Technical and Safety Support

Hinkley Point B Power Station Report

Annual Report for the Hinkley Point Site Stakeholder Group on Radioactive Discharges and Environmental Monitoring at Hinkley Point B Power Station During 2022

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Report Summary

Report title: Annual Report for the Site Stakeholder Group on Radioactive Discharges and Environmental Monitoring at Hinkley Point B Power Station

Report Reference: HINB/R/TET/1113

Summary

This report by EDF Energy Nuclear Generation Limited (EDF NGL) is presented to the Hinkley Point Site Stakeholder Group (SSG) and provides data covering radioactive discharges, solid radioactive waste disposals and environmental monitoring at Hinkley Point B (HPB) power station for 2022. Historic data is available from previous annual reports and graphical trending data presented in this report covers the previous five years.

All radioactive discharges are made under the terms of the permit granted by the Environment Agency (EA). The disposal of radioactive waste from nuclear sites is regulated under the Environmental Permitting (England and Wales) Regulations 2016 (EPR). The permit limits are set after considering the actual quantities of radioactivity that both sites need to discharge but with consideration of the overall requirement to keep the levels as low as reasonably practicable and to keep doses to the public below the internationally recognised limits. The Best Available Techniques (BAT) review report (Ref. 11) was issued on the Environmental Monitoring Programme (EMP). This was a routine review to ensure ongoing suitability; the changes reflected the current position of the Station and will were implemented from 2023 onwards.

Throughout 2022, the levels of radioactivity in liquid and gaseous effluents discharged to sea and air remained below the permitted limits set by the Environment Agency. For radioactive waste, all solid low-level and liquid waste transfers complied with the requirements in the permit. Although releases of radioactivity to the environment are controlled at source, a condition of the authorisations is that a programme of environmental monitoring is maintained. Such monitoring provides reassurance by demonstrating that the controls used to limit radioactive release.

Conclusions

During 2022 the levels of radioactivity in liquid and gaseous effluents, and solid radioactive low level waste transferred for off-site processing, remained well below the permit limits set by the Environment Agency for Hinkley Point B power station.

The Environmental Monitoring Programme has confirmed that there is no evidence of any long term accumulation of radioactivity resulting from the operation of the power station. Radiation doses to members of the public from the discharges and direct radiation from the power station site is well below the UK legal limit of 1mSv per year.

The total dose to members of the public from the all pathways exposure is likely to be similar to the assessed doses for 2021 of 0.030 mSv (Ref.10). This is comparable to previously assessed doses which are well within the public dose constraint value of 0.3 mSv per year from a ‘single site’, recommended by UK Health Security Agency.

Recommendations

There are no specific recommendations arising from the report.

Report issue/amendment

Date	Author	Revision	Amendment
June 2023	M Ziolkowska	000	First issue

Glossary

Word, Phrase or Acronym	Description
AETP	Active Effluent Treatment Plant
AGR	Advanced Gas Cooled Reactor
BAT	Best Available Techniques
BEST	Building Excellence in Safety Together
CO_2	Carbon Dioxide
CW	Cooling Water
EA	Environment Agency
EDF NGL	EDF Energy Nuclear Generation Limited
EMP	Environmental Monitoring Programme
EPR	Environmental Permitting Regulations
GBP	Gas Bypass Plant
HPB	Hinkley Point B Power Station
IC	Improvement Condition
IRR	Ionising Radiations Regulations
MDA	Minimum Detectable Activity
QNL	Quarterly Notification Level
R3	Reactor 3
R4	Reactor 4
RIFE	Radioactivity in Food and the Environment
SSG	Site Stakeholder Group
TLD	Thermoluminescent Dose Meter
TWST	Tritiated Water Storage Tanks
UKHSA	UK Health Security Agency

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1 Introduction

In its simplest form, nuclear power stations use heat generated from the fission process to generate steam. The steam then passes over a number of turbines which spin and facilitate the generation of electricity (Figure 1). Hinkley Point B Power Station operated by EDF Energy Nuclear Generation Limited is an advanced gas cooled reactor (AGR) type which uses gaseous carbon dioxide (CO_2) as the heat transfer coolant.

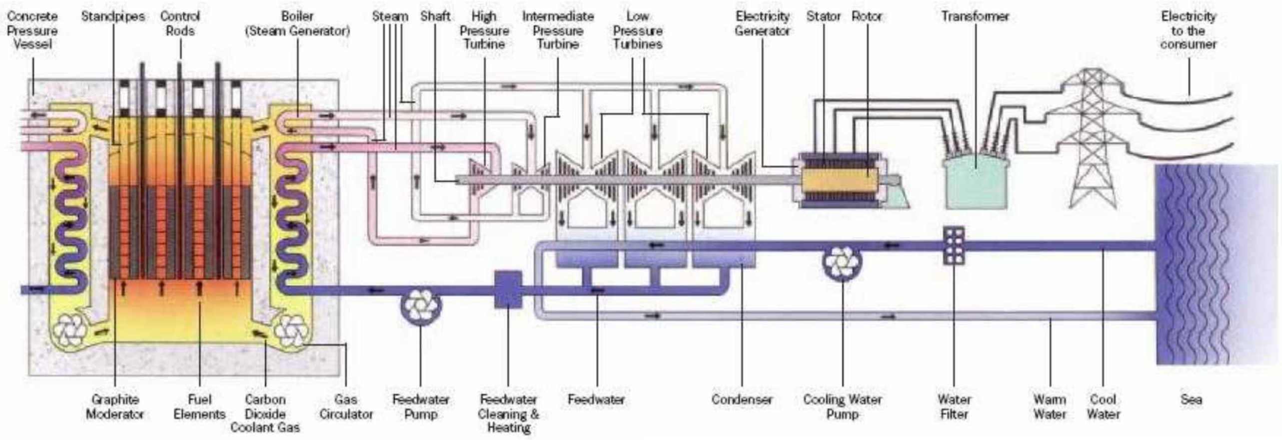

Figure 1: Schematic of electricity generation from nuclear power.

In an AGR, the reactor contains uranium fuel assemblies which are located inside a graphite core. The uranium provides the energy to power the reactor via the fission process. The graphite acts as a moderator to slow down neutrons emitted during the fission process, facilitating a chain reaction and provides structural integrity of the core. Power is controlled by raising and lowering control rods into the graphite core. The control rods absorb neutrons and control the fission process. Inserting the rods causes more neutrons to be absorbed, so less fission occurs and less heat is produced. Fully inserting the rods stops the fission process altogether.

Serpentine boilers have thousands of steel tubes running through them acting as heat exchangers so that as the CO_2 coolant is pumped around the reactor by the gas circulators, heat from the fuel is transferred into the gas and then into the feed water contained within the boiler tubes. The core and boilers are encapsulated by a concrete pressure vessel which allows the gas coolant to be pressurised and also provides shielding from radiation.

Feed water is pumped through the boilers at approximately 500 litres per second. As the feed water travels up the boilers it is transferred into steam and this provides the kinetic energy required to spin the turbines. The turbine setup is one high, one intermediate and three low pressure turbines which have increasing blade size as the steam pressure decreases. This maximises the efficiency of energy transfer from the steam to the turbine. Seawater is passed through condenser tubes and as the steam passes over these tubes, it is cooled and condenses back into water that is then reused in the feed water cycle.

The generator consists of a magnet attached to the turbine shaft (rotor) which spins inside the stationary coils of wire (stator) to generate electricity. The transformers convert 23kV to 400kV for transmission to the National Grid.

Hinkley Point B has two reactors, Reactor 3 (R3) and Reactor 4 (R4), which shut down for the final time on 1st August 2022 and 6th July 2022 respectively. The Station has now progressed into the defueling stage of its life cycle, commencing with R4. Once R3 has been defueled and the site has declared that all nuclear fuel has been removed, the Station will then move into the decommissioning phase.

1.1 ISO 14001:2015

ISO 14001:2015 is an International Standard that provides the elements for an effective Environmental Management System. This system enables us to work and act responsibly towards the environment and it applies to all of the environmental aspects which an organisation has control or influence over. The Standard is integrated with other management requirements to support achievement of HPB's environmental goals.

Three significant benefits are gained by adopting this standard:

- A formal mechanism to apply Company Environmental Policy at site level
- A formal requirement for continual environmental improvement
- Independent verification of Company environmental protection standards

Regular reviews and audits are carried out to ensure that the requirements of the standard are being met. ISO14001:2015 is a fleet wide certification for EDF NGL, therefore any non-conformities identified at any site must be addressed at all other sites. This more vigorous approach will continue to improve the station's environmental performance. The current certificate expires at the end of 2023 with the next audit planned prior to this in Summer 2023.

1.2 Environmental Permitting Regulations 2016

Hinkley Point B holds permits under the Environmental Permitting (England & Wales) Regulations 2016 (EPR 2016) which covers the following activities:

- Radioactive disposals to air (Ref. 1)
- Radioactive disposals to water (Ref. 1)
- Radioactive waste management (Ref. 1)
- Combustion plant (Ref. 2)
- Greenhouse gas emissions (Ref. 3)

Additionally, the Station holds trade effluent and sewage discharge permits which also fall under the jurisdiction of the EA.

1.3 EDF NGL Environmental Policy

EDF's Environmental Policy aligns to our company purpose "Helping Britain Achieve Net Zero" and our approach to achieving a net zero environmental impact across all of our operations to protect a cleaner, healthier and more resilient environment that benefits society and our economy.

Our commitment to continual improvement is demonstrated by our 2030 strategic vision, whereby EDF aims to demonstrate real progress towards reducing our carbon emissions, waste, water use and impact on biodiversity towards Helping Britain Achieve Net Zero. We will also implement circular economy principles into the way we work, pro-actively preventing waste and pollution, achieving greater resource value and productivity. This means we will maintain our position as Britain's biggest generator of zero carbon electricity and leading developer of nuclear new build power stations, as we seek to bring the carbon intensity from our electricity generation to below 10g CO_2 equivalent/kWh by 2035.

All employees and contract partners working with EDF share a responsibility for zero harm to themselves and the environment, and strive to deliver continual improvements.

EDF will, as a minimum, comply with all relevant environmental legislations, permits and other requirements whilst striving to achieve best performance in our sector.

The key principles for achieving this are that:

- We will lead by example by championing innovation and R&D in low carbon technologies including, electricity generation, transportation, heating, building technologies and waste management, where appropriate.

- We will actively monitor our performance and seek opportunities to improve by setting challenging objectives and targets for ourselves and our supply chain partners.
- We will prevent incidents by ensuring our facilities are well designed, safely operated, inspected and maintained and our infrastructure projects are effectively managed.
- We will seek to minimise the environmental direct impacts of our business and that of our suppliers and the goods/services we provide to customers by developing innovative solutions to drive best practice and that enable us to deliver the zero environmental impact goal.
- We will work with interested parties to ensure their and our environmental concerns and expectations are considered as part of a robust and transparent decision-making process.

EDF's Environment Policy is aligned to EDF Group requirements and is assured through the BEST (Building Excellence in Safety Together) framework assessment. The implementation of this Policy will provide a framework for setting environmental objectives through management systems and line management. All employees and contractors are expected to commit to achieve our objectives and work in a manner that helps us to meet our environmental targets.

1.4 Hinkley Point B Environmental Events and Policy Compliance

Any environmental 'events' or 'near misses' are recorded as part of the company's corrective action programme and classified as per the Bird's Triangle shown in Figure 2. The open reporting of 'minor events' and 'near misses' remains encouraging and continues to demonstrate a greater awareness of environmental impacts amongst staff and contract partners. This highlights that staff are not willing to tolerate practices that may have the potential for environmental damage and allows the station to rectify potential problem areas before the environment is put at risk. The site also receives requests for information, largely for student projects and less frequently complaints. These are also formally recorded as part of the Environmental Management System.

