Book 1 Radioactive substances activity operational permit habitats assessment regulation report

Proposed Sizewell C nuclear power station

July 2022

Version 1

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1. Introduction

This is a record of the Habitats Regulations Assessment (HRA) as required by Regulation 63 of the Conservation of Habitats and Species Regulations 2017 (as amended), carried out by the Environment Agency in respect of the permission, plan or project (PPP) for an operational radioactive substance activity operational environmental permit, subsequently referred to as the RSR (Radiological Substances Regulation) permit. This HRA report (HRAR) has been completed using the legislation, guidance and tests set out in the Regulatory Position section of the overarching HRAR of the Environment Agency permit applications for Sizewell C.

Radioactive waste would be produced by activities associated either directly or indirectly with operating and maintaining the proposed nuclear reactors at Sizewell C (SZC). The operation and maintenance of the proposed SZC power station would produce solid, aqueous, and gaseous radioactive waste, some of which would be discharged to the environment.

This assessment will consider the following information supplied by the applicant:

- SZC RSR Permit Application Appendix D – D2 Non-Human Biota Radiological Impact Assessment (NNB GenCo, 2020a)
- SZC RSR Permit Application Non-Technical Summary (NNB GenCo, 2020b)
- SZC RSR Permit Application Appendix F Site plan (NNB GenCo, 2020d)

Most gaseous radioactive waste would be discharged to the environment via 2 main emission stacks, one for each reactor, at a height of 70m above ground level. Aqueous radioactive waste would be discharged with the cooling water into the North Sea via 2 outlet structures approximately 3.5 kilometres offshore at Ordnance Survey grid references 651080, 264125 and 651155, 264125, shown in Figure 1.

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 made available. These activities are not subject to this RSR permit application.

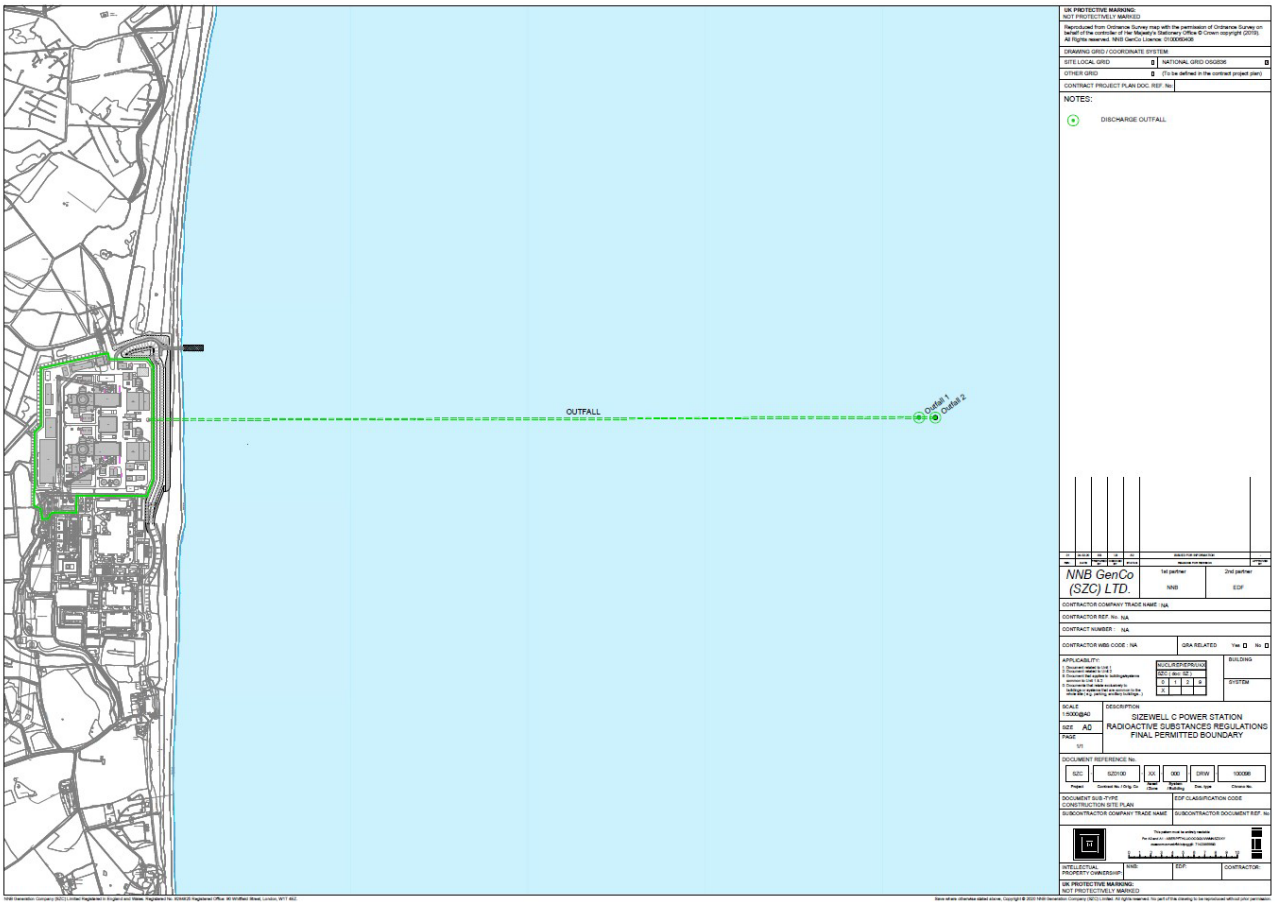

Figure 1 RSR final permitted boundary, taken from RSR Permit Application Appendix F – Site plan (NNB GenCo, 2020e)

An RSR environmental permit will be required for radioactive discharges to the environment (atmosphere and sea) resulting from normal operation of the site. Normal operation includes the operational fluctuations, trends and events that are expected to occur over the lifetime of the facility, such as start-up, shutdown and maintenance. It does not include increased discharges arising from other events, inconsistent with the application of best available techniques (BAT), such as accidents, inadequate maintenance, and inadequate operation, including inadequate training and supervision.

Radiation exposure of wildlife in the vicinity of the Sizewell nuclear site will depend on many factors, including local dispersion conditions, the type of habitat occupied, radionuclide uptake rates, and behavioural patterns such as time spent at different locations.

