4 COMMISSIONING AND OPERATION OF HINKLEY POINT C

4.1 Introduction

4.1.1 This chapter provides a description of the commissioning and operational periods of Hinkley Point C (HPC). It describes the main activities on-site, in particular those with the potential to have an environmental effect during commissioning and the day-to-day operation of HPC, as well as periods of refuelling and maintenance outages. Information is also provided on the operating activities related to the transmission of electricity to the national grid high voltage electricity transmission system via the 400kV substation located to the south-east of the Development Site.

4.1.2 A significant body of legislation is in place to ensure the safe and secure operation of nuclear power stations; further details on nuclear regulation are provided in Volume 1 Chapter 4 of this Environmental Appraisal.

4.2 Commissioning of Hinkley Point C

a) Phases of Commissioning

4.2.1 As previously described, the two UK EPR reactor units would be constructed 18 months apart with Unit 1 scheduled for commissioning in 2017 and Unit 2 in 2019. Commissioning of a reactor involves a series of tests to demonstrate, to the extent practicable, that the plant, as built and including all components and systems, is capable of safe and reliable operation in accordance with its design specification, performance objectives and safety requirements.

4.2.2 The commissioning of the reactor units comprises two phases including:

- **Non-active commissioning** of the safety related systems and components, including hot functional testing, where hot functional testing by pressure testing and examinations of the nuclear components ensures that the reactor is safely operable under full temperature and pressure conditions, albeit without fuel – these tests are completed before fuel is loaded into the reactor; and

- **Radioactive commissioning** commencing 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 the operational and safety performance is verified.

b) Commissioning Discharges and Other Environmental Impacts

i) Discharges to Air

4.2.3 During the commissioning tests, lasting approximately two years (less for reactor components), small amounts of formaldehyde may be produced. Insulation surrounding the equipment and hot piping undergoes thermal decomposition during the first time that the temperature rises, and this releases formaldehyde vapour into the reactor building. At present, the height of each proposed stack is up to 80m; however the final decision on height is dependent on detailed dispersion modelling.
4.2.4 The quantities of formaldehyde and carbon monoxide discharged as gases into the environment after hot tests are estimated using a worst case scenario. During the commissioning tests (lasting up to 52 hours), the maximum quantities produced by each UK EPR are estimated to be just over one kilogram of formaldehyde and just over one kilogram of carbon monoxide. Further details on the discharge of formaldehyde and carbon monoxide are provided in Chapter 11 of this volume which presents the air quality assessment for the proposed HPC.

4.2.5 Plant commissioning will also involve the testing of essential power, such as the emergency diesel generators and station black out generators, and steam supply systems. Testing of this combustion plant will take place in accordance with the limits and conditions of the appropriate environmental permit. Limited discharges of sulphur and nitrogen oxides will take place during the testing.

ii) Discharges to Sea

4.2.6 The commissioning tests use demineralised water for preparing and flushing plant systems, which would be discharged to sea. This may contain a number of chemicals including phosphates, iron, morpholine, bromoform and other oxidants required for the pressure testing, flushing and initial circuit chemical conditioning treatment of the UK EPR. Testing of the primary and secondary circuits requires them to be filled and flushed several times each. The total amount of demineralised water required for the commissioning tests and start up of each unit is estimated to be 72,500 m³ over a period of 12 to 18 months. All discharges to the marine environment will be controlled through the conditions of the environmental permit issued by the Environment Agency. Further details on the potential impacts of these discharges to the marine environment are provided in Chapters 17 and 19 on marine ecology, and marine water and sediments quality respectively.

4.2.7 During the commissioning phase, HPC will continue to produce routine treated sewage effluent in the same way as the construction period.

iii) Other Environmental Impacts

4.2.8 Commissioning of the reactors and associated systems will generate noise, especially during the testing of essential standby plant such as the diesel generators and the overspeed tests of the steam turbines. Communications (public address) systems and emergency sirens will also be tested at various stages during the commissioning programme. Further details on the potential impact of noise during construction and commissioning are provided in Chapter 10.

4.3 Operation of Hinkley Point C

a) Electricity Generation

i) Functioning of the UK EPR Reactor

4.3.1 Each UK EPR reactor unit has an operational design lifetime of approximately 60 years, plus up to 10 years of fuel storage in the ponds inside the plant before transfer to the Spent Fuel Interim Storage Facility. The expected electrical output of HPC would be approximately 1,630 megawatts (MW) per unit giving a total site capacity of 3,260 MW. The UK EPR 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.