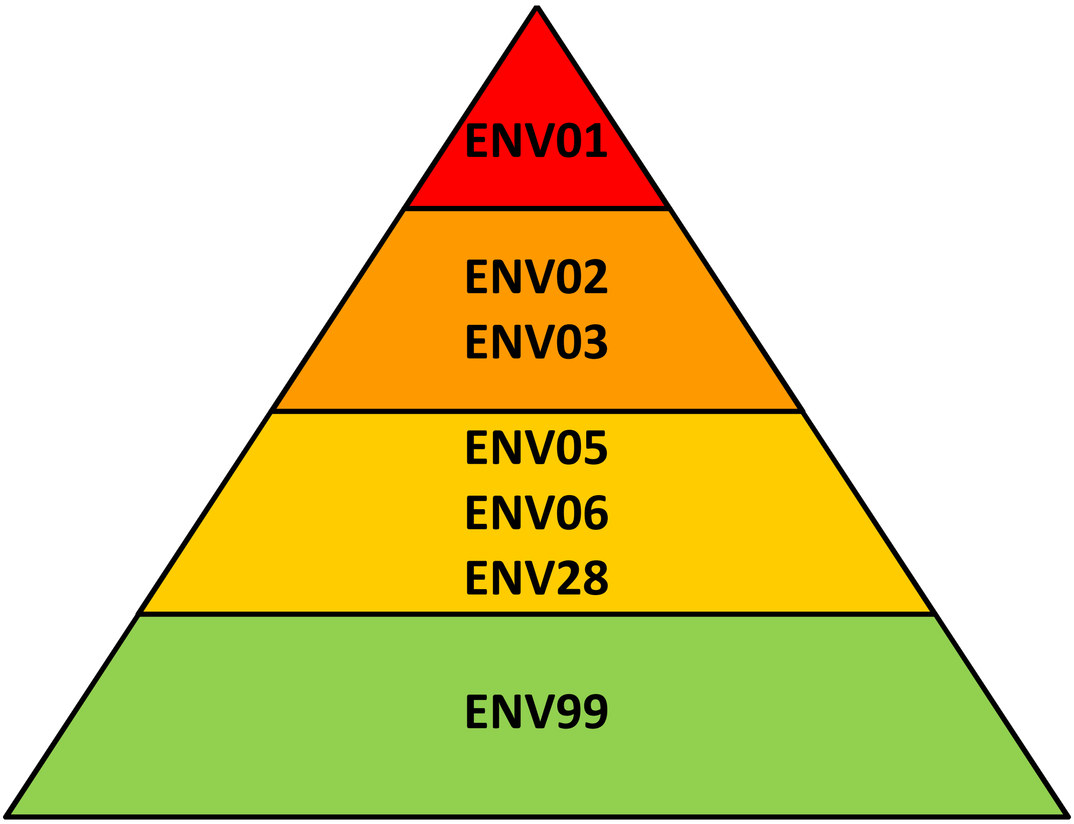

Figure 2: Event classification hierarchy.

An explanation of each category and the number of events occurring in 2022 that specifically affected compliance with environmental legislation and the station permit are detailed in Table 1.

Table 1: Event category definitions and results for 2022.

Event	Description	2022
ENV01	A severe environmental event has occurred, caused by the station, which (environmental pollution release to air, land or water) has caused permanent or long term harm to the environment and / or has had a major effect on the surrounding environment.	0
ENV02	An environmental permit breach or direct environmental legislation non-conformance that has caused harm to the environment that is temporary or can be remediated.	0
ENV03	An environmental permit breach or direct environmental legislation non-conformance which has either, not caused any environmental harm or at most only very localised / transient harm.	3
ENV05	Exceeding a notification level or an unusual discharge / monitoring result.	1
ENV06	Event or near miss that could have led to a higher category report.	8
ENV28	Entry to an unplanned ECO action condition (for environmentally sensitive plant/ equipment) other than normal operating condition.	30
ENV99	Something of environmental interest that merits recording but cannot be fitted into previous categories.	186
Total environmental events		228

Environmental events that require reporting to a regulatory body form one of the key performance indicators for EDF NGL and events are taken very seriously at all levels of the organisation.

During 2022, there were three ENV03 events which are described below:

- Pond water sampling valve (Ref. 4) – In December 2021 a small bore pond valve was not fully closed following sampling activities. Consequently, a volume of pond water entered the active effluent treatment plant (AETP) and was discharged through the normal active discharge route during January 2022. In conjunction with the EA, the Station identified an engineered solution to prevent a reoccurrence and this action was closed out as complete by the EA in Q3 2022.

- Dirty oil tank bund (Ref. 5) – In July 2022, sea water from an oil cooler had leaked into the basement oil bund and was transferred above ground to the dirty oil tanks. A failure occurred on an orifice plate of the tank and the sea water leaked into the bund. This was observed entering the turbine hall basement via an unsealed penetration in the bund base. The remediation works involved repair to the penetration and re-sealing of the bund which was completed in Q3 2022.

- IC5 completion (Ref. 6) – Following a change to the solid waste permitted routes in 2022 an Improvement Condition (IC) was added to the permit for corporate governance to be updated by July 2022. During an EA inspection in October 2022, this action was identified as being incomplete as the fleet documents had not been issued. The EA worked with the Station and corporate environmental team to update to fully cover the requirements for HPB and other stations looking to use this new waste route. The action was closed out in March 2023.

2 Liquid Effluent Discharges

The HPB environmental permit authorises tritium (H-3), sulphur-35 (S-35), cobalt-60 (Co-60), caesium-137 (Cs-137) and other radionuclides to be disposed via specific outlets as liquid effluent discharges. Table 2 shows the annual and monthly discharges of each permitted radionuclide with the respective permit discharge limits.

Table 2: Total liquid discharges during 2022.

Month	Tritium Activity (TBq)	Sulphur-35 Activity (TBq)	Cobalt-60 Activity (GBq)	Caesium-137 Activity (GBq)	Other Activity (GBq)
January	1.95E+01	1.89E-02	0.003	0.167	0.23
February	1.96E+01	2.29E-02	0.003	0.050	0.21
March	1.80E+01	2.62E-02	0.003	0.046	0.20
April	2.66E+01	3.34E-02	0.004	0.071	0.30
May	1.73E+01	2.20E-02	0.005	0.031	0.21
June	1.95E+01	2.20E-02	0.004	0.035	0.23
July	2.11E+01	1.94E-02	0.004	0.043	0.28
August	5.77E-03	1.04E-05	0.002	0.035	0.01
September	4.61E-04	6.12E-06	0.002	0.029	0.01
October	1.12E-04	4.16E-06	0.001	0.031	0.02
November	6.57E+00	2.81E-03	0.004	0.045	0.19
December	3.00E-04	1.26E-05	0.006	0.068	0.01
Annual Total (2022)	148	0.17	0.04	0.65	1.90
Annual Total (2021)	165	0.16	0.05	0.42	2.00
Annual Authorisation Limit	**650**	**2**	**10**	**100**	**80**

The following sections detail each permitted radionuclide or groups of radionuclides separately. All graphical data is scaled to the Quarterly Notification Level (QNL) stated in the permit.

2.1 Liquid Tritium (H-3)

Tritium has a half-life of 12.3 years and the annual discharge limit for liquid tritium discharges at HPB is 650TBq.

Tritium occurs naturally in the environment, in AGR power stations, it is produced in the reactor core by the neutron irradiation of small quantities of lithium present in the graphite and via the fission process. The main source of tritium discharged is from moisture extracted from the gas coolant by the gas bypass plant dryers. The quantity discharged depends on the burn-up of the lithium in the core, the reactor power, operating time and the gas chemistry requirements. As both reactors are now permanently shut down, the production of tritium via the GBP has now ceased. The concentrated tritiated liquid has now been discharged and the Tritiated Water Storage Tanks (TWST) have been diluted and flushed in preparation for isolation of the system.

Liquid tritium discharges over the previous five years are illustrated in Figure 3.

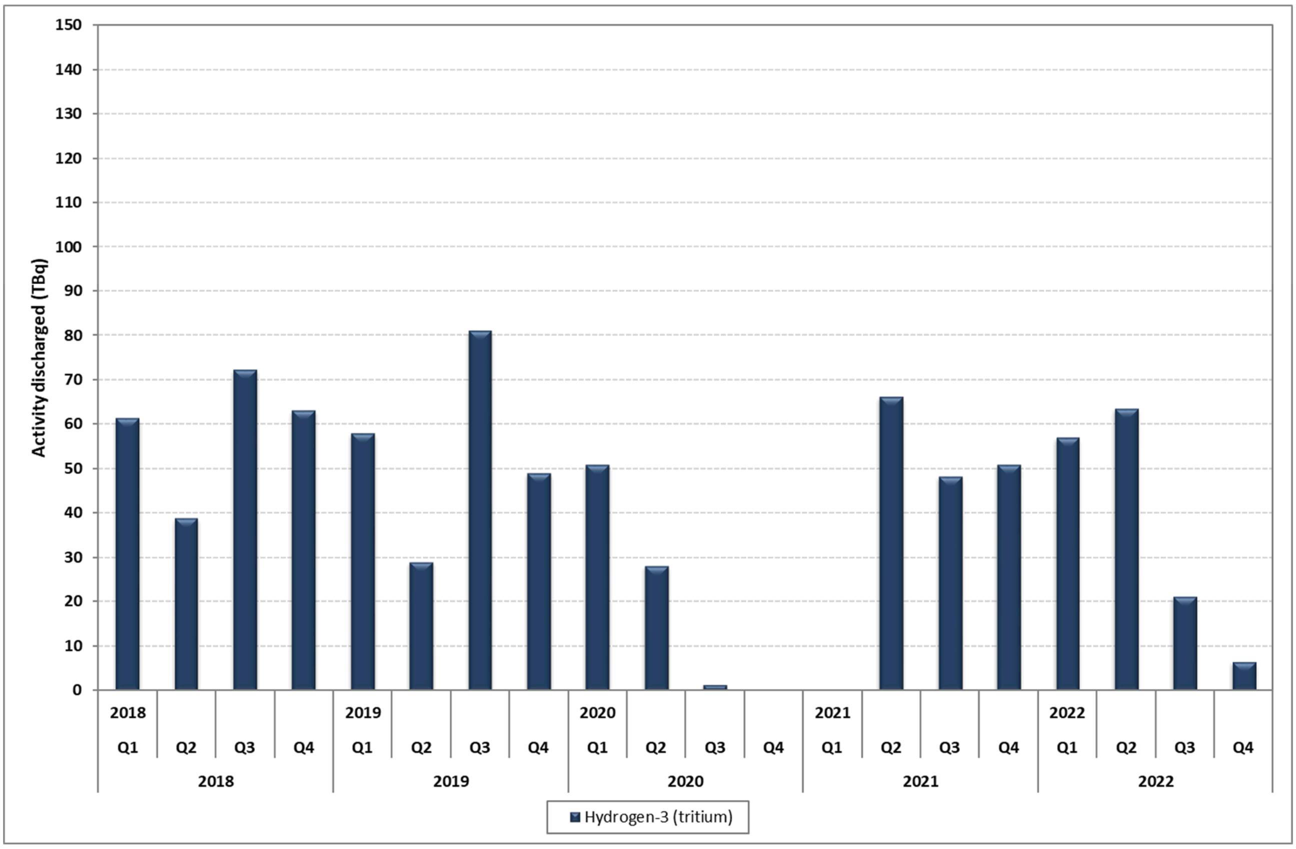

Figure 3: Liquid tritium discharges 2018 - 2022.

2.2 Liquid Sulphur (S-35)

Sulphur-35 has a half-life of 87 days and the annual discharge limit for liquid sulphur-35 discharges at HPB is 2TBq.

In AGR power stations, sulphur-35 is produced as a result of the irradiation of stable chlorine or sulphur that exists as impurities within the graphite or from oil deposits in the reactor and the gas circuits. The principle source of sulphur-35 in the reactor originates from small quantities of chlorine impurities present in the graphite core and in the sleeve of the fuel elements. The sulphur then combines with carbon dioxide and carbon monoxide to produce gaseous carbonyl sulphide. This is removed by the gas bypass plant dryers and condensed into a dischargeable liquid effluent. As both reactors are now permanently shut down, the production of sulphur-35 via the GBP has now ceased. The TWST system previously processed the majority of sulphur-35 and so only residual levels will be expected in future discharges once this system is isolated.

Liquid sulphur-35 discharges over the previous five years are illustrated in Figure 4.

