Environmental Permitting (England and Wales) Regulations 2010

Application by NNB Generation Company Ltd (NNB GenCo) to carry on radioactive substance activities at Hinkley Point C Power Station EPR/ZP3690SY/A001

Decision document

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LIT7931

Executive summary

1 NNB Generation Company Limited (NNB GenCo) has applied for an environmental permit to allow it to discharge and dispose of radioactive wastes from a proposed new nuclear power station it wishes to build at Hinkley Point in Somerset. Radioactive waste disposals are a radioactive substances activity under the Environmental Permitting (England and Wales) Regulations 2010 (EPR 10). The proposed new power station is known as Hinkley Point C Power Station.

2 Hinkley Point is located on the Somerset coast approximately 12 km north-west of Bridgwater. The proposed power station is to be located immediately to the west of the two existing Hinkley Point power stations. The proposed power station has two pressurised water reactors based upon EDF and AREVA's UK EPR™ type (UK EPR™). The total expected net electrical capacity is 3260 MW. This is approximately 6% of the UK national requirement for electricity.

3 We have already assessed the UK EPR™ reactor in our Generic Design Assessment process and issued an interim Statement of Design Acceptability (SoDA) in December 2011. We are now satisfied that EDF and AREVA have fully resolved our two GDA Issues, and we issued a full SoDA in December 2012.

4 Radioactive waste would be produced by activities associated either directly or indirectly with operating and maintaining the reactors. In particular, operating the reactors would generate radioactivity in the water of the reactor's primary circuit, some of which would subsequently become waste discharged to the environment. Radioactive wastes produced by operating the nuclear reactors include:

- Gaseous radioactive waste would be discharged to the environment mostly via two main outlets, one for each reactor.
- Aqueous radioactive waste would be discharged with the cooling water into the Bristol Channel, at a point approximately two kilometres off-shore.
- Solid radioactive waste would be produced during the treatment of gaseous and liquid waste, and during the operation and maintenance of the power station and:
  - low-level solid waste, oils and solvents would be transferred to off-site treatment and disposal facilities, while
  - higher activity solid waste would be stored on-site until suitable disposal facilities are available.

5 We previously advertised the application and consulted on it. We received 200 responses from partner organisations, other interested groups and members of the public. A large number of the public responses used a template letter and raised the same issues. In total we identified just over 100 separate issues. We made all the responses available on public registers, and endeavoured to address all comments in our draft decision document.

6 In our draft decision document we set out our preliminary conclusions on NNB GenCo's application. We considered:

- How NNB GenCo proposed to use best available techniques (BAT) to minimise
  - the production of radioactive waste
  - the discharge of radioactive waste
  - the impact of discharges on people, and adequately protecting other species.
- NNB GenCo's current management arrangements and how they would develop into an operating organisation.
- NNB GenCo's proposals for limits for discharges.
- Our conclusions at GDA.
- The predicted impacts on people.
- The predicted impacts on the environment, including the nationally and internationally important designated habitats and species of the Severn Estuary.
- The matters raised by consultees responding to our consultation on the application.

7 We also drafted a permit with our proposed limits as listed in the table below.

Proposed limits for gaseous discharges		
Radionuclides	**Proposed annual limit GBq**	**Proposed QNL GBq**
Tritium	6,000	400
Carbon -14	1,400	300
Noble gases	45,000	1500
Iodine-131	0.4	0.064
Other Fission and activation Products	0.12	0.008
Proposed limits for aqueous discharges		
Tritium	200,000	60,000
Carbon-14	190	18
Cobalt 60	6	0.3
Caesium-137	1.9	0.1
Other radionuclides	12	0.6

8 Our draft permit was based on our standard template permit for radioactive waste discharges and disposals from a nuclear licensed site. We included 19 requirements to provide additional information and one pre-operational measure. These were to help ensure that the proposed power station would be built and capable of being operated in accordance with commitments made in NNB GenCo's application.

9 We have assessed the impact (known as the radiation 'dose') of discharges at the permit limits for Hinkley Point C to be 8.4 microsieverts (µSv) a year to the theoretical representative person who would be most exposed to the discharges, including an allowance for direct radiation from the site. This person is a known as the 'milk consumer' and the source of the radiation dose is mainly radioactivity in discharges to air.

10 We have also assessed the maximum impact of Hinkley Point A, B and C power stations in total. In this case the most exposed representative person is known as the 'crustacean consumer', this person also spends time on the beach, and most of the dose is from radioactivity in liquid discharges to the marine environment. We assessed the dose to be 43 µSv a year, including a contribution of 36 µSv a year from past discharges.

11 Both these doses are significantly less than the legal dose limit for the public of 1000 µSv a year and less than UK dose constraints.

12 Our assessment of the impact of discharges on wildlife showed that levels were less than one thousandth of the level at which we consider there will be no harm to the integrity of a conservation site.

13 Our overall conclusion at that stage was that there was no reason why we should not grant a permit. We considered that the limits and conditions in the draft permit were suitable to protect people and the environment.

14 We then consulted on our draft decision and draft permit between 13 August and 9 November 2012. The purpose of that consultation was to seek views to help inform our final decision, in particular whether there were any errors, omissions or new relevant information that had not been considered.

15 For our consultation we advertised and published our draft decision and draft permit. We held public surgeries and meetings with local councillors of communities in Somerset and South Wales. We received 44 responses from partner organisations, other interested groups and members of the public. Most of the responses restated views given in responses to the consultation on the application. We have made all the responses available on public registers, and have endeavoured to address all comments in this decision document and provide clarification on restated concerns.

16 We assessed all the issues raised by consultees; we sought advice from the Health Protection Agency on some of the issues raised. We consider that nothing has been raised that requires us to make any changes to our draft decisions. We have, therefore, decided to grant NNB GenCo an environmental permit to allow it to discharge and dispose of radioactive waste from the new nuclear power station it proposes to build at Hinkley Point.

17 The permit we are granting has some minor changes compared to the draft permit we consulted on. We removed the disposal of very low level waste (VLLW) from the permit because NNB GenCo has decided to use an exemption to EPR 10 that came in to force after the application was made. We have made minor amendments to the information requirements to incorporate some new GDA assessment findings. We have also corrected some typographical errors.

Contents

1 Introduction

1.1 About this decision document

18 The purpose of the decision document is to set out our considerations and decisions on the application.

19 This document explains:

- the role of the Environment Agency
- our role in nuclear regulation
- how we process, consult on and determine applications (section 2)

20 In this document we have:

- Summarised the application and our consultation on it (section 3).
- Described our assessment (section 4).
- Included, at the appropriate place, those issues raised by consultees in response to the consultations on the application and our draft decisions. We have:
  - Set out our view on the issues raised.
  - Identified by name organisations we have working together agreements with.
  - Not identified by name members of the public who responded (referring to them only as 'consultee') to our consultation on the application.
- Set out our decision (section 5).

1.2 The Environment Agency

21 Our corporate strategy **Creating a better place 2010-2015**[1] sets out our aims and describes the role we play in being part of the solution to the environmental challenges society faces.

22 Our strategy aims to create a better place by securing positive outcomes for people and wildlife, in five key areas. We will:

- Act to reduce climate change and its consequences.
- Protect and improve water, land and air.
- Work with people and communities to create better places.
- Work with businesses and other organisations to use resources wisely.

[1] http://publications.environment-agency.gov.uk/PDF/GEHO1109BQXE-E-E.pdf. Note all hyperlinks were active at the time of publication.

- Be the best we can.

1.3 Our role in nuclear regulation

23 We regulate the environmental impacts of nuclear sites, such as nuclear power stations, nuclear fuel production plants and plants for reprocessing spent nuclear fuel, through a number of environmental permits. These permits may be needed when preparing the site and constructing, operating and decommissioning the plant.

24 The permits we grant include conditions and limits. In setting these, we take into account all relevant national and international standards and legal requirements to make sure that people and the environment are properly protected. These standards and requirements are described in government and Environment Agency guidance available at:

Defra Environmental Permitting Guidance
http://www.defra.gov.uk/environment/policy/permits/index.htm

DECC managing the disposal of radioactive waste
https://www.gov.uk/government/policies/managing-the-use-and-disposal-of-radioactive-and-nuclear-substances-and-waste

EA Environmental Permitting Guidance
http://www.environment-agency.gov.uk/business/topics/permitting/32320.aspx

EA Nuclear Regulation
http://www.environment-agency.gov.uk/business/sectors/32517.aspx

25 We inspect sites to check that operators are complying with the conditions and limits, and that they have arrangements in place to help ensure compliance. We may take enforcement action (for example, issuing an enforcement notice or taking a prosecution) if they are not compliant.

26 We regularly review permits, and vary them if necessary, to make sure that the conditions and limits are still effective and appropriate. Where significant changes are required, we may consult on these changes.

27 We work closely with the Office for Nuclear Regulation[2] (ONR), which regulates the safety, security and nuclear material safeguards and transport aspects of nuclear sites.

28 A consultee on the application was concerned whether sufficient funds would be available to ensure adequate regulation. In line with the 'polluter pays' principle, we have a cost recovery scheme for the regulation of the nuclear industry that fully recovers our costs from the nuclear operators.

[2] The Office for Nuclear Regulation (ONR) was created on 1st April 2011 as an Agency of the Health and Safety Executive (HSE). It was formed from HSE's Nuclear Directorate and has the same role.

1.4 Our regulatory role in the development of new nuclear power stations

29 As with existing nuclear sites, any new nuclear power station will require environmental permits from us to cover specific aspects of site preparation, construction, operation and eventually decommissioning. In the light of government and industry expectation that plants of almost the same design might be built on a number of sites and potentially be run by different operating companies, we have split our process for assessing and permitting the operational stage of new nuclear power stations into two phases.

30 In the first phase, Generic Design Assessment (GDA), we carry out detailed assessments of candidate designs put forward by reactor designers. We assessed the design of the UK EPR™ pressurised water reactor submitted by Electricité de France SA and AREVA NP SAS ('EDF and AREVA'). In December 2011, we published our decision document and issued an Interim Statement of Design Acceptability (interim SoDA or iSoDA)[3]

31 During our assessment of the design we identified GDA Issues and assessment findings. A GDA Issue is a matter that the reactor designer must resolve before we would issue a full SoDA. An assessment finding is a matter that any future operator has to address during either the detailed design, commissioning or early operation of the reactor.

32 Our GDA decision for the UK EPR™ was subject to two GDA Issues, both joint with ONR. EDF and AREVA proposed resolution plans to address both GDA Issues. With ONR, we reviewed these plans and considered them credible.

33 We summarised the two GDA Issues in our GDA decision document as:

a) Provide a consolidated final GDA submission, including agreed design change for the UK EPR™. The Issue reflects that EDF and AREVA will need to continue to control changes to the GDA submission documents, resulting from the management of possible changes to the design until the issue of the final SoDA. Design changes are also possible in resolving the GDA Issues identified by ONR.

b) Consider and action plans to address the lessons learned from the Fukushima event.

34 We are now satisfied that EDF and AREVA have fully resolved our two GDA Issues, and we issued a full SoDA for the UK EPR™ in December 2012, together with a supplement to the GDA decision document.

35 We have now completed the second phase for Hinkley Point C, and completed our determination of an application for a radioactive substances regulation (RSR) environmental permit from NNB GenCo for its proposed

[3] http://www.environment-agency.gov.uk/homeandleisure/135648.aspx

Hinkley Point C Power Station. In determining the application, we have taken into account the work we have done during GDA, so that our efforts were focused on operator and site-specific matters, including how the operator will address the assessment findings associated with the final SoDA.

36 As for GDA, we worked closely with ONR to assess areas where we have joint regulatory interests, including radioactive waste and spent fuel management, and management arrangements for controlling design changes.

37 Our GDA assessment findings for the UK EPR™ design from the iSoDA are included in Annex 1 together with additional assessment findings from the SoDA. We have also indicated how NNB GenCo has satisfactorily addressed or intends to address the assessment findings.

38 Some consultees on the application raised concerns that NNB GenCo had not incorporated the lessons learned from the Fukushima event in its application. The application was made after the publication of HM Chief Inspector of Nuclear Installations' interim report on the implications of Fukushima but before the final report (the Weightman reports[4]). NNB GenCo considered that as the application was for discharges from routine operations and reasonably foreseeable events, this was appropriate. We agree with this conclusion. However, we have considered the implications of the final report in our GDA assessment. As noted above, with ONR, we raised a GDA Issue to ensure EDF and AREVA addressed the lessons from the Fukushima event. We are now satisfied that EDF and AREVA have fully resolved this GDA Issue, and we have issued a full SoDA.

39 One consultee on the application raised concerns about whether we are able to advise government if, when examining the detail, we discovered major problems with the proposal. Government states in the Nuclear National Policy Statement[5] that the regulators should independently exercise their regulatory powers. We have a duty to provide advice to national and local government to help inform their policy and decision making. We would not grant a permit for a development if we considered that:

- The impact of radioactive discharges would exceed statutory limits.
- Our requirement to use Best Available Techniques[6] could not be met.
- We considered that the operator would be incapable of or unable to meeting the conditions of our permit.

40 Some consultees on the application raised issues concerning accidents and emergencies. We received further comments on this issue in response to our

[4] http://www.hse.gov.uk/nuclear/fukushima/

[5] https://whitehall-admin.production.alphagov.co.uk/government/uploads/system/uploads/attachment_data/file/37051/2009-nps-for-nuclear-volumeI.pdf

[6] http://www.environment-agency.gov.uk/static/documents/Business/GEHO0709BQSA-E-E.pdf

consultation on the draft decision. Our regulation of radioactive substances covers normal operations, including events that are reasonably foreseeable over the lifetime of a station. ONR is responsible for regulating safety and arrangements for responding in the event of accidents and emergencies. NNB GenCo will need to develop emergency arrangements for its site, and Somerset County Council will need to develop an offsite plan under The Radiation (Emergency Preparedness and Public Information) Regulations 2001. We will work with them on these matters, providing expertise on protecting people and the environment.

41 A consultee on the application thought that the new power station would require greater regulation and more monitoring because of a perceived lack of confidence in the operator and design. We take a risk-based approach to regulation, taking potential risks and performance into account to ensure high standards of environmental protection.

42 One consultee on our draft decision document stated that they were not reassured by the above statement about our risk-based approach to regulation, because of gender-bias against women in Environment Agency decision-making and the impact it had on the perception of risk. The consultee also raised wider concerns about lack of women's involvement in the Environment Agency's decision-making and also within the bodies we work with on nuclear matters. We are committed to promoting diversity and equality in all our policies, practices and procedures and to valuing the diversity of our workforce and the customers and communities we deal with. Our public sector equality duty under the Equality Act 2010 extends to protected characteristics including gender. We have published our diversity and equality objectives, principles and targets[7]. They address equality and diversity issues across our whole organisation. We note the consultee's reference to the Convention on the Elimination of all Forms of Discrimination against Women, an international instrument, which is given effect in the UK by various administrative and legislative measures taken by the government, including the Equality Act 2010, and we consider that we are compliant with the Act.

43 We asked the Health Protection Agency (HPA) to consider technical issues raised by this consultee. We have considered the HPA response in section 4.10.9. In addition to providing a response to the technical issues, the HPA commented: '*The correspondent refers to various institutions being male dominated and indeed in many cases there are more males than females in organisations such as IAEA* [International Atomic Energy Agency]*, reflecting the lower numbers of women who do degrees in the physical sciences. However, there are senior female scientists in organisations such as the WHO* [World Health Organisation] *and the current Chair of the ICRP* [International Commission on Radiological Protection] *is a woman, Dr Claire Cousins. The Centre for Radiation, Chemical and Environmental Hazards*

[7] http://www.environment-agency.gov.uk/aboutus/work/99648.aspx

(CRCE) which leads on radiation protection for HPA, has a number of senior female scientists and three of the six members of the directorate are women. At HPA a recent audit of the first author of HPA scientific publications in the first half of 2012 found no evidence of a bias towards males being named as first authors in HPA publications....'

1.5 NNB GenCo's applications for operational environmental permits

44 NNB GenCo applied for three environmental permits that it would require to operate for the proposed power station. These are for the disposal of radioactive waste, the discharge of trade effluent (cooling water and process effluent) and treated sewage effluent, and the operation of the standby diesel generators.

45 This decision document records our consideration of the application for the disposal of radioactive waste. We have produced separate decision documents for the other two applications.

46 NNB GenCo has not begun building the proposed power station at Hinkley Point C. NNB GenCo applied for permission in the form of a Development Consent Order (DCO) from the Infrastructure Planning Commission (IPC). Following changes to planning laws, consideration of the project has passed to the National Infrastructure Directorate (NID) of the Planning Inspectorate who made its recommendation to the Secretary of State for Energy and Climate Change in December 2012 for a decision.

47 The Overarching National Policy Statement for Energy EN1[8] says '*The planning and pollution control systems are separate but complementary*' and that '...*the IPC should work on the assumption that the relevant pollution control regime and other environmental regulatory regimes*, …….will be properly applied and enforced by the relevant regulator', also that '*the IPC should be satisfied, before consenting any potentially polluting developments, that the relevant pollution control authority is satisfied that potential releases can be adequately regulated under the pollution control framework*……'

48 EN1 also states that '*Wherever possible, applicants are encouraged to submit applications for Environmental Permits and other necessary consents at the same time as applying to the IPC for development consent*'.

49 NNB GenCo applied for the permits and we considered the applications at this early stage of the development so that we were able to provide an update on progress with our decision making to the NID at the appropriate time.

[8] https://whitehall-admin.production.alphagov.co.uk/government/uploads/system/uploads/attachment_data/file/37046/1938-overarching-nps-for-energy-en1.pdf

50 We consider that there are significant benefits in regulating at an early stage of site-specific design and the development of the operator's organisational capabilities.

51 Granting a permit early allows us to specify pre-operational conditions and requirements for further information in the permit, so that environmental matters are considered before the detailed design is finalised and throughout construction. We are also able to influence the commissioning programme to ensure that environmental matters are fully addressed.

52 After we grant the permit, we will regulate the site in accordance with our guidance in order to ensure that Best Available Techniques (BAT) are employed.

53 We built on our assessment of the UK EPR™ in GDA that we have previously consulted on. We will assess changes to the reactor design for Hinkley Point C if NNB GenCo proposes to significantly modify the GDA assessed UK EPR™ design.

54 NNB GenCo's proposal for Hinkley Point C includes two UK EPR™ reactors and some additional facilities not addressed in detail in GDA, for example the interim intermediate level waste (ILW) and spent fuel stores. When considering the application, we considered whether the GDA assessment was appropriate for Hinkley Point C, while taking into account the local environment.

55 Two consultees on the application commented that it was too early for an application to be considered properly. As explained above, we considered that there were significant benefits from early regulation.

56 These consultees also considered that the construction of Hinkley Point C should not go ahead until operational experience had been gained at Flamanville 3 (the EPR being constructed by EDF in Normandy, northern France). We noted that the UK EPR™ is an evolutionary design based upon operational PWR power stations in France and Germany. The most recent French design was the N4, brought into commercial operations in 1996 (Chooz B1). The most recent German design was KONVOI, brought into commercial operation in 1989 (GKN-2). We expect NNB GenCo to learn lessons from the detailed design and construction of the other EPRs, but we do not consider it necessary to wait until they are operational.

57 One consultee on the application asked if the application would be translated into Welsh. NNB GenCo only provided its application in English, and there is no requirement for a bilingual application for installations in England. However, because of the potential interest in the proposed Hinkley Point C power station from communities in Wales, we assessed our documents and whether or not we should translate them against criteria set out in our Welsh Language Scheme. These criteria have been approved by the Welsh Language Board, the statutory body charged with promoting the use of Welsh language and monitoring compliance. We concluded, due to the length, complexity and technical nature of the draft decision document, that it should not be translated, for the same reason we are not providing a translation of this document. We translated our Hinkley Point webpage and our Schedule 5

notices for further information into Welsh. We produced a combined summary of the draft decision documents for all three operational draft permits, which was available in a bilingual English / Welsh version. We also produced a bilingual summary of our Habitats Regulations Assessment for our permitting decisions. We are also publishing a bilingual combined summary of our final decision documents.

2 How we process and determine applications

58 The Environment Agency is responsible under the Environmental Permitting (England and Wales) Regulations 2010 (EPR 10), as amended, for regulating certain radioactive substances activities on nuclear sites in England and Wales, namely:

- receiving radioactive waste for the purposes of disposing of that waste
- disposing of radioactive waste on or from the premises
- where the operator is not the nuclear site licensee, keeping or using radioactive material
- keeping or using mobile radioactive apparatus

59 'Disposing of radioactive waste' includes discharges into the air, the sea, rivers, drains or groundwater, disposals to land, and by transfer to another site. A ‘nuclear site’ is one that has a nuclear site licence under the Nuclear Installations Act 1965, as amended.

60 We regulate these sites to protect members of the public from harm from the discharge and disposal of radioactive waste and to protect the wider environment. We regulate within a framework of government policy, strategy and guidance on the management and disposal of radioactive waste. This framework is summarised in the Government Guidance on Radioactive Substances Regulation (RSR).[9] This guidance sets out the government’s position on how RSR should be applied and implemented, and how both the Environment Agency and operators in England and Wales should interpret particular terms. In summary, we require operators to use best available techniques (BAT) to protect people and the environment by:

- Minimising the generation of radioactive waste.
- Minimising the amount of radioactive waste that has to be discharged into the environment.
- Discharging that waste in ways that minimise the resulting radiological impact on the public and protect the wider environment.
- Using the optimal route for the disposal of solid waste.

61 Operators can apply to the Environment Agency for a new permit or a variation to an existing permit at any time. The process we follow in assessing applications is described in government guidance (Core guidance[10]) in general and in our guidance on ‘the regulation of radioactive substances

[9] http://www.defra.gov.uk/publications/files/pb13632-ep-guidance-rsr-110909.pdf
[10] http://www.defra.gov.uk/publications/2013/03/07/pb13897-ep-core-guidance/

activities on nuclear licensed sites' (RSR RGN 2)[11]. The process for nuclear sites is outlined in table 1.

Table 1 Overview of the process for determining applications

Stage		Comment
1	Pre-application	We encourage applicants to discuss applications with us before submission.
2	Receive application and consult on the application	The applicant makes an application, providing the information as set out in the application form and supporting guidance. We advertise and consult on all applications for new permits. We may also advertise and consult on some variations, depending on the nature of the proposals and the likely degree of public interest.
3	Assess application and make a draft decision	We carefully assess the application and any responses received from the consultation and come to a draft decision on whether to grant the application and, if so, the appropriate permit conditions. We take full account of any work we have done during a relevant GDA.
4	Consultation on draft decision	We may choose to consult further on our draft decision and draft permit, depending on the nature of the proposals and the likely degree of public interest.
5	Review, approval and issue of decision	Where we consult on our draft decision, we carefully consider all relevant information we have received during and after the consultation, together with existing information. We decide whether a new permit should be granted and, if so, what its conditions should be. We publish a document that provides the reasons for our decisions.

[11] http://publications.environment-agency.gov.uk/PDF/GEHO0310BSGF-E-E.pdf

62 We advertised and consulted on the application in accordance with our public participation statement and associated working together arrangements: see 'Working together: your role in our environmental permitting'[12]**.** In view of the nature of the application and the degree of public interest, we decided to carry out further consultation on our draft decision and draft permit. We did not make any final decision about the application until we had carefully considered all of the responses to our public consultations.

63 We made our decision taking into account all relevant legal, policy and regulatory matters, and the consultation responses. The DECC guidance on Radioactive Substances Regulation[13] describes the legal requirements and government policy in relation to managing the generation and disposal of radioactive waste. The government has issued statutory guidance[14] to the Environment Agency on how we should regulate the disposal of radioactive waste into the environment. This states that we should base our decision on the principles set out in the 2009 UK Strategy[15], namely:

- Regulatory justification of practices by the government.
- Optimisation of protection on the basis that radiological doses and risks to workers and members of the public from a source of exposure should be kept as low as reasonably achievable (the ALARA principle).
- Application of limits and conditions to control discharges from justified activities.
- Sustainable development.
- The use of best available techniques (BAT).
- The precautionary principle.
- The polluter pays principle.
- The preferred use of 'concentrate and contain' in the management of radioactive waste over 'dilute and disperse' in cases where there would be a definite benefit in reducing environmental pollution, provided that BAT is being applied and worker dose is taken into account.

64 RSR RGN 1 Radioactive Substances Regulation – Environmental Principles (REPs)[16] sets out a consistent and standardised framework for the technical assessments and judgements that we make when regulating radioactive substances.

[12] http://www.environment-agency.gov.uk/static/documents/Business/Working_together_PPS_v2.0.pdf
[13] https://www.gov.uk/government/policies/managing-the-use-and-disposal-of-radioactive-and-nuclear-substances-and-waste
[14] http://tinyurl.com/ad8oeyy (note the National Archive web address is too long for our hyperlink tool)
[15] http://www.scotland.gov.uk/Publications/2009/07/24130814/0
[16] http://publications.environment-agency.gov.uk/PDF/GEHO0709BQSB-E-E.pdf

65 One consultee on our draft decision document stated that we had not applied the precautionary principle and asked how we would define it. As mentioned above, the precautionary principle is one of the principles set out in the 2009 UK Strategy on which the statutory guidance requires us to base our decisions. Our REPs underpin the statutory guidance. 'Uncertainties and the Precautionary Principle' is the title of one of the fundamental principles set out in our REPs, as follows: 'Decisions about radioactive substances should take into account uncertainties and where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing cost-effective measures to prevent potential harm to people and the environment'. The precautionary principle is also a feature of our duty under section 5 of the Environment act 1995 (EA 95) relating to sustainable development, see section 4.13.1 below. We have applied the precautionary principle in coming to this decision and setting the limits and conditions of the permit.

66 We have structured our assessment of the application in section 4 to reflect the layout and questions in the application form. Table 2 shows this layout, setting out the main issues we need to consider when making decisions on the disposal of radioactive waste, and refers to relevant reference documents and guidance. You can access all the reference documents in this section through our RSR nuclear website http://www.environment-agency.gov.uk/business/sectors/32517.aspx.

Table 2 : Main considerations	
Considerations	**Documentation**
General	Government Guidance on Radioactive Substances Regulation (RSR). RSR RGN 2 The regulation of radioactive substances activities on nuclear licensed sites RSR 1 Radioactive Substances Regulation – Environmental Principles
Justification	Justification of practices DECC website[17]
Euratom Article 37	Commission Recommendation of 23 October 2010[18]
Operator and operator competence	RGN 5 Operator Competence[19] Management Arrangements[20]
Disposal of radioactive waste	Statutory guidance to the Environment Agency concerning the regulation of radioactive discharges into the environment.[21] RSR: principles of optimisation in the management and disposal of radioactive waste.[22]
Disposal routes and monitoring	Radiological monitoring technical guidance note 1 - Standardised reporting of radioactive discharges from nuclear sites[23] Radiological monitoring technical guidance note 2 - Environmental radiological monitoring[24] M11 Monitoring of radioactive releases to atmosphere from nuclear facilities[25] M12 Monitoring of radioactive releases to water from nuclear facilities[26]

[17] https://www.gov.uk/government/policies/managing-the-use-and-disposal-of-radioactive-and-nuclear-substances-and-waste/supporting-pages/making-justification-decisions-on-applications-to-use-ionising-radiation
[18] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2010:279:0036:0067:EN:PDF
[19] http://www.environment-agency.gov.uk/static/documents/Business/RGN_5_Operator_Competence.pdf
[20] http://www.environment-agency.gov.uk/business/sectors/117060.aspx
[21] http://tinyurl.com/ad8oeyy
[22] http://www.environment-agency.gov.uk/static/documents/Business/GEHO0709BQSA-E-E.pdf
[23] http://www.sepa.org.uk/radioactive_substances/publications/guidance.aspx

Table 2 : Main considerations	
Considerations	**Documentation**
Radiological assessments	Principles for the assessment of prospective public doses[27]
Other statutory requirements	RGN 4 setting standards for environmental protection[28]

67 In section 4 of this document we explain how we have reached our decision against these and any other relevant considerations. We take into account any consultation responses we receive before making a final decision. We will place the permit and our decision document on the public register.

68 While we will normally determine an application, the Secretary of State can require any application to be sent to him to be determined (regulation 62 of the EPR 10). As noted in the Core guidance[29], this would be an exceptional step and likely to be taken only if the application involves issues of more than local importance – for example, if the application:

- Is of substantial regional or national significance.
- Is of substantial regional or national controversy.
- May involve issues of national security or of foreign governments.

69 It also says in the Core guidance that any decision on the need for determination by the Secretary of State would be made solely on those grounds, with no consideration of the substantive merits of the application itself.

70 The Secretary of State has not 'called in' this application.

[24] https://publications.environment-agency.gov.uk/skeleton/publications/SearchResults.aspx?name=GEHO0811BTVY-E-E
[25] electronic copy available from the Environment Agency on request
[26] electronic copy available from the Environment Agency on request
[27] https://publications.environment-agency.gov.uk/skeleton/publications/ViewPublication.aspx?id=c386b4c3-3474-429c-aa60-549a782f05d6
[28] http://publications.environment-agency.gov.uk/PDF/GEHO0112BUKP-E-E.pdf
[29] http://www.defra.gov.uk/publications/2013/03/07/pb13897-ep-core-guidance/

3 The application and our consultations

71 NNB Generation Company Limited (NNB GenCo) applied for an environmental permit to carry out radioactive substances activities at a proposed new nuclear power station at Hinkley Point in Somerset. The proposed new power station is known as Hinkley Point C Power Station.

72 NNB GenCo (Company number 06937084) was incorporated in 2009. It is a wholly owned subsidiary of NNB Holding Company Limited, which, in turn, is owned by EDF Energy Holdings Limited (80% share) and GB Gas Holdings Limited (20% share). Centrica (GB Gas Holdings) announced in February 2013 its decision not to participate in UK nuclear new build. NNB GenCo is known locally, and for some of the planning applications, as 'EDF Energy'.

73 NNB GenCo's application consisted of the relevant RSR environmental permit application forms and a submission of information to provide the required detailed technical information. Where we need to refer to specific information, we have referred to chapter, sub-chapter or page number in NNB GenCo's submission of information. In this decision document, any references to NNB GenCo's submission or submission of information should be read as a reference to its application for the environmental permit, unless it is clear from the context that some other submission is being referred to.

74 NNB GenCo is a new organisation and construction of proposed Hinkley Point C has not commenced. There are a number of areas where the company and the detailed design of the facilities will need to be developed further. NNB GenCo proposed a forward action plan to deal with these matters in chapter 14 of its submission.

3.1 Location of the site

75 Hinkley Point is located on the Somerset coast approximately 12 km north-west of Bridgwater. The proposed power station is to be located immediately to the west of the two existing Hinkley Point power stations. The proposed power station has two pressurised water reactors (PWR) of the UK EPR™ type (UK EPR™). The total expected net electrical capacity is 3260 MW. This is approximately 6% of the UK national requirement for electricity.

76 There are a number of international and national environmental designated sites close to Hinkley Point. These are:

- Severn Estuary Special Protection Area (SPA)
- Severn Estuary Special Area of Conservation (SAC)
- Severn Estuary Ramsar site
- Exmoor and Quantock Oakwoods SAC
- Bridgwater Bay Site of Special Scientific Interest (SSSI)
- The Quantocks SSSI
- Blue Anchor to Lilstock Coast SSSI

- Berrow Dune SSSI
- Ge-mare Farm Fields SSSI
- Bridgwater Bay National Nature Reserve.

77 The nearest Area of Outstanding Natural Beauty (AONB) is Exmoor.

3.2 Description of the proposed facility

78 A single UK EPR™ unit is capable of generating in total 1735 megawatts (MWe) of electricity and providing 1630 MWe of this to the National Grid. In the reactor core, the uranium oxide fuel (enriched up to 5% of uranium-235) is cooled by water in a pressurised circuit, the primary circuit. This water also acts as the neutron moderator necessary for a sustained nuclear fission reaction. The primary circuit includes four steam generators where heat is transferred from the primary circuit to an isolated secondary circuit, producing steam. This steam then drives a turbine-generator to produce electricity, is condensed, and the condensate returned to the steam generators.

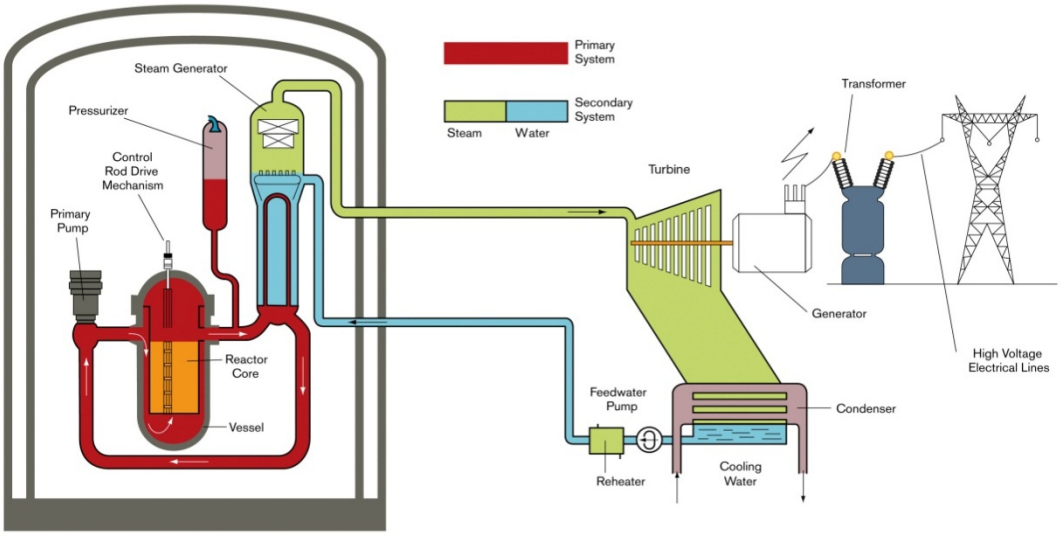

Figure 1 Simplified schematic of the EPR™ reactor (source AREVA)

79 The main ancillary facilities include a spent fuel pool, water treatment systems for maintaining the chemistry of the primary and secondary water circuits, standby diesel generators for providing power in the event of loss of grid supplies, and waste treatment and storage facilities for both waste and spent nuclear fuel. For Hinkley Point C, NNB GenCo proposed that the turbine condenser cooling water is provided by a once-through system using seawater.

3.3 Requested disposal routes and limits

80 Radioactive waste would be produced by activities associated either directly or indirectly with operating and maintaining the reactors. In particular, operating the reactors would generate radioactivity in the water of the reactor's primary circuit, some of which would subsequently become waste.

81 The operation of the proposed Hinkley Point C power station would produce radioactive waste, some of which would be discharged to the environment:

- Most gaseous radioactive waste would be discharged to the environment via two main outlets, one for each reactor.
- Aqueous radioactive waste would be discharged with the cooling water into the Bristol Channel, at a point approximately two kilometres off-shore.
- Solid radioactive waste would be produced during the treatment of gaseous and liquid waste, and during the operation and maintenance of the power station and
  - low-level solid radioactive waste and waste oils and solvents would be transferred to off-site treatment and disposal facilities, while
  - higher activity solid waste would be stored on-site until suitable disposal facilities are developed.