Radiological impact assessment for wildlife is a developing field which is currently limited by the amount of data that is available to determine exposures to flora and fauna. So far, data sets have been compiled for reference organisms (RO) which were designed to be representative of different wildlife groups. Consequently, radiological impact assessments generally focus on these reference organisms. These data sets are available from the International Commission for Radiological Protection (ICRP) for Reference Animals and Plants (RAPs) (ICRP, 2008) and from the Environmental Risk from Ionising Contaminants: Assessment and Management (ERICA) tool for a set of reference organisms (ROs)

(Brown and others, 2016). Current guidance (ICRP, 2008 and IAEA, 2018) recommends that the impact of ionising radiation on wildlife and their habitats can be assessed by calculating dose rates to the RAPs or ROs. 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). Allowing for the dose rate from natural background, which is at most about 60μGy/h, we have adopted a value of 40μGy/h as the level below which we consider there will be no adverse effect on site integrity. This dose rate criterion applies to all radiological discharges affecting a protected site.

2. Assessment of effects

An overview of the legal requirements of the Habitats Regulations and relevant case law is provided in our HRAR report for the SZC environmental permits. We will consider fully in this HRA the effects from the operational RSR permit application.

There is a prescribed screening process for the assessment of likely significant effects (LSE) for radiological emissions, which is set out in section 2.2 of this HRAR.

Both the assessment of likely significant effects and adverse effects, where required, will be carried out alone and in-combination where no effect alone has been established.

2.1. RSR permit application radiological assessment

The RSR permit application included an assessment of the impact of the proposed discharges at the proposed limits on wildlife (NNB GenCo, 2020a). The applicant’s assessment used outputs from the PC-CREAM 08 model (as used for the human impact assessment), the ERICA approach and assessment tool (Brown and others, 2016) and the 'Ar-Kr-Xe dose calculator’ (Vives i Batlle and others, 2015), together with information on protected sites.

The applicant’s assessment considered 5 different habitat types to represent the main ecological receptors or RO in the vicinity of the proposed Sizewell C site. It showed that the dose rate to the most affected ecological receptor or RO from SZC discharges was 0.8μGy/h for a polychaete worm occupying a marine habitat.

The applicant also assessed the impact of combined discharges from Sizewell B (SZB) and SZC. This assessment showed the most affected RO to be insect larvae occupying a freshwater habitat with a dose rate of 2.7μGy/h.

We reviewed the applicant's assessment and concluded that the approach taken was valid and followed appropriate guidance. We also verified the outcomes presented by the applicant by performing our own assessment using the information provided. We were able to reproduce the outcomes presented by the applicant and therefore consider its assessment to be satisfactory.

2.2. Threshold used within this HRAR

Thresholds used within this HRAR have come from Allott and others, 2019:

“In 2009, the Environment Agency published an assessment of the impact of the then permitted radioactive discharges on Natura 2000 sites (Environment Agency 2009a, Environment Agency 2009b). The conclusion of these assessments was that there was no adverse effect on the integrity of the Natura 2000 sites in England and Wales from permitted radioactive discharges. The reports did recommend that the assessment should be kept under review. This report presents a re-assessment of the impact of permitted discharges on Natura 2000 sites in England using current permitted discharge limits and the latest available assessment tools.”

This gives a background to the screening criteria used in this paper:

“The PROTECT project (Andersson and others, 2008 and Andersson and others, 2009) considered dose effects data in detail (for example, from FREDERICA database) and adopted the assessment factor and statistical extrapolation techniques as recommended by the EC for chemical risk assessments (EC, 2003). PROTECT used, wherever possible, statistical extrapolation techniques (Species Sensitivity Distribution, SSD) to derive benchmark values, which has ensured consistency with these chemical risk assessment methodologies. PROTECT has proposed a generic screening value of 10 microgray/h for total exposure from all sources of radiation, other than natural background. The generic screening value should protect 95% of all species within a habitat and doses below 10 microgray/h are considered to be of no regulatory concern. For the purposes of this assessment, the ERICA/PROTECT generic screening level of 10 microgray/h has been used. Where dose rates are below this screening level, no further assessment has been considered.”

“The Environment Agency and Natural England previously agreed a dose rate threshold of 40 microgray/h, below which it could be concluded that there will be no adverse effect on the integrity of a Natura 2000 site. This was derived as follows:

- research from the Euratom FP5 Project ‘FASSET’ (Larsson and others, 2004) indicated that, in general and from the available data, there appear to be no significant adverse effects in biota exposed at levels of up to 100 microgray/h.
- a review paper from the FASSET Project (Brown and others, 2004) indicated that wildlife might receive up to 60 microgray/h from natural sources in European ecosystems
- the threshold of 40 microgray/h for permitted discharges of radioactive substances is the difference between these 2 values”

To give some context to the screening criteria used, the Allott and others, 2019 paper also gave some information on natural background dose rates:

“In order to put the screening values in context, it is useful to understand the dose rates to organisms from natural background radiation. There are published assessments for naturally occurring radionuclides (including potassium-40, uranium and thorium isotopes)

using water, sediment, soil and biota concentration data in England and Wales. In summary, the mean dose rates to reference organisms are:

- marine reference organisms: 0.1 to 6 microgray/h (Brown and others, 2003)
- freshwater reference organisms: 0.4 to 4 microgray/h (Brown and others, 2003)
- aquatic reference organisms: 0.37 to 1.9 microgray/h (Hosseini and others, 2010)
- terrestrial reference organisms: 0.07 to 0.6 microgray/h (Beresford and others, 2008)"

Within this HRA we therefore propose to use 10 microgray/h as likely significant effect threshold and 40 microgray/h for a conclusion of no adverse effect on site integrity, if required.

2.3. Screening for likely significant effects

This section sets out the prescribed stages of an assessment of likely significant effects.

2.3.1. Identification of relevant European sites for assessment

For this assessment, a 10km screening criteria has been applied to scope in sites which could potentially be at risk from the activities associated with the RSR permit. A detailed assessment is made on the closest sites and more distant sites are not considered further if deemed to not be affected.

2.3.2. Screening criteria: distance

There are 11 habitats sites within 10km of SZC that are relevant for screening for potential effects from the proposed operational RSR permit:

- Alde, Ore and Butley Estuaries SAC
- Alde-Ore Estuaries Ramsar
- Alde-Ore Estuaries SPA
- Dew's Pond SAC
- Minsmere to Walberswick Heaths and Marshes SAC
- Minsmere-Walberswick Ramsar
- Minsmere-Walberswick SPA
- Orfordness–Shingle Street SAC
- Outer Thames Estuary SPA
- Sandlings SPA
- Southern North Sea SAC

An assessment will also be carried out of the off-site impacts on the bird populations of the Minsmere-Walberswick SPA and Ramsar on 'functionally linked land'. In developing the methodology for this screening assessment, we have referred to a Natural England commissioned report on functional linkage (Chapman and others, 2016), which says the term 'functional linkage' refers to the role or 'function' that land or sea beyond the boundary of a European site might fulfil in terms of ecologically supporting the populations

for which the site was designated or classified. Such land is therefore 'linked' to the European site in question because it provides an important role in maintaining or restoring the population of qualifying species at favourable conservation status.