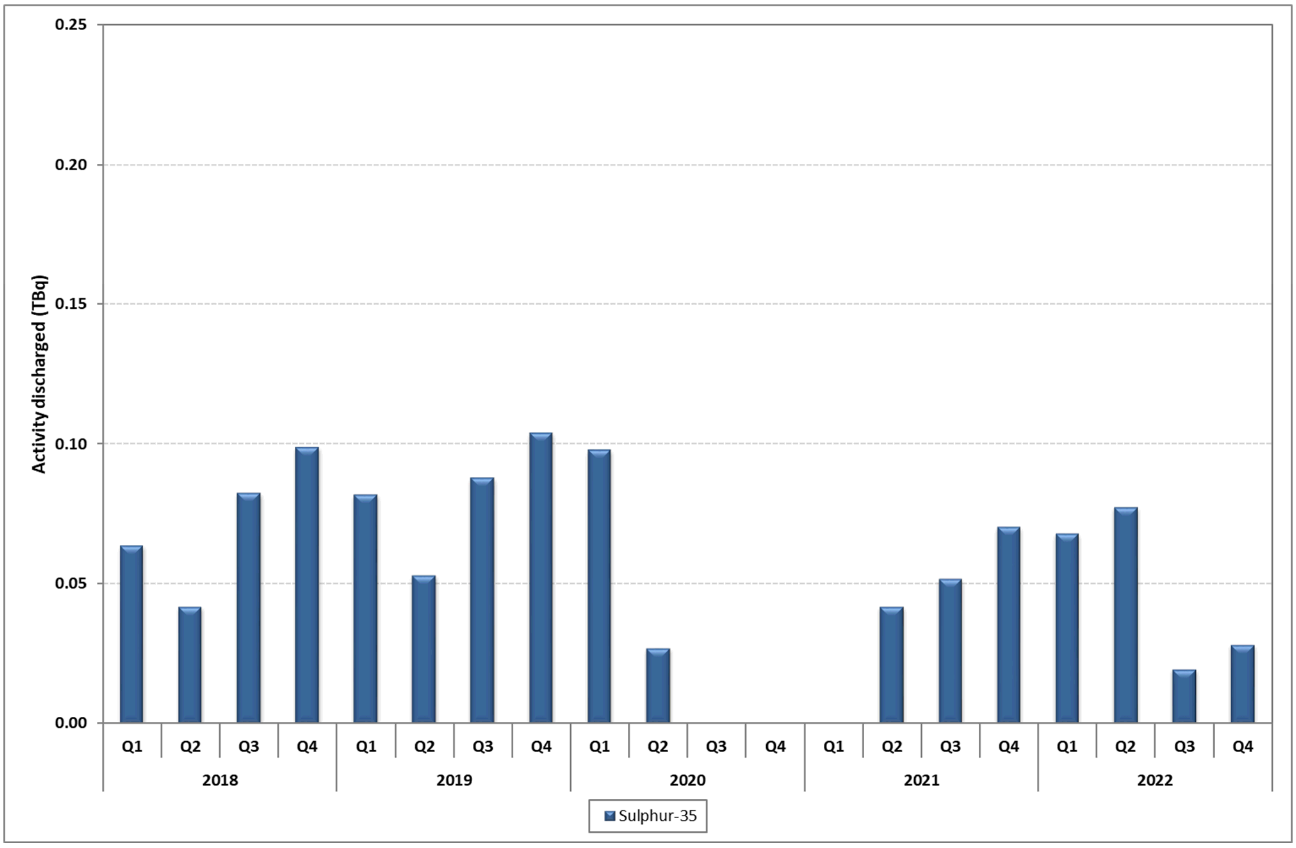

Figure 4: Liquid cobalt-60 discharges 2018 - 2022.

2.3 Liquid Cobalt (Co-60)

Cobalt-60 has a half-life of just over 5 years and the annual discharge limit for liquid cobalt-60 discharges at HPB is 10GBq.

Cobalt-60 arises predominantly from the active effluent treatment plant (AETP) where it has originated from surface contamination on fuel elements. Cobalt-60 discharges is assigned to routine pond water treatment plant operation and levels remain stable.

Liquid cobalt-60 discharges over the previous five years are illustrated in Figure 5.

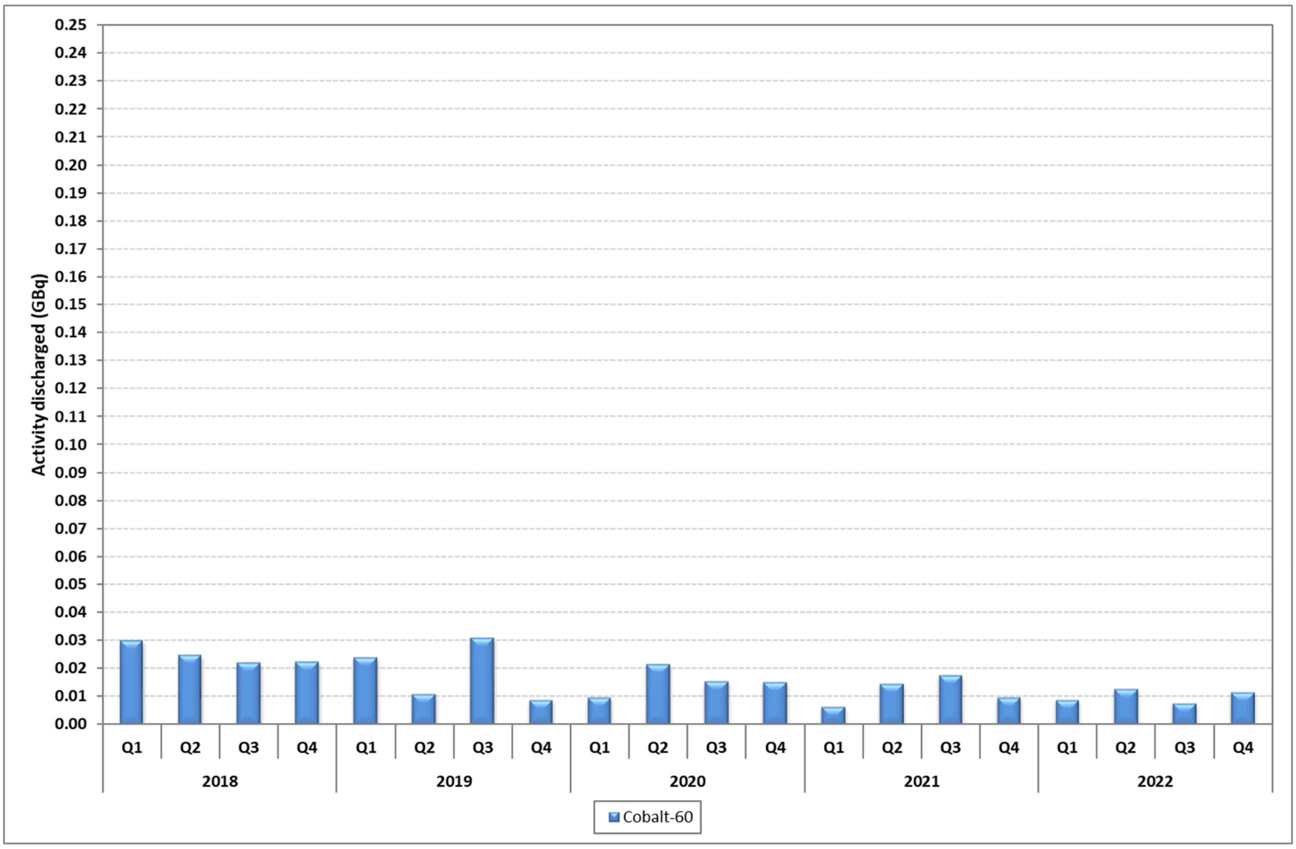

Figure 5: Liquid cobalt-60 discharges 2018 - 2022.

2.4 Liquid Caesium (Cs-137)

Caesium-137 has a half-life of 30.1 years and the annual discharge limit for liquid caesium-137 discharges at HPB is 100GBq.

Caesium-137 is a fission product and the majority of caesium-137 discharges are associated with routine pond water treatment plant operations. Whilst the levels of caesium-137 remain stable, levels were elevated in January 2022 due to loss of pond water as detailed in Ref. 4.

Liquid caesium-137 discharges over the previous five years are illustrated in Figure 6.

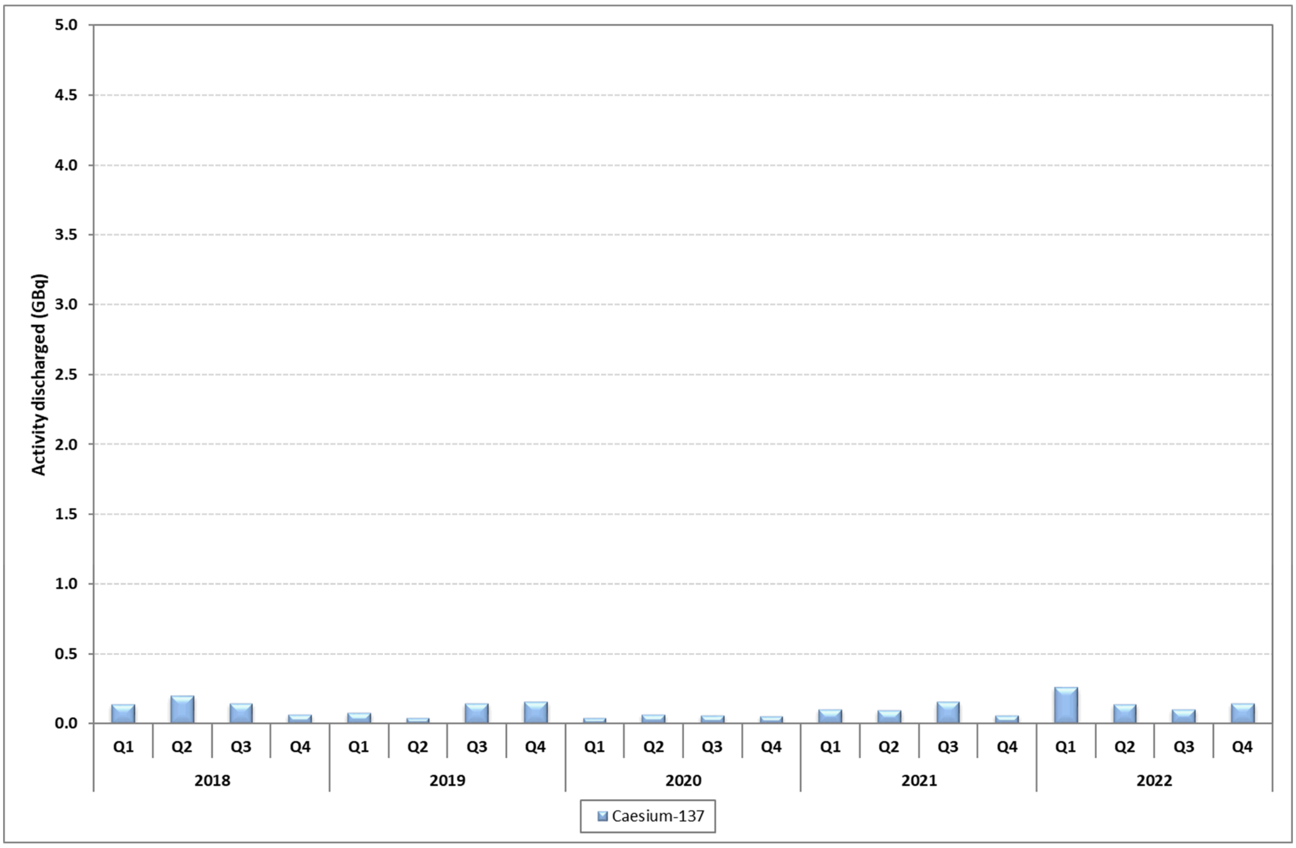

Figure 6: Liquid caesium-137 discharges 2018 - 2022.

2.5 Liquid Other Activity (excluding H-3, S-35, Co-60 & Cs-137)

The 'other activity' present in liquid discharges is defined as a gross measurement of radioactivity present in the effluent that has not already been accounted for within the measurements for the named nuclides tritium, sulphur-35, cobalt-60 and caesium-137. The annual limit for liquid other activity discharges at HPB is 80GBq.

Liquid other activity discharges over the previous five years are illustrated in Figure 7.