82 One consultee on the application asked if the disposals and discharges of radioactive waste would be related to the long-term storage of high-level waste. The application includes arisings from the interim spent fuel store, which only make a small contribution to the overall arisings from the site and are included in our proposed limits. There is no proposal to dispose of the high level waste in the application. Radioactive waste storage on site is regulated by ONR under the nuclear site licence.

83 NNB GenCo provided estimates of the best performance for radioactive waste disposal from Hinkley Point C and proposed rolling annual limits as set out below in Table 3, that take into account matters, including trends and events, it expects to occur during routine operations. These include reactor shutdowns, maintenance activities, fuel defects and the performance of the waste management systems. NNB GenCo also proposed quarterly notification levels (QNL).

84 NNB GenCo stated that it expects Hinkley Point C to perform in the top 25% of the EDF UK and French fleet. The Committee on Medical Aspects of Radiation in the Environment (COMARE), in response to our consultations both on the application and our draft decision document, commented that this is a low or modest ambition. COMARE also supported minimisation of discharges by putting a major effort into minimising at source. We will regulate Hinkley Point C to ensure discharges are minimised by the use of BAT. We provide our review of NNB GenCo's proposals to minimise at source in section 4.5.2 below.

Table 3: NNB GenCo's estimated best performance and proposed limits			
Gaseous discharges			
Radionuclides	**Estimated best performance (GBq y^{-1})**	**Proposed annual limit GBq**	**Proposed QNL GBq**
Tritium	1,000	6,000	375
Carbon -14	700	1,400	305
Noble gases	1,600	45,000	1,480
Iodine-131	0.05	0.4	0.064
Other[1] fission and activation products	0.008	0.24	0.058
Liquid discharges			
Tritium	104,000	200,000	91,500
Carbon-14	46	190	41
Caesium-137	0.114	1.9	0.110
Other[2] fission and activation products	1.2	18.1	0.9

1. For gaseous discharges 'other fission and activation products' excludes tritium, carbon-14, noble gases and iodine-131
2. For liquid discharges 'other fission and activation products' excludes tritium, carbon-14 and caesium-137

3.4 Further information requested from the applicant

85 When we consider an application, if we need further information, we can serve a notice on the applicant in accordance with Schedule 5 of the EPR 10. We refer to these notices as Schedule 5 notices.

86 As we considered NNB GenCo's application we found we needed further information and we served two Schedule 5 notices. We made our notices available on our Hinkley Point webpage[30] and at local public registers. NNB GenCo supplied the information we requested and published it, together with the application, on EDF Energy's Hinkley Point webpage[31].

[30] http://www.environment-agency.gov.uk/homeandleisure/132476.aspx
[31] http://hinkleypoint.edfenergyconsultation.info/public-documents/environmental-permit-applications/environmental-permit-applications/operational/

87 In our first Schedule 5 notice we asked for:

- Some detailed information to help us understand NNB GenCo's impact assessment.
- Three points of minor clarification of information provided with the application.
- An assessment of the impact of EDF and AREVA's reissued GDA Pre-Construction Environmental Report (PCER) for the UK EPR™ in 2011.

88 In our second Schedule 5 notice we asked for some further information on:

- site drainage and the attenuation pond[32]
- discharge tanks
- spent fuel pools
- potential oil contamination of liquid effluent
- the transfer of ion exchange resin used to treat radioactive liquids

89 We assessed the information provided and considered that it met our requirements. We considered that the information provided was further detail that supported the information already provided with the application. We therefore considered that making it publicly available before the start of the consultation on our draft decision fulfilled our 'duty to involve' as described in section 4.13.8.

90 In our draft decision document and this decision document we explain how we took into account the further information provided by NNB GenCo at the relevant place in the document.

91 The information in NNB GenCo's submission built upon EDF and AREVA's Pre-Construction Environmental Report (PCER) for the UK EPR™ that we assessed during Generic Design Assessment (GDA). We noted that the latest version of the GDA PCER was dated March 2011 and that NNB GenCo had referenced an earlier version dated March 2010. We issued a Schedule 5 notice for further information to NNB GenCo requiring a summary of the changes and the impact of the changes on the information in its application. NNB GenCo commented that the changes in the PCER 2011 were either typographical or related to additional information provided to the regulators, and that its submission included all the relevant additional information. It concluded that '*the amendments made to the PCER 2011 do not impact on the information provided in our application*'. We agreed with this conclusion.

[32] The Attenuation Pond is a facility that contains a retention tank, a settling tank and an oil-water separator as well as associated pipe-work and valves. The Attenuation Pond will include sampling access to determine the chemical properties of any effluent that has been retained. The Attenuation Pond facility includes a retention tank to collect polluted water arising from unplanned or emergency situations, such as firewater or spillages. During emergency situations drainage networks can be diverted to the retention tank in the Attenuation Pond facility.

92 The Office for Nuclear Regulation (ONR), in its response to the consultation on the application, brought to our attention issues concerning potential oil contamination and the length of pipework for the transfer of resin. We requested further information from NNB GenCo in a second notice. In that notice, we also required further information on the site drainage and the attenuation pond, sizing of the discharge tanks and spent fuel operations.

3.5 Consultation on the application

93 We advertised and consulted on the application from 25 August to 15 December 2011 in accordance with our Public Participation Statement [33] and Working Together Arrangements [34]. We made the responses available at the public registers, at Environment Agency and local authority offices listed in Annex 2, except where the person making the response asked us not to do so.

94 We received responses to our consultation on the application from organisations we have working together agreements with, other organisations and members of the public.

95 We had some responses that supported the development, some that were opposed in principle to new nuclear development, and some that raised specific issues about the application.

96 Some of the responses were outside our remit and we passed these onto the relevant bodies, for example safety related issues to ONR and general opposition to government policy to the Department of Energy and Climate Change (DECC). Some consultees raised concerns about higher activity waste storage and decommissioning. These issues are matters for government and are subject to the approval of the Funded Decommissioning Plan and the government's Managing Radioactive Waste Safely programme, including the development of a geological disposal facility (GDF). We have forwarded these consultation responses to DECC.

97 We explained how we took into account those consultation issues within our remit at the relevant place in the draft decision document, where we explained our assessment of the application.

3.6 Consultation on the draft decision document and draft permit

98 We advertised and consulted on the draft decision document and draft permit from 13 August to 9 November 2012 in accordance with our Public Participation Statement[35] and Working Together Arrangements[36].

[33] http://www.environment-agency.gov.uk/static/documents/Business/Working_together_PPS_v2.0.pdf
[34] http://www.environment-agency.gov.uk/business/topics/permitting/36420.aspx
[35] http://www.environment-agency.gov.uk/static/documents/Business/Working_together_PPS_v2.0.pdf
[36] http://www.environment-agency.gov.uk/business/topics/permitting/36420.aspx

99 We published the draft decision document and draft permit on our website and made them available as listed in Annex 2.

100 In accordance with our communications plan, we placed advertisements, distributed posters, issued media releases and wrote to about 1,000 individuals and organisations inviting them to take part in the consultation. We held full day public surgeries in Bridgwater, Burnham-on-Sea, Cannington, Otterhampton, Stogursey, Watchet and Barry. We held meetings with local councillors in Bridgwater, Williton and Winsford in Somerset and Barry, Cardiff and Newport in South Wales.

101 We received 44 responses from partner organisations, other interested groups and members of the public. Some of the responses restated views given in responses to our consultation on the application. We have endeavoured to address all comments in this decision document at the appropriate place and, if necessary, provide further clarification on concerns that were made for a second time.

102 We made the responses available at the public registers, at Environment Agency and local authority offices listed in Annex 2, except where the person making the response asked us not to do so.

103 Some of the consultation responses were outside our remit and we passed these onto the relevant bodies as described in section 3.5 above.

104 Giles Chichester, Member of the European Parliament, stated his strong support for the Hinkley Point C project as a vital component of future electricity supply and a low carbon economy. He also welcomed our consultation exercise.

105 Eluned Parrott, Welsh Assembly Member, restated her objection to the project, on the grounds of safety.

106 We received a response to our consultation on the application from the Nuclear Free Local Authorities (NFLA). It was supported by Stop Hinkley, Friends of the Earth Cymru and CND Cymru, Caroline Lucas MP, Martin Caton MP, Paul Flynn MP and Jill Evans MP. This response was based on two reports written by consultants. The NFLA and supporting organisations responded to the consultation on our draft decision, saying that they felt we had not adequately addressed many of the points contained in the original reports. This view was also supported by Cardiff City Council. The NFLA submitted a new report that identified those areas they felt we had not addressed adequately.

107 The original reports from the NFLA contained a great deal of information, much of which was well known facts but some of which was opinion. However, the reports did not appear to draw many clear conclusions from the information provided. We considered that the ‘summary of conclusions’ was also mostly descriptive text. We considered the information provided and addressed those issues that were clearly stated. The new report (2012 response) helped to clarify the NFLA's concerns. However, it draws heavily on the original 2011 submission and we still find the response and submission

difficult to follow. We address each section of the 2012 response in section 4.10.8 of this decision document.

108 Penarth Town Council was concerned that the level of consultation and publicity was low. It suggested that we should have held public meetings rather than public surgeries and that any problems with disruption of meetings could have been '*managed by a good chair person to allow debate*'. We consider that public surgeries give people an opportunity to find out about our permitting work and our consideration of the applications. The surgeries also provide people with an opportunity to discuss their views with us. Public meetings can be dominated by a few individuals who can exclude others from participating even with a strong independent chair. While there may be some disagreement about our approach, we were guided by advice we received from community leaders in Somerset, and we are confident we have met our obligations under our Public Participation Statement, and allowed sufficient opportunity for engagement to any interested parties.

109 A consultee on our draft decision document expressed concern that we were failing in our duty to engage because we had not taken into account the overloading of consultees by the other Hinkley Point C consultations that had taken place in the past three years. The development at Hinkley Point C is a very large project, with many organisations having a role. We have endeavoured to work with other public bodies to make our consultations as efficient as possible. Because we consider Hinkley Point C to be a site of high public interest, we extended our consultation period from the statutory minimum of 20 days on the application to two separate periods; five months for the application and three months for our draft decision document. We spent a considerable amount of effort making our draft decision documents as easy to read and understandable as possible without losing essential detail.

110 The consultee above also said that we had done little to involve people, accusing us '*of doing everything in your power to make it as difficult as possible*'. We do not agree with this statement. We widely publicised our consultation and held meetings with councillors and public surgeries to allow the public to discuss concerns face to face.

111 We asked people who attended our surgeries to fill in our feedback forms to help us assess the effectiveness of the consultation. The main results were:

- Most people said they found the surgeries useful.
- People said that their questions had generally been well answered.
- A majority of people gave a high score for display material, saying that it was well presented and that the handouts were informative.
- Most people indicated that they were better informed about the permits and about the permitting process after attending a surgery. However, a minority said that, while they were more aware of the permits; they were not reassured.
- Overall people felt that they were now able to respond to the consultation.

112 When asked to add additional comments about the surgeries, there was an approximate 50/50 split between positive and negative. People were positive about surgery displays and the friendly, informed staff. They were also positive about the patience of technical staff and the clear explanations given to questions. One respondent commented that it was very useful to be able to speak to experts face to face. Negative comments involved general concerns about nuclear power rather than the surgeries themselves. Our overall conclusion is that our consultation surgeries and meetings helped us fulfil our duty to engage.

3.7 Other applications

113 NNB GenCo applied for two other environmental permits for the power station when it is operational. These are for the discharge of cooling water and trade effluent (application reference EPR/HP3228XT/A001) and the operation of the standby diesel generators (application reference EPR/ZP3238FH/A001). We took a coordinated approach to the consultations on all three draft decision documents for the operational permits.

4 Our assessment

4.1 Introduction

114 In this section we set out the considerations that support our decisions having considered the application and the responses to our consultations.

115 The section titles 'RSR Part X, Q Y' refer to the questions we ask an applicant to answer within an application. There are a number of matters we need to consider before deciding whether to grant the permit and, if we decide to grant a permit, what its conditions should be. These are covered in this section.

116 The section on operator competence considers how NNB GenCo proposes to develop both an organisation and arrangements capable of controlling the design, construction and operation of the proposed Hinkley Point C Power Station.

117 The section on optimisation considers how NNB GenCo proposes to minimise the production and disposal of radioactive waste, and how the radiological impact on members of the public is made as low as reasonably achievable (ALARA) and that the environment is properly protected. This section explains that we consider any relevant statutory requirements or government policy and guidance in relation to how the disposal of radioactive waste is to be carried out.

118 In the section on impact, we consider the radiological impact on members of the public and the environment. In that section, we also consider whether, in permitting disposals of radioactive waste, we would fulfil our duties across a range of environmental legislation.

119 We also addressed a number of wider social-economic duties, including contributing to sustainable development.

120 In reaching our decisions, we considered the relevant legislation, government policy and guidance, our own guidance and the responses to both the consultations on the application and on our draft decision document. Table 2 in Section 2 summarises the main documentation that describes these requirements.

121 There are also a number of issues that are outside our remit and which we did not consider when reaching our decisions. We have set out these issues at the end of this section.

4.2 Justification (RSR Part A Q9)

122 The Justification of Practices Involving Ionising Radiation Regulations 2004 ('the Justification Regulations') are not part of the Environmental Permitting system. But, if an application for an environmental permit relates to a practice under Council Directive 96/29/EURATOM (the Basic Safety Standards Directive - BSSD), we can only grant a permit if the practice is justified. The government has published information on the justification of practices.

123 The Department of Energy and Climate Change (DECC) decided in October 2010 that the generation of electricity by the EPR nuclear reactor is justified. This decision can be found at Regulatory Justification - Department of Energy and Climate Change[37] and there is an appropriate entry in the register of justified process for the operation of the EPR nuclear reactor.

4.3 Euratom Treaty, Article 37 (RSR Part B3 Q2b)

124 Article 37 of the Euratom Treaty requires each Member State to provide the European Commission with general information relating to any plan to dispose of radioactive waste to determine whether implementing such a plan is likely to result in the radioactive contamination of the water, soil or airspace of another Member State.

125 The Commission will issue its opinion within six months, after consulting the group of experts referred to in Article 31 of the Treaty.

126 The Court of Justice of the European Union ruled that Article 37 of the Euratom Treaty must be interpreted as meaning that the Commission will receive general data before the Member State concerned grants the discharge authorisation of radioactive effluents. This is so that the Commission can issue its opinion and this opinion can be taken into account before discharges are authorised.

127 An Article 37 submission was required for this application. A submission was made by the UK Government, and the Commission published its opinion on 3 February 2012. The opinion is that '*the plan for the disposal of radioactive waste arising from the two EPR reactors on the Hinkley Point C nuclear power station……..is not liable to result in a radioactive contamination of the water, soil or airspace of another Member State that would be significant from the point of view of health.*'

128 A further submission was made for the interim storage facilities of intermediate level radioactive waste (ILW) and spent fuel. The Commission published its opinion on this submission on 30 May 2012. The opinion is that '*the plan for the disposal of radioactive waste in whatever form from the interim storage facilities for intermediate level waste and spent fuel at the Hinkley Point C nuclear power station site ……is not liable to result in a radioactive contamination of the water, soil or airspace of another Member State that would be significant from the point of view of health.'*

129 The Commission's opinions did not contain any recommendations, so there is no requirement for us to include specific conditions in the permit on this matter.

[37] https://www.gov.uk/government/publications/regulatory-justification-decisions-on-nuclear-reactors

4.4 Operator and operator competence (RSR Part A Q10)

130 Under EPR 10 we can only grant a permit if the applicant will be the 'operator', that is the applicant has effective control over the operation of the facility. RGN 1 '[Understanding the meaning of operator'](http://www.environment-agency.gov.uk/static/documents/Business/RGN_1_Operator_(v4.0)_30_March_2010.pdf)[38] describes what that means in more detail. There is also a specific duty on us, in relation to an application for the grant or transfer of an environmental permit, that we must not grant or transfer the permit if we consider that the operator will not operate the facility in accordance with the permit.

131 We are satisfied that the applicant is the organisation that would have control over the operation of the facility, when the permit is granted, as described in RGN 1.

132 We recognise that the permit is being granted for a plant which is still in construction when no radioactive discharges are being made, and that the detailed arrangements for operations and compliance are not yet fully developed. However, we require that suitable management arrangements and resources are in place for each lifecycle phase of the project. This will help ensure that, when operations begin, the power station, its management systems and resources are ready and suitable to maintain compliance with our requirements.

133 NNB GenCo is currently within the detailed site-specific design stage and preparation works for construction, which includes procurement of long lead items, such as heavy forgings.

134 NNB GenCo stated in its application that it draws upon the competencies and operational experience of its sister company EDF Energy Nuclear Generation Ltd that operates six nuclear power stations in England and two in Scotland.

135 We have based our assessment on the information available in the application which included a copy of NNB GenCo's management prospectus.

136 NNB GenCo is developing its management arrangements to meet the requirements of both the nuclear site licence and the EPR 10 permits. We are working closely with ONR to ensure that NNB GenCo put in place arrangements that meet both our expectations.

137 We have considered how our GDA assessment findings have been addressed and how the management arrangements will address the assessment findings. We have provided more information on the GDA assessment findings in Annex 1.

138 We have looked for evidence of satisfactory development in the following areas in accordance with our guidance:

- organisational structure

[38] http://www.environment-agency.gov.uk/static/documents/Business/RGN_1_Operator_(v4.0)_30_March_2010.pdf

- governance and environmental leadership
- system implementation
- environmental capability
- change control and living management arrangements
- learning organisation

139 Our assessment is discussed in more detail below, but our overall conclusion is that we have not identified any reasons indicating that the applicant would be unable to operate in accordance with the permit.

140 Some consultees on the application expressed concerns about NNB GenCo's lack of experience and the alleged poor reputation of its parent company EDF SA. We have reviewed the information provided and we consider that NNB GenCo is a suitable organisation to hold a permit.

141 NNB GenCo included the development of its management arrangements as part of the forward action plan described in section 14 of its submission. We have included a further information requirement, IC 1, in the permit that requires an annual progress report on organisational development.

4.4.1 Organisational structure

142 We have assessed NNB GenCo’s organisational structure for its capability in terms of resources and competence to understand the environmental hazards of its activities and promote successful environmental management of waste, both radioactive and non-radioactive, throughout all phases of the project.

143 NNB GenCo’s current structure is identified in the management prospectus and in more detail in chapter 11 of its submission. We are satisfied that it reflects the work being carried out, has been informed by our guidance, and clearly shows lines of control and allocation of responsibilities.

144 NNB GenCo has set up operational control committees to ensure its senior management is monitoring the effectiveness of the structure. We have noted changes to the structure during pre-application discussions in response to business needs.

145 NNB GenCo has also established a Safety, Health and Environment Committee to advise and challenge on matters affecting waste management and environmental matters in addition to safety.

146 NNB GenCo’s organisation covers both the construction activities and the development of the site operational organisation, and the charts available show lines of control and accountability.

147 NNB GenCo’s nuclear baseline and post profiles identified environmental roles and have been subject to a formal process to identify skills and training requirements.

148 NNB GenCo provided in its application clear evidence within the definitions of the posts of how technical and governance responsibilities are assigned and

flow through the organisation. We consider this to be sufficient at this time, but will monitor this as the organisation develops at the power station.

149 NNB GenCo set out clearly in chapter 11 of its submission how the organisation will develop in the future, the timescales for the different phases of the construction, and how the organisation would be developed to meet these requirements. We reviewed the proposals and consider that NNB GenCo can develop the necessary capabilities at site level as the project progresses.

150 NNB GenCo set out in chapter 11 of its submission how it would manage incidents. Primarily, this is within ONR requirements, however we are satisfied it has recognised its responsibilities for clean up and recovery.

151 We are satisfied that NNB GenCo's organisational structure demonstrates the relationship between it and the parent companies. We are satisfied there is governance in place to ensure that NNB GenCo has the appropriate level of autonomy.

152 NNB GenCo also set out in its application the links with other organisations. In particular, it identified the relationship between NNB GenCo and the EDF Nuclear Engineering Division (DIN), which acts as the 'Architect Engineer'. We are satisfied that this is sufficient to demonstrate adequate knowledge of the proposed plant and that NNB GenCo is able to ensure that BAT is incorporated within the design and operational techniques.

153 We will require further demonstration of the effectiveness of the structures proposed. However, this will be addressed as part of the normal regulatory activities when the permit is granted.

4.4.2 Governance and environmental leadership

154 We have assessed how the management arrangements have demonstrated that the environmental culture of the organisation is developing, and that senior management provides effective leadership so that environmental values and behaviours are developed within the organisation.

155 NNB GenCo provided the Health Safety and Environment (HS&E) Policy statement signed by the Managing Director in Appendix B of its management prospectus. It identified that the Safety Director is responsible for the maintenance and implementation of the policy.

156 NNB GenCo stated that the HS&E policy is implemented through NNB GenCo's Board to line management, and is supported by its Safety Health and Environment Committee (SHEC) and its Nuclear Safety Review and Advisory Committee (NSRAC), which has now become its Nuclear Safety Committee (NSC).

157 NNB GenCo's management prospectus and the further information provided in Chapter 11 showed that these committees, along with input from the Independent Assessment Challenge and Oversight (IACO) team working within the Safety Directorate, provide a formal independent challenge to the organisation on safety and environment matters and report to the Board. We

are satisfied that this would provide adequate internal scrutiny and direction on environmental matters.

158 NNB GenCo's management prospectus also set out the Board members' environmental responsibilities. The supporting information in Chapter 11 gave more information on how decisions on implementing the policy are made.

159 NNB GenCo also provided details on the supporting committees and their terms of reference. We are satisfied that there is sufficient information to give us confidence that these committees should be able to inform the NNB GenCo Board and challenge where appropriate.

160 NNB GenCo's application demonstrated that each director has a role profile and is clearly identified on the nuclear baseline. The nuclear baseline identifies safety critical posts. NNB GenCo produced it to support its nuclear site licence application. Also, NNB GenCo has in place a comprehensive training programme to ensure that directors are able to understand environmental issues, and there is a programme of continual improvement.

161 NNB GenCo's management prospectus and, in more detail, Chapter 11 of its submission, provided details of recruitment and training strategies that should raise awareness of the environment policy for staff at all levels as its organisation develops.

4.4.3 Management system implementation

162 We recognise that the management arrangements being developed can only be implemented for the current work being carried out. At the time of application, this related to detailed design, procurement, development of the operational organisation and site preparation. Construction of the power station has not begun.

163 NNB GenCo provided information in Chapter 11 on the strategy for development of the management arrangements at each stage of the construction, commissioning and operation of the plant.

164 We looked at the proposed approach and are satisfied that key activities have been identified, and that regulatory commitments can be met. We are satisfied that there is adequate identification of systems and equipment relevant to the permit, and that there is adequate configuration control of those systems to ensure design development incorporates assessment of BAT.

165 NNB GenCo included a diagram in Chapter 11 showing the hierarchy of documents it intends to produce as part of an integrated management system. This is to be managed through a developing document management system to ensure that the clear path from health and safety policy to the work instruction is maintained. We are working closely with ONR on NNB GenCo's development of its management arrangements, and are content that they are adequate at this time with regard to environmental protection matters.

166 NNB GenCo's commitment to develop the management arrangements for future phases of its project was presented in Chapter 11 and reflected in the forward action plan in Chapter 14. We are satisfied that this will produce

adequate written arrangements. At the appropriate time, as part of our regulatory activities, we will scrutinise these arrangements and ask NNB GenCo to demonstrate their adequacy.

167 NNB GenCo provided information in Chapter 11 to support its requirement to demonstrate that it has developed sufficient environmental capability through gaining adequate advice from technical experts in environmental issues, while developing a 'qualified expert' capability. We are satisfied that this was adequate at the time the application was made. We have since introduced a new requirement for Radioactive Waste Advisors (RWA) to replace 'Qualified Experts'. NNB GenCo has revised its arrangements to reflect this new requirement.

168 Sedgemoor District Council, in response to the consultation on our draft decision document, asked for assurance that Radioactive Waste Advisers would be subject to a full evaluation of their professional competence. We confirm that individual Radioactive Waste Advisers are assessed by assessing bodies that are approved by the environment agencies. A Corporate Radioactive Waste Adviser is assessed in accordance with corporate arrangements put in place by a nuclear permit holder and approved by the environment agencies.

169 NNB GenCo also provided information in Chapter 11 to support its development of the appointment of suitably qualified and experienced persons (SQEP), and how it would develop these through training and working within its sister company EDF Energy Nuclear Generation Ltd that operates six nuclear power stations in England.

170 NNB GenCo included compliance statements for all conditions of the permit, including how it would develop arrangements for maintenance, notification of events, sampling, keeping records etc.

171 We are content that these can be developed at the appropriate time and we have included in the permit various requirements for further information to be provided to us as the project develops.

172 We have discussed how NNB GenCo uses support from its sister company, EDF Energy Nuclear Generation Group Limited in developing competencies and in receiving operational experience information.

173 NNB GenCo supplied details on how it would manage and audit change control. This is a key requirement during design, construction and commissioning and continues into operation. It is discussed in more detail below.

174 We have placed a requirement in the permit for NNB GenCo to provide an annual progress report of the organisational development relevant to permit compliance. This requirement is referenced as IC 1 in table S1.2 of Schedule 1. We will use this report to monitor progress against action 8 of NNB GenCo's forward action plan.

4.4.4 Environmental capability

175 We expect NNB GenCo to have sufficient adequately trained resources and capabilities to support its current environmental management activities and be capable of developing this resource to meet changes to environmental activities carried out at the proposed Hinkley Point C site.

176 NNB GenCo provided information in chapter 11 that explains how it intends to develop core environmental competencies and maintain the ability to put these environmental skills and knowledge into practice to the high standard we expect.

177 We have considered how core environmental competencies have been developed and the processes NNB GenCo has used to identify specialist environmental roles (RWA and SQEP) and the training and development plans proposed to support their development.

178 NNB GenCo also has a training system that identifies the environmental knowledge and responsibilities of both NNB GenCo staff and its contractors at all levels. For NNB GenCo staff, this is embodied in their post profile and training records.

179 We are satisfied that there are clear links to the requirements of the permit, and that good environmental behaviours have been identified as key for staff as they maintain their competence.

180 NNB GenCo provided information on developing a resourcing strategy and how this relates to the nuclear baseline required for safety related activities. It has also provided information on how it would manage environmental competence as the project progresses.

181 We consider the level and capability of the resources available at corporate level to be adequate at this point in the project, and we are content that NNB GenCo is able to manage the development of its processes.

182 We will request regular updates and monitor and assess its performance as the project progresses.

4.4.5 Change control and living management arrangements

183 We recognise that NNB GenCo is a developing organisation. By granting the permit at an early stage in its development, we will maintain a proportionate degree of regulation at each stage of the project. This will ensure that management systems are developed that will support good environmental performance when the plant is in operation.

184 We consider it important that the developing management arrangements are subject to a change control system that is rigorous and provides an organisation that remains capable of meeting the requirements of the permit at all stages of the project.

185 NNB GenCo provided, in Chapter 11 of its submission, information on how it intends to control changes. This includes how changes with regard to its organisation, plant design, construction, commissioning and operation are assessed for their potential impact on environmental performance.

186 NNB GenCo submitted information on how the change process is embedded into its management system, so that there is oversight and governance of any proposed changes at a level appropriate to the environmental risk.

187 NNB GenCo also provided information on how it records changes and a regular review programme that ensures key documents and organisational structures are reviewed for fitness for each stage of the project and recorded within the change management system.

188 We are satisfied that the proposed arrangements are adequate for this stage of the project and NNB GenCo's system provides us with adequate notice of any significant changes as the project progresses and would maintain adequate records of changes for us to review.

4.4.6 Learning organisation

189 We recognise that NNB GenCo is a new developing organisation. We expect that the organisation encourages a culture of learning and continuous improvement, good leadership and control to achieve good environmental practices.

190 NNB GenCo provided information on how it promotes, captures and acts on learning.

191 NNB GenCo's management prospectus provided information about how it uses Oversight Boards, ensuring its Board and senior management team review and act on any learning activities as part of an overall operational learning process. This is a formal system for capturing corporate knowledge of learning events so that it is available to help inform future decisions.

192 NNB GenCo provided information on how it has built on its sister organisation's operational learning arrangements.

193 We are satisfied that the proposed arrangements are adequate for this stage of the project.

4.4.7 Readiness review

194 We carried out a readiness review as part of our assessment of the adequacy of the management arrangements. The objective of this review was to test NNB GenCo's ability to comply with the permit we intended to grant. We reviewed a sample of procedures and interviewed key personnel. We carried out the review in October 2012. NNB GenCo presented a compliance matrix and packages of compliance documents to demonstrate its progress.

195 We found that NNB GenCo has made satisfactory progress and has shown that it has adequate management arrangements to demonstrate compliance with the permit conditions set out in the permit, subject to some minor observations.

196 We also asked NNB GenCo to complete its internal assessment process, including review by the Independent Assessment Challenge and Oversight (IACO) team.

4.5 Optimisation in the management and disposal of radioactive waste (RSR Part B3, Q3, 4a)

197 There is a requirement under EPR 10, arising from the Basic Safety Standards Directive (Council Directive 96/29/Euratom)[39], that we carry out our role so as to ensure that all exposures to ionising radiation of any member of the public and of the population as a whole resulting from the disposal of radioactive waste are kept as low as reasonably achievable (ALARA), taking into account economic and social factors. This is in addition to ensuring that radiation exposures to members of the public arising from the operation of the facility comply with all relevant dose limits and constraints.

198 We do this by requiring the operator to use best available techniques (BAT) in the operation of the facility to:

- Prevent and minimise (in terms of radioactivity) the creation of radioactive waste.
- Minimise (in terms of radioactivity) discharges of gaseous and aqueous radioactive waste.
- Minimise the impact of those discharges on people, and adequately protect other species.
- Minimise (in terms of mass/volume) solid and non-aqueous liquid radioactive waste.
- Select the optimal disposal routes (taking account of the waste hierarchy and the proximity principle) for that waste.

By 'operation', we mean how the facility has been designed, built, maintained, operated and dismantled.

199 BAT is, therefore, applied to such aspects as minimising waste creation (for example through avoiding contamination of materials, and taking opportunities to reuse or recycle materials that might otherwise be disposed of as waste), abating discharges, and monitoring of plant, discharges and the environment. It takes account of such factors as the availability and cost of relevant measures, operator safety, and the benefits of reduced discharges and disposals. If the operator is using BAT, radiation risks to members of the public will be ALARA.

200 In considering the NNB GenCo's proposals, we have had regard to the statutory guidance under section 4 of the Environment Act 1995 to the Environment Agency concerning the regulation of radioactive discharges into the environment[40] and we have also considered other relevant government policy and our REPS.

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[39] http://ec.europa.eu/energy/nuclear/radioprotection/doc/legislation/9629_en.pdf

[40] http://tinyurl.com/ad8oeyy (note the National Archive web address is too long for our hyperlink tool)

201 We have taken full account of the work we have done during GDA, so that our efforts will be focused on operator and site-specific matters, including how the operator has addressed any assessment findings arising from our assessment of the UK EPR™.

202 The applicant must also demonstrate, for any waste created for which there is no currently available disposal route (ILW, high level waste (HLW) and spent fuel):

- Its suitability for eventual disposal.
- How it would be managed in the interim, so as not to prejudice its ultimate disposal.

4.5.1 How the operator has assessed BAT

203 We expect the operator to identify BAT by a methodology that is timely, transparent, inclusive, based on good quality data and properly documented. The methodology should ensure that the new plant uses BAT and should also be able to be carried forward to continually review BAT throughout the lifetime of the plant to see if any upgrading is needed to use newly developed techniques.

204 NNB GenCo provided information on its approach to the assessment of BAT in Chapters 7.1 to 7.4 of its submission. It used a structured approach, incorporating claims, arguments and evidence. NNB GenCo's assessment built upon the approach EDF and AREVA used for GDA. It also used operational feedback gained by EDF (and AREVA) as the operator (and designer) and of numerous French and German pressurised water reactors (PWRs).

205 We assessed this information and concluded that NNB GenCo has an appropriate methodology to identify and review BAT throughout the lifetime of the plant and that this complies with our RSR Environmental Principles (REPs) RSMDP4.

206 Below, we provide a summary of the information NNB GenCo submitted.

207 NNB GenCo's application states in sub-chapter 7.1 that environmental optimisation is a key component of its approach to design, commissioning, operation and decommissioning. It provided a high-level environmental optimisation statement. We consider that the commitments given by NNB GenCo in its statement can provide the high level methodology to identify BAT that we expect from operators.

208 NNB GenCo presented more information on its understanding of BAT and how it relates to Hinkley Point C in sub-chapter 7.2. It said that operational experience from the several hundred PWRs operating worldwide and, in particular the fleet of 57 operated by EDF, is emphasised in the methodology for Hinkley Point C it presents in sub-chapter 7.4. It said its methodology is based on the application of proportionality to risk, so that most focus is placed on those areas with the highest environmental impact. It set out its key expectations relating to BAT.

209 NNB GenCo stated in sub-chapter 7.3 that optimisation of environmental performance would be carried out from design through to decommissioning. It described how environmental optimisation for Hinkley Point C would build on the information for the UK EPR™ design presented at GDA and then be taken through construction and into operation. It identified that changes may be necessary during construction and commits to a '*robust change management process'* to ensure that the use of BAT is not compromised. There was a '*Forward Action Plan*' (Chapter 14 of the submission) that described NNB GenCo's longer term commitment to BAT.

210 NNB GenCo described in sub-chapter 7.4 how it demonstrates environmental optimisation for Hinkley Point C in four steps:

- Step 1 - A review of regulatory policy and guidance documents, including our guidance. It lists the documents it has reviewed.
- Step 2 - Demonstration of BAT for the UK EPR™ in GDA.
- Step 3 - Demonstration of environmental optimisation for Hinkley Point C at the current stage of development. It states that there are some uncertainties at this stage and provides a '*Forward Action Plan*', with matters to be addressed at appropriate times during the project.
- Step 4 - Ongoing demonstration of BAT throughout the life cycle of the facility using the methodology set out in step 3 for future modifications and as part of a periodic review process throughout the lifecycle of the plant.

211 We confirm that NNB GenCo reviewed a comprehensive list of relevant documents in step 1 above.

212 For step 2, EDF and AREVA's assessment of BAT for GDA also considered UK regulatory policy and guidance. It focused on the prevention and reduction of waste at source as the best way to reduce radioactive waste and discharges. The assessment was mainly in Chapter 8 of the GDA Pre-Construction Environmental Report (PCER), supported by a separate BAT Demonstration Report.

213 We assessed BAT for the UK EPR™ in GDA and, in December 2012, we issued a Statement of Design Acceptability (SoDA). Our decision is documented in our 2011 UK EPR™ decision document[41] and 2012 Supplement to the Decision Document[42]. We confirm that it is valid for NNB GenCo to rely on the outcome of GDA to support its demonstration of BAT for the Hinkley Point C reactors.

214 In step 3, NNB GenCo used a methodology of claims, arguments and evidence widely used in the UK nuclear and other high hazard industries in developing safety cases. These elements are:

[41] https://publications.environment-agency.gov.uk/ms/En2JP3
[42] https://publications.environment-agency.gov.uk/ms/Eovx06

a) Claim – a statement of what is being sought in terms of environmental optimisation.

b) Argument – an element which contributes to achieving a claim.

c) Evidence – that is used as the basis of each argument.

