normal operation; and
- limitation of the discharges and their impact.

Sub-chapter 3.4 - Table 3 presents the discharges of chemicals associated with radioactive effluent, for both realistic values corresponding to the expected performance (excluding significant contingency) and maximum values that are intended to cover the amounts of chemicals discharged in all the foreseeable situations; that are likely to be encountered during normal operation.

The impact of zinc acetate injection is considered negligible on liquid chemical discharges (see PCSR Sub-chapter 5.5 and [Ref-1]).

Sub-chapter 3.4 - Table 3: Expected performance excluding contingency and maximum annual additional discharge for chemicals associated with radioactive effluent

Chemicals	Expected performance excluding contingency (kg)	Maximum additional annual discharge (kg)
Boric acid (H_3BO_3)	2000	7000
Lithium hydroxide (LiOH)	Less than 1	4.4
Hydrazine (N_2H_4)	7	14
Morpholine (C_4H_9ON)	345	840
Ethanolamine (C_2H_7ON)	250	460
Nitrogen (expressed as N) excluding hydrazine, morpholine and ethanolamine	2530	5060
Phosphate (PO_4^{3-})	155	400
Detergents	630	1600
Metals	16	27.5
Suspended solids	655	1400
COD	1490	2525

Sub-chapter 3.4 - Table 3 may be complemented by the following comments:

- Boric acid: the proposed treatment of the primary water facilitates greater recycling. The use of boron enriched with boron-10 significantly reduces discharge in normal circumstances;
- Morpholine: forms ethanolamine by thermal decomposition. This in turn decomposes in a series of reactions, which finally forms glycolates, formiates, acetates and oxalates. The estimated maximum annual amount discharged for each of these substances is given in Sub-chapter 3.4 - Table 4.

Sub-chapter 3.4 - Table 4: Annual flux of the degradation products of morpholine and ethanolamine (in kg)

	Acetates	Formiates	Glycolates	Oxalates
Annual amount	1.53	1.9	0.19	0.127

- Nitrogen: nitrogen (excluding hydrazine, morpholine and ethanolamine) in the secondary circuit water is present only in the form of ammonium ions. When collected in the sumps and transferred to the storage tanks, it may be converted into nitrates (or possibly nitrites) on contact with atmospheric oxygen. In the environment, it is stable in the form of nitrates;

- The sodium level associated with phosphates is not specified because the discharge environment is seawater: Sodium is discharged in concentrations that are negligible compared with the concentration in the receiving environment;

- The discharge of detergents, metals, suspended solids and COD is estimated using the values from existing 1300 MW(e) PWR units;

- The distribution of all metals in the T (0KER [LRMDS]) and Ex (0SEK [SiteLWDS]) tanks storing the effluent for existing 1300 MW(e) PWR units, is as follows (Sub-chapter 3.4 - Table 5):

Sub-chapter 3.4 - Table 5: Typical distribution spectrum for all metals

Al	Cu	Cr	Fe	Mn	Ni	Pb	Zn
8.95%	0.70%	14.10%	59.30%	5.60%	0.75%	0.50%	10.10%

5.4. CHEMICALS NOT ASSOCIATED WITH RADIOACTIVE DISCHARGE

5.4.1. Source of chemical effluent and treatment

Chemicals not associated with radioactive discharge originate from the conventional parts of the site, mainly:

- discharge from demineralised water production (either from a demineralisation plant or a desalination unit);

- discharge from biological fouling treatments (seawater chlorination);

- water collected from rainwater drains and black and grey wastewater (effluent from the purification unit); and

- oily water and industrial water collected in the Turbine Hall.

5.4.1.1. Substances produced from pits in a demineralisation plant

Discharges from the process carried out in a demineralisation plant for production of freshwater pumped from a river of groundwaters contains:

- Iron: this may be naturally present in the freshwater pumped from the river, but is mainly introduced in the form of ferric chloride into the settler (coagulation reagent). Most of the iron precipitates during the coagulation and flocculation that form part of the preliminary treatment of the raw water. It is found mostly in the liquid slurry from the settler or in the washing water for the sand filters;

- Suspended solids: this is slurry from the Demineralisation Station and suspended solids released when the filters are washed;

- Sulphates: these are introduced when the resins are regenerated with sulphuric acid or when basic effluent is neutralised with sulphuric acid in the neutralisation pit;

- Sodium: this is introduced at three stages:

    - during injection with sodium hypochlorite (bleach) at the outlet from the freshwater storage ponds;

    - when the resins are regenerated with sodium hydroxide; and

    - when effluent is treated with sodium hydroxide in the neutralisation pit; and

- Chlorides: they are introduced when ferric chloride and sodium hypochlorite are injected into raw water.

