CONTENTS

1 WITHIN-PROJECT ASSESSMENT

1.1 Item 1a of Schedule 5 (No. 5)

a) Summary of the information request

1.1.1 The Environment Agency requested a within project in-combination assessment, taking account of the three SZC operational permit applications currently being determined.

1.1.2 In a meeting with the Environment Agency on 16 September 2021 there was discussion regarding the use of the term 'in-combination assessment'. It was acknowledged and understood that in the context of the Schedule 5 request, this term was being used to refer to the potential combined effects between different effect pathways resulting from the Sizewell C Project as opposed to in-combination effects between the Sizewell C Project and other plans and projects.

b) Initial screening for potential within project combined effect

1.1.3 As the Schedule 5 request notes, there would be potential for a temporal overlap as all three permits are operational permits. Additionally, there could be a spatial effect (described as layering, spreading or scattering). For example, the proposed activities under the operational WDA and RSA permit applications will both discharge effluents directly to the marine environment and the effects of both permits could, therefore, combine to affect the same receptors.

1.1.4 The Schedule 5 request included an example table (Table 1) to illustrate the potential overlap (temporal and / or spatial) of within-project risks which is intended to identify those requiring further assessment in the HRA process. The structure of Table 1 (contained in the Schedule 5 request) has been modified and presented as Table 1.1 in this response to present the sources of potential effect on designated sites from each of the operational permits and the individual risk (or effect) pathways to qualifying interest features.

Table 1.1: Screening for potential combined effect between the three operational permits

	Operational CA[1]	Operational RSA[2]	Operational WDA[3]
Source (of potential effect)			
Discharges to atmosphere	Yes	Yes	No
Discharges to marine environment	No	Yes	Yes
Discharges to freshwater environment	No	No	No
Risks			
Radioactive substances	No	Yes	No
Nutrient enrichment	Yes	No	Yes
Acidification	Yes	No	No
Toxic effect of pollutants (chemicals)	Yes	No	Yes
Disturbance (noise)	Yes	No	No
Thermal effects	No	No	Yes

1.1.5 The Schedule 5 request acknowledges that there is unlikely to be a potential for the activities included in the operational WDA permit to influence the freshwater environment, but added that there is a potential pathway via the tidal Minsmere sluice and the risk to designated receptors should be considered.

1.1.6 As stated in Chapter 19 of the Environmental Statement (Groundwater and Surface Water), the sluice is divided into two chambers, each with its own gravity outlet culvert. The northern chamber receives flows from the northern culvert of the Minsmere New Cut, while the southern chamber receives flows from Leiston Drain and Scott's Hall Drain. The southern

[1] Combustion Activities (CA) permit application (reference: EPR/MP3731AC/A001)
[2] Radioactive Substances Activities (RSA) permit application (reference: EPR/HB3091DJ/A001)
[3] Water Discharge Activities (WDA) permit application (reference: EPR/CB3997AD/A001)

chamber is also connected to the Minsmere New Cut through its southern culvert, which includes a penstock at its upstream face. The penstock is opened to alleviate high water levels in the catchment. When river levels exceed sea levels, water flows from river to sea. When sea levels exceed river levels, flow will cease, and water stored upstream of the sluice. Some ingress of seawater into the freshwater system has been factored into the design.

1.1.7 The ES also notes that water quality in the surface watercourses is influenced by the input of saline water from Minsmere sluice, which results in elevated salinity and sulphate levels in the immediate vicinity of the sluice. This suggests that saline influence is localised to the sluice and/or that saline intrusion is infrequent and does not have a lasting effect on upstream surface water quality.

1.1.8 Modelling of the thermal and chemical plumes indicate that there is the potential for the thermal plume (only) to interact with the coastline at the location of the Minsmere sluice, but the annual surface temperature difference at the coast is predicted to be minimal (less than 1.5^{o}C) (98th percentile).

1.1.9 It is concluded that the risk of the operational cooling water discharge resulting in a negative effect on water quality in the watercourses linked to the Minsmere sluice is very low due to the minimal predicted effect on marine water quality at the coastline (i.e. only the thermal plume is predicted to interact with the coastline) and the fact that seawater can only enter the sluice under specific flow conditions.