It is considered appropriate to assess the Minsmere-Walberswick Heaths and Marshes SSSI (where it occurs outside of the SPA) and Sizewell Marshes SSSI as providing functionally linked land to the following SPA and Ramsars:

- Alde-Ore and Butley Estuaries SPA and Ramsar
- Minsmere–Walberswick SPA and Ramsar

Information on the qualifying features of these sites is provided in Annex 2 of this report (Environment Agency, 2022b), the location of the sites is provided in Figure 2 and Annex 1 of the SZC HRAR (Environment Agency, 2022a).

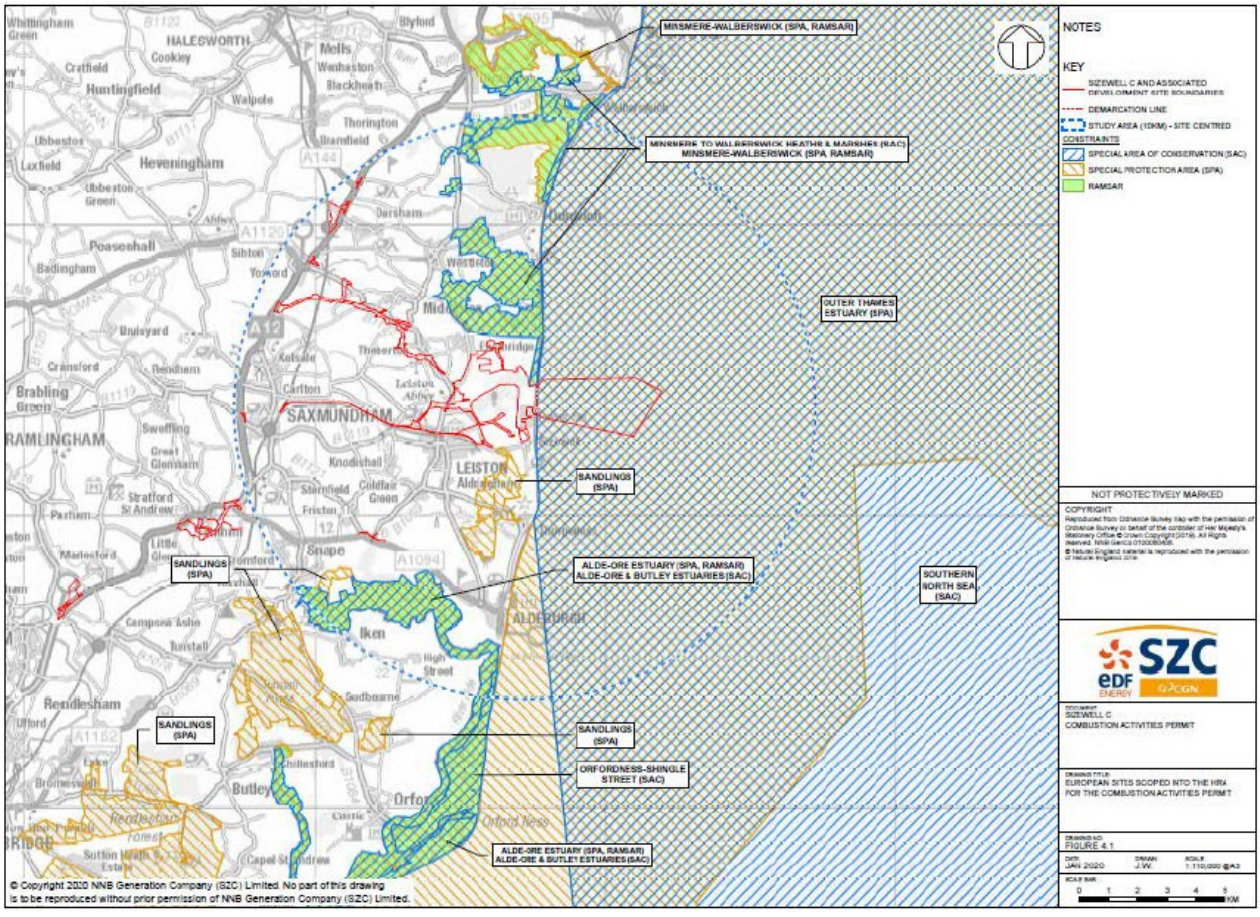

Figure 2 Location of European sites within 10km of SZC. Taken from Figure 4.1 Combustion Activity Permit Application Appendix D, Shadow HRA Report (NNB GenCo, 2020a)

A wind rose generated from 5 years of site-specific meteorological data shows that the wind direction is towards the sea for about half the time. The most frequent wind directions inland are towards the north and the south-west. Following a review of all possible relevant sites, we concluded that the range of habitats and wildlife are well represented by these local sites:

- Minsmere to Walberswick Heaths and Marshes SAC
- Minsmere-Walberswick SPA
- Minsmere-Walberswick Ramsar
- Minsmere to Walberswick Heaths and Marshes SSSI
- Sizewell Marshes SSSI
- Southern North Sea SAC
- Outer Thames Estuary SPA

We selected these sites as they represent those which would be most affected by the radioactive discharges due to their proximity to the SZC site. The first two of these sites include both terrestrial and freshwater ecosystems, while the Outer Thames Estuary SPA and Southern North Sea SAC are marine ecosystems. We consider that the default ROs in the ERICA tool would be an adequate representation of the features on these sites.

The 11 sites and functionally linked land within 10km of SZC all have features that are considered sensitive and there is a source receptor pathway from either aerial emissions or marine discharges. A detailed assessment will be carried out on the nearest sites and, if these are affected, sites further away will also be considered.

2.3.3. Screening criteria: sensitive receptors

Information on the features of the relevant European sites is provided in Annex 2 of the HRAR report for the SZC Environmental Permits (Environment Agency, 2022b).

The types of organism present to the ROs in ERICA were considered for the 3 separate assessment types – marine, terrestrial, and freshwater. How these ROs relate to the sites and features are outlined in Table 1, Table 2 and Table 3.