215 NNB GenCo described in sub-chapter 7.7 its forward programme to develop an environment case through the construction of Hinkley Point C under three headings:

a) Ongoing programmes – through its association with EDF, NNB GenCo has access to research and development by various organisations such as the Electric Power Research Institute, the Safety Directors' Forum and the Environment Agencies' Requirements Working Group. It will keep developing techniques under review, such as those for treatment of radioactive effluents. Also, sampling and monitoring techniques are expected to improve over time, and NNB GenCo will use the latest applicable BAT at Hinkley Point C.

b) Environmental optimisation programme – NNB GenCo stated that it is developing arrangements to ensure that BAT is fully integrated into the design, construction, operation and decommissioning of Hinkley Point C.

c) *Forward Action Plan* – this is presented as nine actions in Chapter 14 of the application, the following are relevant to BAT:

   i) **Review of commissioning and early operation lessons**.
   NNB GenCo noted that EDF will commission an EPR at Flamanville in France before Hinkley Point C starts operating. It will take advantage of EDF's experience of commissioning and early operation of an EPR.

   ii) **Assessment of secondary neutron sources.**
   NNB GenCo committed to assessing the performance of secondary neutron sources to see whether it is practicable to remove the sources. This action relates to our GDA assessment finding UK EPR-AF03. We accept that a decision cannot be made until operation over several fuel cycles has been assessed.

   iii) **Review liquid radioactive effluent abatement systems and techniques**.
   NNB GenCo committed to reviewing techniques used for treating liquid radioactive effluents before commissioning to ensure BAT is used. We say in sub-section 4.5.3 of this decision document that while the equipment in the liquid waste processing system contributes to BAT, the choice of filter cartridges, ion exchange resins and overall management of the system needs to be optimised by operators. This action relates to our GDA assessment finding UK EPR-AF08.

216 We conclude that NNB GenCo has used an adequate method to assess BAT for its application and a suitable forward programme to ensure BAT are used at Hinkley Point C. We have included some information requirements in the permit so that we can continue to monitor progress.

4.5.2 Using BAT to prevent and minimise the creation of radioactive waste

217 NNB GenCo provided information in chapter 7 on the origins of radioactivity and radioactive waste. These are:

a) Fission products formed in the fuel. These may leak into the primary coolant through any defects in the fuel cladding.

b) Activation of chemical species in the primary reactor coolant (the coolant is essentially water with some added chemicals).

c) Corrosion products from the metal components of the reactor system present in the reactor coolant and activated as they pass through the core of the reactor.

218 NNB GenCo set out its case for this topic in sub-chapter 7.6 section 2 as '*Claim 1: Eliminate or reduce the generation of radioactive waste'*. It submitted information under seven arguments that include fuel issues, specification of materials, primary coolant chemistry and secondary neutron sources.

219 We assessed this topic in GDA, see chapter 8 of our UK EPR decision document[43]. We have confirmed that NNB GenCo intends to use the same generic techniques presented in GDA and, therefore, we repeat our conclusions from GDA. We produced assessment findings in GDA, shown in Annex 1, that future operators need to address. We have noted below where NNB GenCo has addressed these findings. Where detail is not finalised, we have carried them forward as further information requirements in the permit.

220 We confirm that NNB GenCo has included the techniques we expect to see used in its Claim 1. We accept NNB GenCo's techniques to prevent and minimise the creation of radioactive waste proposed in Claim 1 contribute to BAT for the installation. We provide below a summary of the arguments NNB GenCo uses to support its Claim 1.

221 Argument 1 covers the design, manufacture and management of fuel. We reviewed NNB GenCo's information against our GDA and generally accept its proposals. However, the final choice of fuel has yet to be made and we will need to check that this meets our expectations from GDA, namely that fuel assemblies should exhibit consistently high operational reliability. We have included information requirements in the permit for NNB GenCo to provide evidence that the design, manufacture and management of fuel will be suitable to meet our expectation. We have included this as part of the requirement IC 2 in table S1.2 of Schedule 1 of the permit.

222 Argument 2 claims that the UK EPR™ maximises efficiency of fuel use. We confirm that the information presented is essentially the same as presented for GDA and we accept the claim.

[43] http://publications.environment-agency.gov.uk/pdf/GEHO1211BTNO-E-E.pdf

223 Argument 3 covers the detection and management of failed fuel. We confirm that the proposals to detect, remove and store failed fuel assemblies are acceptable.

224 Argument 4 concerns the specification of materials to minimise activation of structural materials and generation of corrosion products that become activated. It also includes preconditioning techniques, electro-polishing of steam generator channel heads and passivation of reactor coolant system surfaces during hot functional testing before active operation. Techniques are as we assessed at GDA and, in general, we accept these. However, there are still some specifications that NNB GenCo needs to confirm; these were in our GDA assessment finding UK EPR-AF04. We have included this as part of the further information requirement IC 8 in table S1.2 of Schedule 1 of the permit.

225 Argument 5 concerns optimisation of primary coolant chemistry to minimise corrosion products. We are content with the approach to chemistry control, but NNB GenCo says its final specification has yet to be agreed. NNB GenCo also said it will use zinc injection, but the final specification for use is not yet available. We will keep these matters under review and have included them as part of the requirement IC 2 in table S1.2 of Schedule 1 of the permit.

226 Argument 6 relies on procedures during commissioning, start-up and shutdown to ensure that the generation of corrosion products is minimised. We are generally content with these procedures, but will need to check the final specifications before first operation. We will keep these matters under review and have included them as part of the requirement IC 12 in table S1.2 of Schedule 1 of the permit.

227 Argument 7: NNB GenCo said that secondary neutron sources clad in stainless steel must be kept for safety reasons. However, removing these sources, if possible, would reduce tritium production. NNB GenCo put its assessment of the removal in its Forward Action Plan as Action 3. It will need operational experience over several fuel cycles before it can report. One consultee on the application was concerned that using these sources was not BAT.

228 We consider assessing the removal of these sources is an important topic. We have placed a requirement in the permit for NNB GenCo to provide an assessment of the performance of secondary neutron sources during operations and whether they can be removed. NNB GenCo shall provide a full report on the findings of its assessment within one year of the completion of the third fuel cycle on Unit 1. This requirement is referenced as IC 3 in table S1.2 of Schedule 1. We will use this report to fulfil action 3 of NNB GenCo's forward action plan.

229 We consider that NNB GenCo proposes to use BAT to prevent and minimise the creation of radioactive waste. We have included some information requirements in the permit so that we can continue to monitor progress.

4.5.3 Using BAT to minimise the discharges of gaseous and aqueous radioactive waste

230 As well as using BAT to prevent and, where that is not practicable, minimise the creation of radioactive waste as discussed above, we also expect new nuclear power plants to use BAT to minimise the radioactivity of gaseous and aqueous radioactive waste disposed of by discharge to the environment.

231 NNB GenCo provided its case for this topic in sub-chapter 7.6 Section 3: '*Claim 2 – NNB GenCo shall minimise the amount of radioactivity discharged or disposed of to the environment'*. It has submitted information under 16 arguments to support its claim including: containment, control of reactor chemistry, start-up and shutdown philosophies, design features, abatement techniques and management of waste. The arguments also address our REPs.

232 We assessed this topic in GDA, see chapters 9 and 10 of our UK EPR decision document[44]. We have confirmed that NNB GenCo intends to use the same generic techniques presented in GDA and, therefore, rely on our conclusions in GDA. We produced assessment findings in GDA, shown in Annex 1, that future operators need to address. We have noted below where NNB GenCo has addressed these findings. Where detail is not finalised, we have carried them forward as further information requirements in the permit.

233 We conclude that the techniques NNB GenCo uses to minimise the discharges of gaseous and aqueous radioactive waste contribute to BAT for the installation. We have included information requirements to cover issues such as specifications and final equipment selection that need to be completed before operations begin. We provide a summary of NNB GenCo's arguments and our assessment below.

234 Argument 1 covered the design, construction and operation of containment systems provided to confine the nuclear matter within the facility and prevent it leaking and escaping into the environment, except in accordance with authorised discharge conditions. The argument provides supporting information under eight topics:

a) application of relevant codes and standards to design and construction of containment systems

b) design and construction of the primary system

c) prevention of leaks

d) systems and arrangements for monitoring and testing for leak tightness and the management of leaks

e) containment of gaseous waste by the gaseous effluent treatment and ventilation system

[44] http://publications.environment-agency.gov.uk/PDF/GEHO1211BTNO-E-E.pdf

f) containment associated with other systems

g) containment of spent fuel

h) containment of intermediate level waste (ILW)

235 We assessed these topics at GDA and have considered NNB GenCo's argument. We conclude its proposals to minimise leaks contribute to BAT. At GDA, a report on containment measures was provided. While showing good practice, the report relied on legislation and practice in France. We require protection measures for Hinkley Point C to conform to UK legislation and practice. We expect NNB GenCo to produce its own specification. We have included this topic as part of the further information requirement IC 2 in the permit.

236 Argument 2 concerned the control of secondary coolant chemistry to ensure integrity of the secondary circuit. NNB GenCo said that '*there is potential for radioactivity from the primary coolant to transfer into the secondary circuit and eventually to the environment in discharges as a result of cracks or failures in the primary and secondary circuits arising from corrosion processes and degradation of materials*'. NNB GenCo provided information under three topics:

a) operational experience in secondary coolant chemistry

b) use of *'the best available demineralised make-up water'*

c) optimisation of secondary coolant system chemistry

237 We assessed these topics at GDA and have considered NNB GenCo's argument. We conclude its proposals for control of secondary coolant chemistry contribute to BAT.

238 We need additional information on one topic. The secondary coolant specification for Hinkley Point C is still being developed. We will keep these matters under review and have included them as part of the requirement IC 2 in table S1.2 of Schedule 1 of the permit.

239 Argument 3 was about reactor start-up and shutdown philosophies. NNB GenCo said that there is the potential for increased production of corrosion products and their entry into the coolant during start-up and shutdown. It provides information under three topics:

a) pre-shutdown degasification

b) shutdown procedures

c) start-up procedures

240 Argument 6 of Claim 1 contained related material considering commissioning and first start-up as well as routine outages.

241 We assessed these topics at GDA and have considered NNB GenCo's argument. We conclude that its proposals for reactor start-up and shutdown philosophies contribute to BAT.

242 Argument 4 covered features of the UK EPR™ design to prevent/minimise discharges during operation and decommissioning.

243 We assessed these design features at GDA and have considered NNB GenCo's argument. We conclude that its proposals contribute to BAT. We reviewed NNB GenCo's detailed design to ensure these features have been incorporated as specified in the application. We have included a further information requirement IC 9 in table S1.2 of Schedule 1 of the permit to provide us with this information as the detailed design is developed.

244 Argument 5 was about using ion exchange to treat liquid effluents, and Argument 6 covered the selection of the resins.

245 We assessed this technique at GDA and have considered NNB GenCo's argument. We conclude that its proposal to use ion exchange contributes to BAT.

246 NNB GenCo had not specified at this stage the resins it will use. We will need to review the chosen resins before operation and we have included this issue as part of the requirement IC 10 in table S1.2 of Schedule 1 of the permit.

247 Argument 7 covered the use of evaporation to treat primary coolant or certain liquid effluents.

248 We assessed this technique at GDA and have considered NNB GenCo's argument. We conclude that its proposals contribute to BAT, but we will need to review when NNB GenCo will use the waste system evaporator before operation. We have included this issue as part of the requirement IC 10 in table S1.2 of Schedule 1 of the permit.

249 Argument 8 covered the use of cartridge filters in the UK EPR™, but NNB GenCo said that it had yet to determine the detailed filter specifications for Hinkley Point C.

250 We assessed this topic at GDA and have considered NNB GenCo's argument. We conclude that its proposals contribute to BAT, but we will need to check the NNB GenCo specifications for filter cartridges before operation. We have included this issue as part of the requirement IC 10 in table S1.2 of Schedule 1 of the permit.

251 Argument 9 concerned the segregation and management of liquid effluent and the use of the UK EPR™ liquid waste processing system (LWPS) to minimise discharges of radioactivity to the environment.

252 We assessed the LWPS and the overall management of liquid waste in the UK EPR™ in GDA, in particular with regards to OSPAR (the Convention for the Protection of the Marine Environment of the North East Atlantic). In our UK EPR™ decision document (Section 10.5), we concluded that, while the equipment provided in the UK EPR™ to treat liquid waste contributed to BAT, managing that equipment to minimise discharges was a matter for the future operators to address.

253 NNB GenCo has yet to specify its management of the LWPS to minimise discharges of liquid radioactive waste to the environment. We will need to check its proposed management of liquid waste before operations begin, and

we will consider it when we receive the specification required by IC 11 in table S1.2 of Schedule 1 of the permit.

254 Argument 10 covered the decay storage of liquid effluent before discharge.

255 NNB GenCo said the tanks will not be operated as a dedicated decay system, but there will be some limited benefit in reduced discharges to the environment.

256 Argument 11 covered decay storage of gases before discharge mainly in the gaseous waste processing system (GWPS) and the purge gas system. The GWPS includes activated carbon beds that hold up some gases for periods of time allowing decay.

257 We assessed this topic at GDA and have considered NNB GenCo's argument. We conclude that its proposals contribute to BAT.

258 Argument 12 concerned the use of the purge gas system mentioned in Argument 11 above. Nitrogen is used as a cover gas for safety reasons.

259 We assessed this use of nitrogen as a cover gas in GDA, as the activation of nitrogen-14 produces carbon-14, and have considered NNB GenCo's argument. We conclude that its proposals contribute to BAT.

260 We considered the need for NNB GenCo to effectively manage dissolved nitrogen levels to minimise production of carbon-14 when we set the limits for this radionuclide.

261 Argument 13 covered the use of high efficiency particulate air (HEPA) filters to minimise discharge of radioactive particulates in gaseous discharges.

262 We assessed this topic at GDA and have considered NNB GenCo's argument. We conclude that its proposals contribute to BAT.

263 One consultee on the application questioned whether HEPA filters are effective in removing and retaining small particles of alpha emitting radionuclides, claiming that referenced research highlighted problems with particle retention. We note that the referenced research dates from 1976 and recommended frequent filter changes and the use of pre-filters. It is now normal industry practice to use pre-filters with HEPA filters. The consultee also stated that '*the usual technique for assessing the effectiveness of HEPA filters and, therefore, when to change them is to measure the pressure across the filter, and when it reaches a certain predetermined pressure the need to change them is indicated*'. We note that industry standard practice includes both filter pressure differentials measurements and routine efficiency checks with test aerosols. We consider this to represent BAT for assessing filter performance.

264 NNB GenCo said in argument 14 that using filtration and decay in the GWPS is BAT, but that there are no viable options for the abatement of tritium and carbon-14.

265 We assessed this topic at GDA and have considered NNB GenCo's argument. We conclude that this is reasonable.

266 Argument 15 was about the decay storage of solid radioactive waste. We agree that this can contribute to BAT, as waste that may be initially stored as ILW, can be re-categorised, removed from the interim storage facility and be disposed of as low level waste (LLW).

267 Argument 16 covered the control of fuel pool water conditions. These are important to maintain fuel integrity, but NNB GenCo has yet to set relevant operational control levels.

268 We also noted in GDA that the fuel pool was the main source of tritium in gaseous disposals and included assessment finding UK EPR-07. We need to check NNB GenCo's specification for controlling the fuel pool temperature, ventilation and chemistry before operations commence. We have included this issue as requirement IC 13 in table S1.2 of Schedule 1 of the permit.

269 We will also need to check the similar specification for the interim spent fuel storage facility. As this will be at a later time than the fuel pool, we have included this issue as requirement IC 14 in table S1.2 of Schedule 1 of the permit.

270 ONR raised the issue of whether the active area floor drains contained oil separators to remove oil from the effluent before it enters the treatment plant. We issued a Schedule 5 notice to NNB GenCo to obtain further information on this matter. We reviewed NNB GenCo's response and are content with the proposed strategy for dealing with the potential for oil to enter the effluent treatment system.

271 ONR also raised the issue of increased aqueous waste arising from using water to transfer ILW resins from unit 2 to the effluent treatment building. We issued a Schedule 5 notice to NNB GenCo to obtain further information on this matter. We reviewed NNB GenCo's response and are content with its strategy for dealing with the transfer of resins to the effluent treatment system.

272 We consider that NNB GenCo proposes to use BAT to minimise the discharge of gaseous and aqueous radioactive waste. We have included some requirements within the permit so that we can continue to monitor progress.

4.5.4 Using BAT to minimise the impact of discharges

273 In the previous two sub-sections we have considered how NNB GenCo proposes to prevent the production of and minimise the amount of radioactive waste that will need to be disposed of to the environment. Where discharges cannot be avoided, we expect new nuclear power plants to use BAT to minimise the radiological impact of those discharges on the environment and members of the public. NNB GenCo provided its case for this topic in sub-chapter 7.6 section 5: '*Claim 4 – minimise the impacts on the environment and members of the public from radioactive waste that is discharged or disposed of to the environment'*. It has submitted information under three arguments. We provide a summary of each argument below.

274 Argument 1 covered the preferential partitioning of radioactive substances between liquid, gaseous or solid waste to minimise the overall radiological impact of their disposal.

275 To minimise the dose impact on people and the environment, we consider it best practice to concentrate and contain radioactivity in solid materials rather than disperse it in the environment. If radioactivity cannot be contained in solid material, we need to assess whether it is best to dispose of it to the marine or atmospheric environment. The best option will depend on which radionuclide is considered.

276 Using filtration and ion exchange to transfer radioactivity from gaseous and liquid waste to solid media is considered above. We assessed this topic at GDA and have considered NNB GenCo's argument. We conclude that its proposals contribute to BAT.

277 NNB GenCo described three matters where partitioning of radionuclides minimises the impact of disposals to the environment:

a) Preferential partitioning of tritium into liquid effluents. Systems in the UK EPR™ keep tritium in the aqueous phase where it has a lower dose impact for a unit discharge than as a gaseous discharge.

   We assessed this at GDA and have considered NNB GenCo's argument. We conclude that its proposals contribute to BAT.

b) Preferential partitioning of iodine isotopes into liquid effluents. Systems in the UK EPR™ generally keep iodine radionuclides in the aqueous phase where they are substantially removed by ion exchange. Further, recycling of liquid effluent enables decay of short-lived iodine radionuclides.

   We assessed this at GDA and have considered NNB GenCo's argument. We conclude that its proposals contribute to BAT.

c) Preferential partitioning of carbon-14 into gaseous discharges. Carbon-14 is produced in the coolant, and we have accepted that BAT is used to minimise production and that there are no available techniques to abate carbon-14. NNB GenCo said that the majority of carbon-14, more than 80% of that produced, is degassed during treatment of coolant and discharged as gaseous waste.

278 NNB GenCo said that, of the remaining carbon-14, some is retained in filters, ion exchange resins and evaporator concentrates and becomes solid waste, while the remainder becomes aqueous waste. It said there is some uncertainty about the partitioning between solid and liquid waste. Our dose assessment shows that the difference in impacts of gaseous discharges and liquid discharges of carbon-14 is marginal at Hinkley Point.

279 We assessed partitioning at GDA. We had an assessment finding at GDA on the matter of the partitioning of carbon-14 in waste. We have included this issue as requirement IC 15 in table S1.2 of Schedule 1 of the permit.

280 Argument 2 was about the liquid effluent discharge system. NNB GenCo said that liquid radioactive effluents are collected in the tanks of the liquid radwaste monitoring and discharge system (LRMDS), the T tanks (three tanks each of

750 m^3). Tank contents are analysed and discharges managed to minimise impact to people and the environment. The LRMDS discharges into the outfall pond where there is substantial dilution by the returning cooling water flow (approximately 116 m^3 s^{-1}).

281 Another potential but minor source of radioactivity is drainage water from the turbine hall, including blowdown from the secondary circuit. This is collected in separate discharge tanks, the Ex Tanks, part of the Site Liquid Waste Discharge System (SEK [SiteLWDS]) (two tanks each of 750 m^3), for analysis before disposal to the outfall pond.

282 NNB GenCo said that there is an additional liquid waste discharge system (TER [ExLWDS]), the S Tanks (three tanks each of 750 m^3) that is kept in reserve and can be used to store effluent in the event of any issues with normal discharge arrangements. This provides additional management options to minimise the impact of radioactive discharges.

283 The size and design of discharge tanks are important to contribute to BAT. The size should be adequate to cope with predictable effluent volumes. The design should be capable of containing the effluent over the life of the plant without any leaks. We included GDA assessment finding UK EPR-AF06 on this matter in our GDA decision document. NNB GenCo provided some information on the sizing and design of tanks (concrete with a reinforced metallic liner) in its application chapter 7.6 section 3.1.6.4, but this does not completely address our assessment finding. We included a requirement to provide this information in our second Schedule 5 notice. We assessed NNB GenCo's response and consider that it provided sufficient information to address our concern and to satisfy the finding.

284 We assessed discharge arrangements at GDA and have considered NNB GenCo's argument. We conclude that its proposals contribute to BAT. However, NNB GenCo said that it has not yet fully defined the management arrangements for liquid effluent management at Hinkley Point C. We need to check these arrangements before operations begin and we will consider it when we receive the specification required by IC 11 in table S1.2 of Schedule 1 of the permit.

285 The combined discharge from the outfall pond is discharged into the sea (Bridgwater Bay) through a tunnel, with its outfall some two kilometres offshore. NNB GenCo said that the outfall location and design has been optimised on the basis of detailed marine dispersion modelling in the proposed area. We considered the design of the outfall system and conclude that it contributes to BAT.

286 The Committee on Medical Aspects of Radiation in the Environment (COMARE), in response to our consultation on the application, welcomed the contingency included in the capacity of the discharge tanks. It was concerned that while there was much detail of filtration before the tanks, there was no mention of final filters in the discharge line. We consider that the tanks are part of the monitoring system for the final discharge, and expect filtration and treatment to be carried out before the effluent reaches the tank. This is normal practice on UK nuclear power stations.

287 COMARE, in response to our consultation on the application, raised a concern about the lack of information on the proposed timing of aqueous discharges. In accordance with our template permit, our permit for Hinkley Point C includes a condition to use BAT to '*dispose of radioactive waste at times, in a form, and in a manner so as to minimise the radiological effects on the environment and members of the public*'. Arrangements to comply with this condition will need to be incorporated into station operating procedures at the appropriate time. We have included a further information requirement IC 11 in table S1.2 of Schedule 1 of the permit that will cover this matter.

288 Argument 3 covered the gaseous waste discharge system. NNB GenCo said that gaseous radioactive waste will be collected and discharged from Hinkley Point C through two main discharge stacks, one for each reactor. It has carried out modelling using the code ADMS 4 to determine the effectiveness of dispersion with varying stack heights. It said that a height of 70 m for each stack is BAT. Additional height would not significantly reduce the impact of discharges, but would increase cost and increase the visual impact.

289 We accept the use of the ADMS 4 code and NNB GenCo's assessment that a 70 m stack height gives adequate dispersion. Our assessment presented in section 4.10 is that gaseous discharges contribute 7.2 µSv y^{-1} to the representative person most exposed to gaseous discharges. This is less than 1% of the public dose limit.

290 We conclude that stack heights of 70 m for each unit minimises the impact of gaseous discharges from the main stacks and contributes to BAT for the installation.

291 We consider that NNB GenCo proposes to use BAT to minimise the impact of discharges. We have included some requirements within the permit so that we can continue to monitor progress.

4.5.5 Using BAT to minimise the amount of waste for transfer

292 NNB GenCo provided information in chapter 7 of its submission on how it minimises the generation of radioactive waste. We reviewed this information and consider that it has satisfied the requirements of GDA assessment finding UK EPR-AF11.

293 For GDA, we concluded that the proposed techniques for treating solid waste were BAT, subject to the future operator providing site-specific detail that will only be available when the detailed design is developed. We recorded this as assessment finding UK EPR-AF12 in GDA.

294 NNB GenCo provided information in chapter 2 of its submission on how it proposes to manage waste at Hinkley Point C. This included how solid LLW will be segregated by material type and activity, and what facilities may be provided so waste can be treated by reducing its size, decontamination or dismantling, shredding and low force compaction, where appropriate. We consider that further information is needed to satisfy the requirements of the assessment finding. We have included this as requirement IC 17 in table S1.2 of Schedule 1 of the permit.

4.5.6 Storage and disposability of waste for which there is currently no disposal route available

295 EDF and AREVA provided information on these wastes in the GDA Pre-Construction Environmental Report (PCER) for the UK EPR™, which we assessed for GDA. In general, we found this information to be adequate, subject to two GDA assessment findings on spent fuel storage.

296 NNB GenCo based its application on the GDA PCER and committed in the application to demonstrate, through the ONR site licence provisions, the suitability for disposal and interim management of any waste for which there is no currently available disposal route (for example intermediate and high level radioactive waste, ILW and HLW).

297 For GDA assessment finding UK EPR-AF16 concerning the techniques used to store spent fuel, we felt it appropriate to issue a Schedule 5 notice requiring further information that demonstrates that the choice of wet storage technology is appropriate for Hinkley Point C. We assessed this information and consider that NNB GenCo's proposals are acceptable in principle. We consider that this information meets the requirements of GDA assessment finding UK EPR-AF16.

298 For GDA assessment finding UK EPR-AF17 concerning management and disposability of spent fuel, we will work with ONR to ensure that an adequate Radioactive Waste Management Case supported by Letter of Compliance is developed.[45]

299 NNB GenCo will need to demonstrate that the spent fuel will be safely managed, in the interim, in a way that will not prejudice its ultimate disposal. We will work with ONR as part of routine regulation to satisfy ourselves that this is done.

300 Sedgemoor District Council, in response to the consultation on our draft decision document, brought to our attention a Royal Society report on fuel cycle stewardship. This report recommended that, whenever possible, interim storage under dry conditions should be adopted to enhance nuclear safety and security. During GDA we assessed both wet and dry storage options and considered that EDF and AREVA had demonstrated that all the options they had proposed were BAT. NNB GenCo is proposing wet storage for Hinkley Point C. Radioactive discharges for wet storage are low and we consider that wet storage is an acceptable approach to BAT for Hinkley Point C. We have also brought this report to the attention of ONR.

4.5.7 Our conclusions on the optimisation of the management and disposal of radioactive waste

301 The UK Strategy for Radioactive Discharges[46] has the following objectives:

[45] See http://www.hse.gov.uk/nuclear/wastemanage.htm
[46] http://www.scotland.gov.uk/Publications/2009/07/24130814/0

- To implement the UK's obligations, rigorously and transparently, in respect of the OSPAR Radioactive Substances Strategy (RSS)[47] intermediate objective for 2020.
- To provide a clear statement of government policy and a strategic framework for discharge reductions, sector by sector, to inform decision making by industry and regulators.

with the expected outcomes by 2020 of:

- Progressive and substantial reductions in radioactive discharges (to the extent described in the strategy).
- Progressive reductions in concentrations of radionuclides in the marine environment resulting from radioactive discharges, such that by 2020 they add close to zero to historic levels.
- Progressive reductions in human exposures to ionising radiation resulting from radioactive discharges, as a result of planned reductions in discharges.

302 In the statutory guidance[48] to the Environment Agency concerning the regulation of radioactive discharges into the environment, the government provides guidance on how we should pursue these objectives, namely by applying the environmental principles in the UK Strategy, as listed in section 2 of this document. The statutory guidance also requires us to take account of other government objectives, such as the safe and timely decommissioning of redundant facilities; clean-up of the historic legacy of radioactive waste; security of energy supply, and maintaining defence nuclear capabilities.

303 We assessed NNB GenCo's proposals and are satisfied that they represent the use of BAT and other environmental principles, as appropriate, to minimise discharges to the environment. We have set disposal limits (see section 4.6 below) based on the use of BAT and normal operation of the facility. We consider that this is consistent with our duties in relation to the UK Strategy and the government's statutory guidance to the Environment Agency concerning the regulation of radioactive discharges into the environment.

304 COMARE, in response to the consultation on our draft decision document, welcomed the proposed overall approach taken to waste management by minimising its production at source.

[47] http://www.ospar.org/html_documents/ospar/html/revised_ospar_strategies_2003.pdf
[48] http://tinyurl.com/ad8oeyy

4.6 Disposal routes and limits for discharges to the environment (RSR Part B3 Q4b)

305 We are permitting the disposal of radioactive waste to the environment via the systems described in sub-sections 4.6.1 – 4.6.2 and subject to the limits set out in sub-sections 4.6.3 – 4.6.8.

4.6.1 Systems for the discharge of aqueous radioactive waste to the environment

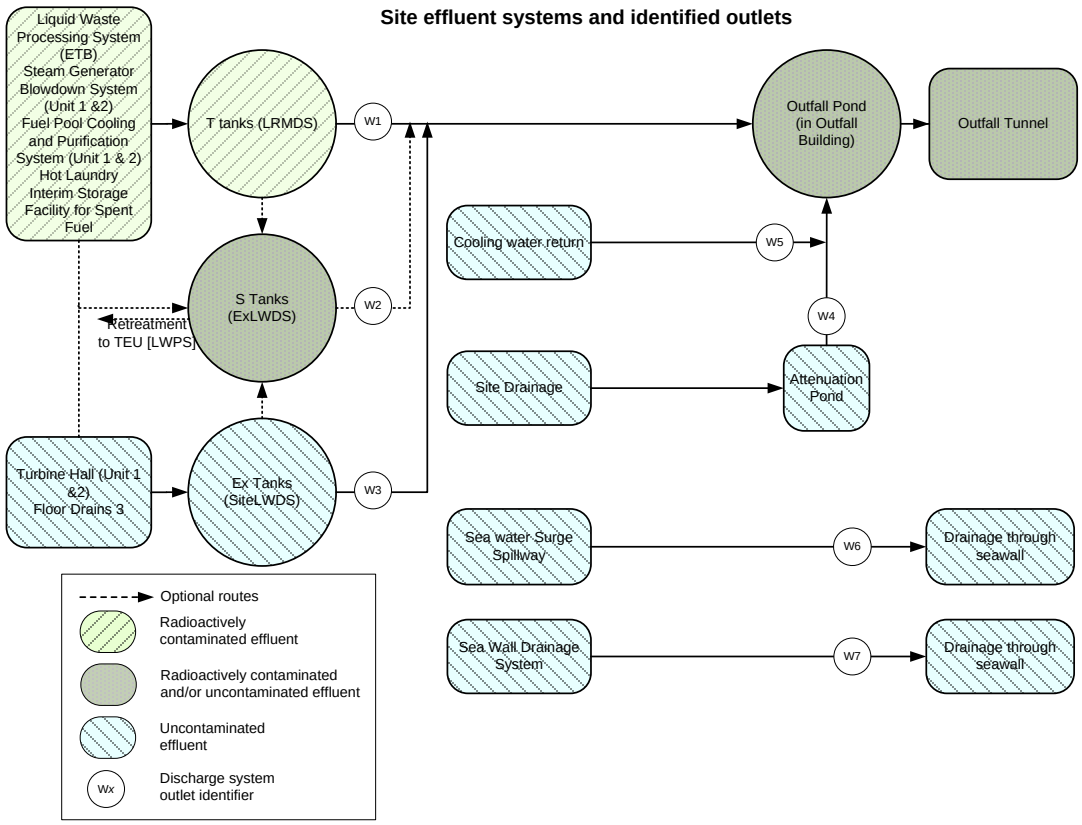
306 The main source of aqueous radioactive discharges is from the treatment of primary coolant. Some aqueous waste is produced by systems collecting equipment drainage, leakage or floor washings that could be contaminated. The liquid waste processing system takes effluent from these sources initially into buffer storage tanks. NNB GenCo will then use filtration, ion exchange or evaporation, as appropriate, to minimise the radioactivity content before effluent is collected in a set of discharge tanks, the T tanks (three tanks each of 750 m^3 capacity). Tank contents are analysed and then discharged through outlet W1 under a management system to the outfall pond where there is initial dilution in the returning cooling water.

307 Another potential, but minor, source of radioactivity is drainage water from the turbine hall, including drainage from the secondary circuit. This is collected in separate discharge tanks, the Ex Tanks (two tanks each of 750 m^3 capacity), for analysis before disposal to the outfall pond through outlet W3.

308 At Hinkley Point C one liquid waste processing system, in Unit 1, handles the liquid effluent from both units, and the discharge tank system is common. The outfall pond discharges into the sea (Bridgwater Bay) through a tunnel, with its outfall some 2 km offshore. We have assessed that the aqueous discharge arrangements contribute to BAT, see section 4.5.3 above.

309 The discharge system includes some reserve tanks, the S Tanks (three tanks each of 750 m^3). The S Tanks can discharge to the outfall pond through outlet W2, but also the contents can be circulated into the liquid waste processing system, if required. There are other drainage systems that have little potential for radioactive contamination. We reproduce below Figure 10 '*Summary of discharge routes from Hinkley Point C site*' from chapter 2 of the submission for ease of reference.

Copy of Figure 10, taken from HPC RSR Submission, Chapter 2.4 on page 63 of 92 with modified colour



310 NNB GenCo has allocated disposal outlet references W1 to W7 as shown above. Most of the radioactivity discharged will be in discharges from the T Tanks, which will be continually proportionally sampled at outlet W1. Outlets W2 and W3 will also have proportional sampling (see section 4.9.1). The other outlets, W4 to W7, are sampled intermittently. We have chosen not to set individual limits for these outlets, but have specified in the permit that total discharges from these shall not exceed 5% of the relevant site annual limits.

a) W4 – water run off from car parks and site buildings is collected in the Attenuation Pond. Contamination is unlikely, and the pond discharges through outlet W4 into the Outfall Pond. We noticed some inconsistency between figure 10 and the description of outlet W4 in NNG GenCo's submission. We asked for further information in our second Schedule 5 notice. Our notice is available on our Hinkley Point webpage[49] and NNB

[49] http://www.environment-agency.gov.uk/homeandleisure/132476.aspx

GenCo's reply is available on EDF Energy's website[50]. We concluded that there are, in fact, two outlets and have included them as W4A and W4B in the permit.

b) W5 – the cooling water (a minimum flow of approximately 116 m^3 s^{-1} of sea water when both units are at power) discharges into the outfall pond through outlet W5. The cooling water will be uncontaminated in normal operation. The cooling water serves several systems in both units. The return of each system will have an internal sampling point to check for contamination.

c) W6 – if there is a cooling water pump failure at high tide, a spillway system discharges water through the sea wall through outlet W6. No contamination is expected.

d) W7 – a sea wall drainage system returns rainwater and wave topping of the wall back to the sea through outlet W7. Again, no contamination is expected.

311 The Nuclear Free Local Authorities (NFLA) commented, in response to the consultation on our draft decision, that the diagram above was incorrectly coloured and gave a false impression of the fate of aqueous radioactive waste. We reproduced the diagram from NNB GenCo's application; there were subtle colours in the diagram that were unfortunately lost in publishing process. However, as NFLA pointed out, the text was quite clear about the fate of radioactivity and we have amended the colours in the diagram for this document to make it clearer.

4.6.2 Systems for discharge of gaseous radioactive waste to the environment

312 The main sources of gaseous radioactive waste are from the:

a) Degassing of the primary coolant - the gaseous waste processing system collects waste and uses a carbon bed delay system for decay of noble gases.

b) Ventilation of buildings - ventilation air is passed through high efficiency particulate air (HEPA) filters before discharge.