1.1.10 When considering the potential for combined effects between the three operational permits due to the same risk pathway, it can be seen from Table 1.1 that only nutrient enrichment is a relevant consideration (i.e. due to the potential for combined effect between the operational CA permit and operational WDA permit). However, it is also necessary to consider the potential for interaction *between* different risk / effect pathways related to the three permits (e.g. Table 1.1 highlights the potential for a combined risk of acidification from the operational CA permit with radioactive substances from the operational RSA permit).

1.1.11 Further analysis of both of these types of interaction to conclude whether or not there is a realistic potential for a combined effect requires more detailed consideration of the nature of the predicted effect and the potentially affected receiving environment (refer to sub-section c).

c) Analysis of potential for combined effects

1.1.12 Although an analysis of combined effects strictly requires consideration of all potential risks / effect pathways together, in this case there is merit in initially 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).

1.1.13 The Environment Agency (with Natural England) have agreed *"a dose rate [of radioactive substances] threshold of 40 microgray/h (µGy/h), below which it has been concluded that there will be no adverse effect on the integrity of a Natura 2000 site"* (Environment Agency, 2009)[4]. Furthermore, the assessment undertaken by the Environment Agency (2010) for the UK EPR™ technology[5] states that *"we have adopted a value of 40 µGy h^{-1} as the level below which no further regulatory attention is warranted"*.

1.1.14 The assessment of radiological emissions for the Sizewell C Project (reflected in the Shadow HRA likely significant effect screening assessment) adopted the default screening value included in the internationally accepted ERICA (Environment Risks from Ionising Contaminants: Assessments and management[6]) Integrated Approach of 10µGy/h. This is the proposed generic screening value below which 95% of all species should be protected from ionising radiation.

1.1.15 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 discharges

[4] Environment Agency (2009). Habitats assessment for radioactive substances. Science report: SC060083/SR1.
[5] Environment Agency (2010). Generic design assessment: UK EPR™ nuclear power plant design AREVA NP SAS and Electricité de France SA.
[6] Beresford, N., Brown, J., Copplestone, D., Garnier-Laplace, J., Howard, B., Larsson, C-M, Oughton, D., Pröhl, G. Zinger, I. (2007) D-ERICA: An Integrated Approach to the Assessment and Management of Environmental Risks from Ionising Radiation. EC Contract FI6R-CT-2004-508847.

from Sizewell C (and also these discharges in combination with discharges at permitted limits from Sizewell B power station).

1.1.16 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.

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

1.1.18 Given the above, it can be concluded that there is no plausible risk for combined effects between emissions of radioactive substances with other risk / effect pathways related to the other operational permits. The potential effects of the operational RSA are, therefore, excluded from further consideration.

1.1.19 As illustrated in Table 1.1, there is potential for interaction between different risk / effect pathways related to the operational CA permit and the operational WDA permit.

1.1.20 The Shadow HRA concludes that the potential effects of the operational WDA permit activities are confined to the marine environment because there is no effect pathway existing for habitats or species located above the level of mean high water spring tides (as evidenced by the discussion in sub-section b) regarding the lack of potential for significant water quality effect at the coastline).

1.1.21 Conversely, the potential effects of the operational CA permit activities (air quality and noise) are confined to the terrestrial environment. While aerial emissions could disperse to the marine environment, and therefore represent a theoretical potential for effect, in reality there is no effect pathway to marine mammal and migratory fish qualifying interest features of Special Areas of Conservation (SACs) or to marine supporting habitats of bird qualifying features of Special Protection Areas (SPAs). The conclusion regarding lack of a realistic effect pathway is reached on the basis of the assessment of sensitivity to aerial concentrations of ammonia, NO_x and SO_2 and nutrient nitrogen and acid deposition reported in the air Pollution Information System (APIS) which confirms these features and habitats are not exposed or sensitive to this effect pathway (as reported in more detail in the Shadow HRA Report for the operational CA permit).