Table 1 Terrestrial reference organisms used in ERICA and their application to the relevant European sites

Reference organism	Examples of specific wildlife present in the region, not all relevant to HRA	Link to relevant European sites within this HRAR
Amphibian	Great crested newt, natterjack toad (only found within Sizewell nuclear site)	Dews Pond SAC
Annelid	Not applicable	Not directly relevant for this HRA
Arthropod - detritivorous	Stag beetle	Not relevant for SAC/SPA or Ramsar considered in this HRA
Bird	Lapwing, nightjar, woodlark, short-eared owl, wheatear and marsh harrier	Alde-Ore Estuary SPA Alde Ore Estuary Ramsar Minsmere-Walberswick SPA Minsmere-Walberswick Ramsar Sandlings SPA
Flying insect	White admiral, Norfolk hawker	Not relevant for SAC/SPA or Ramsar considered in this HRA
Grasses and herbs	Plants of heathland, grazing marsh and acid grassland	Alde, Ore and Butley Estuaries SAC Minsmere to Walberswick Heaths and Marshes SAC Orfordness-Shingle Street SAC Supporting habitat for bird features:

Reference organism	Examples of specific wildlife present in the region, not all relevant to HRA	Link to relevant European sites within this HRAR
		Alde-Ore Estuary SPA Alde-Ore Estuary Ramsar Minsmere-Walberswick SPA Minsmere-Walberswick Ramsar Sandlings SPA
Lichen and bryophytes	Plants generally of woodland areas loving damp and shade, including mosses and liverworts	Not relevant for SAC/SPA or Ramsar considered in this HRA
Mammal - large	Deer (red, roe, fallow, muntjac)	Not relevant for SAC/SPA or Ramsar considered in this HRA
Mollusc - gastropod	Not applicable	Not directly relevant for this HRA
Reptile	Adder, grass snake, slow worm and common lizard	Not relevant for SAC/SPA or Ramsar considered in this HRA
Shrub	Heather	Minsmere to Walberswick Heaths and Marshes SAC Supporting habitat for bird features: Minsmere-Walberswick SPA Minsmere-Walberswick Ramsar Sandlings SPA

Reference organism	Examples of specific wildlife present in the region, not all relevant to HRA	Link to relevant European sites within this HRAR
Tree	Coniferous and deciduous	Not relevant for SAC/SPA or Ramsar considered in this HRA
Badger	Large burrowing mammal (badger, fox)	Not relevant for SAC/SPA or Ramsar considered in this HRA
Bat	Barbastelle, Natterer's, soprano pipistrelles and brown long-eared bats	Not relevant for SAC/SPA or Ramsar considered in this HRA

Table 2 Freshwater reference organisms used in ERICA and their application to the relevant European sites

Reference organism	Examples of specific wildlife present in the region, not all relevant to HRA	Link to relevant European sites within this HRA
Amphibian	Great crested newt, natterjack toad (only found within Sizewell nuclear site)	Dews Pond SAC
Benthic fish	Eels	Prey species for bittern: Minsmere-Walberswick SPA Minsmere-Walberswick Ramsar
Bird	Bittern and water rail	Alde-Ore Estuary SPA Alde Ore Estuary Ramsar Minsmere-Walberswick SPA Minsmere-Walberswick Ramsar Functionally linked land: Minsmere-Walberswick Heaths and Marshes SSSI Sizewell Marshes SSSI
Crustacean	Not applicable	Not directly relevant for this HRA

Reference organism	Examples of specific wildlife present in the region, not all relevant to HRA	Link to relevant European sites within this HRA
Insect larvae	Not applicable	Prey species: Alde-Ore Estuary SPA Alde Ore Estuary Ramsar Minsmere-Walberswick SPA Minsmere-Walberswick Ramsar Functionally linked land: Minsmere-Walberswick Heaths and Marshes SSSI Sizewell Marshes SSSI
Mammal	Otter, water vole	Not relevant for SAC/SPA or Ramsar considered in this HRA
Mollusc - bivalve	Not applicable	Not directly relevant for this HRA
Mollusc - gastropod	Ramshorn snail	Not directly relevant for this HRA
Pelagic fish	Trout, perch	Minsmere-Walberswick SPA Minsmere-Walberswick Ramsar Prey species for birds
Phytoplankton	Not applicable	Not directly relevant for this HRA

Reference organism	Examples of specific wildlife present in the region, not all relevant to HRA	Link to relevant European sites within this HRA
Reptile	Grass snake	Not relevant for SAC/SPA or Ramsar considered in this HRA
Vascular plant	Not applicable	Alde, Ore and Butley Estuaries SAC Alde-Ore Estuary Ramsar Minsmere to Walberswick Heaths and Marshes SAC Minsmere-Walberswick Ramsar Orfordness to Shingle Street SAC
Zooplankton	Not applicable	Not directly relevant for this HRA

Table 3 Marine reference organisms used in ERICA and their application to the relevant European sites

Reference organism	Examples of specific wildlife present in the region, not all relevant to HRA	Link to relevant European sites within this HRA
Benthic fish	Dover and lemon sole, skates and rays	Potential prey species for bird features of Outer Thames Estuary SPA
Bird	Wigeon, shelduck, redshank and dunlin, common tern, little tern and red-throated diver	Alde-Ore Estuary SPA Alde Ore Estuary Ramsar Minsmere-Walberswick SPA Minsmere-Walberswick Ramsar Outer Thames Estuary SPA Functionally linked land: Minsmere-Walberswick Heaths and Marshes SSSI
Crustacean	Edible crab	Not directly relevant to this HRA
Macroalgae	Not applicable	Not directly relevant to this HRA
Mammal	Harbour porpoise	Southern North Sea SAC
Mollusc - bivalve	Mussels, cockles	Potential prey species for features of: Alde-Ore Estuary SPA Alde -Ore Estuary Ramsar
Pelagic fish	Mullet, bass	Potential prey species for bird species of: Alde-Ore Estuary SPA

Reference organism	Examples of specific wildlife present in the region, not all relevant to HRA	Link to relevant European sites within this HRA
		Alde-Ore Estuary Ramsar Minsmere-Walberswick SPA Minsmere-Walberswick Ramsar Outer Thames Estuary SPA
Phytoplankton	Not applicable	Not directly relevant to this HRA
Polychaete worm	Not applicable	Potential prey species for bird features: Alde-Ore Estuary SPA Alde-Ore Estuary Ramsar
Reptile	Leatherback turtles	Not relevant for SAC/SPA or Ramsar considered in this HRA
Sea anemone and true coral	Not applicable	Not relevant for SAC/SPA or Ramsar considered in this HRA
Vascular plants	Not applicable	Alde, Ore and Butley Estuaries SAC Alde-Ore Estuary Ramsar

2.4. Source term

The source term for our assessment is derived from the discharge limits requested by the applicant, together with information provided on the expected breakdown of radionuclides within the discharges from the Sizewell C site.

