The Sizewell C Project

6.3 Volume 2 Main Development Site
Chapter 4 Description of Operation

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Contents

Tables

None provided.

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Figures

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Appendices

4. Operation of Permanent Development

4.1 Introduction

4.1.1 This chapter of the **Environmental Statement** (**ES**) presents a description of the commissioning and operation of the Sizewell C nuclear power station. Unit 1 of the UK European Pressurised Reactors (EPR^{TM}) is scheduled to commence 12 months earlier than Unit 2 (refer to **Figure 2.2** of this volume for the location of the units). A summary of the process of electricity generation is presented together with a description of the sources and characteristics of liquid discharges and gaseous emissions during normal operation and plant commissioning.

4.1.2 Furthermore, this chapter provides details of the operational assumptions made for any other permanent development within the main development site, such as the Beach Landing Facility (BLF) and Sizewell B relocated facilities. The anticipated workforce and visitor profile during the operational phase are also described.

4.1.3 In addition, a summary of the proposed operational environmental and safety management systems and security arrangements for the Sizewell C nuclear power station have been provided.

4.1.4 This chapter is supported by the following appendices:

- **Appendix 4A:** Operational noise sources.
- **Appendix 4B:** Operational liquid discharges.
- **Appendix 4C:** Operational gaseous emissions.

4.1.5 A description of spent fuel and radioactive waste management during the operation of the Sizewell C nuclear power station is provided in **Chapter 7** of this volume, and a description of conventional waste management is provided in **Chapter 8** of this volume. A summary of emergency arrangements is provided in **Chapter 27** of this volume.

4.2 Electricity generation

4.2.1 Electricity would be generated at the Sizewell C nuclear power station from heat energy produced from the two EPR^{TM} reactors. The heat would be used to raise steam which would power turbines to generate electricity. The expected net electrical output of Sizewell C would be approximately 1,670 megawatts (MW) per UK EPR^{TM} reactor unit, giving a total site capacity of approximately 3,340MW.

4.2.2 Electricity generated in the two turbine halls (one for each UK EPR^{TM} reactor) would be converted by transformers to high voltage (400 kilovolt (kV)), before being exported from the site. Electrical connections from the Sizewell C transformers would be made via overhead power lines from the main platform to a new National Grid 400kV sub-station, located adjacent to the existing Sizewell B sub-station. This would provide the connection from Sizewell C nuclear power station to the existing National Grid high voltage transmission system.

4.2.3 A summary of plant associated with the buildings on the main platform, which may generate noise during operation, and the assumptions made for the sound power levels, are included in **Appendix 4A** of this volume.

4.2.4 The Sizewell C nuclear power station would have an operational life of 60 years. Following the end of operation, a period of 25 years for decommissioning has been assumed for the purposes of the Environmental Impact Assessment (EIA). Once the reactor and other facilities have been decommissioned, the Interim Spent Fuel Store (ISFS) would remain on site to allow for a suitable length of cooling time for fuel prior to its disposal. Therefore, an additional 30 years has been assumed prior to the decommissioning of the ISFS. Further information on decommissioning, spent fuel and radioactive waste management is provided in **Chapter 5** and **Chapter 7** of this volume.

a) Heat energy generation

4.2.5 A UK EPR^{TM} reactor produces heat from nuclear fission which takes place in the reactor core. The core is contained within a thick-walled steel pressure vessel which is approximately 10 metres (m) high and 5.5m in diameter. Diverse systems are installed for the safe shutdown of the reactor in the event of any faults.

4.2.6 Within the core of each UK EPR^{TM} reactor, there would be 241 fuel assemblies each containing a 17 by 17 array of fuel rods comprising uranium dioxide pellets in a sealed cladding tube. The uranium is enriched in the fissile isotope Uranium-235 from its naturally occurring level. A fissile isotope is a radioactive form of an element that, when a neutron of a certain energy collides with it, its nucleus splits (“fissions”) into smaller fragments (“fission products”) and releases further neutrons together with energy. In a nuclear reactor, these neutrons are slowed down (“moderated”) to improve their ability to cause fission which results in a sustained chain reaction and the release of nuclear energy as heat.

4.2.7 The UK EPR^{TM} reactor design is such that once the fuel is loaded in the reactor core, the reactor can operate at full power continuously in a ‘fuel cycle’ of up to 18 months. Spent fuel removed from the reactor core would undergo several years of storage to cool in the pools inside the plant before transfer to the ISFS.

b) Operational energy use

4.2.8 Some of the energy produced by Sizewell C would be used on-site to provide power to plant and equipment (approximately 100MW per unit). An auxiliary connection would also be provided for Sizewell C to be able to use electricity from the grid, if needed, to shut down the units in both normal operating situations and if there is an accident. The auxiliary connection acts as a backup to the main connection if the latter fails.

4.2.9 In addition to the auxiliary connection to the grid, backup power supply to the units is also provided by on-site back-up diesel generators (Emergency Diesel Generators (EDGs) and Ultimate Diesel Generators (UDGs)) and dedicated batteries. **Section 4.6** of this chapter provides further information on emissions from the routine testing and maintenance of EDGs and UDGs.

4.2.10 There are no stacks within the main development site that emit a visible plume with the following exceptions: back-up diesel generators may emit a short duration of smoke upon start-up; and steam may occasionally be emitted through a silencer should a relief valve operate, which should rapidly diffuse.

c) Operational water use

4.2.11 Water use for the operation of Sizewell C would comprise seawater cooling water, freshwater for industrial systems, demineralisation plant and potable water for sanitary requirements. A description of the cooling water system is provided in **section 4.3** of this chapter.