1.1.22 Potential noise effects due to the effects of the operational CA permit activities have been assessed in the Shadow HRA for the permit application. For SPAs (i.e. sites with bird qualifying features), the noise level is predicted to be below ambient levels (in the case of the Alde-Ore Estuary SPA and Ramsar site and Sandlings SPA). For the Minsmere-Walberswick SPA and Ramsar site and the Outer Thames Estuary SPA, predicted noise levels are also below the day time ambient levels and only very marginally above night time ambient levels. In any event, when compared with the noise disturbance thresholds presented by Mander and Cutts (2004)[7] and IECS (2008)[8], the predicted noise levels from the combustion activities are well below the level where any direct disturbance effects on birds may be expected and likely significant effect can be excluded.

1.1.23 The operational combustion activities have no potential to generate underwater noise and, therefore, there is no potential for either a direct effect on marine mammal qualifying features of SACs or an indirect effect on the fish prey species for marine birds or marine mammals of SPAs and SACs. Likely significant effect via this pathway can, therefore, be excluded.

1.1.24 In the case of habitat qualifying features of SACs and Ramsar sites, there is no pathway for effect and likely significant effect can be excluded.

1.1.25 A combined effect on designated sites can, therefore, be ruled out on a precautionary basis, beyond reasonable scientific doubt, due to an absence of spatial overlap of emissions and discharges arising from activities under these two permits, as shown in Table 1.1 (i.e. there is no potential for the effects arising from the permits to interact to cause an combined effect that is different to that identified in the Shadow HRAs that form part of the permit applications).

1.2 Item 1b of Schedule 5 (No. 5)

a) Summary of the information request

1.2.1 The Environment Agency requested an in-combination assessment between the different WDA discharge points and characteristics of the proposed operational WDA permit, these being the combined waste streams A to G (i.e. the trade effluent thermal and chemical plumes and sewage treatment work (STW) discharge components) via the two cooling

[7] Mander, L. & Cutts, N (2004). Ornithological Monitoring, Thorngumbald: Annual Report #2 January to December 2003. Institute of Estuarine & Coastal Studies, University of Hull.

[8] Institute of Estuarine and Coastal Studies (IECS) (2008). Conservation goals for waterfowl in estuaries. Report to HARBASINS.

water discharge outlets and the two waste stream H (i.e. the trade effluent from the fish recovery and return (FRR) system) discharge outlets.

1.2.2 In a meeting with the Environment Agency held on 16 September 2021, it was clarified that this request specifically referred to requiring information on the combined effect of thermal and chemical plumes.

b) Initial screening for potential within project combined effect

1.2.3 The Schedule 5 request included Table 2 as an illustrative example of a matrix for identifying the risk of combined effects between pollution sources of the operational WDA permit. This table structure has been reproduced as Table 1.2.

Table 1.2: Risk of potential combined effect between the three operational permits

	WDA waste streams A to F		WDA waste stream G	WDA waste stream H
	Thermal plume	**Chemical plume**	**STW**	**FRR**
Risks				
Thermal	Yes	No	No	No
Chemical	No	Yes	No	No
Nutrient enrichment	No	No	Yes	Yes
Un-ionised ammonia	No	No	Yes	Yes

1.2.4 Table 1.2 illustrates that there is potential for a combined effect between thermal and chemical risks for waste streams A to F, but no potential for a combined effect due to the same risk pathway.

1.2.5 The potential for a combined effect due to the same risk associated with more than one waste stream exists for nutrient enrichment and un-ionised ammonia (arising from waste streams G and H).

c) Synergistic effect of thermal and chemical plumes (WDA waste streams A to F)

i. Consideration of direct effects on marine mammals

1.2.6 There is very little evidence for thermal and chemical discharges having a negative effect on marine mammals. As the Shadow HRA Report (for the operational WDA permit application) notes, marine mammals have the ability to regulate their body temperature during periods of high activity or when the ambient temperature is warm. While the change in temperature associated with the thermal plume would be noticeable to marine mammal species, these species are well adapted and accustomed to the change in water temperature as they dive. Due to the evolved ability of marine mammals to naturally regulate their body temperature, it is concluded that the change in ambient temperature due to the thermal plume would have no direct impact on marine mammal species.