Table 4 Discharges to atmosphere from Sizewell C

Proposed permit – radionuclide or group	Proposed limit (Bq y^{-1})	Radionuclide assessed	Discharges used in this assessment (Bq y^{-1})
C-14	1.40 10^{12}	C-14	1.40 10^{12}
Beta emitting radionuclides associated with particulate matter	1.20 10^{8}	Co-58	3.06 10^{7}
Beta emitting radionuclides associated with particulate matter	1.20 10^{8}	Co-60	3.61 10^{7}
Beta emitting radionuclides associated with particulate matter	1.20 10^{8}	Cs-134	2.81 10^{7}
Beta emitting radionuclides associated with particulate matter	1.20 10^{8}	Cs-137	2.52 10^{7}
H-3	6.00 10^{12}	H-3	6.00 10^{12}
I-131	4.00 10^{8}	I-131	4.00 10^{8}
Not applicable	Not applicable	I-133#	4.77 10^{8}
Noble gases	4.50 10^{13}	Ar-41	1.31 10^{12}
Noble gases	4.50 10^{13}	Kr-85	6.26 10^{12}
Noble gases	4.50 10^{13}	Xe-131m	1.35 10^{11}
Noble gases	4.50 10^{13}	Xe-133	2.84 10^{13}
Noble gases	4.50 10^{13}	Xe-135	8.92 10^{12}

The assessment allowed for expected discharges of I-133 which represents other isotopes of radioiodine.

Table 5 Liquid discharges from Sizewell C

Proposed permit – radionuclide or group	Proposed limit (Bq/y)	Radionuclide assessed	Discharges used in this assessment (Bq/y)
H-3	2.00 10^{14}	H-3	2.00 10^{14}
C-14	1.90 10^{11}	C-14	1.90 10^{11}
Co-60	6.00 10^{9}	Co-60	6.00 10^{9}
Cs-137	1.90 10^{9}	Cs-137	1.90 10^{9}
Other radionuclides	1.20 10^{11}	Cr-51	1.18 10^{8}

2.5. Dose rates to ROs from SZC discharges only for screening for likely significant effect

PC-CREAM 08 was used to calculate environmental activity concentrations following 60 years of operation of SZC.

We assessed the dose rate to wildlife inhabiting locations within the protected sites most considered at risk, that is, those which had the highest predicted environmental activity concentrations.

For Minsmere to Walberswick Heaths and Marshes SAC, Minsmere-Walberswick SPA, and Minsmere-Walberswick Ramsar, locations were selected in the middle of each site and at the point closest to SZC. This was done to scope the range of possible dose rates. Dose rates to freshwater biota at these sites were only calculated for the middle point of the scrape region because these water bodies receive run-off from a large area. It would not be representative to calculate dose rates based on activity concentrations at the closest point to SZC.

All marine wildlife were assumed to be located in the local Sizewell compartment of the model which represents the Outer Thames Estuary SPA and Southern North Sea SAC.

We assessed dose rates (µGy/h) to wildlife in the terrestrial environment for locations in Minsmere-Walberswick Heaths and Marshes SAC, Minsmere-Walberswick SPA, and Minsmere-Walberswick Ramsar.

The dose rates to the most affected terrestrial ROs are summarised in Table 6.

We assessed dose rates (µGy/h) to wildlife in the freshwater environment for locations in Minsmere-Walberswick Heaths and Marshes SSSI and Sizewell Marshes SSSI as

functionally linked land. The dose rates to the most affected freshwater Ros are summarised in Table 7.

We assessed dose rates (µGy/h) to wildlife in the marine environment within the Outer Thames Estuary SPA and Southern North Sea SAC. The dose rates to the most affected ROs are summarised in Table 8.

Our assessments of dose rates have been made assuming discharges will be at the annual limits proposed by the applicant. The values used for the terrestrial assessment were the proposed limits for discharges to air, and those used for the marine assessment were the proposed limits for discharges to the marine environment (see Tables 5 and 6).

There are no direct discharges to freshwater from the Sizewell C site. However, radionuclides could enter the freshwater environment as a result of deposition following discharges to air, or from the marine environment via the Minsmere Sluice. We assessed the impact on freshwater habitats using the approach described in IAEA report SRS 19 (IAEA, 2001) to predict the concentrations of radionuclides present in the freshwater environment following discharges to air at the proposed limits.

The dose rates shown in Table 6, Table 7 and Table 8 are for the ROs that could be most affected by discharges into the air and to water.

Table 6 Dose rates to reference organisms in terrestrial environment from SZC discharges

Location	RO receiving highest does rate	Dose rate Sizewell C (µGy/h)	RO most representative of notable feature	Dose rate Sizewell C (µGy/h)
Minsmere to Walberswick Heaths and Marshes SAC **Minsmere – Walberswick SPA** **Minsmere-Walberswick Ramsar** **(Location nearest to Sizewell C)**	Mammal – small burrowing, Mammal – large	4.6 10^{-3}	Bird Grasses and herbs	4.6$10^{-3}$ 3.1 10^{-3}

Location	RO receiving highest does rate	Dose rate Sizewell C (µGy/h)	RO most representative of notable feature	Dose rate Sizewell C (µGy/h)
Minsmere to Walberswick Heaths and Marshes SAC **Minsmere-Walberswick SPA** **Minsmere-Walberswick Ramsar** **Minsmere-Walberswick Heaths and Marshes SSSI** **(East and west scrape)**	Mammal – small burrowing, Mammal – large, Reptile	$2.5\ 10^{-4}$	Bird Grasses and herbs	$2.5\ 10^{-4}$ $1.7\ 10^{-4}$
Sizewell Marshes SSSI (location nearest to Sizewell C)	Mammal – small burrowing, Mammal – large	$2.3\ 10^{-3}$	Bird	$2.2\ 10^{-3}$
Sizewell Marshes SSSI (Sizewell marshes mid-point of region)	Mammal – small burrowing, Mammal – large	$9.9\ 10^{-4}$	Bird	$9.8\ 10^{-4}$

Table 7 Dose rates to reference organisms in freshwater environment from Sizewell C discharges

Location	RO receiving highest does rate	Dose rate Sizewell C (µGy/h)	RO most representative of notable feature	Dose rate Sizewell C (µGy/h)
Minsmere to Walberswick Heaths and Marshes SAC **Minsmere-Walberswick SPA** **MInsmere-Walberswick Ramsar** **Minsmere-Walberswick Heaths and Marshes SSSI** **(East and west scrape)**	Insect larvae	$9.4\ 10^{-2}$	Bird Vascular plant	$4.4\ 10^{-3}$ $4.5\ 10^{-2}$
Sizewell Marshes SSSI **(Sizewell marshes mid-point of region)**	Insect larvae	$2.3\ 10^{-1}$	Bird	$4.4\ 10^{-3}$

Table 8 Dose rates to reference organisms in marine environment from Sizewell C discharges

Location	RO receiving highest does rate	Dose rate Sizewell C (µGy/h)	RO most representative of notable feature	Dose rate Sizewell C (µGy/h)
Outer Thames Estuary SPA	Polychaete worm	$6.0\ 10^{-2}$	Bird	$1.4\ 10^{-3}$
Southern North Sea SAC	Polychaete worm	$6.0\ 10^{-2}$	Mammal	$2.6\ 10^{-3}$

The RO receiving the highest dose rate was found to be insect larvae occupying a freshwater environment within the functionally linked land of Sizewell Marshes SSSI. The dose rate to the most affected RO was calculated to be 0.23µGy/h. We therefore consider that the discharges of radioactive wastes into the environment at the proposed limits from the Sizewell C site, taken alone, will have no likely significant effect as the dose rate is well below the threshold of 10µGy/h.