5.4.1.2. Substances produced from a desalination unit

Similarly a desalination unit produces the following discharges:

- Iron: this is introduced as ferric chloride at the input to the filtration stage. Most of the iron precipitates during the coagulation and flocculation that form part of the preliminary treatment of the seawater. It is therefore found mostly in the discharge from the filtration unit;

- Sodium: this comes from the sodium hypochlorite (NaClO) and sodium hydroxide used to clean the ultrafiltration membranes, and also from sodium metabisulphite injected to reduce the chlorine and oxygen in the water. It is also a product of resins regeneration in the mixed-bed exchanger. At last it is produced when effluent from the resins regenerating mixed-bed is treated with sodium hydroxide in the neutralisation pit;

- Sulphates: these come from the sulphuric acid used to clean the ultrafiltration membranes and prevent them scaling, and also from regenerating the resins in the mixed-bed exchanger;

- Dispersants: these are products injected to prevent the precipitation of compounds such as calcium carbonate ($CaCO_3$) or calcium sulphate ($CaSO_4$);

- Chlorides: they are introduced as ferric chloride into the process and are also present in the concentrates discharged from the desalination unit;

- Detergents: these are used to clean membranes; and
- Brine: this comes from the seawater.

Note: The type of dispersant depends on which osmosis membrane is used, and can only be known when the specific desalination unit is purchased.

5.4.1.3. Discharge from fouling treatments (seawater chlorination)

The cooling circuits are protected against the development of biofilm and biological fouling through seawater chlorination. Chlorination is carried out as soon as the temperature of the seawater is above 10°C.

Electrolysis is used to produce sodium hypochlorite from seawater.

The process involves discharging both residual oxidants into the sea (both in the free state and as chlorine compounds) and trihalomethanes (as bromoform). Chlorides from cleaning the processing equipment are also discharged into the sea.

5.4.1.4. Discharge collected by the sewage system

The sewage system typically collects:

- rainwater collected over the site;
- black and grey wastewater from lavatories, after treatment in the purification systems and standalone treatment facilities. Chemicals discharged are defined by their BOD_5 (Five-day Biological Oxygen Demand);
- water used in production, which is unpolluted with hydrocarbons or has been de-oiled (i.e. collected by the SEH network and treated using an oil separator); and
- effluent from the demineralisation unit or the desalination unit.

5.4.1.5. Discharge containing oil and hydrocarbons

Water collected in the unit and that could contain oil (transformers, Turbine Hall, oil and grease store and storage areas that might be contaminated with hydrocarbons) is sent to the plant SEH network. This network has a trap that separates out oil and slurry before the outlet towards which the rainwater drains, which limits the amount of hydrocarbons discharged into the sea.

In addition, a by-pass plugged to the main header of the Unit SEO network allows the collection of polluted water (water from fires, or accidentally polluted with chemicals) into a retention area; the latter has an inspection hole allowing the chemical properties of the water to be analysed. This water will either be treated on site, as far as possible, or evacuated to a processing unit, using a mobile device.

The EPR design is such that no phosphates or nitrogenous substances (such as morpholine or ethanolamine) should be discharged into the sewage system.

5.4.2. Final liquid discharge into the sea

The discharge outlet to the sea is site specific. As an example, on the Flamanville site there are different discharge routes:

- into the water intake channel, via three ‘secondary’ discharge outfalls for:
  - effluent from the Demineralisation Station (including that from the neutralisation pit);
  - some of the water collected from rainwater drains and black and grey wastewater; and
  - water which has been polluted by oil, after de-oiling.
- at the sea line, via three discharge outfalls, for some of the rainwater drains and black and grey wastewater;
- at some distance from the coast, via the discharge tunnel, with the cooling water, for:
  - discharge associated with seawater chlorination; and
  - chemicals discharged into the water intake channel, after they have been recirculated through the Pumping Station and mixed with the circulated water.