1.2.7 The approach taken to the assessment of potential effects on marine mammals was to estimate the number of individuals that could be present within the area of the thermal and chemical plume and to assume their exclusion from that area. The estimated number of individuals was then expressed as a percentage of the relevant marine mammal reference population and relevant SAC population.

1.2.8 The approach described above is highly precautionary and accounts for any uncertainty that may exist regarding how marine mammals could be directly affected by thermal and chemical plumes. Furthermore, the same approach was adopted to the assessment of effect on prey species for marine mammals (i.e. it was assumed that all prey species would be displaced from within the thermal and chemical plume). This approach to the assessment also means that there is no potential for any synergistic (or combined) effect to alter the conclusions reached when assessing the effect of the thermal and chemical plumes in isolation (because the assessment is based on maximum spatial extent of effect).

ii. Consideration of direct effects on birds

1.2.9 In relation to the potential for direct toxic effects on birds as a result of the chemical discharges, the Shadow HRA Report did not consider this effect pathway on the basis that the lack of evidence for any such effects, together with the lack of a plausible pathway (when considering the likely properties associated with these discharges), meaning that LSE was not identified in relation to this effect pathway at the screening stage (and this conclusion was not challenged by any party).

1.2.10 This matter was, however, raised by the RSPB and Natural England during the DCO examination and a response was prepared, which is summarised below.

1.2.11 In terms of considering the potential for direct toxic effects on birds from the chemical plume (with bromoform and hydrazine discharges being the specific chemicals referred to by the RSPB and Natural England), the position is that such effects are highly unlikely. This conclusion is reached on the basis that:

- The concentrations of both bromoform and hydrazine are low and of a level which is considered unlikely to result in direct toxicity. For example, based upon the available evidence for effects on fish species, the within-plume concentrations are substantially below levels which have been documented to result in lethal or chronic sub-lethal effects.

- Following from the evidence available on fish, although marine birds might be exposed to such chemicals in the water via contact whilst swimming on the surface, diving in the water or through ingestion of seawater, it is considered precautionary to assume that birds would be expected to display similar levels of sensitivity to these chemicals in the water column to that of vertebrates such as fish which have more direct contact with seawater via the skin and across the gill surface.

- The areas over which both bromoform and hydrazine are predicted to exceed their respective Predicted No-Effect Concentration (PNEC) values due to the Sizewell C discharges are small relative to the foraging ranges of the relevant SPA species. Given this, the likelihood of birds being within these plume areas and, therefore, exposed to the chemicals at concentrations above PNEC for any prolonged period is small (making direct contamination unlikely on this basis alone).

- Both bromoform and hydrazine have low bioconcentration factors so that there is a low likelihood for these chemicals to accumulate through the food chain. Furthermore, bromoform rapidly degrades in the marine environment.

- There is no evidence from any other sites (or similar situations) to suggest that direct toxic effects on birds would result from bromoform or hydrazine discharges at the concentrations predicted for the Sizewell C Project. It is also notable that the bromoform plume resulting from discharges at Sizewell B encompasses an area

approximately six times greater than that which is predicted to result from the operation of Sizewell C.

1.2.12 Synergistic indirect effects of the thermal plumes with chemical discharges are relevant to effects on qualifying seabird interest features of SPAs via effects on the fish prey species. While the indirect effect on prey species for marine mammals was assessed in the Shadow HRA Report, any synergistic effect does not have the potential to alter the conclusion of the Shadow HRA Report with respect to marine mammals for the reason explained in sub-section c i) above.

iii. Synergistic effect between temperature and total residual oxidant (TRO)

1.2.13 Temperature elevation has been shown to increase toxicity of chlorine TRO in fish (Cooke, S.J. and J.F. Schreer. 2001)[9]. In one case covered in this review, an approximate halving of the median lethal concentration (LC50) of TRO was observed with an increase of temperature between 10°C and 20°C. For invertebrates a 5°C increase in temperature more than halved the LC50 concentration of free chlorine and chloramine in 30 minute exposures in the rotifer *Brachionus plicatilis*, larvae of the American lobster *Homarus americanus*, and American oyster larvae *Crassostrea virginica* (Capuzzo, 1979)[10]. However, the studies reviewed report temperature effects on toxicity in acute studies with durations of hours to a few days and with exposure concentrations in the 100s of micrograms (which are significantly greater that the predicted exposure concentrations at Sizewell C). In the same review, in some cases fish were reported to actively avoid much lower TRO concentrations than would be lethal over several days' continuous exposure. This can be explained by the fact that TRO is more of an irritant than a pollutant and easily detected via the gills.