4.3.2 As described in Chapter 2 of this volume, the two reactor buildings would each house one UK EPR. At the heart of the UK EPR is a reactor core which comprises 241 fuel assemblies each containing a 17 by 17 array of fuel rods comprising uranium dioxide pellets in a sealed cladding tube which is cooled by water. The uranium has been enriched in the fissile isotope Uranium-
235 (U-235) from its naturally occurring level of 0.7% up to 5%. A fissile isotope is an isotope where, when it collides with a low energy neutron, its nucleus splits ("fissions") into smaller fragments ("fission products") and releases further neutrons together with energy. In a nuclear reactor, where these neutrons are slowed down ("moderated") by the water surrounding the fuel to the point where they can cause a further nucleus to fission, this results in a sustained chain reaction and the release of nuclear energy as heat. The UK EPR reactor core is capable of producing approximately 4,500MW of heat and is contained within a thick-walled steel pressure vessel which is approximately 10m high and 5.5m in diameter. Diverse systems are installed for the safe shutdown of the reactor in the event of any faults.

4.3.3 The functioning of the UK EPR reactor is based on a primary system, a secondary system and an open circuit cooling system which provide the heat sink for the plant, as illustrated in Volume 2 Chapter 2, Figure 2.2. The systems operate as follows:

- The primary system is a closed water-filled pressurised system installed in a leak tight prestressed concrete containment structure, the reactor building. It comprises a reactor, namely a robust steel vessel containing the fuel assemblies in the reactor core and four cooling loops, each containing a reactor coolant pump and a steam generator. The heat produced by the nuclear fission reaction inside the fuel assemblies in the reactor core is extracted with pressurised water, which circulates in the primary system. The high pressure, generated by a pressuriser in the primary circuit, prevents the cooling water from boiling even though the temperature of the water is around 330°C. The heated water then passes through tubes within the steam generators. Here the heat is transferred through the tube walls into the water of the separate secondary system which flows outside and between the tubes. 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.
- The secondary system is a closed system which is independent of the primary system, and it operates at a lower pressure. Consequently, when heated by the primary system in the steam generators, the water in the secondary system boils to steam. The steam is supplied to the turbine generator located in the turbine hall. Here it powers a single large turbine rotating at 1,500 revolutions per minute (rpm). 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 to the steam generators.
- The cooling system is independent of the primary and secondary systems. It is an open system which draws water directly from the sea. This absorbs heat from the secondary system in the condenser and is then discharged back to the sea. Further details on the cooling system are provided below.

ii) Transmission to the National Grid

4.3.4 Electricity generated in the turbine halls, as outlined above, would be converted by transformers to high voltage (400 kilovolts, or kV), before being exported by two EDF Energy overhead lines connected to the National Grid 400kV substation. Connections to the 400kV main interconnected national grid transmission system are made via six overhead line gantries and three overhead line terminal towers (pylons). These would be situated along the southern and eastern sides of the National Grid substation.

4.3.5 Details of the proposed National Grid substation and associated infrastructure are provided in Chapter 2 of this volume. During operation of HPC, the substation would primarily be unmanned, but controlled and monitored remotely by National Grid from their Electricity National Control Centre, apart from when plant maintenance is undertaken.
b) Refuelling and Maintenance Outages

4.3.6 HPC would undergo refuelling and maintenance shutdowns (otherwise known as ‘outages’) at regular periods throughout its operational life. The length of these shutdowns will vary according to the maintenance and inspections required.

i) Maintenance Outage

4.3.7 For ‘preventative maintenance’ or repair, fuel saving or power grid management, it is expected that these would occur approximately every 18 months for approximately one month per UK EPR reactor unit to ensure the safe and effective operation of nuclear reactors.