4.2.12 Subject to SZC Co. obtaining formal agreement with Essex and Suffolk Water, freshwater for industrial systems, demineralisation plant and potable water would be provided via a connection to the mains water supply operated by Essex and Suffolk Water. Further information on the operational water supply options is provided in the **Planning Statement** (Doc Ref 8.4).

d) Refuelling and maintenance outages

4.2.13 During the 60-year operational life, each UK EPR™ reactor unit would undergo refuelling and maintenance shutdowns (otherwise known as 'outages') at approximately 18-month intervals per unit. The length of these outages would vary according to the maintenance and inspections required, but would typically be up to two months in duration and may require 24-hour working.

i. Refuelling outage

4.2.14 During each refuelling outage all fuel assemblies would be temporarily off-loaded into the fuel storage pool in the reactor building (one for each UK EPR^{TM} reactor). When returned to the core, a proportion of the fuel assemblies (normally a quarter to a third) would be replaced with new fuel. Thus, each fuel assembly would normally spend three 18-month cycles in the reactor before being replaced.

ii. Maintenance outage

4.2.15 Maintenance outages would include 'preventative maintenance', incorporating inspections, tests, repairs and replacements of equipment in order to ensure safety and comply with the Nuclear Site Licence and other regulatory requirements. The aim is to ensure that, throughout the installation's service life, the objectives of nuclear and industrial safety, environmental protection, and security are achieved. Maintenance outages would normally be undertaken in conjunction with refuelling outages. The length of the maintenance outage would vary depending on the scope of work required.

e) Commissioning

4.2.16 Prior to full operation, commissioning tests would be undertaken to demonstrate that the Sizewell C nuclear power station is capable of performing in accordance with its design specification and safety and environmental requirements.

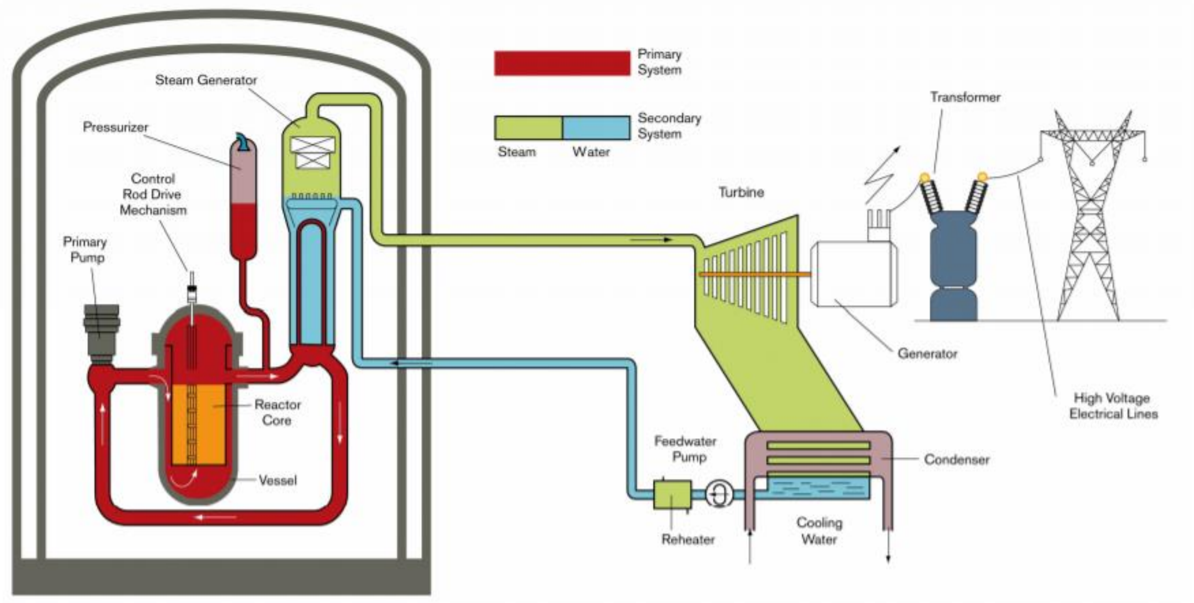
4.2.17 Commissioning activities at Sizewell C nuclear power station are anticipated to commence during the construction phase and continue until both of the UK EPR^{TM} reactor units are operational.

4.2.18 Commissioning is predicted to take approximately three years for each UK EPR^{TM} reactor unit and approximately five years in total (due to overlapping commissioning periods). Commissioning would include liquid and gaseous emissions from the start up and testing of equipment, as described in **sections 4.5** and **4.7** of this chapter.

4.3 Operation of cooling systems

4.3.1 Within the UK EPR^{TM} reactors at Sizewell C nuclear power station, the cooling water infrastructure is formed of three cooling systems, comprising primary, secondary and open circuit systems. These are shown schematically in **Plate 4.1**. A summary of the parameters associated with the cooling water infrastructure proposed at Sizewell C is provided in **Chapter 2** of this volume.