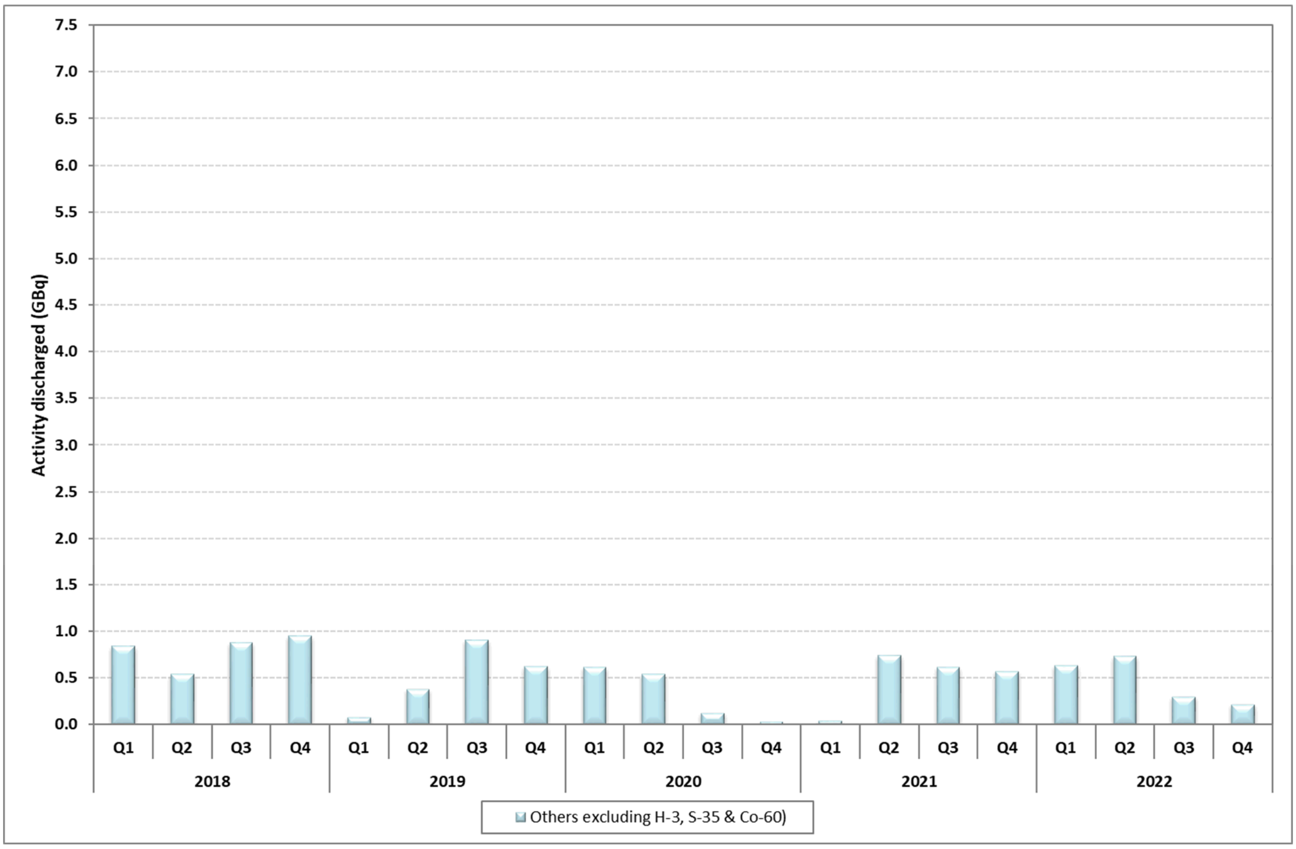

Figure 7: Liquid other activity discharges 2018 - 2022.

3 Hinkley Point B Gaseous Effluent Discharges

The HPB environmental permit authorises tritium (H-3), carbon-14 (C-14), sulphur-35 (S-35), argon-41 (Ar-41), iodine-131 (I-131) and cobalt-60 (Co-60) (associated with particulate matter) to be disposed via specific outlets as gaseous effluent discharges. Table 4 shows the annual and monthly discharges of each permitted radionuclide with the respective permit discharge limits.

Table 3: Total gaseous discharges in 2022.

Month	Tritium Activity (TBq)	Carbon-14 Activity (TBq)	Sulphur-35 Activity (GBq)	Argon-41 Activity (TBq)	Iodine-131 Activity (GBq)	Cobalt-60 Particulate Activity (MBq)
January	0.128	0.105	4.98	1.100	0.00029	0.76
February	0.084	0.075	4.21	0.473	0.00028	0.72
March	0.107	0.108	5.36	0.695	0.00031	0.75
April	0.107	0.101	4.71	0.793	0.00028	0.73
May	0.100	0.122	4.39	0.811	0.00030	0.76
June	0.097	0.108	3.66	0.699	0.00027	0.83
July	0.108	0.279	3.17	0.318	0.00041	1.04
August	0.039	0.309	1.53	0.000	0.00036	0.96
September	0.016	0.000	1.18	0.000	0.00027	0.74
October	0.011	0.000	1.2	0.000	0.00027	0.75
November	0.010	0.000	1.24	0.000	0.00027	0.77
December	0.008	0.000	1.24	0.000	0.00028	0.76
Annual Total (2022)	0.82	1.21	36.9	4.89	0.00358	9.57
Annual Total (2021)	1.11	1.21	40.20	7.19	0.00360	9.68
Annual Authorisation Limit	**12**	**3.7**	**350**	**100**	**1.5**	**100**

The following sections detail each permitted radionuclide or groups of radionuclides separately. All graphical data is scaled to the Quarterly Notification Level (QNL) stated in the permit.

3.1 Gaseous Tritium (H-3)

Tritium has a half-life of 12.3 years and the annual discharge limit for gaseous tritium discharges at HPB is 12TBq.

Tritium is one of the most abundant radionuclides present in the reactor coolant gas. It arises mainly from the ternary fission processes inside the fuel followed by diffusion through the fuel pin cladding into the coolant gas. The production rate for tritium therefore mainly depends on reactor power. As more than 99% of the tritium in the reactor gas is removed as water via the gas bypass plant, gaseous discharges of tritium are far smaller. Liquid discharges are less radiologically significant than gaseous discharges, and therefore a better environmental option.

The main chemical form of tritium is water vapour and it is therefore a gas that will not be trapped by filtration systems. The quantity of tritium that exists in coolant gas at any one time is dependent on coolant chemistry requirements at particular operational states. The chemistry is controlled by the ratio of moisture, methane and carbon monoxide in the coolant gas which balances the rate of graphite core oxidation against excessive carbon deposition on the boilers.

The levels of tritium decreased throughout 2022 following the shutdown of both reactors for defueling.

Gaseous tritium discharges over the previous five years are illustrated in Figure 8.

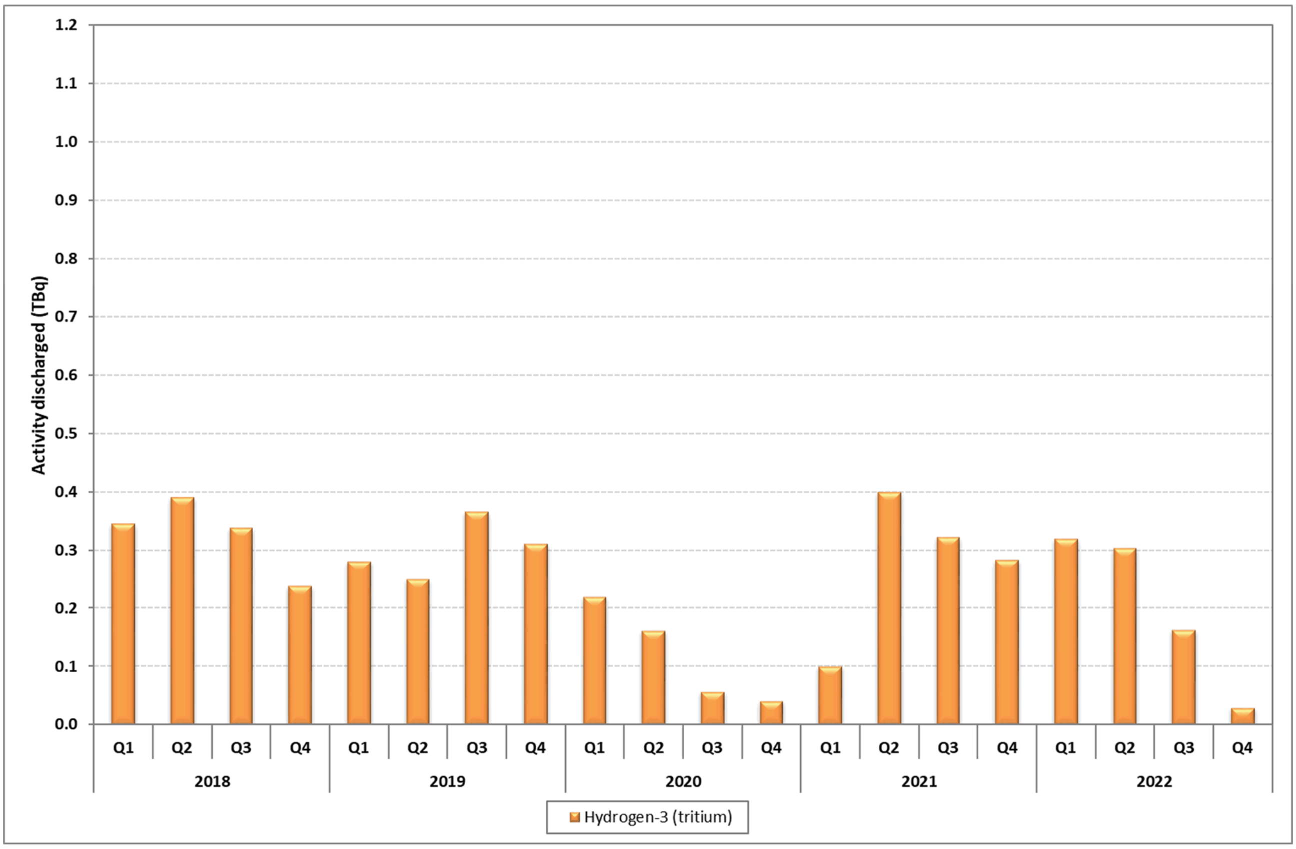

Figure 8: Gaseous tritium discharges 2018 - 2022.

3.2 Gaseous Carbon (C-14)

Carbon-14 has a half-life of 5730 years and the annual discharge limit for gaseous carbon-14 discharges at HPB is 3.7TBq.

Carbon-14 is either produced via the neutron activation of carbon, nitrogen and oxygen in the coolant gas or via the neutron activation of carbon and nitrogen in the graphite core. Once within the coolant gas, activation of nitrogen impurities is potentially the major contributor to carbon-14 production. Furthermore, due to the continued operation, the proportion of carbon-14 in the core increases due to ongoing neutron activation. All carbon-14 discharged to atmosphere is associated with the loss of reactor coolant gas and is discharged as carbon dioxide containing carbon-14.

The peak seen in Quarter 3 2022 is attributable to the depressurisation of the reactors at the end of generation. During August 2022 the blowdown from R3 led to the gaseous carbon-14 exceeding the Quarterly Notification Level (QNL) to 116% as detailed in Ref.7. This covered the rolling quarter of June, July and August, however for the calendar quarter period of July, August and September due to no further carbon-14 production, the discharges versus the QNL dropped to 98%.

Gaseous carbon-14 discharges over the previous five years are illustrated in Figure 9.

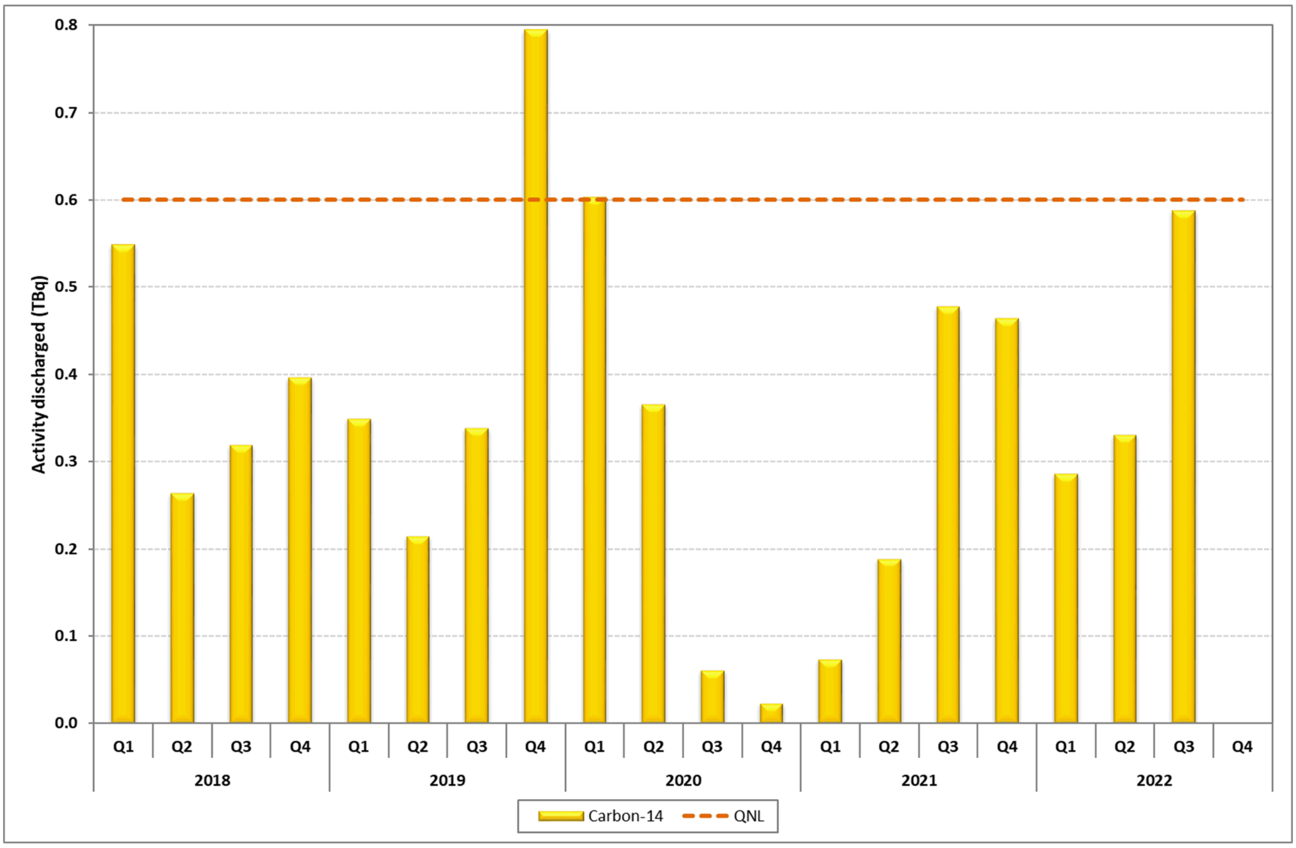

Figure 9: Gaseous carbon-14 discharges 2018 - 2022.