4.3.8 Preventive maintenance includes inspections, tests, maintenance, repairs and replacements aimed at complying 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, security, availability and cost are achieved. The scope of preventive maintenance takes account of:

- safety objectives;
- dose uptake (collective dose target less than 0.35 man-sieverts per year (man.Sv/y)); and
- the target of over 90% plant availability.

ii) Refuelling Outage

4.3.9 A nuclear fuel assembly can produce a very large amount of energy before it needs to be replaced. Generally assemblies remain inside the reactor for three ‘fuel cycles’. During a refuelling outage, a quarter to a third of the fuel inside the reactor core is replaced with fresh fuel. Refuelling outages are planned outages and typically take place every eighteen months for a duration of approximately one month. A maintenance outage always includes a refuelling outage.

c) Operational Workforce

4.3.10 The operational workforce will 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 would be in clerical/administrative positions; and 460 would be in industrial positions. There will also be up to an additional 200 contract staff.

4.3.11 A number of operational staff will work shift patterns. Up to 100 operational staff would work shifts to cover the 24 hr/day operational requirements. The remaining 800 staff would be likely to work day shifts.

4.3.12 During the maintenance and refuelling outages, it is anticipated that a further 600-1000 staff would be required, with the number depending upon the extent of the maintenance scope of the outage, and that a large number would be located in the Operational Service Centre. These additional personnel would access the site via a second set of turnstiles in the inner fence and would work in the reactor building (accessed via the Operational Service Centre), the turbine hall and the cooling water pumphouse.

d) Transport during Operation

i) Staff Travel

4.3.13 It is anticipated that the majority of the 700 permanent staff and 200 contract staff on-site would travel from the three local districts of Sedgemoor, West Somerset and Taunton Deane. A Framework Travel Plan will be produced to reduce the car traffic generated by the operation of the Development Site; reduce single occupancy car trips; encourage alternative transport
modes to the car for travel to work; and influence the travel behaviour of employees and visitors.

4.3.14 In order to determine the trip generation profile for the operational period of HPC, the mode share targets need to be set through the Framework Travel Plan. At the time of the Stage 2 consultation the Framework Travel Plan will be in a draft form; it is intended that this document will continue to be updated and discussed with the key stakeholders as further information becomes available and in light of comments received during the Stage 2 consultation. It is the intention that this would be finalised and agreed with the key stakeholders post the Stage 2 consultation. As such, the trip generation expected during the operational period has not been determined and subsequently the transport assessment presented in Chapter 9 of this Environmental Appraisal does not fully assess the potential transport impacts associated with the operational period of HPC. Similarly, the noise assessment (Chapter 10) and the air quality assessment (Chapter 11) have not assessed the operational transport-related noise and air quality effects respectively.

ii) Deliveries and Transport of Waste

4.3.15 Regular road deliveries of engineering spares and materials, industrial gases, industrial chemicals, diesel fuel oil and food are required during normal operation. Transport of low level radioactive waste and conventional waste off-site would be required. It is anticipated that deliveries of new fuel assemblies, typically a few tens of tonnes in total over a ‘fuel cycle’, would comprise of approximately 20 transport movements per 18-month fuel cycle.

iii) Helipad

4.3.16 A helipad will be located to the east of the Development Site for emergencies and maintenance and inspection of the overhead transmission lines. Use of the helipad will be infrequent with only a few movements per year.

e) Operational Discharges and Emissions

i) Heat Sink Cooling Water System

Cooling Water Discharge

4.3.17 The heat sink cooling water system is an open circuit water cooling system which draws water through the two off-shore intake tunnels at a flow rate of approximately 65m³/s per tunnel. The intake heads would be located approximately 3.3km off-shore.

4.3.18 At its on-shore end, each intake tunnel feeds directly into a large basin known as a forebay. The intake water is filtered as it is drawn from each forebay into an adjacent pumphouse which supplies the cooling water for a single unit. There are two smaller on-shore tunnels running parallel with the shoreline which link the forebays of the two units. This allows each forebay to be fed with water for the safety systems when its own intake tunnel is unavailable (e.g. due to maintenance).

4.3.19 The cooling water from the pumping station to the turbine hall and Nuclear Island is pumped through underground pipes routed in galleries. The cooling water pipework is 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 is channelled into two discharge ponds (also referred to as ‘surge chambers’), one per unit which regulate the water level and control the pressure head on the discharge side of the system. Two on-shore discharge tunnels carry the water from the discharge ponds towards the head of a common off-shore discharge tunnel which extends approximately 1.8km off-shore. The water is discharged to sea via two discharge heads (diffusers) located approximately 100m apart at the end of the off-shore discharge tunnel. The
flow rate of water discharged into the sea through each diffuser would be approximately 65 m$^3$/s per unit. It should however be noted that for the purpose of this Environmental Appraisal, a single diffuser with a flow rate between 116 m$^3$/s and 134 m$^3$/s during normal operation has been assumed. This represents a pessimistic scenario for the purposes of calculations and assessments. The discharged water would be discharged at an increased temperature of between 10.7 and 12.5°C above ambient.