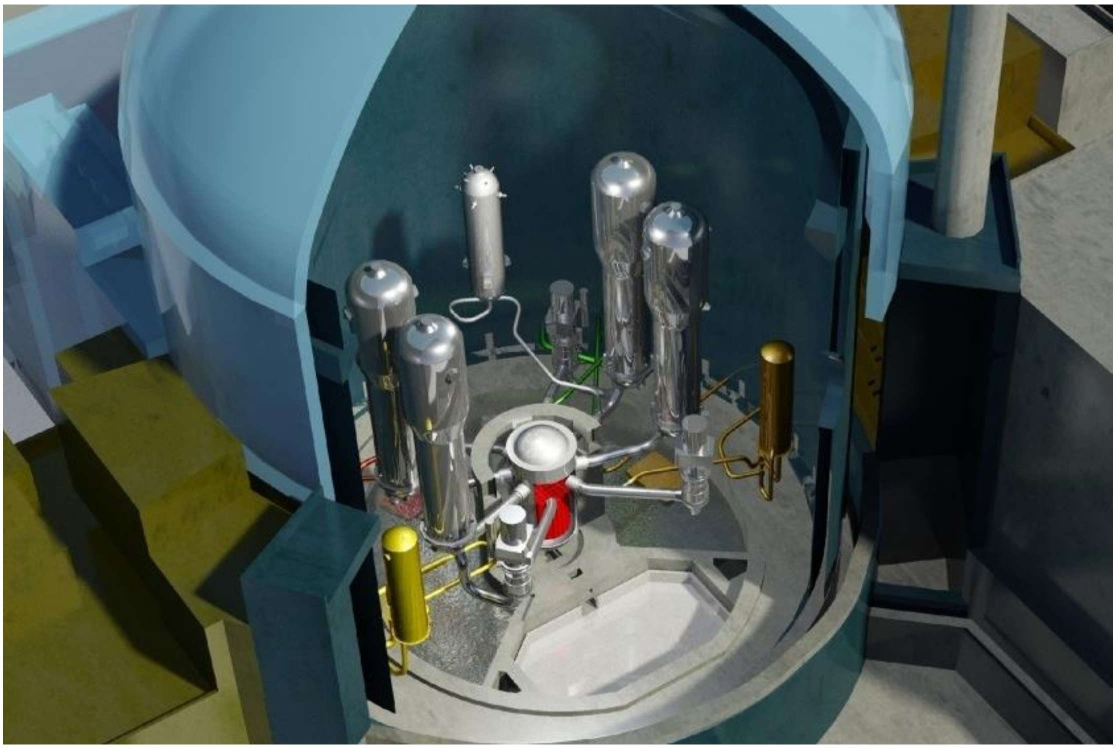
Plate 4.1: Schematic illustration of the functioning of the UK EPR™ reactor.



a) Primary system

4.3.2 The primary system, housed in the reactor building, is a closed water-filled pressurised system which enables the heat produced by the nuclear fission reaction inside the fuel assemblies in the reactor core to be extracted. The system comprises the reactor pressure vessel and four separate cooling loops, each containing a reactor coolant pump and steam generator, as shown on **Plate 4.2**.

Plate 4.2: Schematic illustration of the UK EPR™ reactor building.



4.3.3 The high-pressure conditions of the system, which are controlled by a single pressuriser, prevent the cooling water from boiling even though the temperature of the water is around 330ºC. The water within the system, which is heated by the fission occurring in the reactor, passes through tubes within the steam generators. These act as heat exchangers whereby heat is transferred through the tube walls into the water of the separate secondary system which flows outside and between the tubes. The primary coolant water, having passed through the steam generators is then pumped back to the reactor vessel. The metal cladding of the fuel assemblies, the reactor vessel and primary circuit, and the containment building all form barriers to the potential release of radioactivity.

4.3.4 The water in the primary circuit also slows down (moderates) the neutrons released in the nuclear fission process, which is necessary to sustain the fission reaction. Control is achieved by inserting control rods from the top of the reactor and through changing the concentration of boron in the primary coolant. Both the control rods and the boron absorb neutrons, and therefore reduce the rate of fission.

b) Secondary system

4.3.5 The secondary system is also closed, independent of the primary system and operates at a lower pressure. Consequently, when heated by the primary system in the steam generators, the water in the secondary system boils to produce saturated steam. This steam is first dried inside the steam generators and then delivered to the turbine halls (one turbine hall for each UK EPR™ reactor unit). Here it powers a large turbine rotating at 1,500 revolutions per minute. The turbine is coupled to the generator which produces electricity. After leaving the turbine, the steam is cooled and condensed back to liquid water in the condenser. It is then returned as feedwater to the steam generators.

c) Open circuit system

4.3.6 The open circuit cooling system would be independent of the primary and secondary systems and would draw water directly from the sea. It would absorb heat from the secondary system in the condensers and other parallel heat exchanger systems and, after a single passage through these systems, the now heated water would then be discharged back to the sea.

4.3.7 Sea water would be supplied to the site through the two offshore intake tunnels, each of which would have two seabed mounted intake heads. Each tunnel would be designed to abstract sea water at a rate of approximately 66m^3/second. The flow rate would, in practice, vary according to the tidal state.

4.3.8 At its onshore end, each intake tunnel would feed directly into a forebay (one for each UK EPR™ reactor unit). The intake cooling water would contain suspended solids, which may accumulate to some extent in the forebays. Whilst the forebay is designed to minimise the build-up of silt, it is common practice in the UK power industry at coastal sites to undertake periodic desilting of the forebays. Should desilting be required at Sizewell C nuclear power station, the preferred option would be to return the sediment to the cooling water system for discharge back to the North Sea.

4.3.9 On exiting the forebay to enter the cooling water pumphouse, the seawater would first pass through coarse raking screens to remove large pieces of debris and prevent them from damaging the fine filtration screens in the cooling water pumphouse, prior to being transferred to the filtering debris recovery pit. Once in the cooling water pumphouse, the seawater would pass through the fine filtration system, comprising rotating drum and band screens in order to prevent the blockage of key elements of plant further downstream, primarily the main condensers and other allied heat exchangers. These screens would capture fish, other marine organisms and remaining debris such as seaweed (‘stormwrack’) and marine litter. These various materials would then be washed into gutters by continuous wash water systems and channelled to the filtering debris recovery pit. From there, after passing through another very coarse raking screen to prevent debris blocking the exit, they would be returned to the sea via a dedicated Fish Recovery and Return (FRR) tunnel (one for each UK EPR^{TM} reactor unit) under the shore and seabed to emerge sub-tidally.