313 These gaseous wastes are collected together for discharge by the main stack of each unit at Hinkley Point C (outlets A1 and A2 in Schedule 3 of our permit). Each stack has representative sampling and monitoring (see section 4.10) and discharges to air at a height of 70 m. We concluded that the discharge height contributes to BAT, see section 4.5.4 above.

314 Another source is the ventilation system of the interim spent fuel store. NNB GenCo has not completed the detailed design of this facility, but it expects

[50] http://hinkleypoint.edfenergyconsultation.info/public-documents/environmental-permit-applications/environmental-permit-applications/operational/

HEPA filters to be used in the ventilation system. We consider this to be an important issue and we have included a pre-operational measure (POM 1) in the permit to install filtration to the HEPA standard. The contribution of the facility to the site discharge is shown in a table in section 5.2.1 of the application and is close to 5% of site limits. We consider that the amount of radioactivity predicted to be discharged from this stack and the quantities of radioactivity stored in the facility require this outlet to be considered as a major outlet. The stack for this system is outlet A3 in Schedule 3 of the permit.

315 Other discharges are listed below, but these make a minor contribution to the site discharge. We have specified in the permit that total discharges from these shall not exceed 5% of the relevant site limits.

a) Outlet A4 – stack for the ventilation system of the interim storage facility for ILW. ILW will be securely packaged before storage. NNB GenCo does not expect a filtered ventilation system will be needed in normal operation.

b) Outlets A5 and A6 – main steam relief train vents, one for each unit. In certain circumstances, steam can be let down from the secondary circuit to the atmosphere through silencers and stacks. NNB GenCo lists these as minor discharge points and says it is unlikely any appreciable radioactivity would be discharged through them.

c) Outlet A7 - we have used this outlet reference to cover all other minor discharges to the atmosphere such as louvres, vents, fan-assisted vents, windows and doors associated with radiation/contamination controlled areas, laboratories, turbine hall and radioactive storage areas/tanks not specifically included in any other outlet.

316 One consultee on the application raised a concern that NNB GenCo had not told us about discharges when '*the EPR roofs would be raised every 18 months for a blow through of core radiation build*'. The reactor building roof is fixed and is not raised at any time. We believe the consultee is referring to lifting the reactor pressure vessel head for refuelling. This is a routine operation on a PWR and is carried out with the reactor shutdown. This is carried out within the containment building and associated discharges have been included in NNB GenCo's application.

4.6.3 Limits for radioactive discharges to the environment

317 We have set limits in accordance with the statutory guidance to the Environment Agency concerning the regulation of radioactive discharges into the environment[51]. That is, we have set limits based on the operator using BAT to minimise disposals to the environment allowing for 'normal operation' of the facility. 'Normal operation' takes account of operational fluctuations, trends and events that are expected to occur over the likely lifetime of the facility.

[51] http://tinyurl.com/ad8oeyy

318 We have set out above our conclusion that the techniques NNB GenCo proposes to use contribute to BAT for the installation to:

a) Prevent and minimise the creation of radioactive waste (section 4.5.2), for example by using high integrity fuel.

b) Minimise the discharges of radioactive waste (section 4.5.3), for example by using carbon delay beds in the gaseous waste processing system and by filtration and ion exchange in the liquid waste processing system.

319 Based on this conclusion, we used our REP RSMDP12 and our limit setting guidance[52] to decide which radionuclides or groups of radionuclides to set limits for and the appropriate values for those limits.

320 We have considered the radionuclides and groupings to be discharged, in particular those contained in our RSR Pollution Inventory reporting form[53], and their significance against our guidance. Table 4 below shows those radionuclides for which we have chosen to set limits and levels.

Table 4: Radionuclide selected for limits

Criterion for significance	Gaseous	Aqueous
The critical dose exceeds 1 µSv y^{-1}	Carbon-14	Carbon-14
The 500 year collective dose to the world population exceeds 1 man Sv	Carbon-14	Carbon-14
Disposal exceeds 1 TBq y^{-1}	Tritium Carbon-14 Noble gases	Tritium
Impact on reference organisms exceeds 40 µGy h^{-1}	None	None
Indicators of performance and process control	Tritium Noble gases Iodine-131 Beta emitting radionuclide associated with particulate matter	Cobalt-60 Caesium-137 Other radionuclides

[52] https://publications.environment-agency.gov.uk/ms/Dcuypl
[53] http://www.environment-agency.gov.uk/static/documents/Business/PI_(RAS)v10.1.pdf

321 We have set limits for those radionuclides included in the above table on the basis of a rolling 12 month period.

322 We have also set quarterly notification levels (QNLs) on these radionuclides. QNLs help us to monitor and ensure that BAT is used to minimise discharges. QNLs are based on the expected best performance of the plant and are intended to highlight unusual discharge trends or events that may indicate that BAT is not being used to minimise discharges. Exceeding a QNL is not an offence, but it would be an offence for an operator to fail to let us know that they had exceeded a QNL or to provide a report that reviews the circumstances and whether they continued to use BAT.

323 Radioactivity discharged to the atmosphere over a short period, typically less than 24 hours, can result in higher doses than the same amount of radioactivity discharged over a longer period. This could be important when we consider radiation doses, particularly from food. There are two reasons for this. Firstly, over a short period the direction of the wind will not vary as much and the discharged radioactivity is likely to be concentrated in a smaller sector of the environment. Secondly, less weathering and radioactive decay might occur between the time of the release and the consumption of the food. Assessments of discharges made in a short period consider these possible effects and are pessimistic and precautionary.

324 We have considered whether we need to include any conditions or limits in the authorisations as a result of these short-term effects. In particular, we have considered whether we should include weekly advisory levels (WALs). If discharges exceed these levels, the operator must let us and the Food Standards Agency (FSA) know straightaway. They must also assess the possible impact of any radioactivity deposited onto pasture and crops near the site. This would enable both us and the FSA to consider if we need to take any further action to protect the public.

325 Our assessments indicate that even if the proposed annual limits were discharged in a short period of six hours, at any time of the year, the doses would be much less than the source constraint (300 µSv) and would be below the European Union's Maximum Permitted Level (MPL) also known as Community Food Intervention Level (CFIL) in food. So, we have decided not to set any WALs.

326 The European Union specified MPLs to limit the amounts of radioactivity that are permitted in foods and animal feeds following a radiological emergency. While the legislation specifying these MPLs only applies following a nuclear accident or other radiological emergency, wider policy considerations mean that it is not appropriate to permit routine discharges that may result in these levels being exceeded.

327 One consultee on the application raised concerns about the impact of discharges made in a short period, and quoted an assumption that radiation effects are not linear. As we explained above when we considered the need for short-term limits, we have taken into account that discharges made in a short period (less than a day) might cause a higher dose of radiation. We summarise our assessment in section 4.10 and we have published a full

report on our Hinkley Point webpage[54]. At the low levels of radiation exposure resulting from environmental discharges, there is no direct evidence of harm but the impact of radiation doses, as recommended by the International Commission on Radiological Protection (ICRP) (ICRP Publication 103, 2007), is cautiously assumed to be linear (extrapolated from impacts at higher doses), with no threshold.

328 We set out our proposed limits and levels in Table 5, and our reasons for setting each limit and QNL in sub-sections 4.6.4 – 4.6.8.

Table 5: Estimated best performance and proposed limits

Gaseous discharges					
Radionuclides	**Estimated best performance (GBq y^{-1})**	**Proposed annual limit (GBq)**		**Proposed QNL (GBq)**	
		NNB GenCo	**Environment Agency**	**NNB GenCo**	**Environment Agency**
Tritium	1,000	6,000	6,000	375	400
Carbon-14	700	1,400	1,400	305	300
Noble gases	1,600	45,000	45,000	1,480	1500
Iodine-131	0.05	0.4	0.4	0.064	0.064
Other[1] Fission and activation Products	0.008	0.24	0.12	0.058	0.008
Liquid discharges					
Tritium	104,000	200,000	200,000	91,500	60,000
Carbon-14	46	190	190	41	18
Cobalt 60	0.39	n/a	6	n/a	0.3
Caesium-137	0.114	1.9	1.9	0.11	0.1
Other[2] fission and activation products	1.2	18.1	n/a	0.9	n/a
Other[3] fission and activation products	0.8*	n/a	12	n/a	0.6

[54] http://www.environment-agency.gov.uk/homeandleisure/127159.aspx

[1] For gaseous discharges 'other fission and activation products' excludes tritium, carbon-14, noble gases and iodine-131 and in the permit we define the limit as 'Beta emitting radionuclides associated with particulate matter'.

[2] For liquid discharges 'other fission and activation products', as proposed by NNB GenCo, excludes tritium, carbon-14 and caesium-137.

[3] For liquid discharges 'other fission and activation products', as we propose, excludes tritium, carbon-14, cobalt-60 and caesium-137. We refer to this group of radionuclides as 'other radionuclides' in our permit.

*twice GDA estimate and corrected for Co-60 being subject to a separate limit

329 COMARE, in response to our consultation on the application, commented that some of NNB GenCo's proposed limits were high compared to estimated best performance. NNB GenCo stated that estimated best performance '*represents an ambitious target that would, if achieved, deliver amongst the best performance in the EDF fleet. Importantly, these figures do not include operational contingencies, that is, they are based on the assumption that all systems function at their optimised level and that no contingency or operational failures occur*'. We have taken into account predicted contingencies from older PWRs and, while we expect the performance of the UK EPR™ to be better, we have no operational data for a UK EPR™. We consider it would be inappropriate to set limits that might constrain operations given the low predicted impact of discharges.

330 COMARE, in response to the consultation on our draft decision document, welcomed our reduction of the limits proposed by NNB GenCo for fission and activation products, while recognising that the dose implications are low.

331 We will review limits in future when the performance of the UK EPR™ has been established. It may then be appropriate to reduce the contingency allowed, we will consider the government's statutory guidance on radioactive discharges to the Environment Agency when we carry out any future reviews.

332 There is an overriding requirement for operators to use BAT that applies below the limit, and it is through this requirement that we continue to expect best performance. We have set QNLs that are more closely related to estimated best performance.

333 COMARE, in response to our consultation on the application, also commented on the apparent differences between NNB GenCo's proposed limits and our indicative proposed limits at GDA. NNB GenCo used EDF and AREVA's proposed limits rather than our GDA proposals. We have considered these differences in determining our proposals for Hinkley Point C, as discussed below.

334 COMARE, in response to the consultation on our draft decision document, commented that due to uncertainties it would be advisable to formally review the annual gaseous discharges limits, and in particularly the QNLs after one year of operation. We agree in principle that discharge limits should be kept under review, but we consider that one year of the operation is not enough as it is less than one fuel cycle. We expect to review limits when better discharge data is available, which is part of our normal regulatory process.

335 The Health Protection Agency (HPA), in response to our consultation on the application, commented that NNB GenCo had referred to an International Atomic Energy Authority (IAEA) criterion based on collective dose for exemption from regulatory control. The HPA reminded us that it had commented during GDA that *'…it is the opinion of the HPA that a nuclear power plant should be subject to regulatory control regardless of whether dose criteria for exemption are met or not*'. In GDA, we agreed with HPA's view. This criterion is not contained in the Environmental Permitting Regulations and we only use it when we are considering whether a radionuclide needs a limit.

336 The Food Standards Agency, in response to our consultation on the application, had no objection to us granting a permit at the limits requested. However, it commented that the justification for the requested limits and QNL was not clear. We understand this comment and have, where necessary, formed our own views on the data presented, and indicated this in the text below.

337 The Food Standards Agency, in response to the consultation on our draft decision document, responded that it did '*not see anything obviously inaccurate or missing in the draft decision documents'*, and that it was *'not aware of any information that has come to light since the consultation that we would like to raise'.*

4.6.4 Tritium

338 NNB GenCo described in sub-chapter 2.2 of its submission how tritium is produced in the UK EPR™. Its explanation was based on information EDF and AREVA provided in the PCER that we assessed during GDA. Tritium is produced as a product of:

a) fission in the fuel

b) nuclear reactions between neutrons and helium in the fuel rods

c) nuclear reaction between neutrons and beryllium in the secondary neutron sources

d) neutron reactions between neutrons and boron, lithium and deuterium in the primary coolant

339 Zirconium is practically impermeable to the diffusion of tritium at the operational conditions found in the reactor, and the tritium produced in the fuel remains in the fuel. The stainless steel used for the cladding material of neutron sources is not impermeable to the diffusion of tritium at reactor operating conditions. The main sources of tritium in radioactive waste in the UK EPR™ are from the secondary neutron sources and the activation of boron and lithium. The production of tritium by the activation of deuterium is less significant because it has a low neutron capture cross section.

340 NNB GenCo described measures to reduce the production of tritium and the release of tritium into radioactive waste for disposal in sub-chapter 7.6 of its submission. Our views on these measures are in section 4.5.2 of this document.

341 **Aqueous discharges** – tritium originates in the primary coolant generally as tritiated water and the majority of tritium is discharged as aqueous effluent. NNB GenCo stated that disposal to the marine environment produces a lower impact than gaseous discharges. This is supported by information in its dose assessment, and our independent assessment has confirmed this. Therefore, we consider that the discharge of tritium as liquid effluent in preference to gaseous effluent contributes to BAT.

342 For GDA, we decided that an annual limit for aqueous discharges of 75 TBq of tritium was appropriate for a single UK EPR™. This was based on considering:

a) The measures taken to reduce the production and release of tritium in the reactor.

b) There is no effective process for removing tritium from the aqueous waste.

c) The impact of discharges is low; the dose at the generic site was 0.14 µSv y^{-1} to an adult.

d) Historic discharges at European and US PWRs.

343 NNB GenCo said that the '*expected best performance*' is 104 TBq y^{-1} for the two units at Hinkley Point C and proposed a limit of 200 TBq y^{-1}. Allowing for the two units at Hinkley Point C, the '*expected best performance*' is the same value presented in GDA, but the proposed limit is higher than twice our proposed indicative annual limit in GDA.

344 We have set a limit for tritium as the level of discharge is greater than the 1 TBq y^{-1} criterion in our guidance. However, the impact of aqueous discharges of tritium is very low; we estimate the dose to the public to be 0.0012 µSv y^{-1} and the collective dose to the world population to be 0.0068 manSv at the limit of 200 TBq y^{-1}.

345 NNB GenCo considered that a limit higher than twice the single unit maximum annual discharge is necessary. This is because tritium accumulates in the reactors until towards the end of the 18 month fuel cycle when there are higher rates of discharge of coolant to reduce its boron content. We accepted NNB GenCo's argument that allowance should be made for two planned and a possible unplanned outage occurring within one rolling 12-month period.

346 We consider that this is an infrequent but possible sequence of events that was not considered when the GDA limits were proposed for a single unit and a calendar year. We consider it would be unreasonable to restrict the operation of the power station by imposing a limit that was inappropriately low and have accepted NNB GenCo's argument for a limit of 200 TBq.

347 NNB GenCo proposed a QNL of 91.5 TBq. This was based on an assumption that 80% of the tritium produced in the plant is discharged during a two-month period at the time of the refuelling outage. NNB GenCo estimated that 80% of the tritium produced will accumulate over the 18 months between refuelling outages. This was based on operational experience at Sizewell B.

348 We have reviewed the data supplied by NNB GenCo for both Flamanville and Paluel power stations in France and also provided to us by British Energy

Generation Limited in 2005 for Sizewell B and we cannot see such a clear pattern. We proposed during GDA a QNL of 45 TBq for a single reactor. This was based on the three months of higher discharges before an outage. We do not expect both reactors to regularly discharge at the higher rate within the same quarter. We consider 45 TBq as a maximum for one unit, with the addition of a quarter of the '*expected best performance*' for the other unit. We have rounded this up to 15 TBq, and we consider a QNL of 60 TBq to be appropriate for Hinkley Point C.

349 **Gaseous discharges** - the main source of tritium in gaseous discharges is from evaporation from the surface of pools in the plant, in particular the in-containment refuelling water storage tank. The tritium is collected by ventilation systems and discharged through the main stacks. Apart from some water vapour being condensed on cooling coils in the ventilation systems, there is no abatement of tritium discharges.

350 NNB GenCo said that the '*expected best performance*' is 1 TBq y^{-1} and proposes a limit of 6 TBq y^{-1}. Allowing for the two units at Hinkley Point C, these are the same values presented in GDA.

351 We have set a limit because the level of discharge alone is greater than the 1 TBq y^{-1} criterion in our guidance. However, the impact of gaseous discharges of tritium is very low. We estimate the dose to the public to be 0.256 µSv y^{-1} and the collective dose to the world population to be 0.00196 manSv.

352 The level of gaseous tritium discharge is directly related to the control of the fuel pools, see section 4.5.3. Therefore, the tritium content of gaseous discharges is also an indicator of process control, which is another reason why we propose a limit.

353 NNB GenCo described how it has used operational experience modified for the UK EPR™ case to predict the '*expected best performance*' and supports its prediction with data from the EDF Chooz and Civaux power stations in France.

354 NNB GenCo described the contingencies it believes should be considered to set the limit. These include unplanned shutdown, increased pool area during shutdown, coolant chemistry changes and fuel failure as well as indirect matters such as weather conditions.

355 We have assessed the prediction and the contingencies and accepted them as reasonable. We accept the NNB GenCo proposal for a 12-rolling-month limit for gaseous discharges of tritium of 6 TBq. This is twice the limit we proposed for a single UK EPR™ in our GDA assessment.

356 NNB GenCo proposed a QNL of 375 GBq for a three-rolling-month level. Its approach starts with '*expected best performance*' and allows for normal operation fluctuations, in particular evaporation may be higher in the summer months.

357 In GDA, we proposed a QNL of 150 GBq for a single reactor, which we revised to 200 GBq following consultation to give an adequate margin for operational fluctuations.

358 NNB GenCo's proposal is less than twice the GDA QNL and after reviewing our GDA considerations following consultation we have set a QNL of 400 GBq for gaseous discharges of tritium.

4.6.5 Carbon-14

359 NNB GenCo described in sub-chapter 2.2 of its submission how carbon-14 is produced in the UK EPR™. Its explanation is based on information EDF and AREVA provided in the PCER that we assessed during GDA. Carbon-14 is produced:

a) From activation of the oxygen-17 present in the water of the primary system.

b) From activation of the nitrogen-14 dissolved in the water of the primary system (a variable quantity).

c) In the fuel from oxygen and nitrogen impurities but should be contained within the fuel cladding.

d) From activation of the carbon-13 dissolved in the water of the primary system (a very small amount).

e) From activation of the nitrogen driving the '*aeroball*' system, used to measure neutron flux within the reactor.

f) From activation of oxygen and nitrogen in the air within the reactor pit.

360 The main sources of carbon-14 are the activation of oxygen-17 and nitrogen-14 in the primary coolant water. Most of the carbon-14, over 80%, is degassed from the coolant and is discharged through the gaseous waste processing system to the main stacks. The remaining carbon-14 enters the liquid waste processing system where there is some retention on filters, in ion exchange resins and in evaporator concentrates, but there is no specific abatement of carbon-14 before it is discharged to the sea.

361 There are no available techniques to minimise the production of carbon-14 from oxygen-17, but production from nitrogen-14 can be minimised by optimising the dissolved nitrogen content of the primary coolant, see section 4.5.2 above.

362 COMARE, in response to our consultation on the application, comments that the aqueous and gaseous carbon-14 limits should be reviewed when data from the French monitoring programme becomes available. We are proposing limits for Hinkley Point C and will expect monitoring to be carried out to demonstrate compliance with these limits. We expect to review limits as better discharge data becomes available, which is part of our normal regulatory process.

363 **Aqueous discharges** – NNB GenCo said up to 20% of carbon-14 produced in the primary coolant can be discharged as aqueous effluent. Some carbon-14 will be retained in filters, ion exchange resins and in evaporator concentrate, but this is not the main purpose of those techniques.

364 NNB GenCo said that the '*expected best performance*' is 46 GBq y^{-1} and proposed a limit of 190 GBq y^{-1}. Allowing for the two units at Hinkley Point C, these are the same values presented in GDA.

365 The impact of carbon-14 (at 190 GBq y^{-1}) to public dose was 1.06 µSv y^{-1} in NNB GenCo's assessment. However, in our assessment the dose was predicted to be 0.508 µSv y^{-1} and is below our criterion for setting a limit. Carbon-14 contributes the most of any of the radionuclides to the impact of aqueous discharges and the collective dose to the world population is 2.2 manSv. This is above our criterion for setting a limit, and we have, therefore, set a limit.

366 For GDA, we decided that an annual limit for aqueous discharges of 95 GBq of carbon-14 was appropriate for a single UK EPR™. This was based on considering:

a) The measures taken to reduce the production and release of carbon-14 in the reactor.

b) That there is no effective process for removing carbon-14 from the aqueous waste.

c) Historic discharges at European and US PWRs.

d) Uncertainty of the split of carbon-14 between gas and liquid phases and the level of nitrogen in the coolant.

367 NNB GenCo said that the '*expected best performance*' is based on data from the 1300 MWe plant currently operating in France, modified for the output of the UK EPR™. It said this is similar to a value calculated as 5% of the source term. It provided calculated data against measured discharges that shows wide variance between the two and said accurately predicting discharges is complex as the behaviour of carbon-14 in the plant is affected by its chemical form and that form may change.

368 NNB GenCo provided information on the contingencies affecting discharges of carbon-14: high nitrogen content in the primary coolant; unplanned shutdown; and, contamination of fuel pools. However, its main concern was the uncertainty in the partitioning of carbon-14 between the gaseous and liquid phases. It proposed to base its maximum on 20% carbon-14 in the liquid phase, giving 190 GBq y^{-1}. It said that this maximum includes sufficient margin to cover the contingencies such as higher nitrogen content mentioned above. The discharge of carbon-14 will follow the same pattern as tritium, with 80% discharged in the two months before shutdown. However, on considering the effect of the two units on the 12-rolling-month total discharge, NNB GenCo said there should be no impact, and put forward the maximum, 190 GBq y^{-1}, as the proposed limit.

369 The prediction for '*expected best performance*' and justification for the proposed limit are the same as we assessed and accepted in GDA. We will accept the NNB GenCo proposal for the aqueous carbon-14 12-rolling-month limit to be 190 GBq for Hinkley Point C.

370 NNB GenCo proposed a QNL of 41 GBq for a three-rolling-month level. It based its proposal on 80% of '*expected best performance*' annual discharge in one quarter corrected for 100% availability.

371 We reviewed the data NNB GenCo supplied and could not see such a clear pattern of discharge. We proposed during GDA a QNL of 9 GBq for a single reactor, which was based on a higher discharge in one month. We consider a QNL of 18 GBq to be appropriate for Hinkley Point C.

372 **Gaseous discharges** - most of the carbon-14, over 80%, is degassed from the coolant and discharged through the gaseous waste processing system to the main stacks. There is no abatement of carbon-14.

373 NNB GenCo said that the '*expected best performance*' is 700 GBq y^{-1} and proposed a limit of 1.4 TBq y^{-1}. Allowing for the two units at Hinkley Point C, these are the same values presented in GDA.

374 NNB GenCo's proposed limit is greater than the 1 TBq y^{-1} criterion in our guidance. The contributions of carbon-14 to public dose and collective dose are also greater than our 1 µSv y^{-1} and 1 manSv criteria and also require us to set a limit. While carbon-14 contributes the most of any of the radionuclides to the impact of gaseous discharges, its impact is low. We estimate dose to the public to be 6.59 µSv y^{-1} and the collective dose to the world population to be 16.7 manSv.

375 For GDA, we decided that an annual limit for gaseous discharges of 700 GBq of carbon-14 was appropriate for a single UK EPR™. This was based on considering:

a) The measures taken to reduce the production and release of carbon-14 in the reactor.

b) That there is no effective process for removing carbon-14 from the gaseous waste.

c) Historic discharges at European and US PWRs.

d) Uncertainty of the split of carbon-14 between gas and liquid phases and the level of nitrogen in the coolant.

376 NNB GenCo described how it predicted the '*expected best performance*'. Its main basis is on source terms, with production from oxygen-17 the highest, with an additional variable amount from dissolved nitrogen. Operational experience from predecessor units is not as relevant as the UK EPR™ design is somewhat different.

377 NNB GenCo said that operational feedback from currently operating plant showed highly variable discharge levels of carbon-14. It also said that the dissolved nitrogen level in the coolant, assumed as 18 parts per million (ppm) for '*expected best performance*', could be higher in an operational UK EPR™. Other contingencies include unplanned shutdown and fuel failure. There is also some uncertainty about the distribution of carbon-14 between gaseous (80% assumed) and liquid phases. NNB GenCo, therefore, proposed 1.4 TBq y^{-1} as the limit, to also include minor contributions from the '*aeroball*' system, the reactor pit atmosphere and the interim spent fuel store.

378 We assessed the prediction and the contingencies and accept these as reasonable. We accept the NNB GenCo proposal for a 12-rolling-month limit for gaseous discharges of carbon-14 of 1.4 TBq y^{-1}.

379 NNB GenCo proposed a QNL of 305 GBq for a three-rolling-month period. Its approach started with '*expected best performance*' and allowed for normal operational fluctuations and possibly 100% full power operation in any quarter. Its factor for operational fluctuations was based on analysis of data for predecessor plant between 2002 and 2009.

380 We proposed during GDA a QNL of 100 GBq for a single reactor. We considered the information NNB GenCo provided about fluctuations of discharge, which is more recent than that provided at GDA, and we consider that a QNL of 300 GBq is more appropriate at this stage for the two reactors.

4.6.6 Noble gases

381 Noble gases are chemically inert and include the activation product argon-41, and the fission products of xenon and krypton. Radionuclides of xenon and krypton are formed by fission in the fuel and trace of uranium left on the outside of the fuel during the manufacturing process. They are normally contained within the fuel cladding but can pass into the primary coolant through any cladding defects. They degas from the coolant and are subject to decay by delay in the carbon beds of the gaseous waste processing system (GWPS) before discharge from the main stacks. Some argon-41 is formed by activation of air around the reactor, but it has a short half life and is only discharged when the reactor building ventilation system operates. Noble gases will only be present in gaseous discharges.

382 NNB GenCo said that the '*expected best performance*' is 1.6 TBq y^{-1} and proposed a limit of 45 TBq y^{-1}. Allowing for the two units at Hinkley Point C, these are the same values presented in GDA.

383 The level of discharge at the maximum is greater than the 1 TBq y^{-1} criterion in our guidance, so we will set a limit. However, the impact of noble gas discharges is low. We estimate the dose to the public to be 0.135 µSv y^{-1} and the collective dose to be 0.002 manSv.

384 The presence of noble gases in the discharge is an indicator of fuel leaks and, therefore, a further reason for a limit.

385 For GDA, we decided that an annual limit for gaseous discharges of 22.5 TBq of noble gases was appropriate for a single UK EPR™. This was based on considering:

a) The better integrity expected of fuel.

b) Reduction in discharge activity by decay in the carbon beds of the GWPS.

c) Historic discharges at European and US PWRs.

d) Allowance for a level of fuel cladding failure to avoid constraining operations given that the impact of discharges are low; the dose at the generic site was 0.047 µSv y^{-1} to an adult.

386 NNB GenCo described how it predicted the '*expected best performance*' based on predecessor unit data. Discharges of noble gases are very variable and greatly affected by fuel issues. With no fuel leaks, discharges can be below detection levels, while, when failed fuel is present, discharges of noble gases can be an order of magnitude higher. The '*expected best performance*' has been set at a very ambitious low level only achievable with no fuel leaks.

387 NNB GenCo said that there are two main contingencies to consider for the noble gas limit. One is fuel leaks and the other is any fault in the gaseous waste processing system, in particular any requirement to bypass the delay beds. NNB GenCo proposed a limit of 45 TBq y^{-1}. It accepted that this appeared to be a large headroom over the '*expected best performance*', but data showed the significant impact fuel issues have on discharges. It chose to propose the limit for 1300 MWe units currently operating in France, but said this was effectively a decreased limit for the UK EPR™, as its output is some 20% higher.

388 We accept the prediction for '*expected best performance*' and that fuel issues can significantly increase noble gas discharges. Reactors are designed to run until their next refuelling shutdown with a small level of fuel leaks and, in setting a limit, we do not wish to constrain operations as the dose impact from noble gases is very low. We accepted a limit proposal of 22.5 TBq y^{-1} for a single UK EPR™ at GDA. We considered whether it is valid to double the contingency for two units and decided that fuel leaks could occur on both units at the same time. Also, considering the low site-specific dose impact from noble gases (see above and section 4.10), we accept the NNB GenCo proposal for a 12-rolling-month limit of 45 TBq for Hinkley Point C.

389 COMARE, in response to our consultation on the application, questioned the differences between estimated best performance, BAT and the proposed limits for this group of radionuclides. We consider that fuel contingencies have to be taken into account as explained above. We have considered fuel design and quality together with leak reduction and abatement techniques in sections 4.5.2 and 4.5.3.

390 NNB GenCo proposed a QNL of 1.48 TBq for a three-rolling-month level. It looked at operational data for predecessor plant and identified that there is often a peak discharge in one month. It considered this would be 0.607 TBq for one UK EPR™. It then added two months at '*expected best performance*' to give a three month level.

391 We proposed at GDA a QNL of 2.25 TBq for a single unit. We based our proposal on experience of older plant, with the lower levels of fuel integrity than now expected by NNB GenCo. When we reviewed the NNB GenCo approach, we were content that its proposed QNL of 1.48 TBq would better highlight adverse trends in disposals. We have rounded this value to 1.5 TBq as a reflection of the accuracy of the predictions.

392 One consultee on the application was concerned that we might set a limit for a specific noble gas such as Ar-41 and, therefore, allow all the others to be discharged without limit. We have set a group limit that will include all the noble gases.

4.6.7 Iodine-131

393 Iodine radionuclides are formed by fission in the fuel and are normally contained within the fuel cladding, but they can enter the coolant when there are fuel failures.

394 **Aqueous discharges** - iodines tend to dissolve and are, therefore, mostly found in aqueous effluents. While it is not their main function, the demineralisers in the coolant purification system do absorb significant amounts of iodine if it is present in the effluent. Also, effluents are held up in tanks in the liquid waste processing system awaiting treatment or discharge. The delays will allow most of the shorter half-life iodine radionuclides to decay. Due to the short half life of the other radionuclides of iodine, we consider iodine -131 as a suitable representative for the whole group of iodine radionuclides potentially in discharges.

395 For GDA, we decided that an annual limit for aqueous discharges of iodine-131 was not appropriate for a single UK EPR™. This was based on considering:

a) improved fuel integrity

b) removal in demineralisers

c) historic discharges at European and US PWRs

d) low level of discharge, a maximum of 50 MBq y^{-1}

e) the impact of discharges are very low, the dose at the generic site was 0.000076 µSv y^{-1} to an adult

396 We have decided not to set an iodine-131 aqueous discharge limit for Hinkley Point C as the predicted discharges do not meet any of our limit setting criteria.

397 **Gaseous discharges** – gaseous iodine radionuclides will degas from the primary coolant and enter the GWPS. The recirculation of purge gas in the GWPS will allow decay of shorter-lived iodine radionuclides such as iodine-132 and iodine-134. When purge gas is bled off, it passes through delay beds before it is discharged. While these beds are not targeted at iodine radionuclides, a delay of 40 days is claimed for iodine radionuclides. Iodine-131 is chosen as the indicator for iodine radionuclides to simplify monitoring. Other iodine radionuclides activity can be derived from iodine-131 if needed.

398 NNB GenCo said that the '*expected best performance*' is 50 MBq y^{-1} and proposed a limit of 400 MBq y^{-1}. Information was presented in GDA on total iodines. As iodine-131 is approximately 50% of total iodines, these values are equivalent.

399 In our assessment of the impact of iodine-131, the dose to the public is 0.0805 µSv y^{-1} and the collective dose is 0.0005 manSv, for a discharge of 400 MBq y^{-1}, which is below our criteria for setting limits. However, we have set a limit as the presence of iodine-131 in the discharge is a useful indicator of fuel leaks and the integrity of the delay beds.

400 For GDA, we decided that an annual limit for gaseous discharges of 400 MBq of iodine-131 was appropriate for a single UK EPR™. This was based on considering:

a) The better integrity expected of fuel.

b) Reduction in discharge activity by decay in the carbon beds of the GWPS.

c) Historic discharges at European and US PWRs.

d) Allowance for a level of fuel cladding failure to avoid constraining operations given that the impact of discharges are low; the dose at the generic site was 0.039 µSv y^{-1} to an adult.

401 NNB GenCo described how it predicted the '*expected best performance*' based on data from predecessor PWRs in France. The 50 MBq y^{-1} value taken may be rather high as much of the data was shown at detection threshold rather than measured values. Discharges of iodine radionuclides are very variable and greatly affected by fuel leaks, as with noble gases.

402 NNB GenCo said there are several contingencies to consider for the iodine-131 limit. These are fuel leaks, a fault in the gaseous waste processing system, unpredictable release from paint or pipes and faults in the iodine traps. NNB GenCo proposed a limit of 400 MBq y^{-1} to provide headroom over the '*expected best performance*' to allow for the contingencies. It supported its proposal by reference to peaks in the data from the predecessor PWRs.

403 We accept the prediction for '*expected best performance*' and that fuel issues and other contingencies require sufficient headroom to be added to that value to give the limit. We accept the NNB GenCo proposal for the gaseous iodine-131 12-rolling-month limit to be 400 MBq for Hinkley Point C. This is actually less than that we proposed at GDA, as there we used the predicted maximum, 400 MBq for one UK EPR™ for total iodines, as the limit for iodine-131 alone.

404 NNB GenCo proposed a QNL of 64 MBq for a three-rolling-month level. It looked at operational data for predecessor plant and identified that there is often a peak discharge in one month. It considered this would be 28 MBq for one UK EPR. It then added two months at '*expected best performance*' to give a three-month level.

405 In GDA, we proposed 40 MBq for a single reactor. We consider NNB GenCo's proposal is based on a better estimate from operational experience and have set a QNL of 64 MBq for Hinkley Point C.

406 One consultee on the application commented that the decontamination factor of 40 for iodine shows very poor performance. We note that this factor is related to the delay of the iodine in the carbon beds. The factor of 40 is for iodine-131, which has a long half life compared to most of the other radionuclides of iodine. The decontamination factors for these other radionuclides will be higher. Much higher decontamination factors are achievable on systems with low flow, but we consider the delay achieved in the delay beds is BAT for this type of plant.

407 The same consultee drew our attention to information in the application about discharges of iodine-132 and was concerned that it was not proposed to be subject to a limit. We considered the use of iodine-131 as a surrogate for all radionuclides of iodine at GDA and also when we reviewed British Energy Generation authorisation for Sizewell B power station. For Sizewell B, we have information that even during periods of fuel leakage the typical levels in the coolant of iodine-132 are up to ten times higher than iodine-131. However, the impact from iodine-132 was low compared to the impacts of iodine-131, because the impact per unit activity discharged of I-132 is approximately 1% of the impact of I-131. We have set a limit on iodine-131 as we consider it is a suitable surrogate for all radionuclides of iodine for Hinkley Point C.