**Discharge of Process Water Chemicals, including Hydrazine and Chlorination Products**

4.3.20 During operation, hydrazine would be used within the secondary system to maintain a non-oxidising environment, reducing the oxygen dissolved in the feedwater and limiting fouling of the steam generators caused by corrosion products (such as iron oxides). During shutdown, hydrazine may also be used to condition the steam generators. Hydrazine decomposes to ammonia when heated and is discharged to sea via the cooling water discharge system.

4.3.21 In order to maintain a pH in the secondary circuit where minimum levels of corrosion occur, a basic compound such as ammonia, morpholine or ethanolamine must be injected into the secondary circuit. The eventual discharge of this compound with the cooling water is monitored and controlled as part of the arrangements for compliance with the environmental permit.

4.3.22 It is possible that routine power station operation would not require the addition of biocide (chlorination) to the cooling water (to prevent fouling of the cooling water system by marine organisms such as mussels) because of the current conditions in the Bristol Channel and the design of the intake and discharge structures. However, a chlorination system or storage arrangements for bulk chlorination chemicals would be fitted in case the need arises and testing of this system would be undertaken during the commissioning phase.

4.3.23 Detergents, which would be biodegradable commercial products, may be used in an on-site laundry to clean working clothes. Liquid effluent containing detergent residues would be monitored and discharged using the cooling water system.

**ii) Demineralisation Plant Discharges**

4.3.24 The demineralisation plant produces demineralised water for use in the primary and secondary circuits, to maintain the high levels of chemical purity needed for plant protection and efficient operation. The process generates chemical discharges as a result of pre-treatment to remove suspended solids, cleaning of ultrafiltration membranes using sulphuric acid and sodium hydroxide and regeneration of ion exchange beds using sulphuric acid and sodium hydroxide. Discharged water associated with the desalination and demineralisation plants would include iron, suspended solids, chlorides, sodium, sulphates, detergents and brine. These would be discharged to the foreshore via the wastewater discharge system after monitoring, and treatment if required.

**iii) Surface Water Drainage**

4.3.25 During the operational period of the proposed development the surface drainage system would collect all surface run-off and water treatment works effluent from the HPC site. This water would be collected and discharged into the cooling water discharge pond. There are no surface drainage discharges proposed to the foreshore during the operational period. Effluents from transformers, turbine hall, oil and grease stores 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 off-site drains.
iv) Treated Sewage Effluent

4.3.26 Wastewater from lavatories, kitchens, shower facilities and wash rooms would be treated and filtered to the appropriate quality prior to discharge via the wastewater discharge system after monitoring, and treatment if required.

v) Radioactive Liquid Emissions

4.3.27 The vast majority of radioactivity generated on site remains confined within the fuel. Radioactivity in liquid effluent is the result of activated corrosion products, activation of chemical species in the primary coolant and minor leaks of volatile fission products from small defects in the cladding of fuel assemblies. The production of radioactive waste will be minimised at source and discharges to the environment must be minimised in accordance with Best Available Techniques (BAT). Liquid radioactive waste is filtered and treated and only very small quantities are permitted to be discharged into the environment after monitoring using the cooling water discharge system in accordance with the permit issued by the Environment Agency under the Radioactive Substances Regulations (RSR) section of the Environmental Permitting (England and Wales) Regulations 2010.

vi) Chemical Gaseous Emissions

4.3.28 The operation of the UK EPR reactor units and their associated infrastructure would result in the production of gaseous emissions into the air. These primarily comprise the following:

- Sulphur and nitrogen oxides (SO₂ and NOₓ) would be emitted via the exhaust gases from engines of the four backup diesel generators during periodic testing. These backup generators only operate during periodic tests, which represent an approximate worst-case scenario of 81 hours per year for each of the four main Essential Diesel Generators (EDG) and each Station Black Out (SBO) generator. These gases will be discharged via exhaust stacks.
- Formaldehyde (H₂CO), that may in turn produce carbon monoxide (CO), would be emitted by the thermal decomposition of insulation material during plant start-up at first-use (commissioning) or return to operation following maintenance (approximately every 18 months).
- Ammonia (NH₃) would be discharged during the start-up of the UK EPR reactor units following outages. The steam generators are filled with demineralised water to provide a biological barrier (a radiation shield) while carrying out work in the vicinity. The steam generators are laid-up with hydrazine with added morpholine, ethanolamine or ammonia to prevent corrosion. Once the outage is over, the rise in temperature in the steam generators generates gaseous ammonia.
- Sulphur and nitrogen oxides (SO₂ and NOₓ) would be produced by other combustion plant, for example by fire fighting and hydrant diesel pumps if diesel units are used rather than electric pumps. Emissions from these sources would be discharged into the air via their own flue gas vents.

vii) Radioactive Gaseous Emissions

4.3.29 Operation of the reactors and other radioactive facilities on site (such as the Spent Fuel Interim Storage Facility) produces radioactive gaseous effluent from the degassing of the primary circuit and ventilation of contaminated areas. The production of radioactive waste must be minimised at source and discharges to the environment will be minimised in accordance with Best Available Techniques (BAT). Gaseous radioactive waste is filtered, treated and monitored and only very small quantities are permitted to be discharged into the environment using the discharge stack and other authorised outlets, in accordance with the permit issued by the
Environment Agency under the Radioactive Substances Regulations (RSR) section of the Environmental Permitting (England and Wales) Regulations 2010.

**f) Use and Storage of Hazardous and Radioactive Substances**

**i) Radioactive Substances**

4.3.30 Once transported to the HPC site, fresh fuel is stored in the fuel building before transfer to the UK EPR reactor units during refuelling outages.

4.3.31 Following reactor shutdown during the refuelling process, defuelling would proceed as soon as practicably possible. The process will be undertaken using the existing fuel handling equipment, safety case and operational procedures. Initially the fuel would be cooled in the reactor fuel storage pools for a period of around ten years before transfer to the on-site Spent Fuel Interim Storage Facility, where it is anticipated to remain in storage prior to disposal off-site. As described in Chapter 6 of this volume, it is anticipated that a Geological Disposal Facility (GDF) will be available for final disposal of spent fuel, however the Spent Fuel Interim Storage Facility will be designed such that its life can be extended to last for at least 100 years following the end of the UK EPR operations if required.

4.3.32 The operation of HPC would generate radioactive waste in solid, liquid and gaseous forms. The vast majority of radioactivity generated remains confined within the fuel and is safely stored and managed. The treatment of liquid and gaseous waste means that most of the radioactivity is captured and contained as solid radioactive waste – for example in filters and ion exchange resins. Solid Low Level Waste (LLW) from the site will be packaged and disposed of using the routes authorised in the environmental permit for the site, for example to the national LLW repository in Cumbria. Solid Intermediate Level Waste (ILW) generated during reactor operations will be packaged and stored on the site in the ILW Interim Storage Facility until it is transferred off-site for final disposal. Further details on the management of spent fuel and radioactive waste are provided in Chapter 6 of this volume.

**ii) Non-radioactive Substances**

4.3.33 All chemical substances, either in gaseous, liquid or solid form required during the operation of the HPC would be maintained or stored on the site in accordance with the requirements of the Control of Major Accident Hazards Regulations (COMAH) and the Control of Substances Hazardous to Health (COSHH) Regulations.

**g) Management, Storage and Disposal of Conventional Waste**

4.3.34 Conventional wastes associated with the operation of the HPC will arise from:

- maintenance of the Nuclear Island processes e.g. maintenance of pipes and equipment;
- maintenance of the Conventional Island processes e.g. removal of seaweed from the water abstraction structure;
- activities in the workshops;
- office buildings and training centres; and
- canteens or other welfare facilities.

4.3.35 A detailed waste management strategy will be developed post Stage 2 consultation to manage all conventional waste streams. This will be guided by principles of the ‘Waste Hierarchy’ which aims to reduce, re-use and recycle waste as far as reasonably possible to minimise the amount of waste for disposal. Eliminating the production of waste is the preferred option and disposal is least favourable. Further details pertaining to waste generation and management for HPC, and the Off-site Associated Developments are provided in Chapter 7 of this volume.