4.3.10 The screened cooling water from the cooling water pumphouse would then pass through underground pipes to the turbine hall and nuclear island. The cooling water pipework would be divided between different galleries based on the segregation requirements of the safety systems. Once the cooling water has served its heat removal function and passed through the condensers or other heat exchangers, it would then be returned to the sea via two outfall ponds (also referred to as 'surge chambers'). As with the open forebays the open outfall ponds allow for rapid changes in water level associated with cooling water pumps being switched on or off and thus limit the pressure impacts on the plant itself. The outfall ponds would also receive treated waste water and effluents from the different systems of the Sizewell C power station, after any treatment that may be required has been completed.

4.3.11 An onshore discharge gallery would carry the water from each outfall pond towards the head of the cooling water discharge shaft, where the flows converge and enter the single outfall tunnel which would extend approximately 3.5 kilometres (km) offshore. The warmed seawater would be discharged offshore via two outfall structures or 'headworks', which would be located at the offshore end of the outfall tunnel. The two outfall structures would discharge the cooling water at approximately the same depth but the buoyancy of the warmed seawater would very quickly lift the effluent to the sea surface, forming a thermally buoyant, largely superficial and tidally oscillating plume separated from the cooler waters beneath. Heat loss to atmosphere would constrain the size of that resultant plume.

4.4 Operational liquid discharges

4.4.1 All operational liquid effluents would be discharged to the sea via the outfall ponds and the cooling water outfall infrastructure, aside from the seawater volumes associated with the FRR systems, which would use two dedicated discharge lines to the sea. All operational liquid discharges, including from the outfall and FRR tunnels, would be the subject of a Water Discharge Activities Permit and a Radioactive Substances Regulations (RSR) Permit (where relevant) from the Environment Agency under the Environmental Permitting (England and Wales) Regulations 2016 (as amended). In line with the environmental permit requirements, Best Available Techniques have been applied to prevent and minimise emissions and impacts on the environment from the water discharges.

4.4.2 Sources and characteristics of liquid effluents which would be generated and discharged with the cooling water are described in the following sections and details are presented in **Appendix 4B**.

a) 'Open circuit' cooling water

4.4.3 Heat transfer efficiencies associated with the steam cycle would mean that at full operating load the cooling water would be discharged at an average of approximately 11.6°C above the intake water temperature, and that the combined cooling water volume for both UK EPR™ reactor units would be approximately 132m^3/s at mid tide level, and will vary between 125–140 m^3/s. In practice, both the temperature and volume would vary tidally due to the variable load on the cooling water pumps themselves; where pumping rates are reduced towards higher tidal levels, there would be a corresponding increase in discharge temperature.

4.4.4 In addition to the substances associated with the effluents described in the following sections, the returned cooling water discharged via the outfall would, often, also contain residual biocides arising from low-level chlorination of that cooling water stream. Due to the variance in the distribution and potential ability of marine organisms to foul a cooling water system around the UK coast, the normal practice is to develop a site-specific chlorination strategy reflecting local experience, and a knowledge of the local ecology. The site is known to be associated with a high risk of biological fouling from experience at Sizewell A and B stations, so an appropriate strategy has been developed.

4.4.5 Low level chlorination is the most commonly used and effective means of preventing untoward biological growth within cooling water circuits. The biocide may be introduced either in the form of sodium hypochlorite solution, or produced in situ by electrolysis of seawater, in order to maintain a Total Residual Oxidant (TRO) level of 0.2 milligram per litre (mg/litre) within critical land-based plant (condensers and essential cooling water systems) all year round. The point of chlorination would be downstream of the drum screens, so that no chlorination of the FRR tunnels occurs. Chlorination would only be undertaken when sea water temperatures are above 10ºC (i.e. typically only during the warmer months), and therefore the risk of biofouling is greater. However, if required, spot dosing at lower temperatures may also be undertaken.

b) Production of demineralised water

4.4.6 The primary and secondary circuits would both require a feed of fresh demineralised water. Demineralised water would be produced from mains water using a combination of membrane technology and ion exchange resins. This process would be undertaken in the demineralisation plant and would generate effluents characterised by either high acidity or alkalinity as a result of the use of sulphuric acid and sodium hydroxide to regenerate the resins. Batch treatment of these effluents using acids and alkalis would result in a neutral pH.

4.4.7 No further treatment of demineralisation effluents is proposed and the discharge would contain dissolved solids removed from the mains water as well as substances, such as sulphates, sodium and chlorides.

c) Primary cooling system and other liquid effluents

4.4.8 Increases in the boron concentration for controlling fission in the reactor core would be achieved by dosing the primary coolant with boric acid. To counteract any changes in pH, the primary coolant would also be dosed with small amounts of lithium hydroxide. Decreases in the boron concentration would be achieved by topping up the primary coolant with low concentration borated water and releasing primary coolant to a coolant storage and treatment system.

4.4.9 There are a number of corrosion products that would be associated with the primary circuit including iron, nickel, cobalt, chromium, manganese, antimony and silver. These corrosion products would be minimised at source through the careful selection of materials used in fabricating the reactor systems and the components that would be in contact with the primary coolant. Corrosion products can become activated by neutrons as they pass through the reactor in the primary circuit. Treatment prior to discharge would be undertaken to minimise the amount of corrosion products discharged.

4.4.10 A number of further radioactive elements may be generated in the primary coolant by activation or fission processes. Measures would be taken to minimise the generation of these radioactive elements at source. Once generated, abatement systems would be used to minimise the amount of radioactive effluent discharged. In addition to those materials arising from the primary circuit, radioactive effluents may also be generated from the fuel pool purification systems, the operation of a radioactive laundry facility (hot laundry building) and washings from plant decontamination. Techniques would be applied to minimise the amount of radioactivity produced. In each case, the plant would be designed and operated taking all reasonably practicable steps to minimise the generation and discharge of radioactive materials. **Chapter 7** of this volume provides further details of the liquid radioactive waste management strategy and mitigation embedded within design for the implementation of best available techniques. All radioactive discharges would be controlled under an environmental permit granted by the Environment Agency under the Environmental Permitting (England and Wales) Regulations 2016 (as amended).