The dose rates calculated represent the exposure of the RO to a single environment. Exposures from more than one environment have not been added together as it has been assumed that each RO remains in a single environment. This approach will capture the most realistic worst-case scenario, where an RO remains exposed to the area of highest local contamination all the time.

It is therefore considered there is no likely significant effect alone from the radioactive aerial emissions and marine discharge on the nearest sites:

- Minsmere to Walberswick Heaths and Marshes SAC
- Minsmere-Walberswick SPA
- Minsmere-Walberswick Ramsar
- Outer Thames Estuary SPA
- Southern North Sea SAC
- Sizewell Marshes SSSI as functionally linked land
- Minsmere-Walberswick Heaths and Marshes SSSI as functionally linked land

Given the conclusions regarding the above sites, it is therefore considered that there is no likely significant effect alone on more distant sites:

- Sandlings SPA
- Alde, Ore and Butley Estuaries SAC
- Alde-Ore Estuaries SPA
- Alde-Ore Estuaries Ramsar
- Orfordness – Shingle Street SAC
- Dew's Pond SAC

2.6. In-combination assessment

Regulation 63 of the Conservation of Habitats and Species Regulations 2017 requires the competent authority to consider within the HRA, any permission, plans or projects (PPP) (including Environment Agency PPP) that are likely to have a significant effect on a European site, either alone or in combination with other PPP. Consideration will be given to the potential for in-combination effects with other PPP at both the LSE screening and appropriate assessment stages, where relevant.

In-combination effects can be one of the following:

- additive - the total effect of a number of effects is equal to the sum of the individual effects
- synergistic - the effect of the interaction of a number of effects is greater than the sum of the individual effects
- neutralistic - the effects counteract each other, reducing the overall effect
- overlapping - affecting the same spatial area of a feature and/or the same attributes of the feature. For example, the mixing zones of 2 separate discharges overlap
- discrete - affecting different areas and different attributes of the feature. For example, 2 combustion processes affect geographically discrete areas of a habitat within a site. In combination, the total area of habitat affected may be unacceptable in terms of site integrity

The assessment will consider the following (PINS, 2017):

- projects that are under construction
- permitted application(s) not yet implemented
- submitted application(s) not yet determined
- projects on the National Infrastructure's programme of projects
- projects identified in the relevant development plan (and emerging development plans, with appropriate weight being given as they move closer to adoption), recognising that much information on any relevant proposals will be limited and the degree of uncertainty which may be present

This will also include within project or interlinked decisions in combination from the SZC project itself, where applicable.

The main aspects to consider for in-combination effects are the:

- temporal and geographic boundaries of the effects of activities
- interactions between the activities and the overall ecosystems
- environmental effects of the project, and past and future projects and activities
- thresholds of sensitivity of the existing environment

To be considered within the in-combination assessment, other PPP should meet the following criteria:

- generate their own residual impacts of at least minor significance
- be likely to be constructed or operate over similar time periods
- be spatially linked to the proposed development

2.6.1. In-combination assessment with other RSR permits

We have also assessed the potential impact of radioactive wastes into the environment from SZC in combination with sources from other environmental permits authorising radioactive discharges. We made this assessment using the review of habitats assessments for radioactive substances we carried out in 2017 (Allott and others, 2019). The 2017 habitats report assessed the impact of all permitted discharges on European sites in England and, in each case, reported the total dose rate to the most affected RO. The total dose rate was derived by summing the highest aquatic (marine or freshwater) and highest terrestrial dose rates for the most affected ROs in each environment. This was a cautious calculation, as the most affected organism for the terrestrial and water aspects of a site will not necessarily be the same in each case.

We assessed the total dose rate to the most affected RO at each relevant location by combining the total dose rates to the most affected RO calculated in the habitats report with the dose rates to the most affected organism predicted for SZC discharges. The locations assessed and results are summarised in Table 9.

Table 9 Absorbed dose rates (µGy/h) to most affected RO at each protected site

Location and most affected RO	Dose rate from Sizewell C proposed discharges	Dose rate from existing discharges (Allott and others, 2019)	Total dose rate (in-combination)
Functionally linked land: **Sizewell Marshes SSSI** **Freshwater insect larvae**	$2.3\ 10^{-1}$	$8.1\ 10^{-1}$ #	$1.0\ 10^{0}$
Minsmere to Walberswick Heaths and Marshes SAC **Minsmere-Walberswick SPA Minsmere - Walberswick Ramsar** **Functionally linked land:** **Minsmere-Walberswick Heaths and Marshes SSSI** **Freshwater insect larvae**	$9.4\ 10^{-2}$	$8.1\ 10^{-1}$	$9.0\ 10^{-1}$
Outer Thames Estuary SPA **Polychaete worm**	$6.0\ 10^{-2}$	$1.8\ 10^{0}$	$1.9\ 10^{0}$

Location and most affected RO	Dose rate from Sizewell C proposed discharges	Dose rate from existing discharges (Allott and others, 2019)	Total dose rate (in-combination)
Southern North Sea SAC **Polychaete worm**	$6.0\ 10^{-2}$	$1.8\ 10^{0}$	$1.9\ 10^{0}$

The habitats report only considers European sites, so an assessment of the dose rate from existing discharges is not available for functionally linked land at Minsmere-Walberswick Heaths and Marshes SSSI and Sizewell Marshes SSSI. The dose rate for Minsmere to Walberswick Heaths and Marshes SAC was used to represent the likely dose rate to the most affected organism within the functionally linked land from existing discharges. This is an approximation but should give a reasonable assessment of the impact on this habitat.

The predicted dose rates at the European sites assessed, from the combined radioactive discharges, are orders of magnitude below our threshold value of 10μGy/h, below which we consider that there will be no likely significant effect.

We therefore consider that the discharges of radioactive wastes into the environment at the applicant's proposed limits, together with other authorised discharges of radioactive waste, will not have a likely significant effect on the European sites in combination with other radioactive emissions.