1.2.14 At the immediate point of discharge, the maximum predicted temperatures at the surface are between 7.5°C and 8°C above ambient. As a 98th percentile, the 5°C above ambient temperature contour is 30.6ha in a relatively symmetrical position around the outfalls. Overlapping this area, TRO concentrations above 50µg/l and 20µg/l occur over sea surface areas of approximately 9ha and 98ha, respectively as a 95th percentile.

1.2.15 Absolute temperature uplifts of 28ºC (98th percentile) occur over a very small area (0.11ha) at the sea surface. Absolute thermal uplifts of >23ºC

[9] Cooke, S.J. and J.F. Schreer (2001). Additive Effects of Chlorinated Biocides and Water Temperature on Fish in Thermal Effluents with Emphasis on the Great Lakes. *Reviews in Fisheries Science*, 2001, 9 (2), pp. 69–113

[10] Capuzzo, J.M. (1979). The Effect of Temperature on the Toxicity of Chlorinated Cooling Waters to Marine Animals - A Preliminary Review. *Marine Pollution Bulletin*, 1979, 10 (2), pp. 45–47

occurs over an area of 89.6ha at the surface (and 25.6ha at the seabed) as a 98th percentile.

1.2.16 The most sensitive species in the individual assessments showed effect thresholds at ca. 20µg/l. It is therefore unlikely that the synergistic effects of TROs and modest temperature uplifts or absolute temperature would cause adverse effects to extend beyond the TRO EQS contour. In the very small areas of the thermal plume with temperatures of 5°C above background and in which TRO concentrations are >20µg/l, increased TRO toxicity may occur.

1.2.17 The conditions under which synergistic effects could arise are transient. Moreover, the exposure times of actively mobile organisms or those passively moving with the tides would be very short. Consequently, while there is the potential for synergistic effects, such an effect would be restricted to a very localised area and would be limited in duration, with fish prey species exposed to such effects over a very limited time only due to their high mobility.

1.2.18 The inter-relationship of the TRO and thermal plumes is not predicted to increase the significance of effects as concluded for these pressures acting alone. It is highly unlikely that the inter-relationship between thermal and chlorinated discharges would increase the significance of the effects of localised displacement, beyond the effects predicted for the pressures individually. This conclusion applies to all fish receptors assessed.

iv. Synergistic effect between temperature and hydrazine

1.2.19 Hydrazine toxicity has been shown to increase with elevated temperatures. A study by Hunt *et al* (1981)[11] showed a 25-40% decrease in 96-h LC50 of hydrazine for bluegill with a 5 – 11ºC increase in temperature. However, lethal concentrations are over 1 mg/l and, therefore, more than 14,000 times higher than the potential hydrazine concentration at the initial discharge point of the cooling water before mixing (69 ng/l). Sublethal concentrations based on altered behaviour (Fisher *et al*., 1980)[12] are approximately 1,400 times higher than the potential hydrazine concentration at the initial discharge point.

[11] Hunt, T.P., Fisher, J.W., Livingston, J.M. and Putnam, M.E (1981). Temperature effects on hydrazine toxicity to bluegills. *Bulletin of Environmental Contamination and Toxicology*, 27: 588–595.

[12] Fisher, J., Harrah, C. B. and Berry, W. O. (1980) Hydrazine: Acute Toxicity to Bluegills and Sublethal Effects on Dorsal Light Response and Aggression. *Transactions of The American Fisheries Society*, 109, pp. 304–309.

