The Sizewell C Project

9.89 Draft Fish Monitoring Plan

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Draft Fish Impingement and Entrainment Monitoring Plan

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1 Introduction

NNB Geno (SZC) Ltd (hereafter SZC Co) plans to build and operate a new nuclear power station (Sizewell C, SZC), adjacent to the operational Sizewell B (SZB) and decommissioned Sizewell A (SZA) sites in Suffolk. The station will be of a once-through design, abstracting large volumes of seawater for cooling the condenser steam. Fish (and crustacea) are abstracted with the cooling water and are impinged on fine filtration systems (drum or band screens) that are designed to protect the condensers and other essential cooling water systems from blockage. Biota large enough to be impinged on the fine mesh filtration systems would be returned to the marine environment via the fish recovery and return (FRR) system. Smaller life-history stages including eggs, larvae and juvenile fish of some species are susceptible to entrainment, whereby they pass through the fine filtration screens and passage through the station's entire cooling water system to be discharged at the outfalls. As different life-history stages of fishes may be exposed to either impingement or entrainment, total losses include both components which is herein termed entrapment.

As part of the Development Consent Order (DCO) Application for the new SZC station, the effects of water abstraction on fish populations have been evaluated based on monitoring programmes completed at the operational SZB station. To verify the predicted entrapment effects and quantify losses monitoring is proposed once SZC becomes operational. Condition 50[1] of the draft Development Consent Order [REP2-015] pertains to monitoring stating that:

> ***50.***—*(1) No water abstraction shall commence until a fish impingement and entrainment monitoring plan in general accordance with the Draft Fish Impingement and Entrainment Monitoring Plan has been submitted to and approved by the MMO in consultation with Natural England and the Environment Agency. The plan will set out:*
>
> *a) the monitoring arrangements for assessing the efficacy of the intake head and the fish recovery and return system during the commissioning of Unit 1 and Unit 2;*
>
> *b) the undertaker's duty to consider future additional adaptive measures arising from (a) that may be required during operation of Unit 1 and Unit 2;*
>
> *c) the monitoring methodology, frequency of monitoring and format of monitoring reports; and*
>
> *d) an explanation of the undertakers' confidence that the proposed mitigation will be effective.*
>
> *(2) Unless a shorter period is agreed with the MMO in writing, the undertaker must use reasonable endeavours to submit the monitoring plan at least 6 months prior to the proposed commencement of water abstraction.*
>
> *(3) The determination date is 6 months from submission of the monitoring plan to the MMO.*

The purpose of this report is to provide a draft fish monitoring plan summarising the intended approach to fulfil Condition 50 of the Draft DCO [REP6-009]. As detailed in Condition 50 (2) the final monitoring plan must be submitted no later than 6 months in advance of water abstraction. The final plan would reflect further consultation with statutory bodies in relation to the obligations included in Condition 50 (1), and account for the detailed station design, logistical and Health and Safety considerations relating to monitoring at an

[1] Precise wording of the DML conditions is still under consultation with the MMO; this plan will need updating with the consented DML wording when available.

operational nuclear facility. Such detailed information is not available at this stage. This report therefore addresses the core requirements of monitoring in the following sections:

- Section 2 of this report considers the proposed impingement monitoring methodologies, including frequency of monitoring, the format or reporting and data availability (Condition 50 (1) (c)).
- Section 4 of this report relates to monitoring of the efficiency of the FRR system mitigation (Condition 50 (1) (a)).
- Section 3 considers the proposed entrainment monitoring methodologies, including frequency and duration of monitoring, the format or reporting and data availability (Condition 50 (1) (c)).
- Section 5 of this report relates to ongoing discussions with the Environment Agency pertaining to monitoring populations of conservation species and enhancement measures. A separate smelt monitoring plan will be submitted to and approved by MMO under (and Condition 51 of the DML. This plan will set out the monitoring measures for smelt in Alde-Ore Estuary.

The monitoring outlined herein is based on operational experience at the adjacent Sizewell B site, Hinkley Point B and guidance from the British Energy Estuarine and Marine Studies (BEEMS) Expert Panel Scientific Advisory Reports:

- BEEMS Scientific Advisory Report No 005. Expert Panel. *Methodology for the measurement of entrainment.*
- BEEMS Scientific Advisory Report No 006. Expert Panel. *Methodology for the measurement of impingement*. This methodology is endorsed by the Environment Agency (2018).