4.6.8 Other fission and activation products

408 NNB GenCo described in sub-chapter 2.2 of its submission how radionuclides other than those specifically mentioned above are produced in the UK EPR™. Its explanation was based on information EDF and AREVA provided in the PCER that we assessed during GDA. These were described as:

a) Activated corrosion products – these are products of corrosion that have become activated by neutron flux in the reactor and are found as particulates or dissolved as ions in the primary coolant. The most significant of these are cobalt-60 and cobalt-58.

b) Fission products – there are some other fission products that are formed in the fuel; these are normally contained within the fuel cladding. The most significant of these are caesium-137 and caesium-134.

409 NNB GenCo described measures to reduce the creation of corrosion products and techniques such as filtration and ion exchange to reduce discharges in sub-chapter 7.6 of its submission. Our views on these measures are in section 4.5.2 and 4.5.3 of this document.

410 **Aqueous discharges** – activated corrosion products and other fission products will be present in primary coolant sent to the LWPS for treatment and disposal. Abatement techniques in the LWPS include filtration, ion exchange and evaporation.

411 NNB GenCo proposed limits and QNLs for caesium-137 and '*other fission and activation products'* in sub-chapter 4.5 of its submission. NNB GenCo said that the '*expected best performance*' for caesium-137 is 114 MBq y^{-1} and proposed a limit of 1.9 GBq y^{-1}. It said that the '*expected best performance*' for '*other fission and activation products'* excluding caesium-137 and iodine radionuclides is 1.2 GBq y^{-1} and proposed a limit of 18.1 GBq y^{-1}. Allowing for the two units at Hinkley Point C, these were based on the values presented in GDA.

412 In our assessment of the impact of all the other radionuclides taken together, the dose to the public is 0.0018 µSv y^{-1} and the collective dose is 0.0000014 manSv per year of discharges. Both doses are less than our criteria for setting a limit, so, on the basis of dose alone, we do not need to set a limit. However, we consider that these radionuclides require limits in the permit to act as indicators of plant performance.

413 Caesium-137 is an indicator for fuel failure. Cobalt-60 is an indicator of lack of corrosion control and/or failure of treatment in the liquid waste processing system. We decided to set separate limits for caesium-137 and cobalt-60.

414 We consider that any other radionuclides present in aqueous effluent should be subject to control, and we propose to set a limit that will be based on a method of measurement design to detect a wide range of radionuclides. The definition of and the method for measuring 'other radionuclides' is defined in Table S 3.4 of Schedule 3 of our permit. NNB GenCo proposed such a method in chapter 9 of its submission. The proposed limit will be based on an analytical method, which will not include tritium and carbon-14. These are subject to separate limits. The method will also not measure radionuclides of iodine, which we decided at GDA did not need a limit because it was not proportionate to do so as it had been assessed as having a very low impact.

415 For GDA, we decided that annual limits for aqueous discharges of:

a) cobalt-60 – 1.5 GBq

b) caesium-137 – 0.5 GBq

c) other radionuclides not specifically limited – 3 GBq

were appropriate for a single UK EPR™. This was based on considering:

i) The measures taken to reduce the creation and discharge of cobalt-60, caesium-137 and other radionuclides

ii) Historic discharges at European and US PWRs.

416 NNB GenCo said that the '*expected best performance*' is based on data from the 1300 MWe plant currently operating in France, modified for the output of the UK EPR™, but with a 10% reduction allowed for environmental improvements. It provided a table showing the individual other radionuclides expected and their percentage contribution to the total.

417 NNB GenCo said that the contingencies to be considered for limit setting included fuel failures; accidental contamination of coolant and unavailability of discharge tanks. It also said that, from past experience, a significant portion of discharge will occur at shutdown.

418 One consultee on the application was concerned that alpha emitters had not been properly considered. The consultee referred to information about plutonium-241 from the AP1000 GDA information. We considered alpha emitters at GDA and decided that they did not need detailed consideration as the discharges and impacts were very low. We note that plutonium-241 is not an alpha emitter, but does decay to americium-241. However, the quantities of both are not significant.

419 NNB GenCo stated that alpha emitters would not be detectable in liquid effluent. This is in line with our assessment at GDA and, although we have not set a limit, we will require assessment for alpha emitters for individual and bulked samples. For bulked samples, more sensitive methods can be applied. We will require results to be reported to us and we will make them available on the public registers.

420 **Cobalt-60 –** NNB GenCo did not propose a limit for this radionuclide, but provided a breakdown of the other radionuclides, indicating that Co-60 was 30% of the total. NNB GenCo's predictions were based on the GDA information and, for two units, the best performance is 0.36 GBq and the maximum discharge is 6 GBq y^{-1}.

421 We consider that an annual limit of 6 GBq is appropriate for Hinkley Point C. We considered the methods NNB GenCo used to propose a QNL in section 5 of sub chapter 4.5 of its submission. NNB GenCo's method leads to a QNL of 0.3 GBq. Taking into account the variation in expected performance and the potential contribution of minimum detectable activity results, we consider this is an appropriate value for the QNL.

422 We have notice that there were typographical errors in the draft permit and table 5 of the draft decision document. The QNL for Co-60 was incorrectly entered as 1.5 GBq. We have revised the permit and table 5 to reflect correct value level of 0.3 GBq that we proposed in the text our draft decision document.

423 One consultee on the application questioned why the limits proposed at GDA for Co-60 for the UK EPR™ were higher than the pro-rata limit for the AP1000 design and that the proposed limits for the UK EPR™ did not appear to represent BAT. Both designs use similar technology to reduce the production and discharge of Co-60. The difference in the predicted discharges and proposed limits lies in the differing presentation of expected discharges by the reactor designers. EDF and AREVA asked for more contingency than Westinghouse. NNB GenCo used the same approach as EDF and AREVA. We are content that both approaches are reasonable and that the limit in our permit is appropriate.

424 **Caesium-137** - NNB GenCo proposed a limit for this radionuclide of 1.9 GBq y^{-1} based on expected best performance of 0.114 GBq y^{-1}.

425 NNB GenCo said that the interim spent fuel store will contribute 0.021 GBq y^{-1} to the caesium-137, but this should be accommodated within a limit based on 9.5% of the maximum proposed for other fission and activation products in GDA (20 GBq y^{-1}).

426 At GDA, we proposed an annual limit for one UK EPR™ of 0.5 GBq. This would lead to a limit of 1 GBq, but we consider that the additional information NNB GenCo provided in the application based on recent PWR operational experience justifies a limit of 1.9 GBq. NNB GenCo proposed a QNL of 0.11 GBq. We consider that given the variations in expected performance and the potential contribution of minimum detectable activity results to the measured discharge, a QNL of 0.1 GBq is appropriate.

427 **Other radionuclides** - NNB GenCo said that the maximum discharge at Hinkley Point C of '*other fission and activation products*' will be twice the maximum quoted at GDA (that is 20 GBq) less the caesium-137 value above, but with a contribution from the interim spent fuel store of 1.7 GBq y^{-1}, which they say is 18.1 GBq y^{-1}. It also proposed this value as a 12-rolling-month limit. We note that NNB GenCo did not add in the 1.7 GBq for the fuel store.

428 In line with our usual practice when setting limits for nuclear power stations, we described this grouping as 'other radionuclides', and have described how it is to be measured in the permit. We consider that the method NNB GenCo proposed lacked sufficient detail. For the permit, we drew on the method in the current Sizewell B authorisation. We will approve another suitable method of measurement when NNB GenCo develops it.

429 As we are proposing a limit for Co-60 and we deduced this from the values proposed by NNB GenCo, we have set an annual limit for the revised grouping of 'other radionuclides' of 12 GBq.

430 NNB GenCo proposed a QNL of 0.9 GBq for other fission and activation products. Its grouping included Co-60, so we consider the proposed value should be reduced by 0.3 to account for this change. We have included a QNL for other radionuclides of 0.6 GBq in the permit.

431 **Gaseous discharges** - other fission and activation products (FAPs) are present in the reactor coolant and can be in aerosols produced from equipment leaks or as the coolant is treated, in the chemical and volume control system (CVCS). Most FAPs remain in the liquid phase. Aerosols from equipment leaks are picked up by the ventilation systems, which have HEPA filters that should effectively remove the aerosols before discharge to the main stack. FAPs can be in the gaseous effluent from the CVCS to the GWPS. The gaseous effluent from the GWPS passes through HEPA filters before discharge to the main stack.

432 NNB GenCo said that the '*expected best performance*' for other fission and activation products is 8 MBq y^{-1} and proposed a limit of 240 MBq y^{-1}. Allowing for the two units at Hinkley Point C, these are the same values EDF and AREVA submitted at GDA.

433 The presence of fission products, mainly caesium-134 and 137, and activation products, mainly cobalt-58 and 60, in the discharge would be an indicator of faults in the HEPA filtration system.

434 In our assessment of the impact of all the other radionuclides taken together, the dose to the public is 0.0203 µSv y^{-1} and the collective dose is 0.003 manSv y^{-1} of discharge. Both doses are less than our criteria for setting a limit, so, on the basis of dose alone, we do not need to set a limit. However, we consider that these radionuclides require a limit in the permit to act as an indicator of plant performance.

435 For GDA, we decided that an annual limit for gaseous discharges of 50 MBq for other radionuclides was appropriate for a single UK EPR™. This was based on considering:

a) The measures taken to reduce the creation and discharge of other radionuclides.

b) Historic discharges at European and US PWRs.

c) That the impact of discharges is low; the dose at the generic site was 0.018 µSv y^{-1} to an adult.

436 NNB GenCo described how it predicted the '*expected best performance*' based on data from predecessor PWRs in France. The 8 MBq per year value is more a sum of detection thresholds as most measurements show below detection limits of the monitoring instrumentation.

437 NNB GenCo said that the two main contingencies affecting discharges are fuel issues and faults of HEPA filters. Ventilation systems can be diverted while filters are replaced, but there may be loss of abatement for a short time while the fault is detected. It said that, based on previous experience, monthly discharges could reach 60 MBq if there is a combination of fuel and treatment system failures. It, therefore, proposed substantial headroom for these events, up to the proposed maximum of 240 MBq y^{-1}.

438 We did not accept the arguments for the high level of headroom proposed at GDA and do not accept NNB GenCo's limit proposal of 240 MBq. We have set an annual limit of 120 MBq. This is based on double our proposed GDA limit for Hinkley Point C, with an allowance for discharges from the interim spent fuel store.

439 NNB GenCo proposed a QNL of 58 MBq for a three-rolling-month level. It looked at operational data for predecessor plant and identified that there is often a peak discharge in one month. It considered this would be 28.4 MBq for one UK EPR™. It then added two months at '*expected best performance*' to give a three-month level.

440 We propose a QNL of 8 MBq. We expect the limits of detection of the measuring equipment to be a large portion of the measured result. Small changes in discharges or the limits of detection can have a large impact on the measured discharge. Therefore, we have allowed for an event leading to discharges of 75% of the annual expected best performance in one month, with this unit and the other unit operating at best performance for the rest of the period.

441 In line with our usual practice when setting limits for nuclear power stations, we described this grouping as 'beta emitting radionuclides associated with particulate matter', and have described how it is to be measured in the permit.

442 One consultee on the application was concerned that leakage from the primary circuit to the secondary circuit could lead to gaseous discharges of actinides from the steam vents. We considered the removal of particulate matter from the primary circuit at GDA, and are satisfied that the Chemical and Volume Control System (CVCS) removes particulate matter from the primary circuit. Furthermore, leakage to the secondary circuit is very low, primarily involving tritium diffusion. We consider that this is not a credible route for discharge of actinides.

4.7 Disposal routes and limits for transfers of radioactive waste (RSR Part B3 Q4b)

443 We do not routinely set limits on transfers of radioactive waste to other sites. This is because we require operators to minimise the amount of radioactive waste generated and to minimise discharges of that radioactive waste to the

environment. The removal of radioactivity from liquid and gaseous discharges leads to it being concentrated in solid waste, in line with the 'concentrate and contain' principle. The solid waste will need to be disposed of by transfer to other sites for treatment or disposal as appropriate. A period of interim storage on site will be required for those wastes for which there is currently no disposal route, such as ILW.

444 In accordance with government policy on the management of solid low-level waste, the permit contains a number of standard provisions (Schedule 3, Table 3.3) to facilitate the disposal of low level waste in accordance with the waste hierarchy. You can find further information about the disposal of solid low level waste (LLW) in:

- Government policy for the long-term management of solid low level radioactive waste in the United Kingdom[55]
- Environment Agency guidance on low level radioactive waste[56]
- UK Strategy for the Management of Solid Low Level Radioactive Waste from the Nuclear Industry[57]

445 We assessed the creation, management and disposal of LLW during GDA. We concluded that:

a) EDF and AREVA identified all LLW streams that a UK EPR™ will typically produce.

b) The UK EPR™ uses BAT to minimise the arisings of LLW.

c) The UK EPR™ uses BAT to treat and condition LLW before disposal.

d) The UK EPR™ is not expected to produce LLW for which there is no foreseeable disposal route.

e) EDF and AREVA provided valid estimates for the annual arisings of LLW for both the operational and decommissioning phases. The arisings produced during operations are consistent with those of comparable reactors around the world.

446 NNB GenCo's proposal for the total raw waste volume of operational LLW from two UK EPR™s has been estimated as 148 $m^3 y^{-1}$. In GDA, EDF and AREVA estimated this as 73.15 m^3 for a single EPR unit. This is, therefore, similar, and the GDA conclusions remain valid for this application.

447 NNB GenCo said that a key consideration of the choice of preferred disposal route has been the commitment to demonstrate best use of existing UK LLW

[55] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48970/Low_level_waste_policy.pdf
[56] http://www.environment-agency.gov.uk/business/sectors/100241.aspx
[57] http://www.nda.gov.uk/documents/upload/UK-Strategy-for-the-Management-of-Solid-Low-Level-Radioactive-Waste-from-the-Nuclear-Industry-August-2010.pdf

management assets. Therefore, NNB GenCo saw direct disposal to the low level waste repository (LLWR) as the least desirable option and, where a reasonably practicable alternative disposal route exists, for example incineration or metal melting, it chose this as the preferred option. This is consistent with the national strategy for LLW.

448 We are permitting the transfer of the following types of waste (to a holder of an environmental permit for receiving and disposing of these types of waste) for one or more of treatment, onward transfer for treatment or disposal, incineration, metals recovery, or final disposal:

a) LLW

b) non-aqueous liquid waste

449 In accordance with condition 3.1.4 of the permit, NNB GenCo will need to comply with the directions of the person the radioactive waste is transferred to. We will consider these matters as part of the routine compliance inspection when waste disposal and treatment sites have been selected. The directions of the person the radioactive waste is transferred to are often referred to as 'conditions for acceptance', and compliance with these directions will address GDA findings on conditions for acceptance, that is UK EPR-AF13 and AF14.

450 The permit contains standard conditions in relation to the transfer of radioactive waste. These state that the waste should be properly characterised and that all relevant information be made available to potential consignees, so that they are informed about the content of the radioactive waste and only accept waste they are permitted to receive.

451 The draft permit that we consulted on also included provision for transfer of very low level radioactive waste (VLLW). NNB GenCo wrote to us in November 2012 requesting that we remove this. It made this request because it plans to use the exemption for disposal of solid radioactive waste contained in The Environmental Permitting (England and Wales) (Amendment) Regulations 2011. These regulations came into force in October 2011 after NNB GenCo had made its application. We consulted ONR on this matter because it might lead to accumulations of waste on site and that is regulated by ONR. ONR confirmed that it had no objection to this change and we have removed this type of waste from Table 3.3 of Schedule 3 of the permit.

452 Cumbria County Council, in response to the consultation on the application, welcomed NNB GenCo’s recognition that the LLW repository (LLWR) near the village of Drigg in Cumbria is the 'least desirable option' for LLW disposal (by applying the waste hierarchy). Cumbria County Council challenged the general assumption that the LLWR is a 'fall back' option, and said that it cannot be assumed that, when required, capacity at the LLWR will exist. Currently Cumbria County Council is considering a planning application for further development of disposal capacity at the LLWR, but development consent should not be assumed.

453 Cumbria County Council, in response to the consultation on the application, also noted that VLLW is to go to 'potential future permitted' landfill. Existing permitted landfill is currently all located within the North West of England

(apart from the recently permitted site at Kings Cliffe in Northamptonshire), and there is insufficient capacity for existing projected legacy VLLW arisings. It is the view of Cumbria County Council that, where possible, such waste should be managed on or adjacent to existing licensed nuclear sites and not dispersed 'ad hoc' to permitted landfill. At the time of the application Cumbria County Council opposed a proposed authorisation to dispose of VLLW from Chapelcross to the permitted landfill at Lillyhall in West Cumbria because of the perceived negative impact on the community, economy and environment. We note that these comments are no longer relevant to our considerations of this application because we have removed VLLW from the permit at NNB GenCo's request.

454 These issues were raised during the GDA consultation and we considered that they were outside the scope of GDA. This is because, under the Energy Act 2004, the Nuclear Decommissioning Authority (NDA) is responsible for developing a UK-wide strategy for managing the UK nuclear industry's LLW. These conclusions also apply to our considerations of NNB GenCo's application.

455 Cumbria County Council, in response to the application consultation, said '*Options assessment for radioactive waste management should apply a wider and more holistic sustainability appraisal to give due weight to social and economic impacts when identifying management routes for solid radioactive wastes*.' We agree that BAT assessments should take a holistic approach and consider that NNB GenCo has followed this approach.

456 Cumbria County Council, in response to the consultation on our draft decisions, questioned how the requirements on consultation and public involvement contained in the Government policy on the management of LLW[58] and the Nuclear Decommissioning Authority's (NDA) UK LLW strategy are met for involving communities, which could be affected by the radioactive waste disposal proposals.

457 The government policy on the management of LLW was published in 2007. We are working to Government's Environmental Permitting Guidance[59] for radioactive substances regulation that was issued in September 2011, and paragraphs 4.31 to 4.34 give guidance on the permitting of inter-site transfers of waste. Paragraph 4.31 explains that requirements have changed and that permits do not have to specify the sites where waste will be disposed of. We consult the communities local to waste treatment or disposal sites when we consider applications for environmental permits for these sites.

458 Cumbria County Council also noted that we had not specified limits or disposal sites in the draft permit. We set all the limits and conditions necessary to protect people and the environment local to the disposal site in

[58] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/48970/Low_level_waste_policy.pdf
[59] http://www.defra.gov.uk/environment/quality/permitting/

that site's permit. Our standard permit conditions include conditions to ensure the requirements at the site receiving waste are given to the sender of the waste, who must comply with them. This ensures appropriates controls, including limits, are complied with without placing detailed requirements in the permit of a site sending waste.

459 Sedgemoor District Council, in response to the consultation on the application, welcomed confirmation that there would be no on-site incineration of waste.

4.8 Receipt of waste (RSR Part B3 Q7)

460 The permit authorises the receipt of radioactive waste. The waste is restricted to waste that is associated with the operation of a UK EPR™. NNB GenCo did not include any information on the receipt of waste because it only expects to receive returned samples, waste returned to the site in accordance with permit condition 3.1.6 or waste collected as a result of any future participation in the National Arrangements for Incidents involving Radioactivity (NAIR)[60] or the RADSAFE[61] scheme. The permit contains standard conditions requiring the operator to provide information to potential consignors about waste that can be accepted under this permit to ensure that consignors only send waste that the operator can receive.

4.9 Monitoring (RSR Part B3 Q5)

4.9.1 Discharge and disposal monitoring

461 We assessed NNB GenCo's proposals for discharge monitoring and conclude that it is proposing to follow our guidance and has an appropriate Forward Action Plan to ensure that monitoring will use BAT. We will review its progress against its plan. We have included four further information requirements, IC 4, IC 5, IC 6 and IC 7, in the permit to allow us to assess NNB GenCo's progress at appropriate stages of the development of sampling and monitoring systems.

462 We assessed NNB GenCo's proposals for in-process monitoring and conclude that it is proposing to follow our guidance but it has not included adequate detail in actions 4 and 5 of its Forward Action Plan. We have included a further information requirement to develop an action plan for in-process monitoring. This requirement is referenced as IC 18 in table S1.2 of Schedule 1 of the permit.

463 We have also included requirements to report progress on the actions. This requirement is part of IC 2 in table S1.2 of Schedule 1 of our permit. We have also included a requirement to demonstrate that the proposals are BAT. This requirement is referenced as IC 19 in table S1.2 of Schedule 1 of the permit.

[60] http://www.hpa.org.uk/Topics/Radiation/UnderstandingRadiation/UnderstandingRadiationTopics/RadiationIncidents/incid_Nair/
[61] http://www.radsafe.org.uk/

464 COMARE, in response to our consultation on the application, commented that it strongly supports NNB GenCo's proposal for the continuous monitoring of aqueous discharges from the Ex tanks. We agree with this comment and we will monitor NNB GenCo's progress against its Forward Action Plan through information provided to meet further information requirement IC 5.

465 COMARE, in response to the consultation on our draft decision document, commented that monitoring should be reviewed when real monitoring data becomes available. This is part of our normal regulatory process for an operational site.

466 A consultee on the application expressed concern about the relaxation of regulations and moves towards self regulation of an industry they felt is characterised by secrecy, cover-up and misreporting. We do not agree that the regulations have been relaxed. We consider that we have sufficient regulatory powers to properly enforce the regulations. We consider that the conditions in the permit provide a robust framework for reporting and monitoring of discharges.

467 We consider our risk-based approach to regulation takes into account the risks from the nuclear industry. We carry out regular inspections of nuclear sites to ensure compliance with the conditions of the permit. This may include taking samples for independent analysis. We consider that we have sufficient powers to ensure high standards of environmental protection.

468 One consultee on the application wanted us to have independent online monitoring. We do not plan to do routine online independent monitoring. However, we normally carry out independent spot sampling to verify the operator's results.

469 One consultee on the application raised a question that they had already raised in the GDA consultation about in-line monitors and their ability to measure alpha emitting radionuclides in aqueous discharges. We published the GDA decision document after the consultee raised the issue for the Hinkley Point C application. As we explained in the GDA decision document, there is no expected discharge of alpha-emitters that will require in-line monitoring, but as a precaution we will require some measurements of samples for alpha emitting radionuclides.

470 One consultee on the application was concerned that alpha emitting radionuclides may be present in gaseous discharges. For GDA, it was proposed that a proportional counter capable of measuring both alpha and beta emitters would be used. NNB GenCo proposed a method for measuring beta emitting radionuclides, which will be subject to a limit in the permit. This does not preclude using a counter that will also detect alpha emitters, and we will consider this when we assess the suitability of NNB GenCo's detailed monitoring proposals.

4.9.2 Environmental monitoring

471 We assessed NNB GenCo's proposals for environmental monitoring and conclude that it is proposing to follow the principles in our guidance and has an appropriate Forward Action Plan to implement BAT for monitoring. We will

monitor its progress against its plan. We will require NNB GenCo to provide a report on its proposed environmental monitoring programme by the end of July 2014. We have included this issue as requirement IC 16 in table S1.2 of Schedule 1 of the permit.

472 We will review NNB GenCo's proposals and take this into account when we review the proposed environmental monitoring programme as required by permit condition 3.2.1. We will require the survey programme to commence at least two years before discharges begin to provide us with a baseline.

473 COMARE, in response to our consultation on the application, commented that the proposed environmental monitoring is directed at the human food chain, not plants and animals. We agree with this comment. The joint environment agencies' guidance on environmental monitoring contains two objectives relating to wildlife. We will expect NNB GenCo to consider these objectives within its proposed environmental monitoring programme.

474 Some consultees on the application and our draft decision document raised concerns that more distant areas, in particular, parts of South Wales, would be adversely affected by the discharges. The impacts close to the site have been assessed and are very low as discussed in section 4.10. We expect the impact further away to be even lower and, based on this, monitoring in South Wales would not be expected. However, we expect NNB GenCo to consider these concerns in its proposals. This may include more frequent or more geographically widespread sampling during the early years of operation.

475 Some consultees on the application raised concerns about how radioactivity disperses and accumulates in the environment. We have a considerable amount of historical data for the area around Hinkley Point and the wider environment. We have gathered this through operator monitoring and also independent monitoring by ourselves and other public bodies. We publish this independent monitoring annually in 'Radioactivity in Food and the Environment' (RIFE) reports.

476 One consultee on the application was concerned that the impacts of climate change on the behaviour of environmental radioactivity had not been considered. We consider that while there may be changes in the location of marine sediments, the range of concentrations in the environment will not change significantly. It is more difficult to predict changes in people's behaviour with climate change and these changes may be more significant. We will monitor these changes by routine surveys of the environment and people's habits. We will use the result of these surveys when we from time to time review the adequacy of the monitoring programmes. We will also use the results of these surveys to calculate radiological impacts on people and the environment. There is a large margin between the predicted impacts and public and environmental protection limits and criteria.

477 One consultee on our draft decision document questioned how much is known about environmental pathways, noting changes to the critical group for Sellafield in the 1970s. As discussed above, we carry out a programme of habits surveys to ensure we understand the pathways. The same consultee

referenced some reports and papers from the 1980s on radiological pathways. We consider that these reports do not contain any new information.

478 A consultee on the application raised concerns about alleged contamination of the site with enriched uranium. We carried out independent sampling at the time of the original allegation and made our results publicly available. These results show that the site only contains naturally occurring levels of uranium and the original allegation was unfounded. The same consultee raised this issue again in responses to our consultation on our draft decision document, claiming there were new monitoring results. We have done further work, including further on-site measurements, and we are satisfied that the original allegation was unfounded.

479 Consultees on the application made suggestions to be incorporated into the environmental monitoring programme. These included:

- Possible siting of a high volume air sampler and automated gamma monitoring station at Burnham-on-Sea beach.
- Consideration of improved deposition monitoring and deposition sample assessment by inductively coupled plasma mass spectrometry.
- More analysis for tritium in environmental samples.
- Monitoring for possible sea to land transfer of radioactivity.
- The effects of seaweed composting.

We expect NNB GenCo to consider these matters in its proposed environmental monitoring programme.

480 The Nuclear Free Local Authorities (NFLA) raised some concerns about environmental monitoring. These were closely related to concerns about the assessment of impact and we respond to both matters in section 4.10.8.

4.10 Radiological assessment (RSR Part B3 Q6a): Impact on members of the public

481 Below, we present the results of our assessments of the radiological impact on the public for the proposed discharges from Hinkley Point C. We assess doses to the public from the expected discharges and compare the doses with the criteria specified in Schedule 23 Part 3 (3) of EPR 10. The current criteria are:

- the source constraint (300 microsieverts per year (µSv y^{-1}))
- the site dose constraint (500 µSv y^{-1})
- the public dose limit (1000 µSv y^{-1})

482 Our assessment of doses uses the best available science on health and environmental effects of radiation, and realistic assumptions of the behaviour

and dietary patterns of representative members of the exposed public. This is consistent with the Statutory guidance to the Environment Agency concerning the regulation of radioactive discharges into the environment[62].

483 NNB GenCo has carried out radiological assessments at the predicted maximum annual discharges and at the discharge limits requested in the application. We have carried out a detailed review and validation of NNB GenCo's assessment. We consider that NNB GenCo's approach was valid and followed appropriate practice. We also verified the results of NNB GenCo's assessment.

484 We have carried out an independent assessment at NNB GenCo's maximum expected discharges and at the requested limits. We have set some limits that are less than those proposed by NNB GenCo. We have not carried out a further assessment at our limits because radionuclides for which we have reduced the limits do not make significant contributions to the assessed doses. The Food Standards Agency (FSA) has also assessed the doses to people from radionuclides in the food chain. The assessments carried out also take account of doses from direct radiation from the site, discharges from nearby sites and the residue of past discharges.

485 The Health Protection Agency (HPA), in response to our consultation on the application, stated that it is '*satisfied that the assessment submitted by NNB GenCo follows the general principles for the assessment of prospective doses of members of the public and is consistent with the approach suggested by HPA for this type of assessment. The HPA is also satisfied that the planned radioactive discharges during normal operations at the proposed nuclear facility at Hinkley Point C will not pose significant risks to the health of people living in the area*.'

486 Radiological assessments of doses to the public from future discharges are based on the behaviour and concentrations of radionuclides once they are in the environment. It is assumed that discharges are at 100% of the current or proposed discharge limits for 50 years. The assessments use modelling systems and data that are consistent with the requirements of the Basic Safety Standard Directive. The FSA's assessment used its food chain models. The FSA calculated the potential dose from the consumption of food and other exposure pathways. The FSA's assessment considered combinations of pathways that the FSA regard as reasonable but not extreme. Reasonable future practices were also included because dose calculations were not restricted to pathways and agricultural practices currently existing near the site.

487 Our first step was to carry out an initial radiological impact assessment. We carried out a simple assessment using general non-site specific data for the environment. We assessed doses that were above our threshold (20 μSv y^{-1}) for carrying out a second stage of initial assessment using more refined site-

[62] http://tinyurl.com/ad8oeyy

specific data. In the second stage, we assessed doses that were a little below our threshold for a detailed site-specific assessment. However, we considered it appropriate to make a detailed site-specific assessment because of the scale of the proposed development, the level of public interest and because we had given an undertaking to make a site-specific assessment in GDA.

488 In accordance with the current International Commission on Radiological Protection's (ICRP) recommendations (ICRP Publication 103), we calculate the dose to the 'representative person'. This is an individual receiving a dose that is representative of those members of the public who are estimated to receive the highest dose overall (from gaseous and aqueous discharges and direct radiation). The dose to the representative person is then compared with the dose constraint and dose limit. (The term 'representative person' replaces 'average member of the critical group' as used in previous ICRP recommendations).

489 The assessment was made for eleven different groups using information on habits collected near Hinkley Point in 2010. The habits of the eleven groups were formed into profiles know as candidate representative persons (CRP). Seven of the groups were people who live near the site and consume various local foods in different combinations (including milk) and make some limited use of the marine environment. These seven groups are likely to be most exposed to gaseous discharges and will have a small amount of exposure to liquid discharges. Four of the groups were people who eat a lot of locally caught fish and shellfish and spend time on beaches near the site and were found to consume some local food from land around the site. These four groups are likely to be the most exposed to liquid discharges and will also have a degree of exposure to gaseous discharges from the site. We assessed the dose for each of the 11 groups and the ‘representative person’ is the one with the highest dose.

490 In addition, we carried out assessment of the following for liquid and atmospheric discharges:

- The potential short-term doses from the maximum anticipated short-term discharges from normal operation.
- Collective doses to the UK, European and world populations over the next 500 years.
- Annual dose to a representative person due to combined future operations of all three power stations at Hinkley Point.
- The total annual dose to a representative person, including the contribution from other sites and previous operations.
- Dose rates to a range of reference organisms in the terrestrial and marine environments.

491 The HPA, in response to the consultation on our draft decision document, said that it ‘*has reviewed the consultation documents and has concluded that the assessments carried out by the applicant and the Environment Agency are reasonable and are unlikely to underestimate the radiation doses from the*

proposed new discharges. The doses to a representative person from discharges occurring at the proposed limits are well below the dose constraint recommended by the Health Protection Agency and are of a level that is unlikely to be of concern for public health'.

492 The Nuclear Free Local Authorities (NFLA) raised some concerns about environmental monitoring. These were closely related to concerns about the assessment of impact and we respond to both matters in section 4.10.8.

4.10.1 Our assessment results for Hinkley Point C

493 **For exposure to gaseous discharges**, we assessed a range of terrestrial food consumer profiles from the 2010 habits survey. We found that the most exposed candidate representative person was the adult consumer of milk. We assessed the dose to be 7.2 µSv y^{-1}, this included a very small contribution from exposure to aqueous discharges. We included doses from eating local foods, doses from inhaling radioactivity in the air from discharges, exposure to radiation from discharges in the air, known as 'cloudshine', and radiation from discharges deposited on the ground, known as 'groundshine'.

494 **For exposure to aqueous discharges**, we assessed a range of marine food consumer profiles from the 2010 habits survey. We found that the most exposed candidate representative person was the adult consumers of crustaceans. We assessed the dose to be 0.51 µSv y^{-1} from marine exposures and 3.2 µSv y^{-1} from terrestrial pathways, giving a total dose of 3.7 µSv y^{-1}. The marine exposures include exposure to radiation from radioactivity absorbed on sediments or fishing gear.

495 **Direct radiation**, doses to members of the public from direct radiation originating from within the site boundary are regulated by ONR. However, for the purpose of comparing doses to the dose constraint we have assessed the dose due to direct radiation from the proposed power station. We assessed this to be 1.2 µSv y^{-1}, which applies to the adult milk consumer.

496 **Total dose to the representative person** was therefore 8.4 µSv y^{-1}. The representative person is a local adult milk consumer. Their dose was made up of 7.2 µSv y^{-1} from discharges and 1.2 µSv y^{-1} from direct radiation.

497 **For short term discharges,** we assessed the possible doses due to gaseous discharges made at high rates of discharge over a short period. We discuss our results in section 4.10.5 below.

498 **For collective doses to populations,** we assessed the dose to the UK, European and world populations. We discuss our results in section 4.10.6 below.

499 **In combination assessments,** as well as assessing the impacts of Hinkley Point C, we also assessed the impact of all three power stations at Hinkley Point for aqueous discharges, gaseous discharges, direct radiation, collective doses and historic discharges.

500 **Assessment of NNB GenCo's assessment,** we assessed chapter 12 of NNB GenCo's submission. We consider that NNB GenCo's approach was

valid and followed appropriate practice. We also verified the results of NNB GenCo's assessment.

501 We have published a full report[63] on our dose assessment work: 'Our review of NNB GenCo's dose assessment and our independent dose assessment for the proposed Hinkley Point C Power Station'. We have updated the report with an addendum containing the results of some further sensitivity studies.

502 COMARE, in response to our consultation on the application, asked us to explain why NNB GenCo's site-specific annual dose to the hypothetical group at Hinkley Point C was less than our generic site assessments for GDA, whereas the collective dose assessments were similar. For the hypothetical groups, NNB GenCo's site-specific assessment was based on site-specific dispersion modelling and local food consumption rates, while the generic site assessment was based on more conservative generic modelling and consumption rates. The most significant difference is for exposure to aqueous discharges. In this case, there are significant differences in the parameters of the marine environment and also marine foodstuff consumption rates. Our independent review and assessment confirm that NNB GenCo's assessment is appropriate. The collective doses are for national and international populations and are not as affected by local factors.

503 One consultee on the application was concerned that NNB GenCo had not assessed accumulation in the environment from future discharges. We consider that NNB GenCo's assessment in chapter 12.4 of its submission has adequately addressed this matter. NNB GenCo used PC-CREAM 98®, an application for performing radiological impact assessments of routine and continuous discharges of radionuclides to the environment, which considers build up in the environment from 50 years of discharge, therefore taking account of accumulation in the environment.

4.10.2 Comparison of doses with the source constraint

504 EPR 10 Schedule 23 Part 3 specifies a dose constraint of 300 µSv y^{-1} for the maximum dose to people, due to discharges from a single new source. While this constraint applies specifically to 'new' sources, we generally also apply it to existing sources. In this case, the source is defined as Hinkley Point C Power Station. The dose to be compared to this constraint should include the dose from current discharges and direct radiation, but exclude the dose from historical discharges.

505 The dose that should be compared to the source constraint is the sum of doses from discharges and direct radiation to the representative person. For Hinkley Point C Power Station, this is 8.4 µSv y^{-1}, which is less than the source dose constraint. See table A9.1 of our dose assessment report for a breakdown of this dose.