It is therefore considered that there is no likely significant effect in combination with other radioactive permits from the aerial emissions of marine discharge on the nearest sites:

- Minsmere-Walberswick Ramsar
- Minsmere-Walberswick SPA
- Minsmere to Walberswick Heaths and Marshes SAC
- Minsmere-Walberswick Heaths and Marshes SSSI as functionally linked land
- Outer Thames Estuary SPA
- Sizewell Marshes SSSI as functionally linked land
- Southern North Sea SAC

Given the conclusion for the nearest sites, it is consequently considered that there is no likely significant effect in combination with other radioactive discharges on more distant sites:

- Alde, Ore and Butley Estuaries SAC
- Alde-Ore Estuaries Ramsar
- Alde-Ore Estuaries SPA
- Dew's Pond SAC
- Orfordness – Shingle Street SAC
- Sandlings SPA

A wider in combination assessment is carried out in sections, 2.6.2 and 2.6.3.

2.6.2. In-combination between RSR, operational water discharge activity (WDA) and combustion activity (CA)

As part of the WDA permit determination process, more information from the applicant was requested to cover the potential for in combination between the 3 operational permits currently applied for. The following section has used information received from the applicant (NNB GenCo, 2021):

"An analysis of combined effects strictly requires consideration of all potential risks/effect pathways together, in this case there is merit in considering the effect of the operational RSA permit individually for the following reasons:

- there is a single relevant risk/effect pathway (radioactive substances) associated with this permit
- this risk/effect pathway is not relevant to the other permits
- the assessment of this pathway within the HRA process comprises the application of accepted, quantified screening criteria (meaning that there is a clear threshold below which likely significant effect can be excluded)
- the accepted assessment methodology provides the best available information to provide an assessment

"The assessment of radiological emissions for the Sizewell C project adopted the default screening value included in the internationally accepted ERICA (Environment Risks from Ionising Contaminants: Assessments and management) Integrated Approach of 10µGy/h. This is the proposed generic screening value, below which 95% of all species should be protected from ionising radiation.

"The effects due to emissions of radioactive substances for non-human biota is demonstrated using established methodologies against a number of reference organisms. Terrestrial, marine, coastal and freshwater habitats were considered, and the assessment considered predicted discharge from Sizewell C and also these discharges in combination with discharges from other RSR permits. This information provides the best available information on which to undertake this assessment.

“For all of the receptors evaluated, predicted dose rates were lower (by at least one order of magnitude and, for some receptors, up to three orders of magnitude) than the screening value of 10 µGy/hour that is considered protective of populations of non-human biota across all ecosystems.

“In conclusion, the effect of emissions of radioactive substances on nonhuman biota from the proposed Sizewell C nuclear power plant alone (and in-combination with other RSA permits) are predicted to be trivial and inconsequential. Consequently, it can be concluded that there would be no likely significant effect on designated sites.”

We agree with this assessment by the applicant.

2.6.3. In-combination with other plans and projects

PPP were identified by the applicant in its Shadow Habitats Regulations Assessment Report (Table C.1: Screening other projects for in-combination) Volume 1 Appendix C of its Development Consent Order (DCO) submission (NNB GenCo, 2020d); a review of permits we issued as a competent authority; and through our consultation with other relevant competent authorities carried out in June 2021. The list of competent authorities we consulted is as follows:

Local authorities:

- Boston Borough Council
- East Riding of Yorkshire
- East Suffolk Council
- Hull City Council
- Lincolnshire County Council
- Norfolk County Council
- South Holland District Council
- Suffolk County Council

Inshore Fisheries and Conservation Authorities (IFCA):

- Eastern IFCA

Defra organisations:

- Marine Management Organisation
- Natural England

Of the competent authorities we consulted, we received responses from:

- East Suffolk Council
- Eastern IFCA
- Hull City Council
- North Lincolnshire Council
- North Norfolk District Council

For the remaining authorities, it must be assumed that there are no relevant PPP to be considered in combination.

The applicant did not identify any PPP with associated radioactive emissions (NNB GenCo, 2020c), and none were identified by the competent authorities who responded to our in-combination consultation. An assessment of PPP issued by other relevant competent authorities is therefore not required for any in-combination assessment of the RSR permit.

A list of the PPP identified by the competent authorities is provided in the in-combination assessment for the operational WDA permit HRA (Environment Agency, 2022c).

There are no other plans or projects that have the potential to act in-combination from a radiological perspective. There is therefore no likely significant effect alone or in combination with other plans, permissions or projects.

3. Conclusion

It has been possible to conclude that there is no potential for a likely significant effect on the features of the following European sites both alone and in-combination with other plans, permissions, and projects:

- Alde, Ore and Butley Estuaries SAC
- Alde-Ore Estuaries Ramsar
- Alde-Ore Estuaries SPA
- Dew's Pond SAC
- Minsmere to Walberswick Heaths and Marshes SAC
- Minsmere-Walberswick Ramsar
- Minsmere-Walberswick SPA
- Orfordness – Shingle Street SAC
- Outer Thames Estuary SPA
- Sandlings SPA
- Southern North Sea SAC

This conclusion is also made for the Sizewell Marshes SSSI and Minsmere-Walberswick Heaths and Marshes SSSI as functionally linked land for the Alde-Ore Estuaries SPA and Ramsar, and Minsmere-Walberswick SPA and Ramsar.

There is no requirement for an appropriate assessment of the RSR permit application.

References

Allott, R., Cailes, C., Titley, J. and Rowe, J. 2019. Habitats assessments for radioactive substances: 2017 review. Version 1.0. Bristol: Environment Agency.

Brown, J.E., Alfonso, B., Availa, R., Beresford, N.A., Copplestone, D. and Hosseini, A. 2016. A new version of the ERICA tool to facilitate impact assessments of radioactivity on wild plants and animals'. Journal of Environmental Radioactivity, Volume 153, pages 141-148.

Chapman, C. and Tyldesley, D. 2016. Functional linkage: how area that are functionally linked to European sites have been considered when they may be affected by plans and projects - a review of authoritative decisions. Natural England Commissioned Reports, Number 207.

Environment Agency, 2022a. Annex 1 Relevant Site Plans for Proposed Sizewell C Nuclear Power Station. Bristol: Environment Agency.
Information regarding three new environmental permit applications for the proposed Sizewell C power station – Environment Agency – Citizen Space

Environment Agency, 2022b. Annex 2 Relevant Site Details for Proposed Sizewell C Nuclear Power Station. Bristol: Environment Agency.
Information regarding three new environmental permit applications for the proposed Sizewell C power station – Environment Agency – Citizen Space

Environment Agency, 2022c. Book 2 Operational Water Discharge Activity HRAR for Proposed Sizewell C Nuclear Power Station. Bristol: Environment Agency.
Information regarding three new environmental permit applications for the proposed Sizewell C power station – Environment Agency – Citizen Space

Environment Agency, 2022d. Habitats Regulations Assessment Report Environment Agency Permits for Proposed Sizewell C Nuclear Power Station. Bristol: Environment Agency.
Information regarding three new environmental permit applications for the proposed Sizewell C power station – Environment Agency – Citizen Space

Environment Agency, 2022e. Radiological Impact Assessment for Proposed Sizewell C Nuclear Power Station. Bristol: Environment Agency.
Information regarding three new environmental permit applications for the proposed Sizewell C power station – Environment Agency – Citizen Space

Environment Agency, Scottish Environment Protection Agency, Northern Ireland Environment Agency, Food Standards Agency and Health Protection Agency, 2012. Principles for the Assessment of Prospective Public Doses arising from Authorised

Discharges of Radioactive Waste to the Environment (Issue 2). Penrith: Environment Agency.