4.4.11 In summary, there are three main systems which would remove contaminants from the water in the primary circuit and/or other sources of radioactive liquid effluents:

- Chemical and volume control system – this would maintain the chemistry of the primary coolant by taking some of the primary coolant, known as let-down, cleaning it and returning it back to the system. Water is treated by the use of ion exchange resins and filters. Boric acid and lithium chemistry can be modified, as required, to meet the prescribed conditions in the reactor. This system also provides volume control for the primary coolant and contains any leaks from reactor coolant pump seals.

- Coolant storage and treatment system – this treats the liquid effluent from the primary circuit. The purpose of treatment is that, as far as possible, the boron and water may be recycled through the primary reactor circuit. Treatment for recycling involves demineralisation by ion exchange resins and filtration, evaporation and degassing. The evaporator is used to recover the enriched boric acid for re-use within the reactor coolant system.

- Liquid waste processing system – this is designed to ensure optimisation of the management of effluents by enabling treatment through a variety of techniques, such as filtration, ion exchange and evaporation. The system allows effluents to be retreated and pass through different treatment technologies before being sampled and monitored and, if acceptable, discharged.

4.4.12 After treatment to reduce the radioactive content of the effluent, it is sampled and monitored prior to final discharge to the sea with the cooling water (see **Appendix 4B**).

d) Secondary cooling system

4.4.13 A small proportion of the condensed water is bled continuously from the secondary circuit and replaced with fresh demineralised water. This is to prevent saturation of the secondary circuit with dissolved salts and to prevent the formation of foams or solids in the system that would make it difficult to dry the steam before it enters the turbine, in order to prevent damage to the turbine. The water bled out of the system is known as ‘blowdown’ which is largely made up of demineralised feedwater.

4.4.14 The secondary circuit may also be dosed with hydrazine, morpholine and ethanolamine which would be added to prevent corrosion and control the pH in the secondary circuit.

4.4.15 Hydrazine would be added, as it is a very effective oxygen scavenger and therefore prevents corrosion associated with oxidation of metals in the secondary circuit (i.e. rusting). During shutdown, hydrazine may also be used to condition the steam generators.

4.4.16 The blowdown water from the steam generators would be processed and treated to remove non-radioactive corrosion products and dissolved salts before the water is recycled in the secondary circuit. Treatment involves filtration and the use of ion exchange resins.

4.4.17 As with the primary system, the non-recyclable blowdown effluent would be transferred to a separate system which monitors and further processes effluents where required, before discharge in the main cooling water outfall (refer to **Appendix 4B** for dosing assumptions and discharge concentrations).

e) Groundwater and surface water discharge

4.4.18 An operational phase drainage system would be implemented, including SuDS measures to intercept water, sediment and contaminants.

4.4.19 Rainfall falling onto the main platform would be managed through an engineered drainage system. Forecourt separators would be provided at all locations where fuel handling takes place.

4.4.20 At the western perimeter of the Sizewell C power station platform, a filter drain would be installed to capture surface water runoff and prevent direct discharge to Sizewell Drain.

4.4.21 The Sizewell C access road that passes over Goose Hill and is linked to the power station car park of 1,370 spaces would drain to the north, diverting runoff away from the Sizewell Marshes SSSI. Its design would be compliant with the Design Manual for Roads and Bridges. Drainage will be provided to collect surface water runoff from the road and discharge to the north where it will outfall into a swale and infiltrate to ground.

f) Oily water drainage system

4.4.22 There are a number of areas on the main platform, where oils or hydrocarbon fuels would be used and stored, including the following:

- back-up diesel generators;
- transformer compounds on the Sizewell C power transmission platform and National Grid substation;
- oil and grease store;
- oil and hydrocarbon fuel offloading areas; and
- workshops.

4.4.23 Each EDG building will be constructed to comprise a bund, with any spills captured in sumps and pumped out and disposed off-site at a licensed waste facility. There would be no direct connection to the surface water drainage system.

4.4.24 Drainage from the road and roof surface and minimal uncontaminated atmospheric condensate from the chillers would flow to bypass separators, whilst drainage from the remainder of the oily water network would flow first to full retention oil/water separators, and then combine with the road and roof drainage and chiller condensate in the bypass separators. Both bypass and full retention separators would be Class 1 separators (BS-EN-858) designed to achieve a discharge concentration of less than 5 mg/litre of oil. The oil would ultimately be pumped to a mobile container and disposed of off-site at an appropriately licensed waste management facility. The combined flow would then be transferred to the outfall pond.

g) Foul water or sanitary effluent

4.4.25 The on-site workforce would generate sanitary wastes which would be treated in a sewage treatment plant before being discharged to sea via the main cooling water system. The sewage treatment plant would be designed and sized to accommodate peak numbers of people on-site, for example during an outage, as well as operating effectively to treat effluent from the lower numbers of people expected during normal operations. The foul water drainage network would send effluent to the sewage treatment plant where it would be treated before being discharged to sea via the outfall pond.

4.4.26 The sewage system would typically collect black and grey wastewater from kitchens, lavatories and laundry rooms. After treatment in the sewage treatment plant, the discharge would typically be characterised by a relatively high biochemical oxygen demand, (a measure of the quantity of dissolved oxygen required to break down the residual organic material in the water) when compared to the other effluent streams generated at the site.

4.5 Commissioning – liquid discharges

4.5.1 The commissioning of the reactor units comprises two key phases including:

- Non-active commissioning, which would start with demonstration of equipment functionality and gradually build up to tests of the integrated function of the plant focusing on safety related systems and components. This stage includes hot functional testing, where the plant and equipment is put through its design envelope up to and including full temperature and pressure conditions, as far as practicable without nuclear fuel being in place. These tests are completed before fuel is loaded into the reactor, and therefore no radioactive effluents are generated as a result of these activities.