[63] http://www.environment-agency.gov.uk/homeandleisure/127159.aspx

4.10.3 Comparison of doses with the site dose constraint

506 EPR 10 Schedule 23 Part 3 also specifies a dose constraint of 500 µSv y^{-1} for the maximum dose to people, due to discharges from a site as a whole. The dose to be compared to this constraint is the dose from current discharges, including discharges made by adjacent sites. Doses arising from direct radiation and historical discharges are excluded. Taking into account all the discharges from the three power stations at Hinkley Point, including those from the adjacent A and B stations and the incinerator at Hinkley Point B, the dose is 15.5 µSv y^{-1}, which is below the site dose constraint. See table A9.2 of our dose assessment report for a breakdown of this dose.

4.10.4 Comparison with the dose limit for members of the public

507 EPR 10 requires us to ensure that doses to members of the public from exposure to ionising radiation do not exceed 1,000 µSv y^{-1}. The total dose to members of the public (representative person) near the site takes into account doses arising from:

- future discharges from the site
- future direct radiation from the site
- future discharges from other nuclear sites near the site
- direct radiation from other nuclear sites near the site
- the residue of radioactivity in the environment from past discharges

The total dose of 43 µSv y^{-1} is below the dose limit for members of the public of 1000 µSv y^{-1}. See table A9.6 of our dose assessment report for a breakdown of this dose.

4.10.5 Assessment of short term releases

508 NNB GenCo carried out an assessment of gaseous discharges made in a short period. The assessment was made on what NNB GenCo assessed to be the maximum monthly discharge. NNB GenCo assumed this discharge took place in a 24-hour period. NNB GenCo's predicted maximum discharge varied from 5% of its proposed annual discharge limit for tritium, to 34% of the annual limit for iodine-131. The most radiologically important radionuclide is carbon-14 and, for that, NNB GenCo predicted 7% of its proposed annual limit.

509 We have assessed NNB GenCo’s assessment and confirmed its validity. We have carried out an independent assessment that assumed the quantities predicted by NNB GenCo were discharged in six hours. As an extreme case, we also assessed the impact of discharging NNB GenCo’s proposed annual limits in six hours.

510 NNB GenCo's and our assessments both predicted that, for NNB GenCo’s maximum monthly discharge, the dose is 5.2 µSv. We also assessed the concentration of radionuclides in foods. In all cases, the concentrations were much less than European Union’s Maximum Permitted Levels (MPLs).

511 Our assessment for the extreme case predicted a dose of 72 µSv and food concentration below MPLs. We have used the results of this assessment to confirm that we do not need to set any short-term discharge limits or action levels.

512 One consultee on the application questioned our criterion of 20 µSv for carrying out a short-term assessment. For Hinkley Point C, we carried out a full assessment, including a short-term dose assessment, because we believe that it is in the public interest to go beyond the minimum in our guidance, so that we could check whether short-term limits or levels are needed in the permit.

4.10.6 Collective dose

513 Collective dose is the sum of all the doses received by the members of a population. It can be useful when considering the protection of the public. Collective doses are measured in man-sievert (manSv). There are no limits or constraints for collective dose. However, the International Atomic Energy Agency (IAEA) has set a level for collective doses of less than 1 manSv y^{-1} of discharge as part of its criteria for discharges that do not require regulatory control.

514 The UK Health Protection Agency, Radiation Protection Division, has provided additional guidance on assessing how important the collective doses are. It advises calculating an average dose to members of the population ('per person doses'). The per person doses may be very small, often in the range of a few nanosieverts (nSv) to a few microsieverts (µSv). The Health Protection Agency has advised that if the average per person doses for a population group are only a few nSv y^{-1}, we can consider them to be of limited importance when we make our decisions on discharges. If the per person doses increase above this level, we need to start looking more carefully at the discharge options.

515 Collective doses have been calculated for the UK, European and world populations over the next 500 years for liquid and gaseous discharges, for discharges made at NNB GenCo's maximum predicted discharges and its proposed limits. There is no significant difference in these predicted doses as most of the dose arises from carbon-14, and the proposed limit is the same as the predicted maximum discharge for this radionuclide. The results are 0.37 manSv, 2.2 manSv and 24.7 manSv y^{-1} of discharge to the UK, European and world population, respectively. By comparison, the annual collective dose to the UK population from natural background radiation has been calculated as 131,000 manSv[64]. The collective dose is greater than the IAEA level of 1 manSv per year of discharges, indicating that the discharges should be regulated.

[64] HPA-RPD-001 Ionising Radiation Exposure of the UK Population: 2005 Review, Health Protection Agency, May 2005

516 The highest per person dose is 6.5 nSv to the UK population per year of discharge at our proposed discharge limits. The per person doses to the European and world population are less. As the average per person doses are low, we consider that the proposals to minimise discharges do not require any additional measures to control collective doses.

4.10.7 Issues raised by consultees about dose assessment

517 A consultee on the application raised concerns that the health implications of krypton-85 are not well understood. The reference for this concern is a National Council on Radiological Protection and Measurement (NCRP) paper produced in 1975. We have used more recent International Commission on Radiological Protection recommendations and consider that our assessments are suitable.

518 The consultee also raised concerns that the relative biological effectiveness (RBE) of tritium is higher than unity. The Health Protection Agency considered this matter when it issued advice[65] on the applicability of new International Commission on Radiological Protection (ICRP) recommendations (ICRP publication 103) in 2009. It recommended that a radiation weighting factor of one should continue to be applied for tritium.

519 The consultee also questioned whether dose assessment for people considered accumulation of carbon-14 in the tissue, and how future exposure to accumulated radioactivity in body tissues was accounted for. Our assessments follow the standard procedure, which assesses the exposure from radionuclides inside the body for the next 70 years for infants or 50 years for adults. These projected exposures are added and it is assumed they are received in the year that the radionuclide was ingested or inhaled.

520 The consultee also raised concerns that the risk factor of iodine-132 is too low compared to that of iodine-131 and questioned NNB GenCo's proposal to only set a limit for this isotope of iodine. The research the consultee referenced was produced in 1980, but we have used current ICRP guidance, which as noted above, has reviewed the radiation weightings for all types of radiation. Additionally, iodine-132 has a half life of 2.3 hours and will be effectively trapped within the decay bed rather than discharged. We consider the proposal to limit iodine-131 as the most significant radionuclide of iodine is appropriate.

521 Several consultees on the application questioned NNB GenCo's use of PC CREAM 98, rather than the 2008 version in its dose assessments. We reviewed NNB GenCo's assessment and compared it to our own assessment using both versions of the software. Both assessments are considered to be valid for prospective dose assessments. However, there are differences in the detail in some data that describes the transfer of radioactivity through the

[65] http://www.hpa.org.uk/Publications/Radiation/DocumentsOfTheHPA/RCE12Applicationofthe2007RecommendationsoftheRCE11/

environment, PC CREAM-08 using more up to date data, in particular transfer parameters and Kd (distribution coefficient) values and a different European population for collective dose. Our review showed that the impact of these changes in the software is not significant. Our review is available on our Hinkley Point webpage[66].

522 A consultee on the application commented that while PC CREAM 08 had taken into account ICRP's recommendation in publication 103, the dose coefficients used were from the superseded publication 60. While this is true, ICRP has not yet published revised coefficients and our assessments are based on the most up to date values.

523 One consultee on the application expressed concern over guidance from the National Dose Assessment Working Group on assessing multiple short-term discharges. The consultee was concerned that only considering that one discharge could affect a crop harvest was unjustified. We have made an assessment of an extreme case short-term discharge of the annual limits being discharged in one go. This assessment represents the worst-case conditions and multiple discharges could not give rise to a higher impact.

524 One consultee on the application questioned NNB GenCo's modelling of atmospheric dispersion because the effect of buildings and landscape features had not been adequately considered. The consultee also questioned whether the effects of various weather conditions had been adequately considered. We included an independent review of NNB GenCo's assessment and our independent dose assessment in our dose assessment report. We concluded that NNB GenCo's assessment was appropriate.

525 One consultee on the application raised concerns about an exposure pathway into the bloodstream through wounds and cuts, etc. We do not normally model this pathway as it is not regarded as significant. However, we carried out a screening assessment based on pessimistic assumptions, including the highest reported levels of radioactivity in marine sediment near Hinkley Point and predicted values for the radionuclide concentrations in sediment due to Hinkley Point C discharges. Our assessment confirmed that the dose from this pathway would be very small; 0.5 µSv from the historic discharges and 0.002 µSv from predicted concentrations due to Hinkley Point C.

526 One consultee on the application raised concerns that PC CREAM was unsuitable for modelling intermittent pulsed liquid discharges. HPA states that for PC CREAM '… *models adopted in the methodology are those considered appropriate for routine releases, i.e. releases that can be considered as continuous and constant*'. We do not use PC CREAM to predict instantaneous concentrations from single discharges but we consider it is suitable for providing average results from multiple discharges. For the existing reactors at Hinkley Point, we compared the prospective dose assessments produced by PC CREAM with retrospective dose assessments carried out using

[66] http://www.environment-agency.gov.uk/homeandleisure/127159.aspx

information from samples taken around the site. These assessments are published annually in our Radioactivity in Food and the Environment (RIFE) reports. Taking into account the difference between prospective and retrospective assessments, the retrospective assessment provided confidence that the prospective modelling with PC CREAM is appropriate.

527 One consultee on the application believed that empirical epidemiological studies of exposed populations were more appropriate than using modelling to predict health impacts. We only use modelling in dose assessments to predict radiological doses. We compare the assessed doses against nationally endorsed international recommendations produced by ICRP and in the European Basic Safety Standard Directive. ICRP takes into account epidemiological studies when it produces the risk estimates used in its recommendations.

528 Two consultees on the application expressed concern that only infants, children and adults, but not the foetus, were considered. We considered this in our review of NNB GenCo's dose assessments and we considered the approach was appropriate because it follows HPA guidance note RCE-5[67] on this matter.

529 A consultee on the application expressed concern about the absence of gender consideration in the dose assessments. We are following the advice of the HPA on the application of ICRP recommendations on this matter. HPA advice is that for prospective dose assessments such as those done for this application; there is no benefit in considering men and women separately. HPA considers there is only benefit in considering the sexes separately when more detail is required, for example for medical exposure.

530 The same consultee also responded to our draft decision document, raising similar concerns about the absence of gender specific considerations in our radiation dose assessments. The consultee also restated a concern about the effects on pregnant women and foetuses and raised a question about ICRP's threshold for teratogenic (abnormalities of the foetus) effects. We asked HPA for advice on these matters. The HPA responded that it had considered the points raised and confirmed its advice that the recommendations of ICRP should form the basis of our considerations of the impact of radioactive discharges on people. HPA provided more information in an annex to its reply. We have included the correspondence in Annex 3 of this document.

531 A consultee on our draft decisions was concerned that people bathed and consumed fish and crustaceans in the waters of the Bristol Channel. We assessed the impacts of the discharges, we based our assessment on a survey of local people's habits and the habits mentioned were taken into account. We are satisfied that the impacts are low and that people and the environment are protected.

[67] http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1207121671036

532 Penarth Town Council, in response to the consultation on our draft decisions, asked how we had taken into account the estuary conditions when we considered the impact of the new power station. We explained these factors in our draft decision document and our radiological dose assessment.

4.10.8 Issues raised by the Nuclear Free Local Authorities about dose assessment and environmental monitoring in response to the consultation on the draft decision document

533 The Nuclear Free Local Authorities (NFLA) responded to the consultation on our draft decision document. It was concerned that we had not addressed all the issues it raised in response to our consultation on the application. Most of the matters raised were about the behaviour of radioactivity in the environment. We consider those matters relating to dose assessment and environmental monitoring in the section below. We use the NFLA terminology by referring to its consultation response to the application as its '2011 submission' and the consultation response to the draft decision as its '2012 response'. In this section we have dealt with each section of the NFLA 2012 response in order.

534 **NFLA 2012 response, section 2 -** in paragraph 2.7 to 2.9 the NFLA claimed that there were significant gaps in the data needed to assess the impacts of liquid radioactive discharges. It made reference to sections 1 to 6 of its 2011 submission on liquid discharges. Section 1 to 6 of the 2011 submission contained information on the behaviour of the water and sediments of the Bristol Channel. The section was descriptive and we could not see any conclusion about that information in the NFLA's 2011 submission.

535 The NFLA 2012 response concentrated on gaps in data on sediment behaviour. The 2012 response focused on a paper *'A review of the sediment dynamics in the Severn Estuary: Influence of Flocculation'* by Manning *et al* from Marine Pollution Bulletin volume 61, 2010. Aspects of this review were originally funded by the Environment Agency. The review focused primarily on the Severn Estuary rather than the Bristol Channel where Hinkley Point is located. The paper recommended areas for investigations to improve the current understanding of physical processes and sediment dynamics in the Severn Estuary, but it does not conclude that current understanding is inadequate, and does not consider the modelling used for our assessments. We consider the areas for investigations identified are not significant for our dose assessment.

536 **NFLA 2012 response, section 3 -** in paragraph 3.6 to 3.10 the NFLA raised concerns that we had not taken into account specific parameters for the Bristol Channel. It made reference to sections 7 to 11 of its 2011 submission on liquid discharges. Sections 7 to 11 of the 2011 submission contained information on the sediment concentrations in the Bristol Channel and the behaviour of radioactivity in the Irish Sea, including sea to land transfer. The sections were descriptive and we could not see a clear conclusion about that information in the NLFA's 2011 submission.

537 The NFLA 2011 submission contained no specific comments on the dose assessment contained in NNB GenCo's application when it reached its

conclusion that it was inadequate and that '*the proposed development in its current form should be rejected outright*'. NNB GenCo had used PC Cream 98 with a local compartment model of an area offshore from Hinkley Point within the Bristol Channel. We reviewed and validated that model and consider that it was suitable for assessing the annual radiation doses to the most exposed members of the public.

538 We based our draft decisions on an independent dose assessment. Our independent dose assessment used PC Cream 08 and also used a local compartment of an area offshore from Hinkley Point within the Bristol Channel similar to that used by NNB GenCo. The parameters for the local compartment were set out in table A5.2 of our assessment report. We published our dose assessment report and made it available alongside our draft decision document. In its 2012 response, the NFLA did not consider our dose assessment and only repeated its earlier statement about data gaps.

539 The NFLA response suggests that the suspended solid load in the water column can be as high as 10 g l^{-1}, which could have an effect on the transport of radionuclides attached to suspended sediment and exposure of people by sea to land transport and by seaspray. Both NNB GenCo's and our assessments used a suspended sediment load of 200 mg l^{-1}. NFLA's higher values are peak values during spring tides. The value we used is representative of average value across the tidal cycles, and we consider it is suitable for the modelling and assessments we carried out. The value we used is much higher than those for the Irish Sea that were referred to by the NFLA in its 2011 submission.

540 We welcomed the fact that the NFLA's concerns were more clearly expressed in its 2012 response. We carried out sensitivity studies for our dose assessment using a range of suspended sediment loadings, reduced mixing due to discharged radioactivity remaining in the thermal plume instead of readily mixing into the Bristol Channel, and a higher distribution coefficient for tritium between water and sediment. We also reviewed our assessment of doses from seaspray in the area around the site. We are publishing the results of these sensitivity studies in an addendum to our dose assessment report. It will be available with this decision document on our website.

541 In our sensitivity studies we considered the effects of increasing the suspended solid load in the local compartment from 200 mg l^{-1} to 400 mg l^{-1}, 1000 mg l^{-1} and 10,000 mg l^{-1}. We also increased the suspended solid load in the wider Bristol Channel area from 10 mg l^{-1} to 100 mg l^{-1}. The overall effect on the predicted concentration of radioactivity in dissolved material, suspended sediment and sea bed sediment were assessed. We then used these concentrations to predict doses.

542 We found that annual radiation doses to the members of the public most exposed to liquid discharges decreased as we increased the suspended sediment loads in our dose assessment. This is because the main doses are from consumption of fish and shellfish. Increasing the suspended solid load transfers more radioactivity out of the water column onto sediment and makes less available to fish and shellfish for uptake. Therefore the predicted

concentrations in shellfish and fish are lower at high suspended solid loads than they would be at low suspended solids.

543 We also considered the effect of possible reduced mixing due to discharged radioactivity remaining in the thermal plume instead of readily mixing into the Bristol Channel. These studies showed that reduced mixing of water by a factor of 25 increases concentrations locally by about a factor of 9 to 23 depending on radionuclide. Doses overall are dominated by carbon-14 and therefore are influenced by the change in carbon-14 predicted concentrations which are between 14 and 16. The highest predicted dose is increased from 0.4 to 6.2 µSv y^{-1}.

544 We also considered the effects of a higher distribution coefficient for tritium between water and sediment. We found this had only very small effects on the doses predicted by our dose assessments.

545 We also considered the effects of seaspray returned to land. We consider that seaspray is a minor pathway relative to other routes such as consumption of marine foods. This is because the amount of seaspray in air is relatively low, between 0.1 and 10 mg m^{-3} of air, the resulting levels of radioactivity in air from seaspray are, therefore, much lower than would be found in seawater and seafood. For this reason, we did not model it in our original dose assessment. We included an assessment in our addendum to the dose report. This shows that the doses are more than 1000 times lower than from fish and shellfish consumption. A further conservative assessment was made based on the concentration of water vapour in air at 10 g m^{-3}. We conservatively assumed that the seaspray was generated from water associated with the restricted dispersion in the plume of cooling water. Even at this pessimistic concentration of water in air, the predicted doses to the public are still 100 times lower than doses from fish and shellfish. Therefore exposure to radionuclides in seaspray is a minor pathway compared with other pathways.

546 The Food Standards Agency has measured levels of radionuclides in seafood and shows low but measureable levels from time to time. The assessment of doses from measured and modelled radionuclides in fish indicates very low doses. We also measured radionuclide levels in air (using high volume air samplers) placed along the coast at Burnham-on-Sea, and were only able to find trace levels of natural radionuclides.

547 **NFLA 2012 response, section 4** - in paragraph 4.4 of its 2012 response the NFLA raised concerns that we had only considered routine discharges and not a loss of coolant accident (LOCA). We had only considered routine discharges because the permit we grant only covers normal operations, including minor events that are reasonably foreseeable over the lifetime of a station. A LOCA is a type of severe accident not covered by our permit. Severe accident management is regulated by ONR under the nuclear site licence. We are aware that the NFLA has brought its concerns to the attention of ONR.

548 **NFLA 2012 response, section 5 -** we have addressed NFLA's comment regarding a figure in the Consultation document in section 4.6.1 of this document.

549 **NFLA 2012 response, section 6 -** in paragraphs 6.2 to 6.5 the NFLA raised concerns that we had not considered deposition of gaseous discharges into the marine environment. We did not assess the impact of gaseous discharges on the marine environment because most of the gaseous discharges are gases that will not be transferred to the marine environment in significant quantities. A more significant portion of the amount of 'Other Fission and Activation Products' discharged to the atmosphere could be deposited in the sea as it will be particulate rather than gaseous. However, the quantities that will be discharged to the atmosphere are a small percentage of those that will be directly discharged to the marine environment, and even if all the discharges to the atmosphere were deposited in the sea, they would not make a significant difference to our assessment.

550 **NFLA 2012 response, section 7** - in paragraphs 7.6 and 7.8 the NFLA said we had not addressed its concern about 'pulsed' discharges of aqueous radioactive waste. It made reference to sections 14 to 18, 19 to 20 and 23 but drew on its conclusions for sections 23 and 24. The NFLA used the term 'pulsed' to describe short periods of higher than average discharges, such as at the end of the fuel cycle of the reactors (typically 18 months).

551 Sections 14 to 18 of the NFLA's original submission were about discharges of tritium. Section 19 to 20 was about discharges of caesium-137. Section 23 had a title referring to *'Discharge regime for liquid radioactive waste discharges'* and was about the mixing of radioactive waste with the warm cooling water.

552 We are not aware of any credible pathways for individual disposals of liquid waste to lead to exposure to the radioactivity before dispersion takes place. For gaseous discharges, the wind can blow in a single direction during a short-term discharge and a crop could be harvested soon after the plants have absorbed the gaseous radioactivity. We are not aware of a similar mechanism for liquid discharges. The NFLA did not propose any scenarios to illustrate its concern, and, for these reasons, we did not model a short-term scenario for liquid discharges. We consider that the assessment of annual exposure to liquid radioactive discharges is adequate.

553 In sections 15 and 16 of its submission, the NFLA referred to higher environmental concentrations of tritium in the Bristol Channel and Severn Estuary. These concentrations are due to the discharges of organically bound tritium in the Cardiff area from a radio-pharmaceutical site. These discharges behave differently in the environment to the discharges of tritiated water from nuclear power stations and have a higher impact per amount of discharge.

554 In section 17 of its submission, the NFLA referred to new research on the absorption of tritium onto organic matter in marine sediments that found higher than expected absorption of tritium on marine sediments. The NFLA also referred to the latest edition of the relevant IAEA recommendations, Technical Report Series 422. This report recommended a distribution

coefficient between water and sediment of 1. We used PC Cream 08 for our modelling that uses the value recommended by the IAEA. We carried out a sensitivity study assuming a distribution coefficient for tritium of 600 m^3 t^{-1}.

555 We found that increasing the distribution coefficient for tritium from 1 to 600 had little effect on the assessed doses. This is because the dose from marine pathway is mainly from carbon-14. Tritium contributes very little to the total. Changing the prediction of the distribution of tritium between estuary water and sediment in favour of sediment reduces the concentrations in fish and shellfish and reduces overall doses by a very small amount. We report on this in a supplement to our dose report that we have published with this decision document.

556 The NFLA was also concerned about how we monitor for the impacts of 'pulsed' disposals of liquid waste in the Bristol Channel. It was concerned that we do not monitor the environment frequently enough to detect maximum concentrations in the environment and food stuffs.

557 The criteria for protecting humans are based on annual radiation doses. We do not need to measure or model maximum concentrations as the annual doses are average results taking into all the discharge. We do not need to trace 'pulses' of discharges as they travel through the environment. We consider that combined programmes of the operator, the Environment Agency and the Food Standards Agency are sufficient to determine representative average values in foodstuffs and the environment. We have set out our views on environmental monitoring programmes in section 4.9.2 above.

558 **NFLA 2012 response, section 8** - in paragraph 8.8 and 8.9 of its response, the NFLA raised a concern about the cumulative effects of discharges of aqueous radioactive waste, in particular discharges of tritium from nuclear power stations into the Bristol Channel and Severn Estuary. It made reference to section 13 of its original submission on liquid discharges. Section 13 contained information on the discharges of tritium into the Bristol Channel. The section was descriptive and we could not see a clear conclusion about that information in the original NLFA submission.

559 We have assessed the impacts of Hinkley Point C on its own and in combination with the A and B stations at Hinkley Point. We did not assess the impact of current or future discharges from other existing or future plants because we do not consider there are any significant cumulative impacts for radioactive discharges from other sites. Our assessment included an assessment of the impact of accumulated discharges in the environment of the Bristol Channel and Severn Estuary, including accumulated radioactivity already in the environment from whatever source together with future discharges at Hinkley Point.

560 The NFLA in its response referred to DECC's considerations in the Appraisals of Sustainability for the revised draft Nuclear National Policy Statement that there were possible cumulative impacts of two new power stations on the Severn Estuary Coast. We did not assess the cumulative radiological impact because the low level of impact from the new power station locally is so small that a second one could be located adjacent to it without significantly

changing our conclusions about the impact. This is especially true for tritium from the reactor, which is discharged from the reactor site as tritiated water and only causes a small fraction of the radiological impact.

561 The NFLA 2011 submission claimed discharges of tritium into the Bristol Channel would be significantly increased by the discharges from Hinkley Point C. Hinkley Point B has been operating with lower temperatures in the reactors and reduced output since 2007. Before 2008, the station was usually producing about 1250 MW of electricity with liquid tritium discharges between 300 and 400 TBq y^{-1}. The expected best performance of Hinkley Point C is approximately 100 TBq y^{-1} of liquid tritium discharges, while producing three times as much electricity (3260 MW).

562 **NFLA 2012 response, section 9** - in paragraph 9.5 and 9.6 the NFLA claimed we did not address its concerns about the behaviour of tritium. It made reference to section 16 and 17 of its 2011 submission.

563 We have considered this matter when addressing the concerns about pulsed discharges of tritium in reply to section 7 of the NFLA 2012 response.

564 **NFLA 2012 response, section 10 -** in section 10 of its response, the NFLA 'draws attention to the comments made in 5 (above)' concerning pulsed discharges of tritium. Section 5 was about the colours used in a diagram, we believe the NFLA was referring to section 7. We have addressed this concern in our response to section 7 of the NFLA 2012 response.

565 **NFLA 2012 response, section 11** - section 11 of the 2012 response was titled *'Discharges of fission and activation products',* but section 11 concentrated on the discharges and behaviour of caesium-137. Other fission and activation products were covered in later sections of the NFLA's 2012 response.

566 In paragraph 11.11 to 11.12 of its response, the NFLA claimed that we had not responded to its concerns about the pulsed nature of caesium-137 liquid radioactive discharges. We found this section quite confusing because the information drawn from the NFLA submission is about several other factors concerning the behaviour of caesium-137 but not 'pulsed' discharges. We have endeavoured to address all the points here.

a) The submission said that caesium is concentrated in sediments. We are aware of this, and our dose assessment uses concentration factors to replicate the enhancement in sediment. Our predicted concentrations for sediment and seawater in Table A10.1 of our dose assessment report give a ratio of approximately 1000 to 1.

b) The submission said that low levels of caesium are transferred to land by using seaweed as a fertiliser. We are aware of that potential pathway. We reported in the 2008 edition of the Radioactivity in Food and the Environment (RIFE) report that there was no evidence that this pathway leads to any uptake of radioactivity in foodstuffs grown on land fertilised with seaweed.

c) The submission said that 80% of the Bristol Channel environment is not monitored. We concentrate our monitoring on the environment local to the

nuclear sites. For Hinkley Point, this includes areas with fine sediment such as the Parrett Estuary, where we expect the highest concentration to be found. Environmental monitoring has been more extensive in the past and programmes have been reduced since the early days of nuclear power as more confidence was gained about the extent of the spread of contamination from power stations. We set out our position on environmental monitoring for Hinkley Point C in section 4.9.2 of this document.

d) The submission said that doses to individuals in the Hebrides have been assessed as being higher than those of the critical groups close to the power stations. However, the source of the radioactivity was Sellafield and the critical group exposure assessed for Sellafield was significantly higher than for the power stations. The comparison made by the NFLA is inappropriate.

e) The submission said that the existing monitoring programmes are not stringent enough to detect the effects of pulsed discharges. We have addressed this matter in section 4.9.2.

567 **NFLA 2012 response, section 12** - the NFLA claimed that we had not responded to its concerns about the cobalt-60 liquid radioactive discharges. We addressed this concern in paragraph 398 of the Hinkley Point C draft decision document (see paragraph 423 of this document).

568 The NFLA appeared to raise a new concern that the margin between best estimated performance and the proposed annual limits indicates uncertainties in the integrity of stainless steel reactor and cooling system components. The margins we have allowed in setting limits are to allow for the uncertainties in the production of radioactive waste not the integrity of the reactor vessel and components. In our draft decision document, we reported that we considered that NNB GenCo's proposals to prevent and minimise the creation of radioactive waste contributed to the use of BAT. NFLA made no specific comment on this aspect of our draft decision document.

569 **NFLA 2012 response, section 13** – the NFLA claimed that we had not addressed its concerns that significant quantities of plutonium, americium and other alpha emitting actinides will be discharged by Hinkley Point C. NNB GenCo said in its application that discharges of alpha emitting radionuclides would be below minimum detection levels. We addressed this matter in paragraph 394 of the draft decision document (see paragraph 418 of this document).

570 The NFLA drew on material supplied by Westinghouse Electric Company LLC during GDA of the AP1000® reactor when it made its claim. We considered, in section 9.3 of our GDA decision document for the AP1000®, reactor, that there was no requirement to set a limit on plutonium-241, the precursor to americium-241, as the GDA dose assessment shows the impact is insignificant. However, there is still an overriding requirement on NNB GenCo to use Best Available Techniques (BAT) to minimise the amount of all radionuclides, including alpha emitting radionuclides, discharged in aqueous radioactive waste.

571 The NFLA repeated six questions from its 2011 submission. Two were about in-line monitors; we addressed this matter in paragraph 439 of our draft decision document (see paragraph 469 of this document). The others were about sources, quantities and isotopic composition of alpha emitters in EPR liquid discharges.

572 To provide further reassurance because the NFLA had raised this matter for a second time, we included an assessment of an alpha discharge in our sensitivity studies. We undertook a stage 2 screening assessment of potential alpha discharges at the amount referred to by the NFLA based upon discharges from the AP1000® reactor. The NFLA assumed alpha discharges of 37,000 Bq y^{-1} and plutonium-241 discharges of 108,000 Bq y^{-1} from a single AP1000® reactor, we increased this by a factor of three to allow for the higher output of Hinkley Point C. We assumed the alpha emitters were all Plutonium-239 and allowed for the ingrowth of americium-241 from plutonium-241. The NFLA assumed that a proposed new power station at Oldbury would also discharge similar amount, we have only used their values for Hinkley Point C. The screening assessment gave a dose of 0.00016 µSv y^{-1}. This is very low and well below the criteria agreed for limit setting. This confirms that the discharges of alphas can be considered to be negligible.

573 **NFLA 2012 response, section 14 -** in section 14 of its 2012 response, titled '*In–site monitoring (liquid waste streams)*', the NFLA repeated the information about the significance of alpha emitters from section 13 of its 2012 response. We have addressed those matters in the section above. In paragraph 14.12 and preceding unnumbered paragraph, the NFLA stated that concentrations of alpha activity in shellfish in the Bristol Channel are rising, as reported in our RIFE reports. We reviewed the information in our RIFE reports for the period from 2000 to 2012; we do not agree that there is a rising trend.

574 The NFLA also questioned whether, in light of the alleged rising concentrations of alpha activity in environmental samples, we were working with the objectives of the 2009 UK strategy for radioactive discharges. As we stated above, we cannot find any significant upward trend in environmental concentrations. We, therefore, consider that our conclusion in section 4.5.7 of this decision document is valid.

575 **NFLA 2012 response, section 15 -** in section 15 of its 2012 response, titled '*Off-site monitoring (liquid waste streams): Draft Decision document (Chapter 5.10)*', the NFLA criticised the Hinkley Point monitoring programme reported in the annual RIFE reports. The monitoring programme for Hinkley Point reported in RIFE reports is for the independent monitoring carried out by Environment Agency and the Food Standards Agency. This programme is in addition to the monitoring programmes we require the operators of nuclear licensed site to carry out around their sites.

576 NNB GenCo included a proposed programme for its own monitoring around Hinkley Point C in its application. The programme was based on the programmes carried out by the operators of the A and B stations at Hinkley Point. We considered NNB GenCo's proposals for its own programme in our draft decision document. The NFLA in its 2011 submission and its 2012

response said nothing about NNB GenCo's proposed programme, which suggests they had overlooked it or confused it with the independent RIFE monitoring programme. We presented our considerations of NNB GenCo's environmental monitoring programme in section 5.10.2 of the draft decision document (section 4.9.2 of this document).

577 The NFLA claimed that there is a lack of radiological monitoring data for the Bristol Channel; it referred to the draft decision document paragraph 455. The NFLA appears not to have noted that we said: 'We have gathered this through operator monitoring and also independent monitoring by ourselves and other public bodies' and based its criticism on our monitoring alone, as reported in the RIFE reports.

578 The NFLA claimed we were 'dismissive and ill informed' in our response in paragraph 466 of our draft decision document to its concerns about the impact of climate change on the behaviour of radioactivity in the environment.

579 Its first reason for this claim was because radioactivity concentrates in finer sediments. We are aware of research reported over the years in the open literature that shows that some radionuclide concentrate in fine grained sediments. While the NFLA did not give any reasons why it expected there to be either more fine sediments or finer sediments if climate change occurs, the concentration of some radioactivity on sediments only has a small overall impact on predicted doses.

580 Its second reason for this claim seemed to be based on a restricted definition of what routine in 'routine survey' means. We use routine to describe 'repeated and regular' compared to 'one-off' or 'ad-hoc' monitoring.

581 While we expect to do 'routine monitoring' many times in the same way and at the same place so that we can detect trends in the environment, this does not mean that we will never review and change what we do. In our draft decision document we said we would monitor changes in the environment and people's habits so that we could detect changes and revise programmes if necessary.

582 We will also consider the NFLA's concerns when we assess NNB GenCo's detailed programme. However, we are aware of a number of factors that will limit the marine environmental programme:

- The range of aquatic species in the Bristol Channel is limited due to the unusual environmental conditions, for example high water velocities and turbidity.
- There is little commercial fishing in the area.
- The consumption rates of local marine foods are low.

583 The NFLA was also concerned that we will allow NNB GenCo 'licence and discretion' when it prepares its proposals for its environmental monitoring

programme. In 2010 we published joint guidance[68] with the Scottish Environment Protection Agency and the Food Standard Agency on environmental monitoring. We expect the operator to use this guidance when it prepares its environmental monitoring programme as required by permit condition 3.2.1 (b). We no longer specify the environmental monitoring programmes as we did before we published our guidance. However, in permit condition 3.2.5, we still have powers to specify monitoring, including environmental measurements and assessments, if needed.

584 **NFLA 2012 response, section 16 -** in section 16 of its 2012 response the NFLA claimed we had failed to identify the best available science of the fate and behaviour of aqueous radioactive waste discharged into the Bristol Channel. The NFLA only referred to paragraph 454 of our draft decision document. However, in paragraph 467 we referenced a detailed report containing our review of NNB GenCo's assessment and our independent assessment. We published this report with our draft decision document and it was available on our website and in public registers. In appendix 2 of our dose assessment report[69], we considered in detail the parameters used by NNB GenCo and the parameters we would use for our independent assessment.

585 The NFLA also questioned why we considered that the changes from PC CREAM 98 to PC CREAM 08 were not significant. We covered this in paragraph 487 of our draft decision document. We compared the results of assessments produced by both versions of PC CREAM and the results were not significantly different. The NFLA questioned why HPA had said PC CREAM 08 is a significant improvement over PC CREAM 98 and why it had stopped supporting PC CREAM 98. This is primarily a matter for HPA but in our view the significant improvements are primarily in the user interface and the support for newer PC operating systems and, therefore, newer and more powerful computers. It is common practice for software suppliers to stop supporting older software; we regard that as primarily a commercial matter for the supplier. We repeat our conclusion that NNB GenCo's assessments were satisfactory. We also carried out independent assessments using PC CREAM 08 that produced similar results. Finally, we note the HPA comments on NNB GenCo's assessment, reproduced in paragraph 453 of the draft decision document, that '*...and is consistent with the approach suggested by HPA for this type of assessment.*'

586 The NFLA raised a concern that the DORIS marine dispersion model might not be up to date with changes to the EC MARINA II model published in 2003. The DORIS model in PC-CREAM-08 is based on the EC MARINA-II model and for the reasons given in the paragraph above, we are satisfied that this is not a significant issue.