3.3 Gaseous Sulphur (S-35)

Sulphur-35 has a half-life of 87 days and the annual discharge limit for gaseous sulphur-35 discharges at HPB is 350GBq.

In AGR power stations, sulphur-35 is produced as a result of the irradiation of stable chlorine or sulphur that exists as impurities within the graphite or from oil deposits in the reactor and the gas circuits. The principle source of sulphur-35 in the reactor originates from small quantities of chlorine impurities present in the graphite core and in the sleeve of the fuel elements. The sulphur then combines with carbon dioxide and carbon monoxide to produce gaseous carbonyl sulphide which can be released from the reactor during normal operational activities and planned blowdowns.

Gaseous sulphur-35 discharges have been generally stable over the years, which reflects good control of the sulphur content in the reactor coolant. As both reactors are now not operating, the current levels sulphur-35 will decay away over time.

Gaseous sulphur-35 discharges over the previous five years are illustrated in Figure 10 .

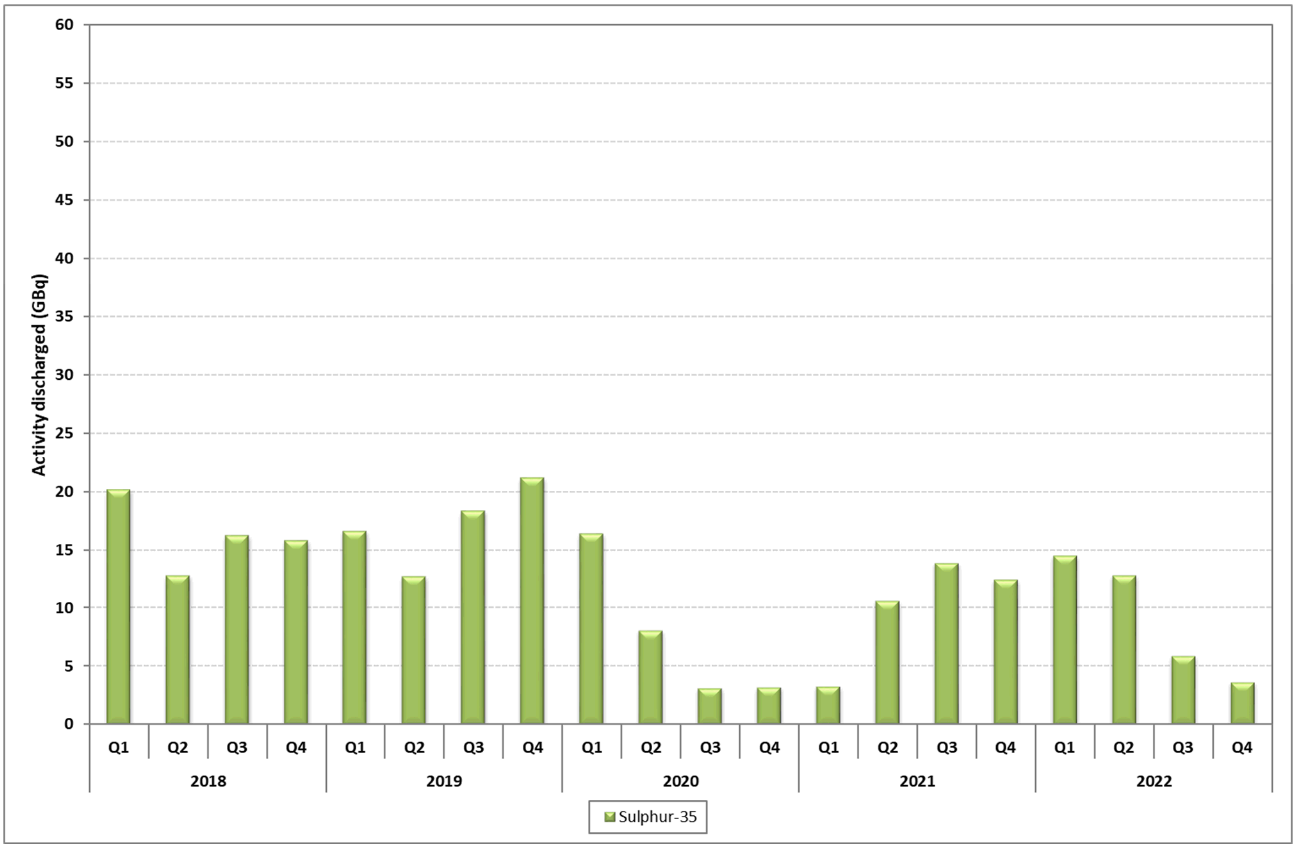

Figure 10: Gaseous sulphur-35 discharges 2018 - 2022.

3.4 Gaseous Argon (Ar-41)

Argon-41 has a half-life of 110 minutes and the annual discharge limit for gaseous argon-41 discharges at HPB is 100TBq.

Argon-41 is produced in the reactor by neutron activation of naturally occurring non-radioactive argon-40 that is present in the coolant gas as a contaminant from residual air and other bulk gases. Care is taken to exclude argon impurities in the coolant gas which will therefore minimise potential discharges. Due to its short half-life, argon-41 discharges are directly proportional to reactor power and the quantity of coolant gas being discharged.

The levels of argon-41 decrease in the discharges for 2022 due to its short life and the shutdown of R3 and R4. As there is now no production mechanism for argon-41, future discharges will remain at zero.

Gaseous argon-41 discharges over the previous five years are illustrated in Figure 11.

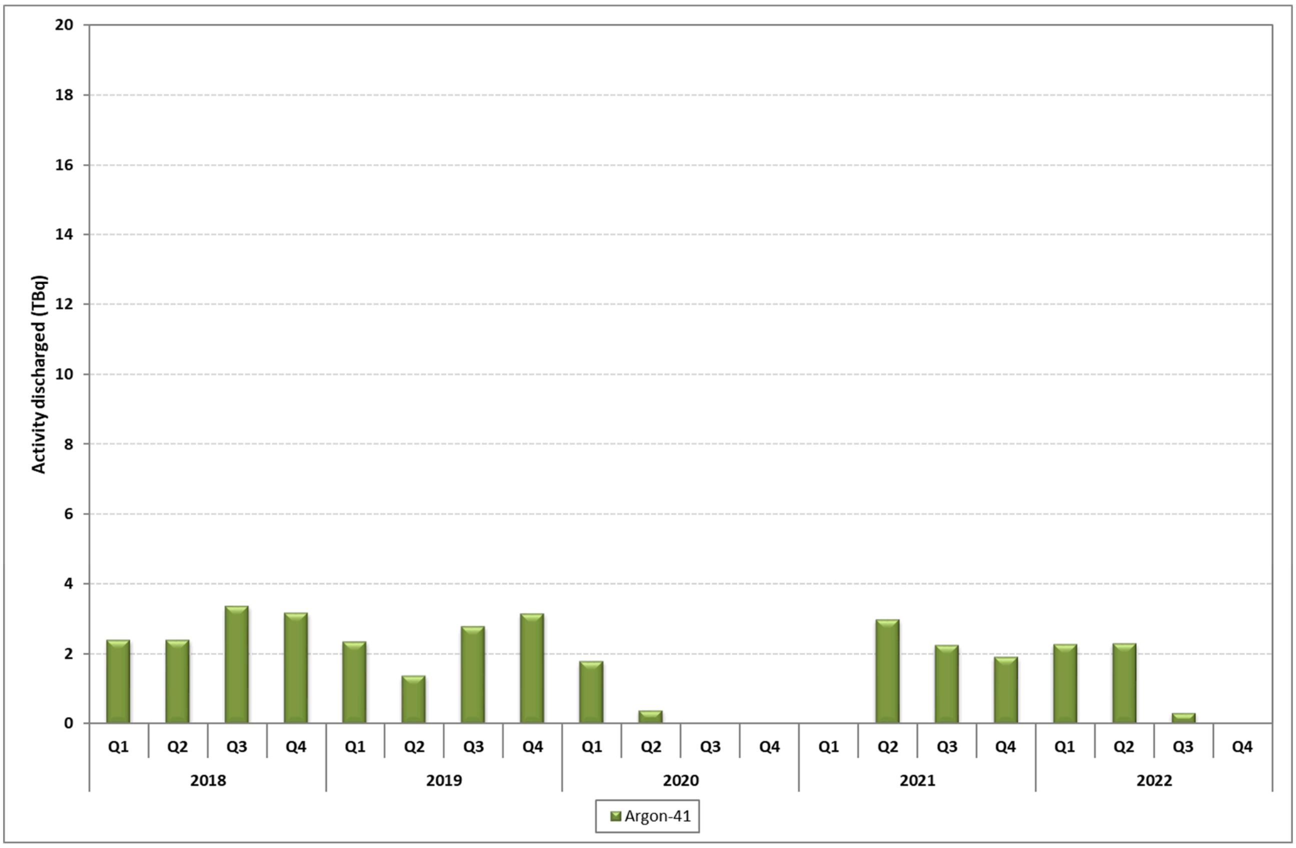

Figure 11: Gaseous argon-41 discharges 2018 - 2022.

3.5 Gaseous Iodine (I-131)

Iodine-131 has a half-life of just over 8 days and the annual discharge limit for gaseous iodine-131 discharges at HPB is 1.5GBq.

Iodine-131 is a fission product that remains inside the fuel unless there is a failure in the fuel cladding. If the cladding were to be breached, it would be detected by reactor instrumentation and reactor gas sampling, enabling measures to be put in place to minimise gaseous discharges. In addition, discharges of reactor coolant gas are routinely passed over iodine adsorption beds containing activated charcoal which are tested.

The discharges are reasonably constant as most results are below the Minimum Detectable Activity (MDA). There has been no significant variation in the monthly iodine-131 discharges and no positive results following shutdown of the reactors and verification of them being free of failed fuel.

Gaseous iodine-131 discharges over the previous five years are illustrated in Figure 12 .