Written comments from Natural England [REP 5-159] on the Draft DCO [REP2-015] are also incorporated including the availability of monitoring data and a commitment to the collaborative involvement of relevant agencies in the design of the monitoring plan and consultation on the interpretation of results.

2 Impingement

The term impingement refers to the retention of organisms on power station Cooling Water (CW) intake screens.

The basis for predictions of impingement by SZC is data collected at the operational SZB station known as the Comprehensive Impingement Monitoring Programme (CIMP). Impingement monitoring data used in preparation of the DCO assessments consisted of a total of 205 sample visits in the combined period February 2009 to March 2013, and April 2014 to October 2017. The number and weight of fish, invertebrates and other material passing through the station cooling water systems was recorded. SZB impingement monitoring methodologies are detailed in BEEMS Technical Report TR339 [AS-238].

Eight species of fish contribute to the top 95% of impingement numbers. These include sprat *Sprattus sprattus*, herring *Clupea harengus*, whiting *Merlangius merlangus*, sea bass *Dicentrarchus labrax*, sand gobies *Pomatoschistus spp*, Dover sole *Solea solea*, anchovy *Engraulis encrasicolus*, and dab *Limanda limanda*. Fin-fish species of conservation concern have been recorded, including the European eel *Anguilla anguilla*, twaite shad *Alosa fallax*, river lamprey *Lampetra fluviatilis,* and smelt *Osmerus eperlanus.* Occasional records of allis shad *Alosa alosa* and sea lamprey *Petromyzon marinus* have also occurred.

Invertebrate catches are dominated by the brown shrimp *Crangon crangon*, the pink shrimp *Pandalus montagui* and the Atlantic prawn *Palaemon serratus*.

The CIMP design for SZB was based on the recommendations in the BEEMS Expert Panel Scientific Advisory Report SAR006. Likewise, the SZC CIMP will also be based on BEEMS Scientific Advisory Report SAR006, which defines a randomised design, of sufficient sampling frequency, to give estimates of annual impingement rates that are not biased by state of tide, time of day or season. Ongoing operational experience from SZB will also be used inform the SZC monitoring methodology.

Monitoring for the purpose of estimating annual impingement would apply a systematic random design, whereby, a specified number of dates are selected at random within a given quarter. Sampling on those dates would be for 24 hours. This approach is intended to remove biases associated with diurnal patterns of impingement, tidal, and seasonal patterns.

Interannual variability in the abundances of species would be accounted for by undertaking a minimum of three years intensive impingement monitoring during the initial operation of SZC . See Section 2.1 for intercomparison with SZB.

High natural mortality of early life stages means the primary impacts of water abstraction on fish populations is related to impingement of larger individuals. The SZC station has been specifically engineered to facilitate impingement monitoring by the inclusion of fish sampling culverts after all of the filtration systems and immediately before return to sea, thereby allowing impingement to be monitored.

2.1 Comparison between SZC and SZB

SZB is scheduled to remain operational beyond the time SZC comes online. It was recommended in the Environmental Statement (Section 22.12 c) [APP-317]) that impingement monitoring is completed at both sites for a period of 3 years. This will allow a comparison between the impingement data at the two sites. Furthermore, impingement monitoring at SZB would provide a calibrator/reference for fish populations at Sizewell once SZC is operational in comparison to the period when impingement predictions were made. This ‘future baseline’ information will help SZC Co understand the trends and patterns of fish populations and collate more information on any deviations to help determine if impingement predictions are accurate and whether deviations from the predictions are due to population fluctuations.

2.2 Sampling methodology at SZC

2.2.1 Sample points

At SZB the forebay and drum screens are open (Figure 1). Impingement sampling is undertaken after the drum screens. During sampling, the water flow from the drum screens is diverted from the FRR into a trash pit and intercepted by sampling nets (Figure 2). The design of the SZC cooling water system is more advanced than at SZB and fish monitoring has purposefully featured in the design of the cooling water infrastructure.

The SZC FRR system will be designed to replicate the Hinkley Point C system that has been subject to intensive design scrutiny and has received regulatory approval. The drum screens will be housed in the pump house and fish impinged on both the band and drum screens will be collected on a common gutter system and transported to the debris recovery building. A culverted fish sampling point will be incorporated into the design of the main fish return gutter at the exit point of the debris recovery building, immediately prior to return to sea. Flow control gates will divert fish from the main FRR flow into a fish trap where sampling will take place.