[68] http://www.sepa.org.uk/radioactive_substances/publications/guidance.aspx
[69] http://www.environment-agency.gov.uk/homeandleisure/127159.aspx

587 The NFLA, in paragraph 31.7 of its 2011 submission, raised a concern that a report with a working title *'Identifying Key Parameters which Control Coastal Dispersion Modelling'* due for publication in 2010 by an unidentified organisation should have been taken into account. The NFLA, in its 2012 response, noted that we had not addressed this matter in our draft decision document. We considered it unreasonable to expect NNB GenCo to take into account unpublished research. However, we think we have identified the report as one we published in 2010 titled *'Parameter values used in coastal dispersion modelling for radiological assessments'*[70].

588 Our report contains a review of parameter values. It does not provide parameters for Bridgwater Bay/Hinkley Point but does provide values for areas close to Hinkley Point. The values we used in our assessments are similar to those in the report for areas close to Hinkley Point and we are confident we have used appropriately conservative values in our assessments.

589 The NFLA, in paragraph 16.8 of its 2012 response, returned to the issue of 'pulsed' discharges. We have considered this concern in our response to section 7 of the NFLA's 2012 response.

590 The NFLA, in paragraph 16.9 of its 2012 response, returned to the issue of dissimilarities between the Irish Sea and the Bristol Channel. We think this might be because EDF and AREVA used the Irish Sea parameter for its generic site assessment in GDA. However, NNB GenCo carried out assessments based on parameters for the Bristol Channel. We consider our and NNB GenCo's assessments for Hinkley Point were made using appropriate parameters.

4.10.9 Recent studies on health risks near nuclear plants and risk factors from radionuclides

591 A number of consultees on the application raised concerns about health risks near nuclear sites. Most used a template produced by the Stop Hinkley group. They were concerned that there is no safe dose of radiation. They brought to our attention a German report known as the KiKK study (Kinderkrebs in der Umgebung von Kernkraftwerken)[71] (childhood cancer in the vicinity of nuclear power plants report) and a report by researchers at the University of South Carolina relating to alleged cancer clusters in the UK, Canada, France, USA, Germany, Japan and Spain. They also mentioned a French survey carried out in 2007. There were also specific concerns about studies relating to Burnham-on-Sea.

592 There is little direct evidence that very low doses of radiation affect health. However, the approach taken in radiation protection is precautionary by assuming there is no dose so low that it cannot potentially cause harm. The

[70] https://publications.environment-agency.gov.uk/ms/BTvYcg
[71] http://www.bfs.de/en/kerntechnik/kinderkrebs/stellungnahme_kikk.html

purpose of radiation protection, as in other health and safety fields, is to provide an appropriate standard of protection against ionising radiation without placing unnecessary restrictions on the beneficial uses of radioactive material and radiation. Achieving this balance involves considering risk.

593 Our dose assessments take into account health risks arising from exposure to radiation using UK dose to risk factors that have been recommended by the Health Protection Agency (HPA). The UK factors are based on those recommended by the International Commission on Radiological Protection (ICRP) and form part of a wider radiation protection framework (ICRP 60 and ICRP 103), enacted into legislation through the Basic Safety Standards Directive (96/29/EURATOM) and in the UK through the Ionising Radiation Regulations 1999, and the Environmental Permitting Regulations 2010. The risks from doses are reflected in the dose limits and dose constraints set out in this legislation.

594 The HPA report HPA –RPD-066[72] states that the KiKK study was reviewed by the German Commission on Radiological Protection, who concluded that the design of the KiKK study was unsuitable for establishing relationships between leukaemia and exposure to radiation from nuclear power plants. This is because the natural radiation exposure within the study area and its fluctuations are greater by several orders of magnitude than the radiation exposure from the nuclear power plants themselves. Similar UK and French data have subsequently been analysed for any trend with distance, and do not show higher levels of leukaemia close to power stations.

595 The Committee on Medical Aspects of Radiation in the Environment (COMARE) has published an in-depth review of the available evidence from several countries operating nuclear power programmes, including Britain and Germany (COMARE 2011) [73]. The review included a current analysis for risk of childhood leukaemia in children under five years of age living within five km of a nuclear power plant in Britain. COMARE found no reason to change its previous advice that there is no evidence of an increased risk of childhood leukaemia and other cancers in the vicinity of nuclear power plants due to radiation effects. COMARE recommended, however, that the government keeps a watching brief in this area. Its previous recommendation to continue initiatives into leukaemia and cancer research, to identify the causative mechanisms for childhood leukaemia, has been re-iterated. COMARE strongly recommends that there is no reduction in the surveillance of the environment and the health of the population. This would include environmental measurements of radioactivity, which give an independent check on reported and measured discharges from British nuclear installations, with a particular focus on carbon-14.

[72] http://www.hpa.org.uk/webc/HPAwebFile/HPAweb_C/1274090258191
[73] http://www.comare.org.uk/press_releases/documents/COMARE14report.pdf

596 COMARE issued a statement[74] in 2004 on the reports by Green Audit and Parents Concerned about Hinkley (PCAH) published in 2002 and 2004 relating to cancer incidence in Burnham-on Sea. COMARE found that the Green Audit study and report provided no reliable information about cancer in Burnham-on-Sea, and that a South West Cancer Intelligence Service study[75] had conclusively demonstrated that there is no association between cancer incidence in Burnham-on-Sea and its local estuary and Hinkley Point nuclear power stations.

597 We consider that the reports referred to by consultees, in response to our consultation on the application, have been adequately addressed in the reports we refer to above, and that out current guidance remains appropriate to protect the public and the environment.

598 One consultee on the application raised concerns that other consultees would be raising unfounded concerns about health risks. We note this concern.

599 One consultee on the application was concerned that the ICRP recommendations and NNB GenCo's dose assessments do not consider internal emitters of radiation. ICRP recommendations and NNB GenCo's assessments do consider internal emitters. The assessments include the main pathways that can lead to internal exposure such as ingestion of food containing radionuclides or the inhalation of air containing radionuclides.

600 One consultee on our draft decision document claimed that actual dose downwind of a nuclear power station was not reported, and that internal dose would be considerably more. We assessed future exposure for predicted discharges to air around Hinkley Point C, taking into account site specific weather based on 10 years of observations. Therefore downwind air concentrations of radionuclides were estimated and published for our consultation. We also publish, in our annual RIFE report, assessed dose based on actual discharges for the existing power stations and concentrations in the environment. Our assessments are for the most exposed people, known as the 'representative person'; the assessments include doses from radionuclides taken into the body.

601 Transition Eynsham Area, in response to the consultation on our draft decisions, brought to our attention a French study on health risk known as GEOCAP. It had not been considered by COMARE, see paragraph 595 above. We asked HPA for advice on this matter, see paragraph 604 below.

602 One consultee on our draft decision document bought to our attention that new health studies are being instigated around nuclear power plants. The consultee also drew our attention to recent studies from Japan carried out after the Fukushima accident, concerning alleged higher general mortality rate, excess rates of abnormal thyroid growths and a high incidence of

[74] http://www.comare.org.uk/statements/comare_statement_burnham.htm
[75] http://www.swpho.nhs.uk/resource/item.aspx?RID=9091

diabetes in children in the area around Fukushima. We asked HPA for advice on this matter, see paragraph 604 below.

603 Another consultee on our draft decision document brought to our attention a petition to the President of the European Parliament. The petition referenced a number of recent studies that had not been considered by COMARE.

604 We asked HPA for advice on these recent studies. The HPA responded that it had considered the points raised and confirmed that no additional evidence had been provided that would lead it to change its advice that the recommendations of ICRP should form the basis of our considerations of the impact of radioactive discharges on people. HPA provided more information in an annex to its reply. We have included the correspondence in Annex 3 of this document.

4.11 Radiological assessment (RSR Part B3 Q6b): Impact on non-human species and our conservation duties

605 In this section, we have considered the radiological impact of the discharges on the environment. We have also considered the impact in relation to our duties under various statutory provisions ('conservation duties') as set out below in Table 6.

Table 6: summary of conservation duties

Provision	Duty
Section 6(1)(b) of EA 95	We have a duty, to such extent as we consider it desirable, generally to promote the conservation of flora and fauna which are dependent on an aquatic environment.
Section 7(1)(b) of EA 95	We have a duty to have regard to the desirability of conserving flora, fauna and geological or physiographical features of special interest.
Section 7(1)(c)(ii) of EA 95	We have a duty to take account of the effect any proposal would have on the beauty or amenity of any rural or urban area or any flora, fauna, features or sites.
Section 8(3) of EA95	We take account of any notification and/or consultation responses received under section 8(3) of EA 95 (relating to sites of special interest).
Section 9 of EA95	In discharging our duties under section 6(1), 7 or 8 of EA 95, we must have regard to any code of practice approved under section 9.
The Conservation of Habitats and Species Regulations 2010	Before deciding to grant a permit for a plan or project which: (a) is likely to have a significant effect on a European site or a European offshore marine site (either alone or in combination with other plans or projects), and (b) is not directly connected with or necessary to the management of that site, we must make an appropriate assessment of the implications for that site in view of that site's conservation objectives And we must consult Natural England if there is a significant effect.

Table 6: summary of conservation duties	
Provision	**Duty**
Section 11A of the National Parks and Access to the Countryside Act 1949	We must have regard to the purposes of conserving and enhancing the natural beauty, wildlife and cultural heritage of specified areas and of promoting opportunities for the understanding and enjoyment of the special qualities of those areas by the public.
Section 28G of the Wildlife and Countryside Act 1981	We must take reasonable steps, consistent with the proper exercise of our functions, to further the conservation and enhancement of the flora, fauna, or geological or physiographical features, by reason of which a site of special scientific interest (SSSI) is of special interest.
Section 28I of the Wildlife and Countryside Act 1981	We are under a duty to consult Natural England/Countryside Council for Wales before permitting any operation which is likely to damage any flora, fauna or geological or physiographical features by reason of which a SSSI is of special interest.
Section 85 of the Countryside and Rights of Way Act 2000	In exercising or performing any functions in relation to, or so as to affect, land in an area of outstanding natural beauty, a relevant authority shall have regard to the purpose of conserving and enhancing the natural beauty of the area of outstanding natural beauty.
Section 40 of the Natural Environment and Rural Communities Act 2006	We must have regard to the purpose of conserving biodiversity when deciding whether to grant a permit (and what conditions to impose). Biodiversity includes, in relation to a living organism or type of habitat, restoring or enhancing a population or habitat.

4.11.1 Criteria for comparison with assessment in relation to environmental impact

606 The European research project, *'Framework for Assessment of Environmental Impact (FASSET)'* concluded that the threshold for statistically significant effects on organisms is about 100 microgray per hour (µGy h^{-1}). Allowing for the dose rate from natural background, which at most is about 60 µGy h^{-1}, we have adopted a value of 40 µGy h^{-1} as the level below which we consider there will be no adverse effect on non-human species. In addition, the ERICA assessment tool includes the conservative screening dose rate of 10 µGy h^{-1} we referred to in our dose assessment report.

4.11.2 Applicant's assessment

607 NNB GenCo included an assessment of the impact of the discharges (at the proposed discharge limits) on non-human species. It used the European

Commission's ERICA (Environment Risks from Ionising Contaminants: Assessments and management) assessment tool for most of the assessment, and our Research and Development report R&D 128 methodology for considering releases of noble gases. NNB GenCo considered a terrestrial, marine, coastal and freshwater habitat. Its assessment considered predicted discharges from Hinkley Point C and also these discharges in combination with discharges at permitted limits from Hinkley Point A and B power stations. We have reviewed the methods used by NNB GenCo and verified the results of its assessment. Our assessment is included in our detailed dose assessment report[76].

608 COMARE, in response to the consultation on our draft decision document, commented that NNB GenCo could have considered IAEA concentration ratios rather than default ERICA values; used a specific approach for C-14 dose and used the ICRP derived consideration reference levels of 4 µGy h^{-1} for mammals, birds and pine trees. However, it concluded that the overall conclusions about the risks to the environment are likely to be correct. We agree with this conclusion.

609 NNB GenCo's results for the in-combination discharges from Hinkley Point, for all four habitats and all considered organisms, were less than 40 µGy h^{-1}, the level below which we consider there will be no adverse effect on non-human species.

610 We considered the potential effects of discharges of radioactive waste from Hinkley Point C on plant and animal life at the relevant designated 'European sites' (Special Protection Areas (SPAs) for birds, and Special Areas of Conservation (SACs) for other species, and for habitats) under the Conservation of Habitats and Species Regulations 2010, which implement the Habitats and Birds Directives. We used the European Commission's ERICA (Environment Risks from Ionising Contaminants: Assessments and management) assessment tool for most of the assessment, and our Research and Development report R&D 128 methodology for considering releases of noble gases. We can also use them to determine the potential effects that proposed discharges could have on designated areas and ecosystems in general, in support of our other conservation duties. The methods calculate dose rates to a wide variety of species, including those that would be of conservation interest near the site.

611 We carried out an independent assessment of the impact of gaseous and aqueous discharges from Hinkley Point C alone, and from the three power stations at Hinkley Point in total. The assessments of potential dose rates to plant and animal life have been made at the predicted maximum discharges. The values used for the terrestrial environment assessment were the limits for discharges to the air. Those used for the marine environment assessment were the limits for discharges to the marine or estuarine environment.

[76] http://www.environment-agency.gov.uk/homeandleisure/127159.aspx

612 The potential dose rates to plant and animal life at maximum annual discharges are shown in tables 7 and 8 below for discharges from Hinkley Point C. We assessed the dose rates to a range of reference organisms and some other species likely to be present in the area (badger, bat and fox).

Table 7 Dose rates to marine reference organisms due to liquid discharges from the proposed Hinkley Point C nuclear power station

Organism	**Total dose rate per organism [µGy h^{-1}]**
(Wading) bird	1.10E-03
Benthic fish	8.62E-04
Benthic mollusc	7.27E-04
Crustacean	7.42E-04
Macroalgae	5.50E-04
Mammal	1.28E-03
Pelagic fish	8.13E-04
Phytoplankton	8.92E-06
Polychaete worm	7.98E-04
Reptile	1.28E-03
Sea anemones or true corals - colony	7.22E-04
Sea anemones or true corals - polyp	7.13E-04
Vascular plant	5.59E-04
Zooplankton	6.18E-04

Table 8 Dose rates to terrestrial reference organisms (plus three species of interest) due to atmospheric discharges from the proposed Hinkley Point C nuclear power station

Organism	Total dose rate [µGy h^{-1}]
Amphibian	3.34E-03
Bird	3.45E-03
Bird egg	2.37E-03
Detritivorous invertebrate	1.35E-03
Flying insects	1.33E-03
Gastropod	1.35E-03
Grasses & Herbs	2.36E-03
Lichen & bryophytes	2.36E-03
Mammal (Deer)	3.46E-03
Mammal (Rat)	3.45E-03
Reptile	3.45E-03
Shrub	2.36E-03
Soil Invertebrate (worm)	1.35E-03
Tree	3.36E-03
Badger	3.42E-03
Bat	3.41E-03
Fox	1.94E-03

613 The R&D 128 methodology was used to calculate dose rates to terrestrial reference organisms from noble gases discharged from the proposed Hinkley Point C nuclear power station. The highest dose rate to any reference organism was 2.10 E-03 µGy h^{-1}.

614 The predicted dose rates from the discharges from Hinkley Point C alone are significantly less than the value of 40 µGy per hour, below which we consider there will be no adverse effect on non-human species. The dose rates are also below the ERICA screening level of 10 µGy h^{-1}. We consider that the discharges of radioactive waste into the environment at our proposed limits, taken alone, would not adversely affect the integrity of European sites.

615 We also assessed the potential impact, at the relevant designated European sites, of the discharges of radioactive waste into the environment from Hinkley Point C in combination with those from Hinkley Point A and B power stations. The potential dose rates to plant and animal life at maximum annual discharges from the Hinkley Point C and at the discharge limits for Hinkley Point A and B power stations are shown in tables 9 and 10 below.

Table 9 Dose rates to marine reference organisms due to total liquid discharges from the Hinkley Point site

Organism	Total dose rate per organism [µGy h^{-1}]
(Wading) bird	2.98E-03
Benthic fish	4.37E-03
Benthic mollusc	4.28E-03
Crustacean	3.96E-03
Macroalgae	4.34E-03
Mammal	3.15E-03
Pelagic fish	1.29E-03
Phytoplankton	4.62E-05
Polychaete worm	8.07E-03
Reptile	5.17E-03
Sea anemones or true corals - colony	5.09E-03
Sea anemones or true corals - polyp	5.05E-03
Vascular plant	3.97E-03
Zooplankton	9.36E-04

Table 10 Dose rates to terrestrial reference organisms (plus three species of interest) due to total discharges to atmosphere from the Hinkley Point site

Organism	**Total dose rate [µGy h^{-1}]**
Amphibian	6.35E-03
Bird	6.54E-03
Bird egg	4.56E-03
Detritivorous invertebrate	2.70E-03
Flying insects	2.64E-03
Gastropod	2.68E-03
Grasses & Herbs	5.07E-03
Lichen & bryophytes	5.07E-03
Mammal (Deer)	6.55E-03
Mammal (Rat)	6.55E-03
Reptile	6.54E-03
Shrub	5.07E-03
Soil Invertebrate (worm)	2.70E-03
Tree	6.91E-03
Badger	6.49E-03
Bat	6.47E-03
Fox	3.76E-03

616 The R&D 128 methodology was used to calculate dose rates to terrestrial reference organisms from noble gases discharged from the proposed Hinkley Point site. The highest dose rate to any reference organism was 8.76 E-03 µGy h^{-1}

617 The predicted dose rates from the combined discharges (that is, the proposed discharges from Hinkley Point C together with the discharges from Hinkley Point A and B power stations) that affect a designated environmental site are below our guideline value of 40 µGy h^{-1}. The dose rates are also below the ERICA screening level of 10 µGy h^{-1}. We consider that the discharges of radioactive waste into the environment at our proposed limits, together with other relevant authorised discharges, would not adversely affect the integrity of the European sites.

618 We applied the same approach to our other conservation duties (as listed in Table 6) and also conclude that, because the dose rate is below 40 µGy h^{-1}, there will be no effect on any of the flora and fauna in the environment. By definition, there can be no effect on purely physical features, such as the geology, physiographical or the built environment. We are therefore satisfied that we have addressed our conservation duties as set out in Table 6 in relation to discharges of radioactivity.

619 Sedgemoor District Council, in response to our consultation on the application, raised a concern about the impact of operational emissions on the County Wildlife site adjacent to Hinkley Point C. NNB GenCo considered the County Wildlife site as habitat 1 and 4 in its assessment of environmental effects; the results are presented in chapter 13 of its application. The impacts of radioactive discharges are assessed as negligible. We assessed NNB GenCo's assessment and agree with its conclusions.

4.12 Non-radiological issues

620 Some legislation that applies to non-radioactive properties of waste does not apply when the waste is radioactive waste. We considered whether we need to address in the RSR EPR permit any non-radioactive aspects of the waste. We did not identify any requirements.

4.13 Other statutory considerations

4.13.1 EA 95 – Section 4 Principal aim of the Environment Agency ('sustainable development')

621 We considered the principal aim of the Environment Agency, set out in section 4 of the Environment Act 1995 (EA 95), which relates to sustainable development and the guidance issued to the Environment Agency in December 2002 (The Environment Agency's Objectives and Contributions to Sustainable Development: Statutory Guidance, December 2002)[77] and links to the UK Sustainable Development Strategy (*A Better Quality of Life: A strategy for sustainable development in the UK* (May 1999), Cm 4345)[78], although we note that this strategy has now been updated, see below).

[77] http://archive.defra.gov.uk/corporate/about/with/ea/documents/ea-susdev-guidance.pdf

[78] http://collections.europarchive.org/tna/20080530153425/http:/www.sustainable-development.gov.uk/publications/uk-strategy99/index.htm

622 This document provides guidance to us on matters such as the formulation of approaches that we should take to our work, decisions about our priorities and our allocation of resources. We are required under section 4(4) of EA95 to have regard to the statutory guidance when carrying out our roles, but it does not directly apply to our individual regulatory decisions.

623 The guidance states that our main contribution to sustainable development will be to meet our various objectives in a way that takes account (subject to and in accordance with EA 95 and any other enactment) of economic and social considerations. In respect of radioactive substances regulation, the guidance refers to the objective of regulating aerial and liquid radioactive discharges and solid radioactive waste disposal in accordance with statutory duties, statutory guidance and UK Government and Welsh Government policy.

624 The UK Sustainable Development Strategy was updated in 2005 with the publication of The UK Government's Sustainable Development Strategy (March 2005), Cm 6467[79]. This states that *'Our [UK] Strategy for sustainable development aims to enable all people throughout the world to satisfy their basic needs and enjoy a better quality of life without compromising the quality of life of future generations*', and introduces five guiding principles. These are:

- **Living within environmental limits**: respecting the limits of the planet's environment, resources and biodiversity – to improve our environment and ensure that the natural resources needed for life are unimpaired and remain so for future generations.
- **Ensuring a strong, healthy and just society**: meeting the diverse needs of all people in existing and future communities, promoting personal wellbeing, social cohesion and inclusion, and creating equal opportunity for all.
- **Achieving a sustainable economy**: building a strong, stable and sustainable economy, which provides prosperity and opportunities for all, and in which environmental and social costs fall on those who impose them ('polluter pays'), and efficient resource use is incentivised.
- **Using sound science responsibly**: ensuring policy is developed and implemented on the basis of strong scientific evidence, while taking into account scientific uncertainty (through the 'precautionary principle') as well as public attitudes and values.
- **Promoting good governance**: actively promoting effective, participative systems of governance in all levels of society – engaging people's creativity, energy and diversity.

[79] http://archive.defra.gov.uk/sustainable/government/publications/uk-strategy/documents/SecFut_complete.pdf

625 The government published further guidance on 'mainstreaming sustainable development'[80] in 2011.

626 In relation to radioactive substances, our contribution to sustainable development is to regulate aerial and liquid radioactive discharges and solid radioactive waste disposal in accordance with statutory duties, statutory guidance and government policy.

627 We consider that the overall approach described in this decision document, and in particular the application of BAT, which takes into account social and economic factors, and the assessment of the impact of the discharges on members of the public and the environment, contributes appropriately to the aim of achieving sustainable development, having regard to the statutory guidance.

4.13.2 EA 95 - Pollution control powers

628 Section 5 of EA 95 sets out the statutory purpose for which the Environment Agency's pollution control powers, including our powers under EPR 10, must be exercised, namely 'preventing or minimising, or remedying or mitigating the effects of, pollution of the environment'.

629 We consider that we have properly exercised our pollution control powers as required by section 5 of EA 95, in that:

- We have set limits and conditions based on BAT, as specified in the statutory guidance, having regard to government policy.
- The impact of the permitted discharges on members of the public is ALARA.
- The environment is protected.

4.13.3 EA 95 - Amenity issues

630 Under section 7(1)(c)(ii) of EA 95 the Environment Agency must take into account any effect which the proposals would have on the beauty or amenity of any rural or urban area or on any such flora, fauna, features, buildings, sites or objects. Our assessment of the radiological impact from the proposal is that there are no effects that would require us to include additional limits or conditions in the permit.

631 Sedgemoor District Council, in response to our consultation on the application, raised the issues of loss of area and potential air quality impacts on the Hinkley Point County Wildlife Site. The loss of area is within the scope of our duties under section 7(1)(c)(ii). The loss of area is primarily a planning matter. We are satisfied that the planning process can deal with this matter without us having to include additional limits or conditions in the permit. We consider that the radiological impact from gaseous radioactive discharges is

[80] http://sd.defra.gov.uk/documents/mainstreaming-sustainable-development.pdf

well within guidance levels and will not detract from the benefits that such wildlife sites provide to wildlife species, habitat and amenity for the local population. Our assessment of the radiological impact from the proposal is that there are no effects that would require us to include additional limits or conditions in the permit. We have summarised our assessment of radiological impact in section 4.10.

632 Sedgemoor District Council, in response to our consultation on the application, raised concerns that there was a lack of information on the transport of waste through local communities, including whether 'shipping' included marine transport. We regard this as both potentially an amenity issue under section 7(1)(c)(ii) and a well-being of communities issue under section 7(1)(c)(iii) below.

633 The Environment Agency does not have any powers to regulate the means of transport or the routes used for radioactive waste consignments. It is the operator's responsibility to follow the relevant transport regulations, which are regulated by the Office for Nuclear Regulation's Radioactive Materials Transport team (formerly in the Department of Transport).

634 We are satisfied that these regulations address the issues that arise from the transport of waste without us having to include additional limits or conditions in the permit.

4.13.4 EA 95 – Well-being of local communities

635 Under section 7(1)(c)(iii) of EA 95, we must have regard to the effect our proposals would have on the economic and social well-being of local communities in rural areas.

We have had regard, as appropriate, to the potential effect on the economic and social well-being of the local community as part of our:

- Assessment of the operator’s proposals in relation to using BAT, which involves considering costs and benefits.
- Considerations in relation to the principal aim of the Environment Agency (sustainable development).
- Assessment of the impact of disposals.

Our assessment of the radiological impact from the proposal is that there are no effects that would require us to include additional limits or conditions in the permit.

4.13.5 EA 95 – Likely costs and benefits

636 We have taken into account the likely costs and benefits in accordance with section 39 of EA 95 in our assessment of BAT. We are satisfied that the conditions in the permit are proportionate.

4.13.6 Water Environment (Water Framework Directive) (England and Wales) Regulations 2003 - Groundwater Directive (Schedule 22 to EPR 10)

637 Under the Water Environment (Water Framework Directive) (England and Wales) Regulations 2003, we must exercise our relevant functions to secure compliance with the Water Framework Directive (Directive 2000/60/EC), which seeks to protect ground and surface water on an integrated river basin basis. We considered NNB GenCo's proposals in relation to using BAT to minimise discharges of radioactivity to the environment and the impact of these discharges on members of the public and the environment. As described earlier in section 4, we consider that NNB GenCo's proposals and the permit conditions represent the use of BAT to reduce the impact to as low as reasonably achievable. We are, therefore, satisfied that the conditions are sufficient in relation to these regulations.

638 Schedule 22 of EPR 10 implements the Groundwater Directive to require all necessary measures to be taken to prevent the input of any hazardous substances (which includes radioactive substances) to groundwater, and to limit the input of non-hazardous pollutants into groundwater so as to ensure these pollutants do not cause pollution. The permit does not permit any releases to groundwater from the radioactive substances activities.

4.13.7 Human Rights Act 1998 (HRA 98)

639 In our draft decision we stated that we had considered potential interference with rights addressed by the European Convention on Human Rights in reaching our decision. We considered that our draft decision was compatible with our duties under the HRA 98. In particular, we considered the right to life (Article 2), the right to a fair trial (Article 6) (which here includes the right to a reasoned decision – as provided in draft form in the draft decision document), the right to respect for private and family life (Article 8) and the right to protection of property (Article 1, First Protocol).

640 One consultee stated that our assessment of human rights had been cursory, that our draft decision could not be described as reasoned (Article 6) because it did not include women in its reasoning, and that we had, through sex discrimination, violated Article 14 (prohibition of discrimination) and interfered with Articles 3 (prohibition of torture), 6 (right to a fair trial including a reasoned decision), 8 (right to respect for private and family life) and 9 (freedom of thought, conscience and religion). We have addressed the gender equality and gender bias issues raised by the consultee as appropriate throughout this decision document. We have set out our views and the basis for those views as clearly as possible. We have reviewed the gender equality and gender bias issues raised by the consultee in the light of the protection afforded by the HRA 98, including the Articles specifically referred to by the consultee. We remain of the view that this decision is compatible with our duties under the HRA 98.

4.13.8 Duty to Involve

641 Regulation 59 of EPR 10 requires the Environment Agency to prepare and publish a statement of its policies for complying with its public participation duties. We have published such a document, 'how we work together'[81] and this application has been consulted on in line with our public participation statement, as well as with RGN 6 on Sites of High Public Interest[82]. The latter addresses extended consultation arrangements for determinations where public interest is particularly high. This satisfies the requirements of the Public Participation Directive.

642 Section 23 of the Local Democracy, Economic Development and Construction Act 2009 requires us, where we consider it appropriate, to take the necessary steps to involve interested persons in the exercise of our functions by providing them with information, consulting them or involving them in any other way.

643 We have described, in section 3 of this document, our consultations in relation to the application and our draft decision document. In that section we have also described the way in which we have taken account of representations we have received.

4.13.9 Marine and Coastal Access Act 2009

644 We have taken into account the new duties placed upon us under the Marine and Coastal Access Act 2009. One of the most important duties is set out in Part 3, Chapter 4, section 58 and requires that any authorisation decision taken by a public authority must be in accordance with the appropriate marine policy document, that is the relevant Marine Plan or the Marine Policy Statement (MPS); unless relevant considerations indicate otherwise.

645 The MPS outlines the government's policies for achieving sustainable development in the marine environment around the UK, while at a local level, Marine Plans will be developed to provide the statutory basis for decision making on activities within that area. There is currently no Marine Plan for the Severn Estuary, with the first two proposed Marine Plans in England being developed for the waters off the North Yorkshire coast. The proposed Hinkley Point C discharge will, however, be made into waters that fall within the proposed future South West Inshore Marine Plan, in England. As a cross-border estuary, the marine area potentially affected by the Water Discharge Activity will also be subject to a future Marine Plan developed by Welsh Government.

646 The permitting decision we have made affects the marine waters of the Severn Estuary marine SAC and so we referred to the MPS in making our decision. We believe that our decision is in accordance with the MPS.

[81] http://www.environment-agency.gov.uk/business/topics/permitting/36420.aspx
[82] http://publications.environment-agency.gov.uk/PDF/GEHO1111BUKC-E-E.pdf

4.14 Other considerations

4.14.1 Convention on Safety of Spent Fuel and Radioactive Waste Management

647 The International Atomic Energy Agency (IAEA) Joint Convention on Safety of Spent Fuel and Radioactive Waste Management[83] relates to spent fuel and radioactive waste resulting from civilian nuclear reactors and applications, and spent fuel and waste from military or defence programmes when materials are transferred permanently to and managed within exclusively civilian programmes. The Convention also applies to planned and controlled releases into the environment of liquid or gaseous radioactive materials from regulated nuclear facilities.

648 The objectives of the Convention are to:

- Achieve and maintain a high level of safety worldwide in spent fuel and radioactive waste management through the enhancement of national measures and international cooperation, including, where appropriate, safety-related technical co-operation.
- Ensure that during all stages of spent fuel and radioactive waste management there are effective defences against potential hazards, so that individuals, society and the environment are protected from harmful effects of ionising radiation, now and in the future, in such a way that the needs and aspirations of the present generation are met without compromising the ability of future generations to meet their needs and aspirations.
- Prevent accidents with radiological consequences and to mitigate their consequences should they occur during any stage of spent fuel or radioactive waste management.

649 Our responsibilities under EPR 10 relate to limited aspects of the Convention, while other regulators such as the ONR are responsible for other parts of the Convention. We have reviewed the implications of this Convention and consider that we are meeting the relevant objectives. Details of national arrangements are set out in periodic national reports that are reviewed by the contracting parties, including the UK.

4.14.2 Convention on Nuclear Safety

650 The IAEA Convention on Nuclear Safety[84] relates to nuclear reactors and has three objectives:

[83] http://www.iaea.org/Publications/Documents/Conventions/jointconv.html
[84] http://www-ns.iaea.org/conventions/nuclear-safety.asp

- To achieve and maintain a high level of nuclear safety worldwide through the enhancement of national measures and international co-operation including, where appropriate, safety-related technical co-operation.
- To establish and maintain effective defences in nuclear installations against potential radiological hazards in order to protect individuals, society and the environment from harmful effects of ionising radiation from such installations.
- To prevent accidents with radiological consequences and to mitigate such consequences should they occur.

651 Our responsibilities under EPR 10 relate to limited aspects of the Convention, while other regulators such as the ONR have responsibility for other parts of the Convention. We have reviewed the implications of this Convention in relation to the application and consider that we are meeting the relevant objectives.

4.15 Matters that are outside the Environment Agency's permitting remit

4.15.1 Location of the installation

652 Decisions about land use are matters for the land-use planning system. The location of the facility is a relevant consideration for environmental permitting, but only with regard to its potential to have an adverse environmental impact on members of the public or sensitive environmental receptors. The impact on members of the public and the environment has been assessed as part of the determination process, is reported in section 4 of this document, and is small and well within relevant limits and constraints.

4.15.2 Impacts on tourism

653 Penarth Town Council and a member of the public, in response to the consultation on our draft decision document, raised concerns about the possible impacts of a new nuclear power station on tourism in South Wales and the south west of England. This is a matter for the Planning Inspectorate and the Secretary of State to consider when assessing the Development Consent Order application.

654 Penarth Town Council also asked whether compensation would be provided for them to clean up local beaches. We have assessed the impact of radioactive discharges on members of the public and the environment, as reported in section 4.10 of this document, and it is small and well within relevant limits and constraints, and we do not believe it should have any impact that would require the beaches to be cleaned.

4.15.3 Severn barrage

655 Penarth Town Council, in response to the consultation on our draft decision document, raised concerns that the development of Hinkley Point C might prevent the development of a Severn barrage. We considered permissions, plans or projects that needed to be assessed in combination with Hinkley Point C when we carried out our Habitats Regulations Assessment. As no

application to develop a barrage has been made, we did not need to consider it further as part of our assessment. We have not considered the impact of a possible barrage on the dispersion of radioactive liquid discharges. However, as the most recent proposals are outside our local compartment used for modelling and given the low impact of liquid discharges, it is unlikely there would be any grounds for concern on that matter.

4.15.4 Flood risk

656 We provide advice and guidance on flood risk in our consultation responses relating to NNB GenCo's application to the planning authority for a Development Control Order. Both the applicant and planning authority normally accept our advice on these matters. The ONR considers flood risk as part of the licensee's safety case under the Nuclear Site Licence.

657 Some consultees on the application raised concerns about the effects of flooding on the safety of the site. We have passed these consultation responses to the ONR. Some consultees on our draft decision document raised similar concerns. We have also passed these consultation responses to the ONR.

4.15.5 Funded Decommissioning Programme (FDP)

658 Some consultees on the application raised concerns about the liabilities from the storage and disposal of higher activity waste and site decommissioning. These issues are matters for government, rather than us, and are subject to the approval of the FDP and the government's Managing Radioactive Waste Safely (MRWS) programme, including the development of a geological disposal facility (GDF). We have forwarded the consultation responses to the Department of Energy and Climate Change (DECC).

4.15.6 Geological disposal facility (GDF)

659 COMARE, in response to our consultation on the application, restated its concern that the GDF should be established as soon as practicable. Sedgemoor District Council, in response to our consultation on the application, also commented that although there is a general UK Government commitment to developing GDF, there are no firm candidate sites or a definitive programme for implementation. Cumbria County Council, in response to our consultation on the application, stated that relevant Cumbrian authorities are considering engaging with government and the NDA in a GDF siting process, but it is far too early to assume a facility will be available for disposal of higher activity waste arisings from Hinkley Point C. Other consultees on the application raised concerns about allowing the power station to operate before the GDF is available, and that the permit should contain time limits for the disposal of ILW. Policy relating to management of spent fuel arising from any new nuclear power stations is set out in the 2008 Nuclear White Paper and in the Nuclear National Policy Statement. The UK's Managing Radioactive Waste Safely programme includes development of a GDF. We forwarded these consultation responses to DECC.