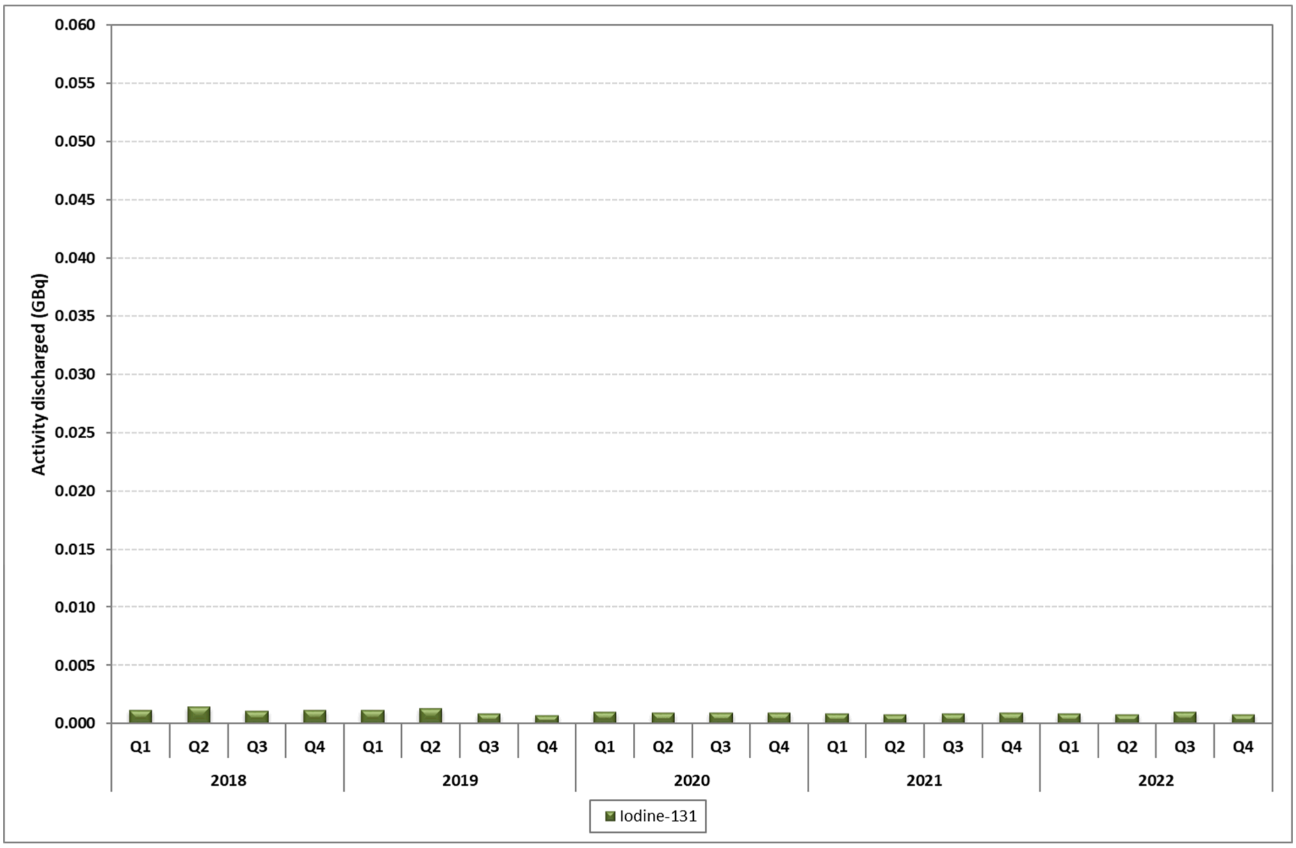

Figure 12: Gaseous iodine-131 discharges 2018 - 2022.

3.6 Gaseous Particulate Activity (Co-60)

Cobalt-60 has a half-life of just over 5 years and the annual discharge limit for gaseous cobalt-60 discharges associated with particulate matter at HPB is 100MBq.

Cobalt-60 is produced by neutron activation of cobalt-59 within steel components. Whilst most cobalt-60 remains immobile within these steel components, it can become mobile by mechanisms such as corrosion and erosion and be released into the reactor coolant gas. Corrosion is minimised by strict reactor coolant chemistry. Discharges of cobalt-60 associated with particulate matter are further minimised by filtration systems on routes subject to reactor gas and contaminated ventilation air with the main discharge points being:

- Contaminated ventilation systems which discharge ventilation air from many places around each reactor and from the central block. This route is also used for minor carbon dioxide discharges from the reactors to adjust reactor pressures or purity of the gas coolant.
- The reactor blowdown stack used for major discharges of carbon dioxide by reactor depressurisation.

The cobalt-60 levels have been stable throughout the period and are well below the annual limit of 100MBq due to most results being below the MDA.

Gaseous cobalt-60 discharges over the previous five years are illustrated in Figure 13 .

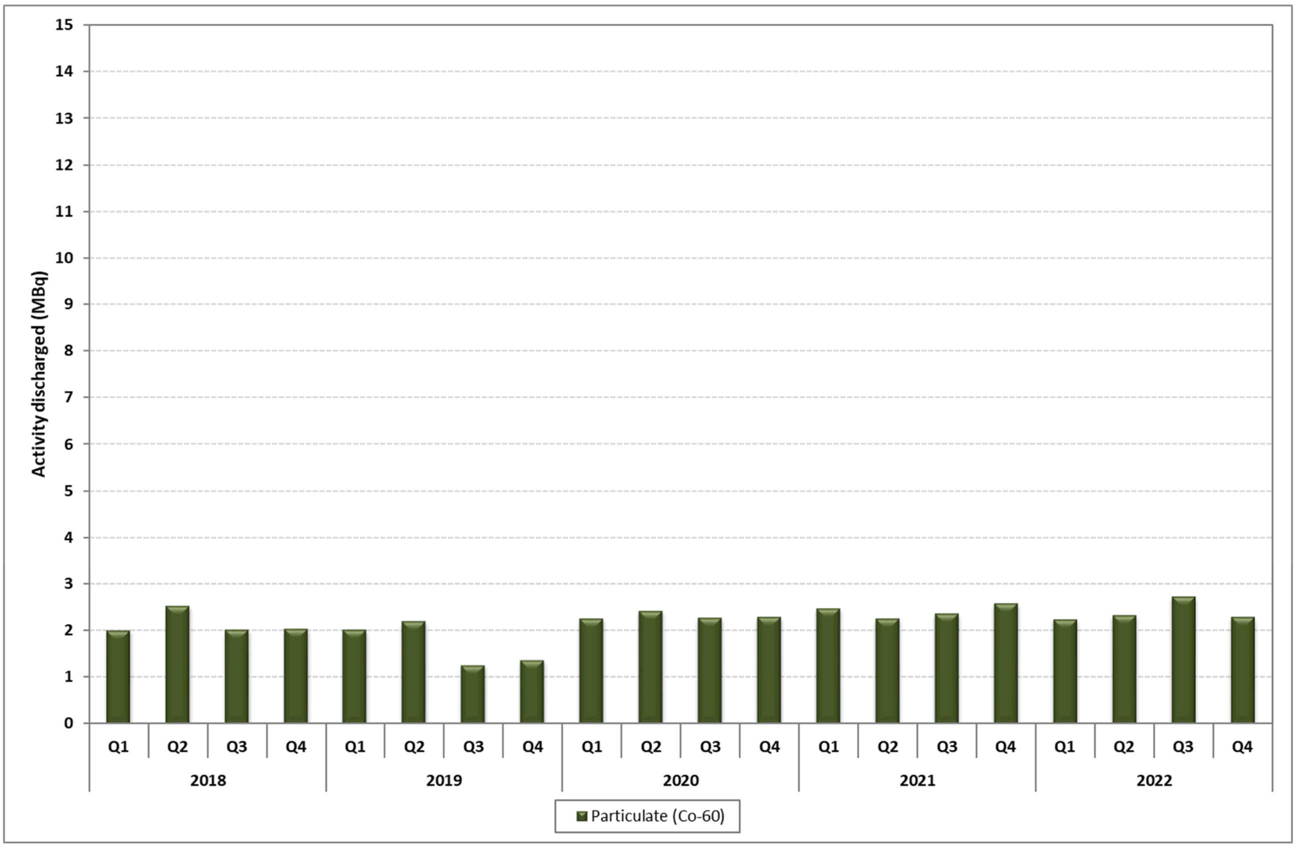

Figure 13: Gaseous cobalt-60 discharges (particulate) 2018 - 2022.

4 District Survey Monitoring

A substantial number of samples are taken from various reference points around the areas surrounding Hinkley Point B. The analysis ensures that any impact that the operation of the power station may have on the environment is adequately monitored according to the company procedures and the environmental permit. The district survey monitoring data, along with habit surveys of the local area are used to create a company dose model for the critical population. It is also utilised by the Centre for Environment, Fisheries and Aquaculture Science for their annual report on radioactive doses to members of the public.

4.1 Beach Dose Rates

The presence of radionuclides in sediments and soils can make a significant contribution to the total exposure to members of the public. For this reason, the estimation of 'external dose' is assessed by measuring gamma dose rates at specific locations.

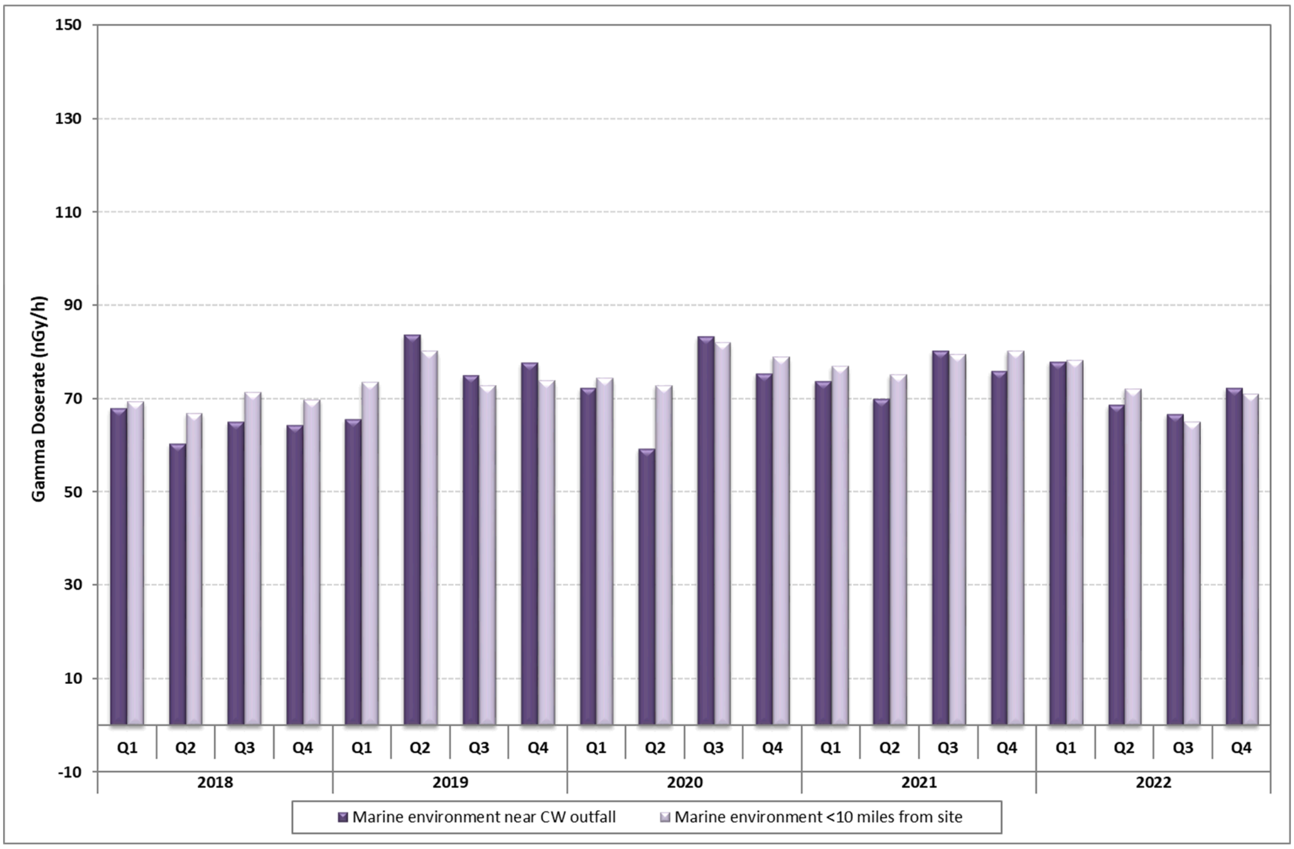

Figure 14: Gamma radiation monitoring on the beach 2018 - 2022.

The results in Figure 14 show the gamma dose rate in the vicinity of the cooling water (CW) outfall at HPB. The dose rate has remained fairly stable over the past 5 years with an average dose rate of approximately 72nGy/h. The major contribution to the observed gamma dose rate is from natural sources, rather than radioactive discharges from HPB. This includes cosmic rays and naturally occurring radionuclides in the sediment and rocks.

A better indication of the impact of liquid discharges on beach sediment can be seen from the caesium-137 activity concentrations shown in Figure 16.

Figure 14 also shows dose rates within a 10 mile radius from site. These results are a mean of ten separate measurements taken at a range of different sites. Although the dose rates vary slightly between individual sites depending on the underlying geology, there is no significant difference between the average dose rate at these points and those that are near to the outfall. The dose rate within a 10-mile radius from site is also fairly stable over the past 5 years with an average dose rate of approximately 74nGy/h.

4.2 Marine Sampling

Seaweed and sediment are all collected from a number of locations around the locality and analysed under the environmental monitoring programme each quarter.