International Atomic Energy Agency, 2001. Generic Models for use in Assessing the Impact of Discharges of Radioactive Substances to the Environment. Safety Reports Series No. 19. Vienna: International Atomic Energy Agency.

International Atomic Energy Agency, 2018. Prospective Radiological Environmental Impact Assessment for Facilities and Activities, IAEA Safety Standards Series No. GSG-10. Vienna: International Atomic Energy Agency.

International Commission on Radiological Protection, 2008. Environmental Protection - the Concept and Use of Reference Animals and Plants. ICRP Publication 108. Ann. ICRP 38, (4-6).

NNB Generation Company (SZC) Limited (NNB GenCo), 2020a. Sizewell C project Combustion Activity Permit application: Appendix D - Shadow HRA Report. NNB GenCo (SZC) Ltd, London. Document 100207664, Revision: 01.

NNB Generation Company (SZC) Limited (NNB GenCo), 2020b. Sizewell C project RSR Permit application: Appendix D Support Document D2 - Non-Human Biota Radiological Impact Assessment V. NNB GenCo (SZC) Ltd, London. Document 100199175, Version: 1.0.

NNB Generation Company (SZC) Limited (NNB GenCo), 2020c. Sizewell C project RSR permit application: Non-Technical Summary. NNB GenCo (SZC) Ltd, London. Document 100205681, Revision 01.

NNB Generation Company (SZC) Limited (NNB GenCo), 2020d. Sizewell C project Shadow Habitats Regulations Assessment Volume 1: Screening and Appropriate Assessment. NNB GenCo (SZC) Ltd, London. EN010012, Revision 1.0. Available via Planning Inspectorate website.

NNB Generation Company (SZC) Limited (NNB GenCo), 2020e. Sizewell C project RSR Permit application: Site plan. NNB GenCo (SZC) Ltd, London. Document 100233395, Revision 01.

NNB Generation Company (SZC) Limited (NNB GenCo), 2021. Sizewell C Project: Response to Schedule 5 No. 5. NNB GenCo (SZC) Ltd, London.

Smith, J.G. and Simmonds, J.R., 2009. The Methodology for Assessing the Radiological Consequences of Routine Releases of Radionuclides to the Environment Used in PC-CREAM 08. HPA-RPD-58. Chilton: Health Protection Agency.

Vives i Battle, J., Jones, S.R. and Copplestone D., 2015. A method for estimating 41Ar, 85,88Kr and 131m,133Xe doses to non-human biota. Journal of Environmental Radioactivity, Volume 144, June 2015, Pages 152-161.

Abbreviations

Term	Meaning
BAT	Best available technology.
Bq/y	Abbreviation meaning becquerel per year.
CA	Combustion activity.
EPR™	European Pressurised Reactor.
ERICA	Environmental Risk from Ionising Contaminants: Assessment and Management. http://www.erica-tool.com/
FASSET	Framework for assessment of environmental impact.
Gy, μGy	Abbreviation meaning gray, microgray. A unit of absorbed dose.
HRA	Habitats Regulations Assessment.
HRAR	Habitats Regulations Assessment Report.
ICRP	International Commission on Radiological Protection.
LSE	Likely significant effects
PC- CREAM 08	Radiological Impact Assessment Software.
PPP	Permissions, plans or projects.
Ramsar	Wetland of international importance.
RAP	Reference animals and plants.
RO	Reference organism.
RSA	Radioactive Substances Activity.

Term	Meaning
RSR	Radioactive Substances Regulation.
SAC	Special Area for Conservation.
SPA	Special Protection Area for birds.
SSSI	Site of Special Scientific Interest.
SZB	Sizewell B.
SZC	Sizewell C.
WDA	Water discharge activity permit.
µGy/hr	Abbreviation meaning microgray per hour.

Glossary

Term	Meaning
Activity	A generic title for the practices or operations which require to be permitted (unless exempted from the need for a permit).
Applicant	NNB Generation Company (SZC) Limited, the body applying for the RSR permit. Responsible for carrying out the necessary preparatory work in support of the application to enable the Environment Agency as competent authority to carry out its duties.
BAT	Best available techniques/technology, usually referring to the technique or process that will yield the greatest environmental benefit or cause the least environmental damage.
Competent authority	Decision maker under the Habitats Regulations. For the RSR permit it is the Environment Agency.
Dose rate	The quantity of radiation absorbed per unit of time, for example, microgray per hour, µGy/hr.
European sites	Sites such as SPAs and SACs which are protected under European and UK law. Ramsar sites are also included in line with government policy.
Habitats Regulations	The Conservation of Habitats and Species Regulations 2017 (as amended).
Qualifying features	The features for which the European site is designated and to be protected and managed for conservation.
Special Area of Conservation	A protected area designated under the Conservation of Habitats and Species Regulations 2017 (as amended) in England and Wales, or the Conservation of Offshore Marine Habitats and Species Regulations 2017 (as amended) for UK offshore areas.
Scrape	This is the name for a series of shallow pools studded with islands within the Minsmere to Walberswick Heaths and

Term	Meaning
	Marshes SAC, Minsmere-Walberswick SPA and Minsmere-Walberswick Ramsar.
Shadow HRA	The applicant is required to provide the competent authority with the information they need in order to carry out a Habitats Regulations Assessment. This information may be provided in the format of an HRAR which would be referred to as the applicant's shadow HRA.
Source term	The types, quantities, and physical and chemical forms of the radionuclides present in a nuclear facility that have the potential to give rise to exposure to ionising radiation, radioactive waste or discharges.
Special Protection Area	Special Protection Areas are protected areas for birds classified under the Wildlife & Countryside Act 1981 (as amended), the Conservation (Natural Habitats, &c.) Regulations 2010 (as amended) and the Conservation of Offshore Marine Habitats and Species Regulations 2017 (as amended).
Wind rose	A graphic tool used by meteorologists to give a succinct view of how wind speed and reaction are typically distributed at a particular location.

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