660 In January 2013, Cumbria County Council decided that it would not participate in the next stage of the Government's Managing Radioactive Waste Safely

(MRWS) programme of geological investigations to help identify suitable locations for a GDF, although Copeland and Allerdale District Councils both said that they were willing to proceed. We note that, following these decisions, the government issued a ministerial statement that the MRWS programme continues. The Secretary of State said further that *'…The Government's position regarding prospective new nuclear power stations has been clear that there must be provision in the long-term for safe disposal of higher-activity waste produced by new nuclear power stations. The Managing Radioactive Waste Safely programme is a long-term one, and I am confident that it is sound and that it will be put into effect. The decisions by the councils in Cumbria do not change this. Nor do these decisions undermine the prospects for new nuclear power stations.'*

661 The Secretary of State continued, *'Until such time as a GDF is implemented, it remains the Government's policy that higher-activity radioactive waste should continue to be held in interim storage, which domestic and international experience indicates is safe and effective and will remain so for as long as is necessary.'*

662 We, together with the Office for Nuclear Regulation, will ensure that:

- The waste arising from any new nuclear power stations remains safe and secure.
- The environment is properly protected.
- The waste remains in a stable condition such that it is capable of being disposed of once a geological disposal facility becomes available.

5 Our decision

663 We consulted on our draft decision that we should grant an environmental permit for radioactive substance activities at Hinkley Point C Power Station and what the conditions of the permit should be. We have now carefully considered all the consultation responses and consider that our original conclusions remain valid.

5.1 Permit conditions

664 The permit is based on our standard template permit for radioactive substances activities carried out on a nuclear site. We have developed the standard template over a number of years and regularly review it to make sure that it is up to date and effective. We also regularly check that permits for specific sites properly protect people and the environment and are consistent with the relevant government policies. The permit template and its conditions are described more fully in the document 'How to comply with your environmental permit for radioactive substances on a nuclear licensed site'[85].

665 The standard permit template includes:

- an introductory note (this is not part of the permit)
- a certificate page granting the permit
- Parts 1-4, being standard conditions about management, operations, disposals and monitoring, and providing information
- Schedule 1, defining the activities permitted
- Schedule 3, specifying routes for, and limits on, disposals
- Schedule 7, a site plan showing the geographical extent of the regulated facility

666 We have not modified the conditions in Parts 1-4 of the proposed permit from the standard conditions of our template except to remove the condition relating to reporting weekly advisory levels.

667 In Schedule 1, we have included:

- 19 information requirements
- one pre-operational measure for future development

for the reasons explained in section 4.

668 Since our consultation, we have made minor changes to information requirement IC 2, to reflect recent GDA assessment findings associated with the issue of the SoDA.

[85] http://publications.environment-agency.gov.uk/dispay.php?name=GEHO0410BSHS-E-E

669 We have also made some minor typographical changes to the permit to reflect changes to our template permit.

670 Schedule 3 specifies the approved types of waste and disposal routes and, as relevant, the limits that apply to specific radionuclides or groups of radionuclides for each of the approved disposal routes. We have also included 'quarterly notification levels' (QNLs) for discharge of gaseous and aqueous waste into the environment. The purpose of QNLs is described in the 'notifications' section of the How to comply guidance. We have corrected a drafting error for the value of the QNL for aqueous discharges of Co-60.

671 We have removed VLLW from table 3.3 of Schedule 3 as requested by NNB GenCo. We explain this change in paragraph 451. We have amended the definition of VLLW in the permit to be consistent with that for exempted waste in EPR 10.

672 We have amended information requirements IC 16, to clarify the purpose of the report we require on environmental monitoring.

673 We have added two interpretations to Schedule 6 to clarify which GDA documents were are referring to in the information requirements.

674 We are of the view that our decision and permit conditions are consistent with the relevant legislation, and that we have determined the application having had regard to the statutory guidance concerning the regulation of radioactive discharges into the environment and relevant government policy.

675 Watchet Town Council, in response to our consultation on the application, asked how it would be able to understand the plans and processes for disposals. Our permit contains requirements to provide further information as the project develops and report discharges when the plant is operational. We will make these reports available on local public registers.

676 Sedgemoor District Council (SDC), in response to the consultation on our draft decision document, asked us to prohibit the permitted activities taking place outside the areas marked on the site plan in the draft permit. We cover this in our standard permit conditions and it is included in the permit for Hinkley Point C as condition 2.2.1.

677 SDC supported the principle of using BAT to manage radioactive waste on site.

678 SDC commented on the permit conditions about maintaining systems and equipment and for the monitoring of discharges and the environment. It asked us to ensure the permit conditions do not compromise or in any way conflict with the requirements within the Development Control Order (DCO). We consider that all the permit conditions are appropriate to protect people and the environment from the impacts of radioactive discharges. We do not expect any conflicts with the DCO requirements. This is consistent with the expectations of the Nuclear National Policy Statement.

679 SDC sought assurance that for section 2.6 of the permit only waste produced on the site will be managed and controlled on the site and that the permit would not allow imported waste to be managed on the site. We have included

our standard conditions for receiving radioactive waste to allow waste from the National Arrangements for Incidents involving Radioactivity or in the Radsafe scheme. Other radioactive waste from the operation of UK EPR™ reactors can also be received on site, but we have not permitted any on-site burial. We do not regulate the storage of radioactive waste on site as this is a matter for ONR under the nuclear site licence.

Glossary

Term	Meaning
Activity	A generic title for the practices or operations, which have to be permitted (unless exempted from the need for a permit).
ALARA	As Low as Reasonably Achievable (economic and social factors being taken into account). Radiation doses comply with ALARA when they have been reduced to a level that represents a balance between dose and other factors (including economics). This is a statement of the optimisation principle.
Becquerel (Bq)	the standard international unit of radioactivity equal to one radioactive transformation per second. megabecquerel (MBq) – one million transformations per second gigabecquerel (GBq) – one thousand million transformations per second terabecquerel (TBq) – one million million transformations per second
BAT	Best Available Techniques - see paragraph 680 below for a full definition.
BSSD	Basic Safety Standards Directive (Directive 96/29/EURATOM).
CFIL	Community Food Intervention Level, see MPL below
COMARE	Committee on Medical Aspects of Radiation in the Environment
DCO	Development Consent Order
DECC	Department of Energy & Climate Change
Defra	Department for Environment, Food and Rural Affairs
EPR 10	Environmental Permitting (England and Wales) Regulations 2010.
FAP	Fission and activation products.
FSA	Food Standards Agency.
GW	Groundwater (specifically in relation to a groundwater activity under EPR 10).

Term	Meaning
HSE	Health and Safety Executive. Regulator with responsibilities under IRR99 and NIA65, which it delivers through ONR.
HPA	Health Protection Agency.
VLLW	Very low level radioactive waste.
IAEA	International Atomic Energy Authority
ICRP	International Commission on Radiological Protection.
ILW	Intermediate level radioactive waste.
Justification	The benefits and detriments of any practice that could result in exposure to ionising radiation must be assessed before the practice is permitted. If the benefits outweigh the detriments, the practice is justified.
LLW	Low-level radioactive waste.
LLWR	Low-level radioactive waste repository.
Licensee	An operator licensed under NIA65.
manSv	man Sievert – a measure of collective dose to a population.
MPL	European Union's maximum permitted level for radioactivity in food following a radiological emergency.
NIA65	The Nuclear Installations Act 1965.
NID	National Infrastructure Directorate of the Planning Inspectorate.
NII	Nuclear Installations Inspectorate - now part of ONR.
NLS	Nuclear Licensed Site: a site licensed under the Nuclear Installations Act 1965.
ONR	Office for Nuclear Regulation: an agency within the HSE.
Options assessment	Any formal and recorded method by which a preferred solution is determined from a number of possible alternatives.

Term	Meaning
OSPAR	Oslo and Paris Convention for the Protection of the Marine Environment of the north-east Atlantic. The UK is a signatory to this Convention, whose strategies aim to prevent pollution of the maritime area by continuously reducing discharges, emissions and losses of chemically hazardous substances and radioactive substances.
Proximity principle	The proximity principle seeks to avoid excessive and unnecessary transportation of wastes for disposal. It means enabling waste to be disposed of in one of the nearest appropriate installations.
QNL	Quarterly notification level is a level of discharge set in the permit to help us to monitor and ensure that the operator BAT is using to minimise discharges
Regulated facility (RF)	A collective term for the range of activities permitted under EPR 10.
REP(s)	Radioactive Substances Regulation – Environmental Principles. Environment Agency guidance, which sets out, at a high level, the principles that the Environment Agency applies to RSR.
RSR	Radioactive Substances Regulation.
RWA	Radioactive Waste Adviser.
Sievert (Sv)	A measure of radiation dose received. millisieverts (mSv): one thousandth of a sievert. microsieverts (µSv): one millionth of a sievert. nanosieverts (nSv): one thousand millionths of a sievert.
Sustainable development	Development that meets the needs of the present without compromising the ability of future generations to meet their own needs. Specific to radioactive waste, the government's policy is to 'ensure that radioactive waste is managed safely and that the present generation, which receives the benefit of nuclear power, meets its responsibilities to future generations'.
UK EPR™	A design of pressurised water reactor developed by EDF and AREVA
WAL	Weekly advisory level is a level of discharge that may be set in the permit. If discharges in a week are greater than a WAL the operator must let us and the Food Standards Agency know straightaway.

Term	Meaning
Waste hierarchy	A principle of waste management, which requires that (in order of preference) waste is: avoided minimised reused recycled disposed of
WDA	Water discharge activity, the discharge of water to the environment as defined in Schedule 21 of the Environment Permitting Regulations 2010. An environmental permit is required to carry on this activity.

680 BAT is defined as:

The use of the best available techniques shall emphasise the use of non-waste technology, if available.

The term 'best available techniques' means the latest stage of development (state of the art) of processes, facilities or methods of operation that indicate the practical suitability of a particular measure for limiting discharges, emissions and waste. In determining whether a set of processes, facilities and methods of operation constitute the best available techniques in general or individual cases, special consideration shall be given to:

a) Comparable processes, facilities or methods of operation that have recently been successfully tried out.

b) Technological advances and changes in scientific knowledge and understanding.

c) The economic feasibility of such techniques.

d) Time limits for installation in both new and existing plants.

e) The nature and volume of the discharges and emissions concerned.

It, therefore, follows that what is 'best available techniques' for a particular process will change with time in the light of technological advances, economic and social factors, as well as changes in scientific knowledge and understanding.

If the reduction of discharges and emissions resulting from using best available techniques does not lead to environmentally acceptable results, additional measures have to be applied.

'Techniques' include both the technology used and the way in which the installation is designed, built, maintained, operated and dismantled.

Annex 1 – GDA assessment findings

681 Below is a table showing the GDA assessment findings for the UK EPR™ and how we propose to deal with them for Hinkley Point C.

682 We listed 18 assessment findings in our 2011 decision document. We have added seven additional assessment findings following our assessment of the GDA Issues outstanding when the 2011 decision document was published. The full list of assessment findings is shown in the table below.

Reference	Assessment finding	Action
UK EPR-AF01	The future operator shall, at the detailed design stage, identify any changes to the 'reference case' for solid radioactive waste and spent fuel strategy, and provide evidence that the site-specific integrated waste strategy (IWS) achieves the same objectives.	Further information requirement IC 2 will provide the required information.
UK EPR-AF02	The future operator shall, at the detailed design stage, provide an updated decommissioning strategy and decommissioning plan.	We will work with ONR and DECC on this matter, including considering the Funded Decommissioning Plan.
UK EPR-AF03	Future operators shall keep the removal of secondary neutron sources (to further minimise creation of tritium) under review. EDF and AREVA should provide future operators with relevant EPR operational information when available to facilitate their reviews of Best Available Techniques (BAT).	Further information requirement IC 3 will provide the required information.

Reference	Assessment finding	Action
UK EPR-AF04	Future operators shall, during the detailed design phase for each new build project, review BAT on minimising the production of activated corrosion products for the following matters, where possible improvements were identified in the PCER: i) corrosion resistance of steam generator tubes; ii) electro-polishing of steam generator channel heads; iii) specification of lower cobalt content reactor system construction materials; iv) further reducing use of stellites in reactor components, in particular the coolant pump. Where appropriate, any improvements considered BAT should be incorporated into the new build.	Further information requirement IC 8 will provide the required information.
UK EPR-AF05	Future operators shall, before the commissioning phase, provide their proposals for how they intend to implement zinc injection. The proposals shall be supported by an assessment of the impact of zinc injection on waste and crud composition.	Further information requirement IC 2 will provide the required information.
UK EPR-AF06	Prior to construction of the conventional and nuclear island liquid effluent discharge tank systems, future operators shall demonstrate that site-specific aspects such as size and leak-tight construction techniques are BAT.	NNB GenCo has provided adequate information on tank sizes in its response to our Schedule 5 notice. We will work with ONR to assess the leak tight construction techniques.
UK EPR-AF07	Future operators shall, before the commissioning phase, provide an assessment to demonstrate that proposed operational controls on the fuel pool are BAT to minimise the discharge of tritium to air.	Further information requirements IC 13 and IC 14 will provide the required information.

Reference	Assessment finding	Action
UK EPR-AF08	Future operators shall, during the detailed design phase, provide their proposals for the operational management of the Liquid Waste Processing System to minimise the discharge of radioactivity from the site so that exposures of any member of the public and the population as a whole are kept as low as reasonably achievable (ALARA) and to protect the environment. The proposals should be supported by a BAT assessment to show that the use of the evaporator, the choice of filter porosity and the demineralisation media have been optimised to minimise the dose to members of the public. The future operator shall also provide evidence that the Water Treatment Systems have sufficient capacity and resilience to cope with all the aqueous radioactive waste arisings consigned to the evaporator by the proposals. The proposals should consider all plant states, including for example outages and unavailability due to maintenance or breakdown.	Further information requirements IC 9, IC 10 and IC 11 will provide the required information.
UK EPR-AF09	Future operators shall, during the detailed design stage, provide a predicted mass balance showing how their proposed aqueous radioactive waste management regime will affect the disposal of carbon-14 to the gaseous, solid or aqueous routes. For each route, the form of carbon-14 expected shall be provided. For solid waste, the quantities of each type of waste shall be provided with expected carbon-14 content.	Further information requirement IC 15 will provide the required information.

Reference	Assessment finding	Action
UK EPR-AF10	The future operator shall provide confidence that adequate radioactive waste management cases (RWMCs), supported by appropriate stage Letters of Compliance (LoCs), can be developed for all intermediate level waste (ILW) on the timescales identified in EDF and AREVA's plan for disposability of ILW.	We will work with ONR on this matter.
UK EPR-AF11	The future operator shall provide evidence during the detailed design phase that the proposed specific techniques for preventing and, where that is not possible, minimising the creation of low level waste (LLW) and ILW are BAT.	NNB GenCo has provided adequate information in its submission.
UK EPR-AF12	The future operator shall provide evidence during the detailed design phase that the proposed specific techniques for treating and conditioning of LLW and ILW before disposal are BAT.	Further information requirement IC 17 will provide the required information.
UK EPR-AF13	If smelting of any LLW is pursued, the future operator shall demonstrate that the conditions of acceptance of the selected smelting facility can be met.	Permit conditions 3.1.5 and 3.1.6 address this finding.
UK EPR-AF14	If incineration of any LLW is pursued, the future operator shall demonstrate that the conditions of acceptance of the selected incineration facility can be met.	Permit conditions 3.1.5 and 3.1.6 address this finding.
UK EPR-AF15	If incineration of any ILW is pursued, the future operator shall demonstrate that the conditions of acceptance of the selected incineration facility can be met.	Not applicable.
UK EPR-AF16	The future operator shall, before the commissioning phase, propose techniques for the interim storage of spent fuel following a period of initial cooling in the pool. The future operator shall provide an assessment to show that the techniques proposed are BAT.	NNB GenCo has provided adequate information in its response to our Schedule 5 notice.

Reference	Assessment finding	Action
UK EPR-AF17	The future operator shall, before the commissioning phase, provide confidence that adequate RWMCs, supported by appropriate stage LoCs and taking due account of necessary storage periods, can be developed for spent fuel on the timescales identified in EDF and AREVA's plan for disposability of spent fuel.	We will work with ONR on this matter.
UK EPR-AF18	Future operators shall provide: a) during the detailed design phase, the location and arrangement of sampling and continuous monitoring facilities for gaseous and aqueous waste supported by an assessment that these will provide representative sampling and monitoring; b) during the detailed design phase and before final equipment selection, the details of equipment and techniques to be used for analysis of gaseous, aqueous and solid waste supported by an assessment that these represent BAT for monitoring.	Further information requirements IC 4, IC 5, IC 6 and IC 7 will provide the required information.
UK EPR-AF19	Future operators shall provide evidence during the detailed design phase that the methodology (developed in response to GDA Issue GI-UKEPR-CI-04) used to qualify SMART devices for nuclear safety functions, has been applied to relevant SMART devices that provide an environmental protection function.	Further information requirement IC 2 will provide the required information.
UK EPR-AF20	When undertaking detailed design of structures, systems and components (SSCs) that deliver an environmental protection function, future operators shall provide evidence that demonstrates the allocation of actions between humans and technology has been substantiated and dependence on human action to maintain a benign state has been optimised.	Further information requirement IC 2 will provide the required information.

Reference	Assessment finding	Action
UK EPR-AF21	Future operators shall provide evidence during the detailed design phase that the methodology (developed in response to GDA Issue GI-UKEPR-CC-01) used for categorising safety function and classifying structures, systems and components (SSCs) has been applied to relevant SSCs that deliver an environmental protection function.	Further information requirement IC 2 will provide the required information.
The following are joint assessment findings with ONR and we have used ONR's numbering system for consistency.		
AF-UKEPR-CC-08	A future licensee shall use relevant arrangements under the licence and environmental permits to ensure that an independent technical review is completed on the design changes described in Change Management Forms 24, 26 and 31 and listed in the GDA Reference Design Configuration UKEPR-I-002 Rev. 15.	Further information requirement IC 2 will provide the required information.
AF-UKEPR-CC-09	A future licensee shall use relevant arrangements under the licence and environmental permits to demonstrate that the impact of design changes raised after 31 May 2012 and included in the GDA Reference Design Configuration UKEPR-I-002 Rev. 15 are As Low As Reasonably Practicable (ALARP) / Best Available Techniques (BAT), and confirm their categorisation in terms of significance to nuclear safety and environment prior to their implementation into the site-specific detailed UK EPR™ design.	Further information requirement IC 2 will provide the required information.
AF-UKEPR-CC-10	A future licensee shall ensure that the development of the site-specific detail of the UK EPR™ design from the GDA UK EPR™ design, including work that is undertaken by vendors / contractors, is carried out under relevant arrangements as required by the licence and environmental permits.	Further information requirement IC 2 will provide the required information.

Reference	Assessment finding	Action
AF-UKEPR-CC-11	A future licensee shall use relevant arrangements under the licence and environmental permits for implementing the design changes listed in the GDA Reference Design Configuration UK EPR-I-002 Rev. 15 and described in the design change handover package documentation (see UKEPR-0020-001 Issue 01).	Further information requirement IC 2 will provide the required information.

Annex 2 – Places where the draft decision documents and draft permits were advertised or could be viewed

Print and digital media

683 We placed an advertisement announcing the start of the consultation in The Somerset County Gazette, Western daily Press and the Bridgwater Mercury. We also advertised in the South Wales Echo.

684 We issued a media release to key regional and local media outlets.

685 We displayed posters on Parish Council noticeboards

686 We used social media such as Twitter and Facebook to help promote the consultation.

687 We sent emails and letters to those people and organisations in our database for Hinkley Point consultations.

688 We updated our Hinkley Point web-pages to link to the application documents and inform people about how to respond.

Locations where the documents could be viewed

Environment Agency
Rivers House
East Quay
Bridgwater
Somerset
TA6 4YS

Environment Agency Office
Rivers House
St. Mellons Business Park
Fortran Road
St. Mellons
Cardiff
CF3 0EY

West Somerset Council
West Somerset House
Killick Way
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Civic Offices
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Annex 3 – Relevant correspondence

Mr S Gibson
HM Superintending Inspector
Office for Nuclear Regulation
C/O The Joint Programme Office
New Reactor Licensing
Redgrave Court
Merton Road
Bootle
Merseyside
L20 7HS

Our ref: EPR/ZP360SY
Your ref: 2012/464537

Date: 5 December 2012

Dear Mr. Gibson

Application reference: **EPR/ZP3690SY/A001**
Operator: **NNB Generation Company Limited**
Facility: **Hinkley Point C Power Station**

Removal of radioactive Very Low Level Waste (VLLW) disposal from our proposed permit

Thank you for your letter of 28 November 2012 in response to our consultation on draft environmental permits for the proposed Hinkley point C Power Station.

As you are aware NNB Generation Company Limited (NNB GenCo) has been considering requesting that we remove the disposal of VLLW from the RSR environmental permit. We have now had a formal request for NNB GenCo for us to make this change. I enclose a copy of the letter from NNB GenCo on this matter.

NNB GenCo plan to use the exemption for disposal of solid radioactive waste contained in Part 7 Section 5 of the new Schedule 23 to the amended Environmental Permitting Regulations, this schedule came into force in October 2011 after the permit application was made. Government guidance is that a waste stream cannot be divided between exemption and permit, so NNB GenCo would not be able to use the exemption unless we remove VLLW from the permit.

We are minded to make this change to the permit, however we are seeking your view on this matter before we proceed, a reply before 20 December 2012 would assist us in meeting our programme. Please contact Granville Roberts on 01278 484667 if you require any further information.

Yours sincerely

Office for Nuclear Regulation

An agency of HSE

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Your Ref: EA/EPR/ZP3690SY

Our Ref: 2012/483162

11 December 2012

Dear Ms C Fields

Subject: **Environmental Permitting Regulations (England and Wales) 2010.**
NNB Generation Company Ltd.
Hinkley Point C Power Station.
Consultation on environment permit application:
EA/EPR/ZP3690SY – Radioactive Substances

ONR acknowledges receipt of your letter dated 5 December 2012 inviting comment on NNB Generation Company Ltd's (NNB GenCo's) proposal to remove the specified radioactive waste Very Low Level Waste (VLLW) from the environment permit.

ONR understands that this request arises as a result of changes to the Environment Permitting Regulations that came into force following NNB GenCo's original application. The amendment will allow NNB GenCo to adopt the exemption for disposal of solid radioactive waste contained in Part 7 Section 5 of the new Schedule 23 to the amended Environmental Permitting Regulations.

ONR and the EA have discussed whether introducing the VLLW exemption would lead to accumulations of un-disposable very low level waste on the licensed site. This dialogue concluded that this is unlikely to be an issue at Hinkley Point C.

ONR notes that the Environment Agency is minded to make this change to the permit and advises that it has no objection to the NNB GenCo's proposal.

Yours sincerely

Mr S Gibson

Ms Jane Simmonds
HPA, Centre for Radiation, Chemical and Environmental Hazards
Chilton
Didcot
OX11 0RQ

Our ref: EPR/ZP3690SY

Date: 11 December 2012

Dear Ms Simmonds

Responses to our consultation on the draft decision and draft environmental permit for the proposed Hinkley Point C Power Station
Permit reference: EPR/ZP3690SY (Radioactive Substances)

Thank you for the Health Protection Agency's response to our consultation on our draft decisions and permit.

When we consulted on the application for this permit in 2011, we received a number of responses that expressed concern about possible health impacts of the proposed discharges. When we assessed these concerns we considered that they had all been addressed either in the COMARE 14 report or in reports prepared for the local Primary Care Trust.

In response to our consultation of our draft decisions some of these concerns have been restated and some new concerns have been raised. The new concerns are raised in

- A petition to the President of the European Parliament, in particular in the references numbered 10, 19, 20, 24, 27 to 31, 37, 40 43 to 50, 55 and 56 in appendix 1.
- Another consultee raised further recent concerns about health, these relate to
    - the GEOCAP study,
    - new health studies being commissioned in the USA,
    - two studies related to Fukushima, footnotes 3, 4 and 6 in the attached consultation response,
    - that "60 per cent of Fukushima children under 12 who were tested have diabetes"
    - that the radiation risk to females is being underestimated (the last 3 paragraphs on the fifth page and the first 2 on the sixth page)
    - that there is a "lack of knowledge about the metabolism of radionuclides in the mother child system and fetal tissues" (sixth page)

- ICRP threshold of 100 mSv for teratogenic effects (sixth page)

We enclose a copy of the petition and the consultation response. We would be grateful for an opinion as to whether the referenced reports contain any significant new information that undermines the ICRP recommendations that is the basis for our considerations of the impact of discharges upon people.

Please phone Granville Roberts on 01278 484667 if you need further information on this matter. We would appreciate a reply by 21 December 2012.

Yours sincerely

Carol Fields
Permitting Support Advisor

Enclosed
Petition to the President of the European Parliament (consultee 14)

Consultation response (consultee 26)

Centre for Radiation, Chemical and Environmental Hazards

Health Protection Agency

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2 January 2013

Your Ref: EPR/ZP3690SY

Dear Ms Fields

RESPONSE TO THE EA CONSULTATION FOR THE PROPOSED HINKLEY POINT C POWER STATION

Thank you for your letter dated 11 December 2012 regarding various points made in responses to the EA consultation on the draft decision and draft environmental permit for the proposed Hinkley Point C Power Station.

HPA has considered the points raised by the submissions that you have brought to our attention and can confirm that no additional evidence is provided that leads us to change our advice that the recommendations of the International Commission on Radiological Protection (ICRP) should form the basis for EA's considerations of the impact of discharges of radioactive material on people. Some specific responses to the points raised are given in the annex to this letter.

Yours sincerely

J. Simmonds

Ms JANE SIMMONDS
Head, Environmental Assessments Department

Direct dial: 01235-822778
e-mail: jane.simmonds@hpa.org.uk

Enc

Annex

Responses to the concerns raised in the EA consultation

Petition to the European Parliament

This petition sets out to provide evidence that the ICRP protection system underestimates risks from internal exposures to radionuclides and is therefore inadequately protective for such exposures. A large number of references are cited in support of this view. Most of these have been considered previously by HPA, by the Government Committee Examining Radiation Risks from Internal Emitters (CERRIE; www.cerrie.org) and / or the Committee on Medical Aspects of Radiation in the Environment (COMARE). The general conclusion has in all cases been that ICRP methodology provides appropriate control of radiation exposures form all sources and there is no support for the suggestion that risks from incorporated radionuclides have been grossly underestimated. The petition refers only to evidence in support of the view being expressed, ignoring the views of the majority of scientists which are supported by good evidence published in the peer reviewed literature. A recent review paper by HPA staff summarises the main arguments (Mobbs et al 2011); also relevant is the COMARE 14th report (COMARE 2011).

The petition refers to recent French studies that are of considerable interest but do not change the conclusions reached by HPA as outlined below:

Childhood leukaemia around French nuclear power plants: Sermauge-Faure et al (2012)

This study considered the risk of childhood acute leukemia (AL) around French nuclear power plants (NPPs) and was a nationwide "Geocap" case-control study that included the 2,753 cases diagnosed in mainland France from 2002-2007 and 30,000 contemporaneous population controls. The results suggest a possible excess risk of AL in the close vicinity of French NPPs in 2002-2007. However, the absence of any association when considering dose-based geographic zoning rather than linear distance from NPPs may indicate that the association is not explained by NPP gaseous discharges. Overall, the findings call for investigation for potential risk factors related to the vicinity of NPP and collaborative analysis of multisite studies conducted in various countries.

Given that doses to members of the public from discharges from NPPs are extremely low and well below those received from the various sources of natural background exposure, there is no good reason to expect health effects relating to releases of radionuclides. A more probable explanation or contributory cause remains an unusual pattern of exposure to infection (McNally and Eden 2004), and studies have shown a link between population mixing and childhood leukaemia (eg. O'Connor and Boneva 2007, Stiller et al 2008, Kinlen 2011). As discussed by Mobbs et al (2011), the most striking examples of clustering of childhood leukaemias that have been reported relate to sites in the USA for which there is no suggestion of increased radiation exposure. In the UK, analyses by COMARE (2006) showed no general clustering of childhood leukaemia around NPPs, although COMARE concluded that many types of childhood cancer do not occur in a random fashion and show a natural tendency to cluster.

The petition includes a number of incorrect assertions. One such misrepresentation in the section on childhood leukaemia near nuclear installations is that ICRP "do not accept the Stewart findings or at least they are not incorporated into the model." The ICRP cancer risk models are based very largely on follow-up studies of the survivors of the atomic bombings at Hiroshoma and Nagasaki. Studies of cancers in children exposed in utero to x-rays during diagnostic radiography, principally the Oxford Survey of Childhood Cancers (OSCC), have shown statistically significant increases in childhood leukaemia and solid cancers at doses of the order of 10 mGy (Bithell and Stewart 1975, Wakeford and Little 2003). The risk per unit dose estimated for the OSCC was compatible with that obtained from the A-bomb survivor studies (Wakeford and Little 2003).

Cancer, leukaemia/lymphoma and heart disease in uranium workers: Canu et al (2010, 2012)
These are good studies presenting preliminary results on possible associations between cancer and circulatory disease and exposures to uranium by inhalation. There is no suggestion that the results indicate that risks from uranium exposure are greater than estimated previously but follow-on studies should provide direct quantitative risk estimates.

Points made by Cecily Collingridge
This letter contains many of the same references as the Petition to the European Parliament and the points made above also apply here. Additional points are as follows:

Post-Fukushima studies
International efforts are in progress to assess radiation doses and risks to workers and members of the public as a result of the accident in Japan in 2011. In particular, the World Health Organisation (WHO) has published an assessment of doses received (www.who.int) and will shortly complete a risk assessment. This will be followed by a substantial first analysis by the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR). WHO and UNSCEAR reports are being prepared by experts from around the world.

On specific points made, there is no reason on the basis of extensive evidence from other sources on risks from radiation exposure to expect radiation-associated diabetes. Because cancer take some time to develop, early observations of such health effects are highly unlikely to be attributable to radiation. While studies of mutations in other animal and plant species are of interest, they do not inform directly on risks to humans.

Protection of females and the unborn child
Differences in sensitivity to radiation-induced cancer and other health effects between men and women, and children and adults are recognised by ICRP. The sensitivity of the developing embryo / fetus has received special attention. The ICRP protection system is designed to protect members of the public of all ages and radiation workers of both sexes. However, this is done by keeping radiation exposures low, below limits and constraints that apply to all members of the public and all workers.

The latest ICRP recommendations explain the complex procedures involved (ICRP 2007). In terms of cancer risk at low doses, numerical values of age- and sex- specific risk are derived for a range of cancer types and these are then used to specify what are called "tissue weighting factors" that are used in the calculation of a risk-related quantity called effective dose, with units of sieverts (Sv). For example, the tissue weighting factor for breast was increased in the most recent ICRP recommendations, reflecting an increase in the estimated risk of radiation-induced breast cancer in females. One set of tissue weighting factors is used for males and females of all ages for radiation protection purposes.

In calculating radiation doses to children and the developing embryo/fetus, their smaller sizes and organ dimensions are taken into account. In the future, separate male and female models will be used but the calculated doses will be averaged in the calculation of effective dose. The dose to this averaged reference person is used for dose limitation – and avoids the use of separate limits for males and females, and children of different ages. The use of single limits for
all workers and all members of the public does not disregard differences in radiation sensitivity but provides a workable system of protection for all.

In considering radiation doses from inhaled or ingested radionuclides, ICRP has developed detailed age-related models for the transfer of radionuclides from the lungs and digestive tract to

other body organs and their excretion from the body. Models have also been developed for radionuclide transfer across the placenta to the fetus and in breast-milk to the suckling infant. However, in the vast majority of cases the dose received by the fetus or the breast fed infant is less than that received by the mother and so it is not necessary to consider these doses explicitly. The exception is for radioisotopes of elements that readily transfer across the placenta or to breast milk (for example, calcium and phosphorus, iodine) where the doses to the fetus and breast fed infant have to be considered explicitly. This is discussed in more detail in two publications produced by the Health Protection Agency (HPA 2008), and the predecessor body, the National Radiological Protection Board (NRPB 2005).

Specific references are made to the radiosensitivity of the embryo and fetus. The threshold for teratogenic effects of 100 mGy (ICRP 2003, 2007) is a reasonably cautious interpretation of the available evidence – damage to tissues causing developmental effects can only be expected to occur at higher doses. The appendix by Schmitz-Feuerhake and Bertell refers to studies in which the fetal haemopoietic system was shown to be very sensitive to alpha particle irradiation from plutonium-239 (Lord et al 1992, Jiang et al 1994). The studies involved measurements of the viability of haemopoieitic cells in the bone marrow of newborn mice. Subsequent studies of chromosome aberrations in marrow cells from mice exposed to plutonium-239 also showed substantially greater sensitivity in offspring following in utero exposure than in mothers (Kozlowski et al 2004). However, as discussed by Kozlowski et al (2001), despite the apparent in utero sensitivity of haemopoietic tissue to alpha-irradiation suggested by these studies, evidence from mouse life-span studies indicate that this does not translate into risk of haemopoietic neoplasia. No cases of acute myeloid leukaemia (AML) were observed in AML prone mice after in utero exposure to plutonium-239 at doses that had previously been shown to cause AML in adults (Humphreys 2001, Mountford-Lister 1997). These results support other observations that indicate that while developing haemopoietic tissue in utero may be more sensitive to the induction of early genetic mutations that predispose to leukaemia, the further genetic changes that are necessary for the development of leukaemia occur more readily in irradiated adults. HPA maintains an active research programme on radiation leukaemogenesis as part of a larger programme on radiation effects at low doses.

Schmitz-Feuerhake and Bertell also refer to the possible concentration of alpha-emitting radionuclides in the yolk sac during embryogenesis and irradiation of primitive haemopoietic cells. This is an important concern, recognised and discussed in some detail by ICRP (2001), but the yolk sac plays a lesser role in development in primates than in many other mammals, including rats and mice. In rodents, the yolk sac folds during development to envelop the embryo and it continues to have a nutritive role throughout gestation, complimentary to that of the placenta. In humans, the yolk sac does not fold around the embryo but folds internally to form part of the gut and a vestigial structure within the umbilical cord. The human embryo is enveloped instead by the amnion and protection is afforded by the amniotic fluid that fills the amniotic cavity. The yolk sac in the human does not contain food reserves but is an example of a developmental process that recapitulates evolutionary history. The irradiation of primitive haemopoietic cells in the yolk sac of humans by retained alpha-emitting radionuclides may contribute to total in utero dose to haemopoietic tissue but is likely to be substantially less important in humans than in rodents.

The correspondent refers to various institutions being male dominated and indeed in many cases there are more males than females in organisations such as IAEA, reflecting the lower numbers of women who do degrees in the physical sciences. However, there are senior female scientists in organisations such as WHO and the current Chair of ICRP is a woman, Dr Claire Cousins. The Centre for Radiation, Chemical and Environmental Hazards (CRCE) which leads on radiation protection for HPA, has a number of senior female scientists and three of six members of the Directorate are women. At HPA a recent audit of the first author of HPA scientific publications in

the first half of 2012 found no evidence of a bias towards males being named as first authors in HPA publications (Dr Jill Meara, HPA personal communication).

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