- Active commissioning which commences with fuel delivery and active commissioning of the reactor components (e.g. testing the fuel storage systems before fuel loading, loading of fuel into the reactor vessel, initial criticality and power ascension testing, where the reactor is progressively increased in power and operational and safety performance is verified). Unlike the non-active commissioning phase, some radioactive effluents are generated in this phase.

a) Non-active commissioning discharges

4.5.2 When considering discharges to sea, the non-active commissioning of Sizewell C can be broken down into two distinct phases, i.e. cold flush testing and hot functional testing.

i. Cold flush testing

4.5.3 Cold flush testing involves the cleaning and initial preparation of various plant components. The main activity in this phase is cold flushing of pipe work (using demineralised water) to remove surface deposits and residual debris from installation including rust.

4.5.4 The discharges from this phase would primarily comprise water containing suspended solids and iron oxide (rust) and small quantities of conditioning chemicals including:

- hydrogen peroxide;
- zinc acetate;
- lithium;
- boron;
- ammonia;
- ethanolamine;
- hydrazine; and
- phosphates.

4.5.5 For a worst-case assessment, it has been assumed that cooling water pumps would not have been commissioned in time to accommodate cold flush commissioning discharges, therefore the cooling water system would not be available as a discharge route of these effluents. The cooling water system would be static (no significant flow) and unsuitable for receiving effluent for discharge through the cooling water outfall. This means that discharges would be made via the Combined Drainage Outfall (CDO), following any necessary treatment to meet the relevant environmental permit limits at point of discharge.

4.5.6 The CDO route would be to sea via a dedicated outfall pipe that would run under the sea defences and intertidal shore to reach a seabed mounted outfall, approximately 400m offshore (refer to **Chapter 2**). Treatment would be provided, as appropriate, to meet the relevant environmental permit limits at point of discharge.

4.5.7 Cold flush testing would be staggered so that only one unit would undergo this activity at a time.

ii. Hot functional testing

4.5.8 Hot functional testing is a process whereby the UK EPR™ reactor is tested under high temperature and pressure prior to the loading of nuclear fuel into the reactor. The hot functional testing phase of commissioning begins following the successful completion of the cleaning/flushing and cold performance tests and when the required equipment and functional units, including the operational gallery are deemed to be available.

4.5.9 The chemical substances discharged during the hot functional testing phase of commissioning would be the same as those discharged during the normal operation of Sizewell C. There would not be any radioactive effluents produced during the hot functional testing phase of non-active commissioning. During the hot functional testing phase, the cooling water system would be operational and therefore, available to receive effluents and apply adequate dilution. Hot functional testing discharges are discharged via the offshore cooling water outfall and would have the necessary treatment to meet the relevant environmental permit limits at point of discharge.

4.5.10 Once the hot functional testing has been completed, the primary circuit must be fully drained prior to refuelling with borated water. The steam generators are then either drained and placed in dry lay-up or wet lay-up (depending on the duration of preservation required).

b) Active commissioning discharges

4.5.11 Active commissioning discharges would be the same as the operational liquid discharges and use the operational cooling water outfall. Therefore, discharges of chemical (non-radioactive) effluents during the active commissioning phase would be bounded by the limits described in the relevant operational water discharge activity environmental permit.

Discharges of radioactive liquid effluents would be bounded by the limits in the RSR environmental permit.

c) Foul water or sanitary effluent

4.5.12 During the commissioning phase, Sizewell C would produce routine sewage effluent, which would be treated and discharged using the same approach associated with the construction works via the CDO to sea (refer to **Chapter 3** of this volume for further details). Once the permanent sewage treatment plant and cooling water infrastructure is available, the sewage effluent from the Sizewell C nuclear power station would be rerouted and discharged via the cooling water galleries.

4.6 Operational gaseous emissions

4.6.1 The potential operational emissions to air would primarily include:

- From the nuclear auxiliary building stack:
  - Formaldehyde, that may in turn produce carbon monoxide, emitted by the thermal decomposition of insulation material during reactor return to operation following maintenance outages.
  - Discharge of radioactive gaseous effluents arising from the degassing of primary coolant and maintenance and operations in building areas containing radioactivity.
- Ammonia discharged as the temperature rises in the steam generators during start-up following a maintenance outage.
- Sulphur dioxide (SO_2), nitrogen oxides (NO_X), carbon monoxide (CO), unburned hydrocarbons and particulate matter (PM_{10} and $PM_{2.5}$) in the exhaust gases from engines of back-up diesel generators during periodic testing.
- SO_2, NO_X, carbon monoxide , PM_{10} and $PM_{2.5}$ from plant including; firefighting and hydrant diesel pumps, thermal driven mobile pumps and other small-scale diesel generators and domestic heating boilers.

4.6.2 Details of the above emissions, including stack parameters and emission rates are presented in **Appendix 4C**.

a) Start-up of the reactor plant

4.6.3 During the return to operation, following a maintenance outage (approximately every 18 months per unit), thermal decomposition of plant piping insulation material would result in the release of steam containing formaldehyde that may in turn produce carbon monoxide. It is estimated that during return to operation following maintenance, the operating time required to evacuate these emissions would be eight hours at normal flow and 42 hours at low flow. These gases would be captured by the ventilation extraction system and discharged to atmosphere via the nuclear auxiliary building stack, which would be approximately 70m in height above ground level (for parameters refer to **Chapter 2** of this volume).