The reduced tidal range at Sizewell means the SZC FRR system has some design benefits over the Hinkley Point C FRR system. For example, each reactor unit will have its own dedicated FRR system and no requirement for an Archimedes screw to raise the fish to platform level prior to discharge back to sea through the FRR tunnel. This reduces both the handling of fish and the transit time. In terms of monitoring, the dedicated FRR systems for each reactor means there is not a shared sampling point. As such, impingement monitoring will sample from either reactor and be scaled up for the total operational flow as described in Section 2.2.3.

Figure 1 The four drum screens at Sizewell B

Figure 2 Placement of hourly sampling nets in the trash bin at Sizewell B, the position of the bulk net is shown.

2.2.2 Sampling frequency and duration

A sampling intensity equivalent to 40 x 24-hour periods per annum has previously been suggested for impingement sampling, with the effort distributed in quarterly blocks of 10 dates, randomly selected within each quarter (BEEMS Scientific Advisory Report SAR006). This consistent level of sampling intensity over multiple years has proven to be logistically impractical with the other monitoring commitments and operationally challenging. This is particularly the case during station outages that can last for weeks to months. Monitoring experience at SZB has demonstrated that 28 samples per annum, with 7 samples per quarter provides robust data.

Impingement sampling will consist of 28 samples per annum at SZC and SZB for a period of 3 years.

Reports will be provided annually to the MTF and, after 3 years, the results from both stations will be compared and analysed and a final report provided to the Marine Technical Forum (MTF) for discussion. The final report will explain how the results relate to the data submitted with the DCO Application. It is expected that this monitoring will show no significant difference from the data submitted with the DCO Application. In that event, the monitoring at SZB will cease. Any action or additional monitoring considered necessary in response to the results will be agreed with the MTF.

2.2.3 Sample Procedure and Scaling

To establish 24-hour impingement estimates, the monitoring will adopt a similar approach to the SZB CIMP. The SZB CIMP sampling comprises of six 1-h samples and one 18-h bulk sample each sample visit. All the hourly samples are collected on the first sampling day, and the bulk sample is set on the first day and processed on the second day (Table 1). The data collected during the six 1-h samples and one 18-h bulk sample is scaled up to represent a 24-hour impingement estimate.

Table 1 Standard sampling pattern for Cefas impingement sampling

Day	Time	Sample
Day 1	09:00 – 10:00	Hourly 1
Day 1	10:00 – 11:00	Hourly 2
Day 1	11:00 – 12:00	Hourly 3
Day 1	12:00 – 13:00	Hourly 4
Day 1	13:00 – 14:00	Hourly 5
Day 1	14:00 – 15:00	Hourly 6
Day 2	15:00 – 09:00	Bulk

Restricted site access at operational nuclear power stations means it has not been possible to resource overnight monitoring for hourly samples. Instead, a single 'bulk' sample is collected overnight. However, on previous occasions bulk samples have overflowed at SZB when the sample net has become full or clogged. In summer months, overflow typically arises due to large numbers of ctenophores clogging the nets. Overflows may also result due to ingress of weed and/or mud, or in the winter months due to inundation of pelagic species, primarily sprat and herring, and demersal whiting. For SZC overnight sampling will be undertaken if feasible, and discussions are underway with SZB for overnight sampling at SZB for comparison. Reducing the incidence of overflowing bulks forms part of ongoing collaborative work with SZB and will be factored into the design of the bulk monitoring programme at SZC.

During each sample visit to SZC the full environmental and operational parameters for each reactor will be recorded. These will include:

- Time and date of sample;
- Duration of sample if sub-sampling required;
- Operational parameters including number of screens and pumps in operation and flow (abstraction) rates and reactor unit sampling took place from;
- Water temperature and salinity;
- Tidal conditions.

On occasion, sub-sampling may be required due to high catch rates, in such instances the weight and numbers of fish and invertebrates will be scaled up accordingly. The operational parameters of the two Units will allow the numbers of fish impinged to be scaled up appropriately for each sample visit to determine impingement rates.

2.2.4 Fish and invertebrate measurements

Each sample will be sorted into fish, invertebrates and weed to the lowest taxonomic level possible. Marine litter will also be processed.