Seaweed is collected from three locations near the HPB cooling water outfall and from beaches within 10 miles from the site. A particular variety of seaweed, Bladderwrack (*Fucus Vesiculosis)* is collected. In addition to occasional use in foods and as fertilisers, seaweeds are useful as indicator materials in an environmental monitoring programme because they effectively concentrate radionuclides.

The sole gamma emitting artificial radionuclide that was positively detected in seaweed was caesium-137. Measurements of gross beta activity were once again assessed for reassurance purposes. The gross beta activity in seaweed close to the HPB cooling water outfall in 2022 was in the range of 166 to 313 Bq/kg (wet weight). The predominant contribution was due to the presence of the naturally occurring potassium-40 radionuclide, with levels considerably greater than those for caesium-137. The data from seaweed analysis over the previous 5 years is shown in Figure 15.

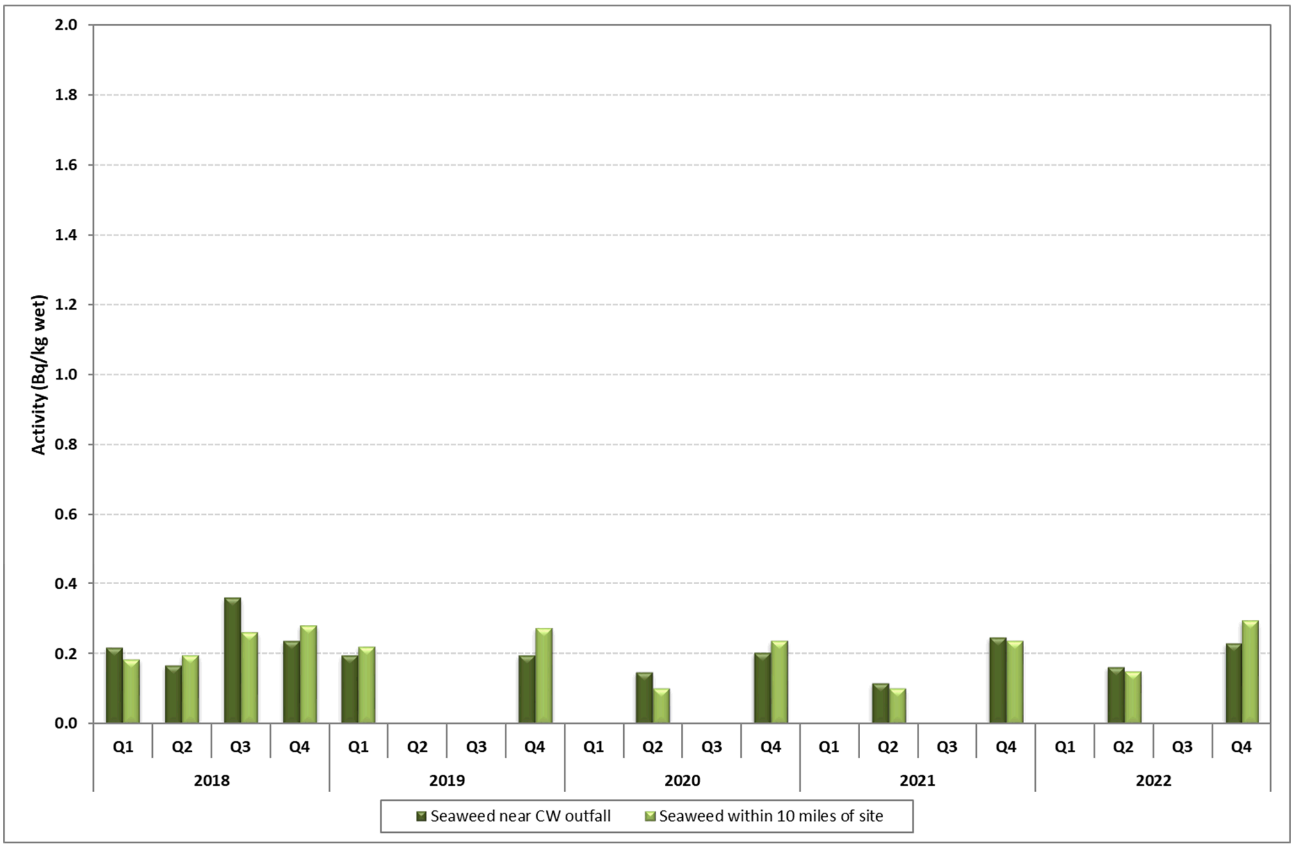

Figure 15: Ceasium-137 activity in seaweed 2018 - 2022.

The caesium-137 activity concentration appears broadly stable over the period considered here albeit that, due to the low levels, there is some scatter in the data. Although maximum activity concentrations have been observed in samples obtained closest to the outfall, there is no consistent trend apparent within the inevitable scatter inherent in a series of low level data. It is therefore considered that both sets of results are similar.

Like seaweed, sediment is a useful indicator material in an environmental monitoring programme because it effectively concentrates radionuclides. The presence of radionuclides in sediment can make a significant contribution to the total exposure of members of the public, via the external exposure pathway. The sole gamma emitting artificial radionuclide that was positively detected in sediment in the vicinity of Hinkley Point was caesium-137.

Samples of sediment are collected quarterly from three locations near the HPB cooling water outfall and from beaches within 10 miles of the site. Data in Figure 16 shows the average caesium-137 concentration in sediment. The range of activity concentrations is broadly similar for both sets of samples, although as expected, the actual activity in the samples within 10 miles of site is generally less than the activities present at the HPB cooling water outfall.

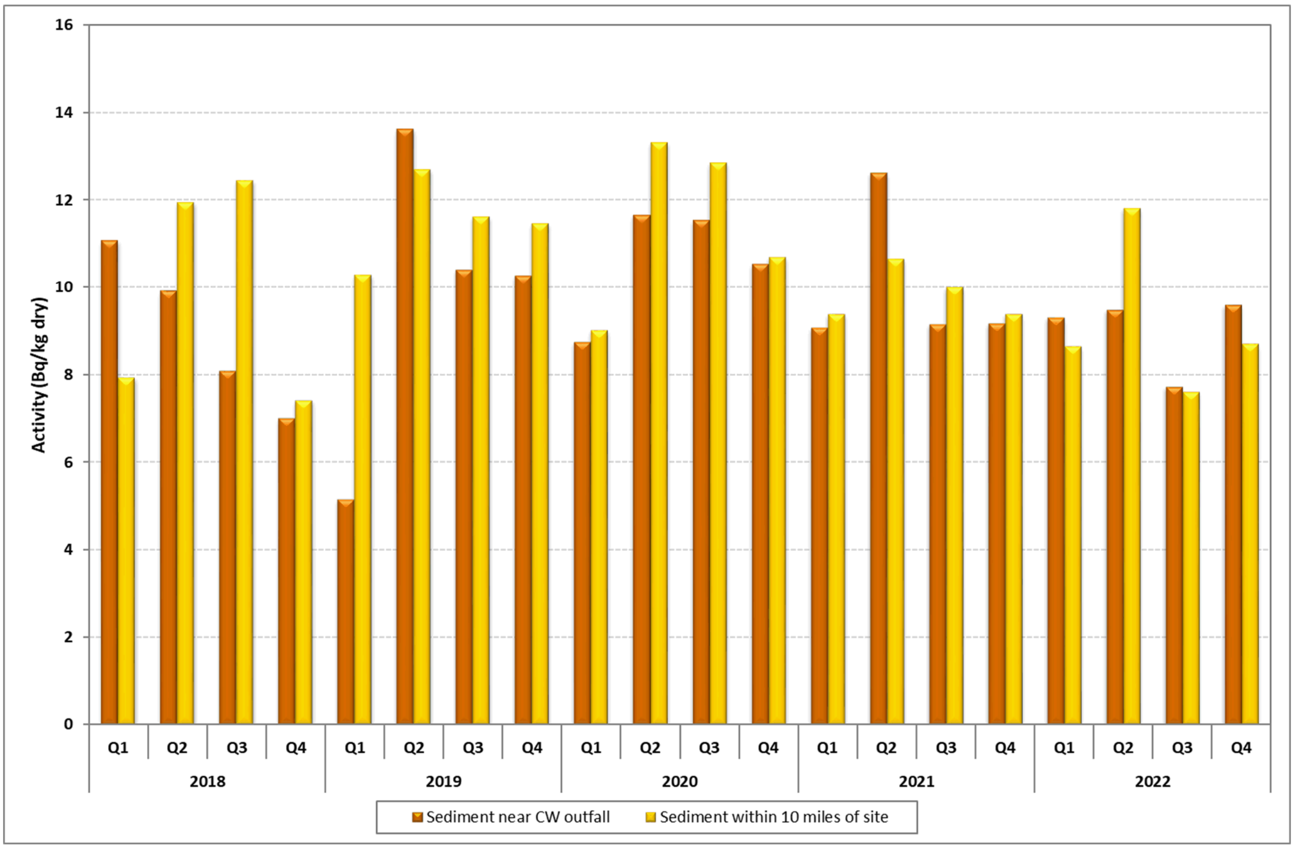

Figure 16: Ceasium-137 activity in sediment 2018 - 2022.

Measurements of gross beta activity are also undertaken and values for sediment close to the cooling water outfall in 2022 were in the range of 701 to 1096Bq/kg (dry weight). The predominant contribution was due to the presence of natural radionuclides including potassium-40.

4.3 Terrestrial Dose Rates and Radioactivity

Terrestrial (land) dose rates are measured quarterly within 1 mile from Hinkley Point and between 1 and 5 miles from HPB. The radiation dose rates shown in Figure 17 represent the average from the 14 analysis sites (7 locations < 1mile and 7 between 1 and 5 miles from HPB).

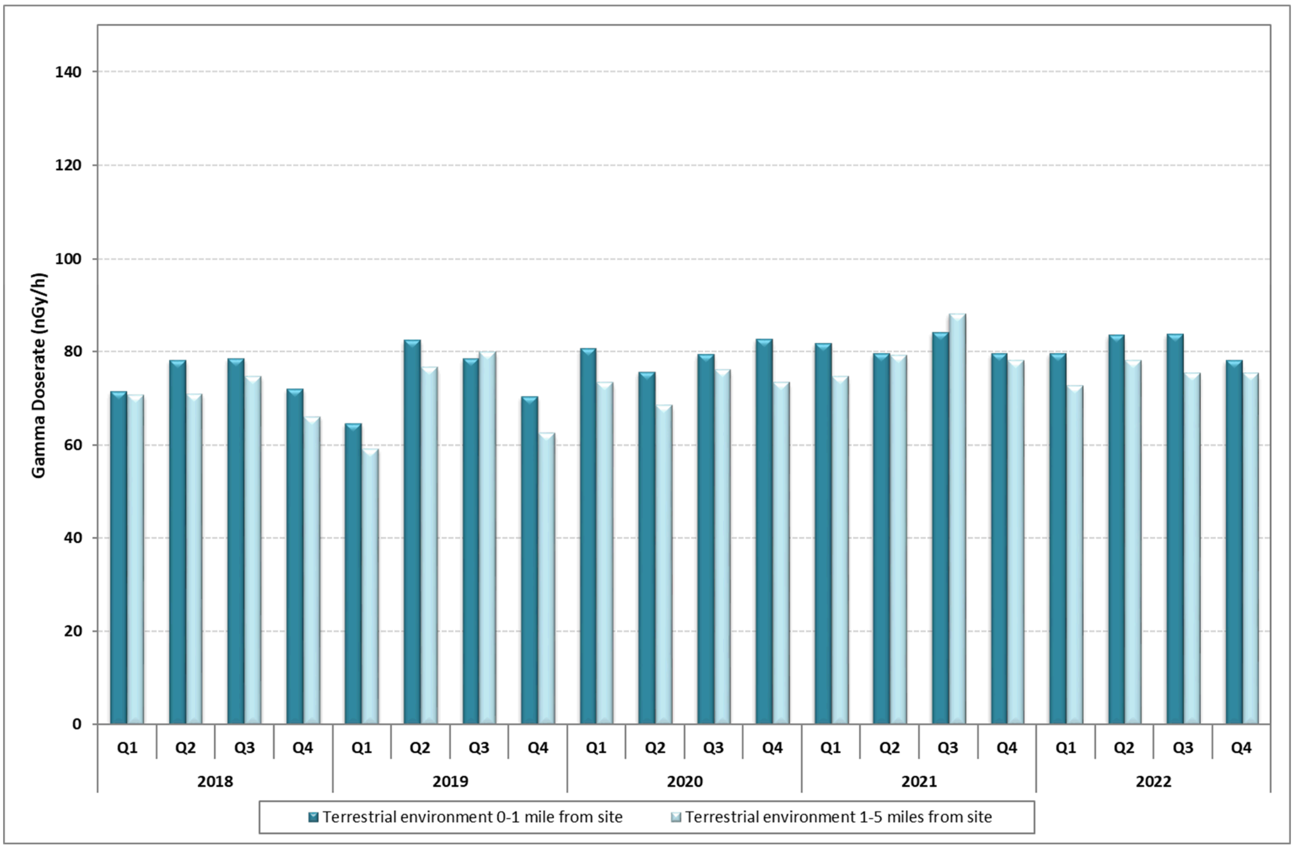

Figure 17: Terrestrial gamma dose rate up to 5 miles from HPB 2018 - 2022.