4.6.4 Start-up following a maintenance outage may also result in the production and emission of ammonia. Depending on the type of maintenance planned during an outage, the steam generators may need to be filled with demineralised water and corrosion inhibitors to prevent their fabric corroding and also provide a biological barrier (a water shield). Once the outage is over, the rise in temperature in the steam generators generates gaseous ammonia partly from this wet lay-up solution, and partly from the steam generators emergency feedwater system. These emissions would be discharged via four steam relief valves associated with each UK EPR™ reactor unit. For the purpose of this ES, it has been assumed that the ammonia emissions from one steam generator would be released during a period of 83 hours per restart. Two installation restarts are assumed per year.

b) Periodic testing of the back-up diesel generators

4.6.5 To ensure that the back-up diesel generators remain fully operational when required, these critical safety systems would undergo testing on a routine basis during the life-time of the Sizewell C power station. Each diesel generator would be run for 24 hours following a maintenance outage and 60 hours per year for routine testing. It is not anticipated that more than one diesel generator would undergo routine testing at any one time. Emissions would be discharged via exhaust stacks located on the roof of the emergency diesel generator buildings.

4.6.6 The operation and maintenance of the back-up diesel generators would be controlled under the combustion activity permit granted by the Environment Agency under the Environmental Permitting (England and Wales) Regulations 2016 (as amended). Relevant stack and emission parameters for the diesel generators are provided in **Appendix 4C** of this volume. Stacks from the emergency diesel generator buildings would have a height within the parameters shown on **Figure 2.4, Chapter 2** of this volume. Emission rates for the diesel generators, including pollutant releases to air and exhaust gas flow rates and temperatures, are indicative.

c) Other gaseous emissions

4.6.7 Domestic heating boilers, diesel pumps, thermal driven mobile pumps and other small-scale diesel generators would be routinely used around the

Sizewell C nuclear power station (particularly during periods of cold weather). Firefighting diesel pumps located around the main platform would only be used for short periods in the event of an emergency or during periodic tests. Emissions from these sources would be discharged to air via their own flue gas vents and are likely to comprise SO_2, NOx, carbon monoxide, PM_{10} and $PM_{2.5}$.

d) Radioactive gaseous emissions

4.6.8 Operation of the reactors and other radioactive facilities on the Sizewell C power station produce radioactive gaseous emissions from the degassing of the primary cooling circuit and ventilation of potentially contaminated areas. Gaseous radioactive emissions are filtered and treated and only very small quantities are permitted to be discharged. These discharges into the environment would use the stacks on the nuclear auxiliary buildings and other authorised outlets, in accordance with the RSR environmental permit. **Chapter 7** of this volume provides further details on the control and management of radioactive gaseous emissions.

4.7 Commissioning gaseous emissions

4.7.1 During commissioning there would be a number of emissions to air, including:

- Nuclear auxiliary building stack:
  - formaldehyde, that may in turn produce carbon monoxide, emitted by the thermal decomposition of insulation material during reactor plant start-up (commissioning);
- Ammonia discharged from the steam relief valves as the temperature rises in the steam generators during start-up (commissioning); and
- Back-up diesel generators: sulphur dioxide SO_2, nitrogen oxides (NO_X), carbon monoxide and particulate matter (PM_{10} and $PM_{2.5}$) in the exhaust gases from engines of back-up diesel generators during commissioning.

a) Start-up of the reactor plant

4.7.2 During start-up (commissioning) of the reactor building or return to operation following an outage (approximately every 18 months per unit), thermal decomposition of plant piping insulation material results in the release of steam containing formaldehyde, that may in turn produce carbon monoxide. Assuming the worst-case with respect to emissions (i.e. the shortest period over which the emissions may occur), it is estimated that during commissioning, it would take 10 hours to evacuate these gases at normal flow rates, and 52 hours at low flow rates. As with operational discharges, these gases would be captured by the ventilation extraction system and discharged to atmosphere via the nuclear auxiliary building stack.

b) Commissioning of the back-up diesel generators

4.7.3 During commissioning, all four EDGs per unit will be tested simultaneously to simulate a loss of off-site power scenario. Loss of off-site power testing is expected to have a maximum run time of three hours.

4.7.4 Each of the EDGs will then be run for approximately 243 hours during commissioning. Each of the UDGs will be run for 738 hours.

4.7.5 It is anticipated that Unit 1 and Unit 2 diesel generators will be commissioned separately, one year apart.

4.7.6 As for the operational testing of the diesel generators, these emissions would be discharged via exhaust stacks located on the roof of the EDG buildings.

4.8 Operation of the Beach Landing Facility

4.8.1 For a worst-case assessment within the EIA, it has been assumed that the BLF would be used once every five years for the individual deliveries of abnormal indivisible loads during the operational phase. Deliveries would take place more regularly during the construction period and further details are set out in **Chapter 3** of this volume. Example barges suitable for using the BLF would include osprey intrepid and osprey trader. These would be assisted by tugs for open water towing and port manoeuvres. BLF usage would be most likely during the low wave energy season (approximately April to October) Dredging of the navigation channel leading up to the BLF may be required prior to the deliveries to site.

4.8.2 During the delivery, the Suffolk Coastal Path would be temporarily closed for approximately half a day to a day to allow for materials to be brought in and out of site. A banksman would be used to manage the crossing with the Suffolk Coastal Path.

4.9 Operation of Sizewell B relocated facilities

4.9.1 Sizewell B relocated facilities, as described in **Chapter 2** of this volume, would be managed and maintained in line with the procedures and processes implemented at the existing Sizewell B nuclear power station. EDF Energy Nuclear Generation Limited, which operates the Sizewell B station, has a well-established integrated management system that has been certified to the ISO 14001:2015 environmental management standards.

4.9.2 Furthermore, the Nuclear Installations Act 1965 (as amended) and the Nuclear Installation Regulations 1971 set out the nuclear site licensing requirements for the Sizewell B power station. Sizewell B has an extant Nuclear Site Licence dated 25 March 1996 (amended March 1999). All necessary approvals and authorisations required by the Nuclear Site Licence in respect of design, construction and operation of Sizewell B relocated facilities would be sought from the Office for Nuclear Regulation (ONR) by EDF Energy Nuclear Generation Limited.