1.2.20 The inter-relationship of the hydrazine and thermal plumes is therefore not predicted to increase the significance of effects concluded for the pressures alone. It is highly unlikely that this inter-relationship would increase the significance of the effects of localised displacement, beyond the effects predicted for the individual pressures. This conclusion applies to all fish receptors assessed.

v. Conclusion for SPA seabird qualifying features

1.2.21 In relation to the potential for synergistic effects between the thermal and chemical plumes and the resulting implications for effects on SPA seabird qualifying features, it is important to consider the highly precautionary basis for the assessment of the potential effects. The Shadow HRA assumes that, on a precautionary basis, foraging opportunities for seabirds are substantially reduced within the areas encompassed by the plumes. Given that the predicted spatial distributions of the chemical plumes are encompassed by that of the thermal plume (or at least substantially overlapping in the case of the 3ºC uplift and TRO for SZC), the assumed large reduction in food availability within the areas of the plumes means that any synergistic effect between the chemical and thermal plumes would not affect the conclusions of the assessment (because this precautionary assumption of a large reduction in food availability is applied irrespective of whether it is assumed to be due to the effects of the thermal plume alone or the thermal plume combined with the chemical plumes).

1.2.22 Furthermore, coastal vantage point surveys demonstrate that little tern, common tern and Sandwich tern do forage within the area encompassed by the thermal plumes from Sizewell B, whilst loafing and foraging red-throated diver also occur within the areas encompassed by these plumes (as evidenced in Plates 6.6 – 6.8, 6.10 and 6.13 and Plate 8.7 in the Shadow HRA Report [APP-145] and Figures 6A.2 – 6A.10 in the Shadow HRA Report Addendum [AS-174] to [AS-177]). As noted above, this area also encompasses the chemical plumes from Sizewell B indicating that the assumption that foraging opportunities for seabirds are substantially reduced within this area is highly precautionary.

d) Nutrient enrichment and un-ionised ammonia (waste streams G and H)

1.2.23 As identified in Table 1.2, there is a risk of nutrient enrichment and un-ionised ammonia from waste streams G and H.

1.2.24 Waste stream G is sanitary effluent (from offices, site restaurant and mess facilities, which will be treated in an appropriate effluent treatment plant (i.e. sewage treatment works discharge)) before being discharged with the

significant flow of waste stream A via the two cooling water discharge outlets.

1.2.25 Waste stream G (sewage treatment works discharge) was screened out from the appropriate assessment stage in the Shadow HRA for the operational WDA permit (a point noted in item 1c of the Schedule 5 request). The justification for that screening decision is provided in response to item 1c of the Schedule 5 request (see section 1.4) and, for the reasons provided, any risks from waste stream G (nutrient enrichment and un-ionised ammonia) can be excluded from the further consideration of combined effects.

1.2.26 Waste stream H is effluent from the FRR system, discharged to sea continuously through dedicated separate outfalls (one outfall for each UK EPR™ unit).

1.2.27 Waste stream H (effluent from the FRR) was screened out of the Shadow HRA process for designated sites with bird and marine mammals qualifying interest features. The basis for that decision is contained in BEEMS Technical Report TR520 (Revision 3, dated 02/04/21) which explains that the combined effect of the operational phase inputs from the waste streams, including the FRR, on water quality are very low magnitude and the HRA concludes that there is no pathway for an effect on bird and marine mammals qualifying interest features. For this reason, the Shadow HRA Report did not present the overlap between the area of organic enrichment arising from the discharge via FRR and bird foraging ranges or, with regard to marine mammals, the Southern North Sea SAC.

1.2.28 For the above reasons, this response does not include assessment of the FRR within any consideration of combined effects of the various waste streams. However, the Environment Agency has provided its own modelled area of organic from the FRR and has requested this is used in the assessment. Because the Environment Agency has not provided the supporting input parameters for the calculation of this modelled area, SZC Co. emphasises that it does not recognise or accept the result. Nevertheless, in order to assist the Environment Agency in its HRA process, SZC Co. has agreed to use the Environment Agency's modelled area in calculating the overlaps between foraging ranges and the FRR organic enrichment plume in responding to item 3i of Schedule 5 request No. 6. However, for the reason stated above, no interpretation of these calculations has been made by SZC Co.