Dose rates have remained broadly stable over this 5 year period and there is no significant difference between the average dose rate of approximately 78nGy/h at up to 5 miles away, and those that are close to Hinkley Point with an average dose rate of approximately 74nGy/h.

Exposure figures are measured at the HPB site on a quarterly basis using a number of thermoluminescent dose meters (TLD). The annual boundary gamma dose rates for 2022 are presented in Report for Direct Radiation Dose to the Public from EDF Energy Nuclear Power Stations in 2022 (Ref. 8). This compares favourably with the annual accumulated gamma dose measured by TLDs positioned some distance from HPB.

Radioactivity is measured using tacky shades positioned at 9 sites around the locality. A range of radionuclides are analysed for on a monthly basis as shown in Table 4 with the values reported being maximum figures from the 12 month period. They are all MDA and are therefore maximum estimates.

Table 4: Radioactivity in tacky shade collectors during 2022.

Radionuclide	Typical MDA (Bq/shade)
Chromium-51	<0.70
Manganese-54	<0.05
Cobalt-58	<0.06
Cobalt-60	<0.05
Zinc-65	<0.16
Silver-110m	<0.05
Iodine-131	<1.09
Caesium-134	<0.07
Caesium-137	<0.05
Americium-241	<0.70

4.4 Terrestrial Sampling

Milk and herbage samples are taken from farms within 5 miles of HPB once a quarter and involve both on site analysis and some that is conducted by an external analytical laboratory. Annual soil core samples at various depths are also taken from the local farms on a rotational basis.

HPB were unable to report the results for S-35 for both milk and herbage for the Q4 of 2022. This was due to the samples that were sent for analysis at the external EDF Contracted Analytical Laboratory were lost in transit. This was documented under Ref. 9 and following review by the EA, the Station's management system for sample dispatch was deemed appropriate and no further was taken.

Milk samples are analysed for sulphur-35, iodine-131, caesium-134 and caesium-137. Second quarter samples are additionally analysed for carbon-14. The maximum results from the milk samples for each quarter are shown in Table 5.

Table 5: Maximum results for milk samples <5 miles from HPB during 2022.

Quarter	C-14 (Bq/l carbon)	S-35 (Bq/l)	I-131 (Bq/l)	Cs-134 (Bq/l)	Cs-137 (Bq/l)
1	Not analysed	<0.38	<0.18	<0.10	<0.07
2	22	<0.54	<0.12	<0.10	<0.06
3	Not analysed	<0.72	<0.18	<0.10	<0.07
4	Not analysed	Not analysed	<0.16	<0.10	<0.07

The natural background levels of carbon-14 in the environment are approximately 250 Bq/kg of carbon. The pathway for carbon-14 into milk is via deposition on herbage from gaseous discharges. The most likely source of any radio-caesium is fall-out from weapons testing and the Chernobyl incident with the results for radio-caesium and iodine-131 being below the threshold of detection for the respective analysis techniques.

For herbage, usually grass, the sulphur-35 content is measured each quarter with an additional carbon-14 measurement being made in the second quarter. Site 5 is the closest location to the station where grass can be sampled, but there are no edible crops grown there. The other two farm locations where grass is sampled are further away from HPB. The data from 2022 for herbage analysis is shown in Table 6.

Table 6: Radioactivity in herbage samples during 2022.

Sampling Location	Sulphur-35 (Bq/kg)				C-14 (Bq/kg carbon)
	Q1	Q2	Q3	Q4	Q2
Site 5 (nearest)	3.63	2.02	1.36	Not analysed	15.80
Inner Farm 23	1.12	3.18	0.64	Not analysed	12.40
Inner Farm 24	2.65	1.41	1.28	Not analysed	10.70

The results in Table 6 show by comparison, slightly elevated readings of both sulphur-35 and carbon-14 at the nearest sampling location (Site 5). This is due to the close proximity of the sampling location to the power station and the prevailing winds. The levels do however decrease at sampling locations further away from HPB and the carbon-14 readings are only slightly above the natural background level of 250 Bq/kg of carbon-14 in the environment. Readings of sulphur-35 correspond to reactor gas blowdowns during shutdown periods. The actual impact from these levels is low. Gamma spectroscopy of herbage is also undertaken, and traces of caesium-137 are detected, consistent with national background measurements resulting from known historic events. Due to changes in the Environmental Monitoring Programme, Inner Farm 20 is no longer sampled.

Annual soil core samples are taken on a rotational basis so that each site is sampled at least once every five years. In 2022, Site 5 was the sampling location and the results are shown in Table 7.

Table 7: Reactivity in soil core samples for 2022.

Sampling Location	Total Beta (Bq/kg dry)	Caesium-134 (Bq/kg dry)	Caesium-137 (Bq/kg dry)
Site 5 (5cm Depth)	1108	<0.88	7.61
Site 5 (30cm Depth)	1013	<0.80	3.00

The results show no evidence of build-up of contamination from site emissions and instead are likely to represent the legacy of fallout from atmospheric testing of atomic weapons in the 1950's and 1960's.

5 Dose Summary

An annual report entitled Radioactivity in Food and the Environment (RIFE) is compiled by the Centre for Environment, Fisheries and Aquaculture Science on behalf of the Environment Agency, Food Standards Agency, Food Standards Scotland, Natural Resource Wales, Northern Ireland Environment Agency and the Scottish Environment Protection Agency (Ref 1). The report uses data from monitoring programmes conducted by these agencies and by nuclear site operators to assess the radioactive dose received by members of the public in the vicinity of nuclear licensed sites and industrial and landfill sites.

The estimated annual dose to members of several local groups of the general public in 2021 is summarised in Table 8. Full dose assessment figures for 2022 are not yet available and will be documented in the next annual report.

Table 8: Summary of doses taken from the annual 2021 RIFE report (Ref. 10).

Radiation Exposure Pathway	Exposure (mSv per year)		
	2019	**2020**	**2021**
Total dose to the public from all pathways and sources of radiation	0.021	0.023	0.030
Fish and shellfish consumption, and exposure to external radiation over intertidal areas	0.014	0.014	0.018
Terrestrial foods, external exposure and inhalation near site	<0.005	0.005	<0.005

Discharges of radioactivity from Hinkley Point B and results of the environmental monitoring measurements have shown no significant change in 2022. The population group affected is small and it is therefore unlikely that annual doses to members of the public will vary from the figures listed in Table 8.

The total dose from all pathways and sources of radiation was 0.030 mSv in 2021 (Ref.10). This equates to approximately 3 % of the effective dose limit (1 mSv) to members of the public as defined in the Ionising Radiations Regulations 2017 (IRR17). For comparison, the average annual radiation dose to the public in the UK from natural radioactivity is 2.7 mSv as shown in the UK Health Security Agency (UKHSA) information in Figure 18.

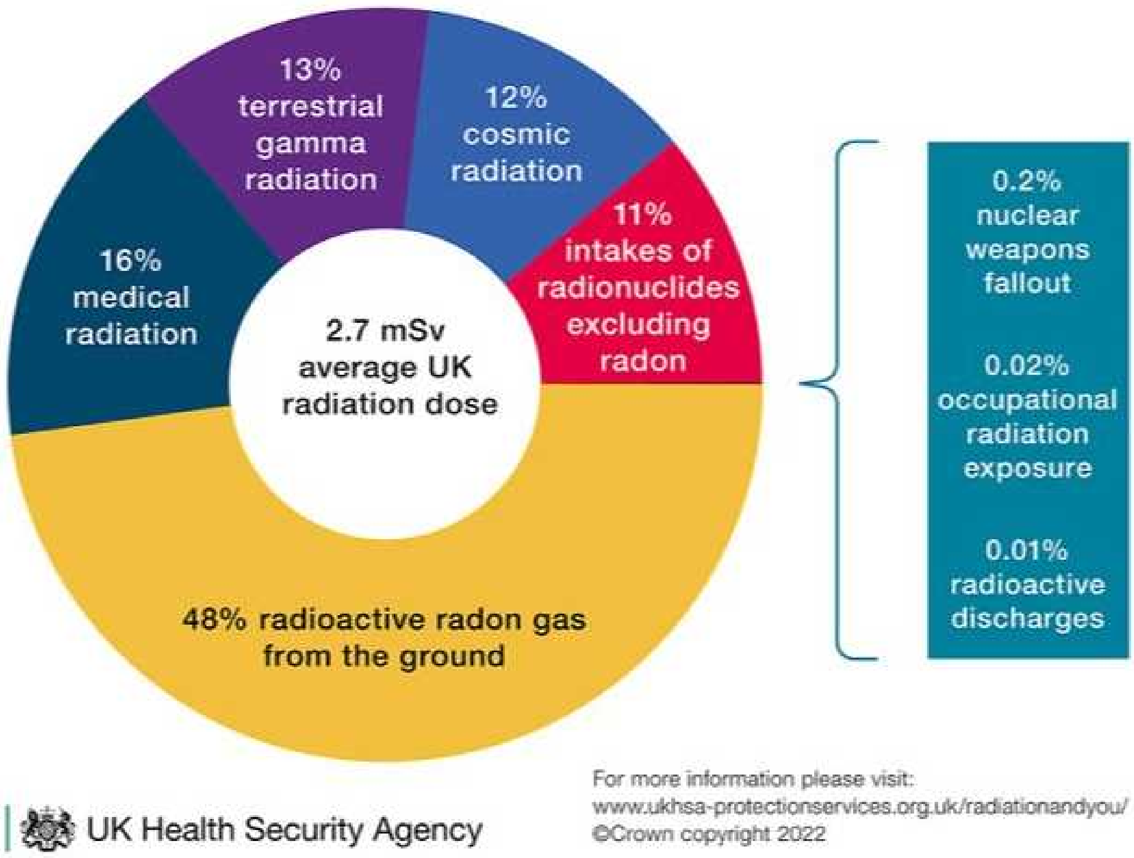

Figure 18: UKHSA comparison of radiation doses.

6 Solid and Non-Aqueous Liquid Waste Disposal

Waste minimisation and management proceeded well during 2022. There were seven dispatches during 2022 which were made up of:

- large volume metal waste from the flask bay refurbishment,
- larger metal items on pallets such as bearing and valves,
- a Full Height ISO (FHISO) of some higher activity wastes sent to Winfrith for onward super-compaction thus reducing the volume held in the Station's decay store,
- AETP sludge,
- 124 drums of soft waste,
- 8 pallets of filters.

Overall, 2022 saw a significant amount of solid waste dispatched, especially some of the more difficult to process and labour intensive items and those over two years old. This had a positive result on volumes of old waste and larger items, although resulted in the Station being slightly above the target of 50m^3 at the end of the year due to some post shutdown waste processing that occurred on the Station and the generation of further AETP waste at year end.

7 References

Ref.	Document Identifier	Document Title
1.	EPR/CB3735DT	RSR EPR Permit
2.	EPR/EP3334LZ	Combustion Plant EPR Permit
3.	UK-E-IN-11441	Greenhouse Gas Emissions Trading Permit
4.	AR 01260071	Ponds sampling valve left open
5.	AR 01282310	Dirty oil tank bund leak – Unplanned ECO entry E6
6.	AR 01306149	RDR/221107/CB3735DT – Permit compliance for solid radwaste
7.	AR 01284326	Expected C-14 QNL Exceedance for R3 PDO Blowdown
8.	ERO/REP/0253/GEN	Direct Radiation Dose to the Public from EDF Energy Nuclear Power Stations in 2022
9.	AR 01305137	Missing samples – milk and herbage Q4
10.	RIFE 27 for 2021	https://www.gov.uk/government/publications/radioactivity-in-food-and-the-environment-rife-reports/rife-27-summary-radioactivity-in-food-and-the-environment-2021
11.	HINB/R/TET/1088	Best Available Techniques Review of the Hinkley Point B Environmental Monitoring Programme 2022