Impinged fish will be counted, weighed and measured for Total Length (*TL*). *TL* is defined as the length from the most anterior point of the body to the tip of the longer lobe of the caudal (tail) fin, usually measured with the lobes compressed along the midline. This is a straight-line measurement and does not measure the curve of the body. *TL* is the length routinely used in all Cefas' biological sampling programmes (research vessel surveys; sampling of commercially landed fish on fish markets), and in BEEMS offshore sampling.

Invertebrates will be weighed and, in some cases enumerated, such as for those species with specific significance, for example brown crabs and lobsters

2.2.5 Annual impingement estimates

Estimates of annual impingement will be calculated by summing all samples from each quarter of the year and raising the quarterly total by the ratio between the number of days in the quarter and the number of sampling visits. The quarterly totals will then be summed to give an annual impingement estimate. Confidence intervals will be achieved by bootstrapping the dataset – randomly selecting a set of visits from each quarter and repeatedly estimating the total annual impingement to give 95 % confidence estimates around the mean value.

2.2.6 Reporting and data availability

Impingement estimates will be reported to the MTF annually. Annual impingement estimates will be presented in terms of absolute numbers for each of the species. Impingement estimates for preceding years will also be presented in terms of effects relative to the relevant population comparator (e.g., spawning stock biomass) once such information is available.

2.3 Summary

In principle, impingement sampling is anticipated to consist of the following elements:

- Detailed impingement methodologies will be consulted on with the MTF to agree the final design which will be submitted to the MMO for approval.
- 3 years of impingement data will be collected simultaneously (where possible) at SZB and SZC.
- Sample intensity will aim to target 28 samples per annum at each site with effort distributed into quarterly blocks. Sample dates will be randomly selected within each quarter.
- Sampling at each site will consist of 24-hour sample intensity.
- Annual reports and data will be provided to the MTF.
- After 3 years the results would be reviewed in consultation with the MTF.
- Once monitoring has been shown to satisfactorily demonstrate impingement predictions in the ES were appropriate, impingement monitoring will cease.
- If monitoring demonstrates that impingement predictions are statistically significantly higher than predicted in the ES, when compared with the reciprocal impingement numbers at SZB, annual entrapment estimates (as equivalent adults) will be compared with a population comparator such as spawning stock biomass (SSB) once the relevant data for a given year are available.
- If monitoring shows that impingement is statistically significantly higher than predicted (when compared with SZB) leading to an increase in total entrapment above the precautionary 1% stock threshold, an explanation must be submitted to the MTF for discussion. Any action or additional monitoring considered necessary in response to the results will be agreed with the MTF

3 Entrainment

The power station cooling water systems will be protected by fine mesh drum and band screens, however, small organisms will pass through the screens and become entrained into the cooling system. Typically, these include fish eggs, larvae and juveniles and planktonic invertebrates. These organisms are subject to a range of stresses, including pressure changes, temperature shocks, chlorination, and mechanical stresses.

The SZC entrainment monitoring will be based on the SZB Comprehensive Entrainment Monitoring Programme (CEMP). The CEMP design for SZB was based on the recommendations in BEEMS Scientific Advisory Report No 005. The SZB CEMP was underpinned by offshore plankton surveys to validate the species composition (BEEMS Technical Report TR318 [APP-324]). The entrainment studies combined with the offshore plankton surveys completed between 2008-2017 provided robust evidence for the species composition and seasonality of the ichthyoplankton, and holoplankton communities in the Greater Sizewell Bay (BEEMS Technical Report TR315 [APP-319]).

The CEMP entrainment monitoring at SZB involved an intensive study over the course of 1 year in 2010/11. The SZB CEMP was based on forty 24-hour periods, in quarterly blocks of ten dates, randomly selected within each quarter. A 24-hr sampling approach was used to eliminate diurnal and short-term (~13-hr cycle) tidal bias, with longer-term tidal bias being eliminated by randomising sampling dates. Water was pumped directly from the forebay into plankton nets affixed in sampling tanks (Figure 3). The sample nets consisted of one coarse mesh (500µm) and one fine mesh (270µm). Samples were preserved onsite and transported to the laboratory for processing (Section 3.1.3).

This section provides a summary of the draft entrainment monitoring approach. The design and optimisation of the methodologies will depend on the specific monitoring objectives and will be based on consultation with the MTF and approved by the MMO under DML Condition 50.

Figure 3 Sizewell B CEMP sampling tanks.