5.4.3. Amounts of chemicals discharged

5.4.3.1. Chemical effluent from the production of demineralised water

The demineralisation water is produced either by a demineralisation plant or a desalination unit, this being a site specific issue. The process leads to discharge of iron, suspended solids, chlorides, sodium, sulphates, detergents and brine.

Sub-chapter 3.4 - Table 6 presents, as an order of magnitude, the maximum amounts of discharged chemicals that have been estimated for the Flamanville 3 EPR Unit, where the demineralised water is produced by a demineralisation plant 40 days per year, and by a desalination unit the rest of the time.

Sub-chapter 3.4 - Table 6: Maximum amounts discharged during the production of demineralised water for the EPR Unit

Substances	Annual flux (kg)
Suspended solid	1621
Iron	848
Chlorides	3616
Sulphates	11,725
Sodium	13,523
Detergents	312

Brine is discharged into the intake channel at a rate of 150 m^3 h^{-1} at a concentration of 70 g l^{-1}.

5.4.3.2. Discharge of black and grey wastewater, water in contact with oil and rainwater

Chemicals discharged into the sea from the sewage network are previously treated in a Purification Station. This treatment ensures that the BOD_5 (Five-day Biological Oxygen Demand) of the discharged effluent is less than 35 mg l^{-1}.

Wastewater that could contain hydrocarbons is treated in the on-site scrubbers and oil filters. The hydrocarbon concentration in the discharged water is below 5 mg l^{-1}.

5.4.3.3. Effluent from fouling treatments (seawater chlorination)

- Normal chlorination: the standard processing method is chlorination using a concentration of 0.5 mg l^{-1} of active chlorine. Injection is sequential, once every 30 minutes per cooling channel.

- Exceptional cases: a change to the water quality may cause excessive biological fouling, requiring exceptional chlorination at 1 mg l^{-1} (10 days each year per unit, non consecutive) to treat the various sections of the service water circuits.

In addition, shock chlorination at 6 mg l^{-1} may be applied to the SEN, SEC [ESWS], and SRU [UCWS] circuits, which have piping taking top-up water from the Pumping Station, with a number of dead areas, which are highly likely to develop biological fouling.

Realistic values for the expected discharge from the EPR Unit, based on the experience of the existing units, are shown in Sub-chapter 3.4 - Table 7.

Sub-chapter 3.4 - Table 7: Expected performance excluding contingencies for the chemicals from electrochlorination

	Realistic concentration in the discharge pond (mg l^{-1})	
	Residual oxidants	**Bromoform**
Chlorination	0.14	0.0027

The estimated discharge from treating circuits against biological fouling is as follows (Sub-chapter 3.4 - Table 8).

Sub-chapter 3.4 - Table 8: Oxidant and bromoform discharge from the EPR Unit

	Maximum concentration in the discharge pond (mg l^{-1})	
	Residual oxidants	**Bromoform**
Normal chlorination	0.5	0.02
Exceptional chlorination, at 1 mg l^{-1}	1	0.04
Shock chlorination, at 6 mg l^{-1}	0.72	0.0244

The annual mass of discharged chlorides is estimated at 2600 kg.

5.4.4. Consent for discharge

The discharge of non radiological chemicals to the marine environment of an UK EPR would be undertaken under consent obtained from the relevant regulatory authority. The consents would regulate temperature, composition and flow discharges. Limits are to be agreed with the Environment Agency, after a priority assessment has been carried out. The assessment is presented in Chapter 12 of the PCER.

6. DREDGING

Depending on the site underwater conditions and the water intake system design, dredging may be necessary to remove silting to facilitate the pumping of the raw water for cooling. The dredged material and the discharged substances must be disposed of.

As an example for Flamanville, bathymetric surveys are used to determine when the intake channel requires dredging to remove silting, to facilitate the pumping of the raw water for cooling. About 20,000 m^3 of substances are discharged every three to five years.

For each dredging site, the necessary permits and authorisations will be obtained, in accordance with the relevant UK regulations.

SUB-CHAPTER 3.4 – 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.

[Ref-1] Zinc Injection claims, arguments and evidences: overall balance for UK-EPR. ECEF110139. Revision A. EDF. March 2011 (E)