4.9.3 Sizewell B relocated facilities will also comply with all existing relevant Sizewell B environmental permits, consents and licences, if appropriate, such as those granted under the Environmental Permitting Regulations 2016 (as amended), Planning (Hazardous Substances) Regulations 2015 (as amended) and the Control of Major Accidents and Hazards Regulations 2015 (as amended).

4.9.4 Further information on the operation of Sizewell B relocated facilities is provided within **Volume 1 Appendix 2A** of the **ES** (Doc Ref. 6.2).

4.10 Transport

4.10.1 Once Sizewell C is operational, the park and ride facilities, freight management facility, accommodation campus, Land to the East of Eastlands Industrial Estate and the green rail route would all be removed and reinstated.

4.10.2 In the operational phase, there would be no significant remaining requirement for large scale freight movement. The green rail route would be removed and returned to its original land use. However, the BLF would be retained to enable some AIL deliveries by sea during the operational phase. Other freight deliveries would be brought to Sizewell C by road, making use of the two village bypasses, the Sizewell link road, A12/B1122 roundabout and other highway improvements, which would remain in place permanently.

4.10.3 The main access to the operational Sizewell C would be via a new access road starting from the B1122 at the main site access roundabout used during the construction phase. The route would incorporate facilities that would enable operational staff to walk or cycle to work. A secondary, independent access via the Sizewell B site would be provided for security reasons.

4.10.4 The permanent car park at the Sizewell C would provide 735 spaces for the 900 operational staff. Details of electric vehicle charging points are set out in **Chapter 2**. On the basis that 810 of the 900 staff are predicted to be at work at any one time, the parking ratio would be one parking space per 1.1

operational staff. The parking provision allows for some workers to walk or cycle to the site and car sharing at a level consistent with the National Travel Survey data for journeys to work. It reflects the limited potential for bus services to Sizewell C.

4.10.5 SZC Co. will prepare and implement an Operational Travel Plan to encourage staff to walk, cycle or car share whenever possible. The preparation and implementation of this Operational Travel Plan will be secured through an obligation in a Section 106 Agreement (see **draft Section 106 Heads of Terms** provided as an appendix to the **Planning Statement** (Doc Ref. 8.4).

4.10.6 A further 600 car parking spaces are planned for use by approximately 1,000 outage staff. Details of electric vehicle charging points are set out in **Chapter 2**. This car park would not be available for use by operational staff from Sizewell B and Sizewell C. An additional 35 spaces would be provided for visitors to the training facility located within the Operational Service Centre.

4.11 Workforce and visitors

a) Workforce numbers

4.11.1 The operational workforce would gradually build up during the commissioning phase and it is anticipated that the operational workforce of approximately 700 permanent staff would be employed on-site during normal operations, of which approximately 180 would be employed in professional and managerial positions; 60 in clerical/administration positions; and 460 in industrial positions. There will also be up to an additional 200 contract staff, making a total of around 900.

4.11.2 It is anticipated that the majority of the operational staff would travel from within the local districts of East Suffolk and Mid Suffolk. Further details on the expected workforce profile are provided in **Chapter 9** of this volume.

4.11.3 During the maintenance and refuelling outages, approximately 1,000 additional staff would be required to work on site at any one time, with the number depending upon the extent of the maintenance planned for the outage.

b) Working hours

4.11.4 A number of operational staff would work shift patterns. Approximately up to 150 operational staff would work shifts to cover the 24-hour day operational requirements. The remaining staff (permanent and contract) would be likely to work day shifts (08:00–16:30).

4.11.5 The outage workforce would work day and night shifts with approximately 60% of the workforce working a day shift and 40% a night shift. It is envisaged that the outage day shift would be 07:00 to 19:00 and the night shift would be 19:00 to 07:00.

c) Visitor hours

4.11.6 The proposed Sizewell visitor centre would accommodate the following components; reception; exhibition space; auditorium; classrooms for school parties; media centre / VIP area; refreshment area; office and associated conference room and an external viewing area.

4.11.7 The visitor centre would be occupied by visitors and staff. The occupancy would vary with a total maximum occupancy of 135 people per day at 6m^2 per person. Groups would predominantly pre-book to visit, however the facility would also be open to walk-in visitors.

4.11.8 The visitor centre would typically be open six days a week 09:00–16:00 Monday to Saturday. Opening could be extended beyond these hours for specific events.

4.12 Operational environmental, safety and security management systems

4.12.1 SZC Co. is committed to setting its own high standards in ensuring compliance with all of its legal and regulatory obligations. This would include developing appropriate management arrangements for Sizewell C that will utilise best practice from industry regulators and the EDF Energy parent company. A key aspect of the management arrangements would be that they will form part of a fully integrated management system, certified to appropriate international standards. Management arrangements for the design, construction and operation of the Sizewell C nuclear power station would be subject to approval by the Environment Agency and the ONR to satisfy the requirements of the RSR environmental permit, the relevant Nuclear Site Licence condition and other operational permits.

4.12.2 The ONR Civil Nuclear Security is responsible for approving security arrangements within the civil nuclear industry. The ONR Civil Nuclear Security will require for its approval the submission of a Sizewell C site security plan, for construction and operation, before the proposed development is brought into use.

a) Management of landscape and ecology

4.12.3 Details on the management of the landscape and ecology during operation are set out in the **Outline Landscape and Ecological Management Plan** (Doc Ref. 8.2).

b) Coastal processes monitoring and mitigation plan

4.12.4 During operation, a Coastal Processes Monitoring and Mitigation Plan would be implemented which sets out the operational monitoring requirements, in addition to the requirements for replenishing the soft coastal defence feature, if eroded during storm events. An outline of the arrangements to be included in the plan are set out within **Chapter 20** of this volume.