3.1 Approach

Most holoplanktonic species reproduce at a sufficient rate to negate significant entrainment losses (BEEMS Expert Panel Scientific Advisory Report SAR005). Therefore, the primary focus of entrainment studies will be on ichthyoplankton and the juvenile life-history stages of fish to confirm the predictions in the DCO Environmental Statement [APP-317]). The species composition, seasonality and abundance of entrained individuals will be evaluated.

The specific objectives of the entrainment sampling will be subject to consultation with the MTF and will inform the sample design, sample frequency and duration.

3.1.1 Sample points

The optimal sample point for entrainment sampling is being confirmed and will either involve pump sampling from the forebay or in-line sampling point. Should pumping be employed from the forebay, the pump specifications will be selected to conform with the recommendations of BEEMS Scientific Advisory Report SAR005. This includes pumping rates of 10-25 l s^{-1}, the selection of the appropriate pump will be based on ensuring the required flow rate accounting for the greater drop and avoiding damage to fragile ichthyoplankton.

3.1.2 Sampling frequency and duration

The sample frequency and duration will be subject to the specific objectives of the entrainment monitoring programme to be agreed with the MTF. Entrainment sampling will either be targeted at determining entrainment rates during specific periods of seasonal abundance of ichthyoplankton or invertebrate larvae or be designed to determine seasonal and interannual variability.

Entrainment sampling will not be a long-term monitoring programme. It is envisaged that depending on the specific objectives, the monitoring programme will be a minimum of 1 year and no more than 3 years.

If monitoring is completed for 1 year, a target sample intensity of 40 samples per annum is recommended, although sampling may be unevenly distributed with a greater proportion of samples in months of higher biological activity (BEEMS Scientific Advisory Report SAR005).

If monitoring objectives require sampling over a period of 2 or more years, it is recommended that the sampling intensity is reduced accordingly. Statistical techniques would be employed to determine the required sampling intensity to meet the specific monitoring objectives.

3.1.3 Sampling processing

Samples will be fixed on site and returned to the laboratory for taxonomic analysis and enumeration. Enumeration and taxonomic identification will follow standard practices by a suitably experienced laboratory.

The following observations will be recorded for each species:

- date of capture.
- species identification.
- total number of individuals for each species over the 24-hour period (raised from subsamples if necessary).
- length measurements for juvenile and larval fish (subsampling is likely to be required).

3.1.4 Annual entrainment estimates

Entrainment results from SZC will be compared with those from simultaneous monitoring at SZB where possible. If not possible, monitoring at SZC and SZB will occur as close together as possible in time to reduce temporal variation. Estimates of annual entrainment will be calculated by summing all samples from

each month of the year and raising the monthly total by the ratio between the number of days in the month and the number of sampling visits. The monthly totals will then be summed to give an annual entrainment estimate.

3.1.5 Reporting and data availability

Entrainment estimates will be reported to the MTF annually. Annual entrainment estimates will be presented in terms of absolute numbers for each of the species. Entrainment estimates for preceding years will also be presented in terms of effects relative to the relevant population comparator (e.g., spawning stock biomass) once such information is available.

3.2 Summary

In principle, impingement sampling is anticipated to consist of the following elements:

- Detailed impingement methodologies will be consulted on with the MTF to agree the final design which will be submitted to the MMO for approval.
- 3 years of impingement data will be collected simultaneously (where possible) at SZB and SZC.
- Sample intensity will aim to target 28 samples per annum at each site with effort distributed into quarterly blocks. Sample dates will be randomly selected within each quarter.
- Sampling at each site will consist of 24-hour sample intensity.
- Annual reports and data will be provided to the MTF.
- After 3 years the results would be reviewed in consultation with the MTF.
- Once monitoring has been shown to satisfactorily demonstrate impingement predictions in the ES were appropriate, entrainment monitoring will cease.
- If monitoring demonstrates that entrainment predictions are statistically significantly higher than predicted in the ES, when compared with the reciprocal entrainment numbers at SZB, annual entrapment estimates (as equivalent adults) will be compared with a population comparator such as spawning stock biomass (SSB) once the relevant data for a given year are available.
- If monitoring shows that entrainment is statistically significantly higher than predicted (when compared with SZB) leading to an increase in total entrapment above the precautionary 1% stock threshold, an explanation must be submitted to the MTF for discussion. Any action or additional monitoring considered necessary in response to the results will be agreed with the MTF.

4 Fish Recovery and Return (FRR) system effciency

The FRR system is designed to return robust species (particularly flatfish, eels, lampreys and crustacea and to a lesser extent demersal species such as bass, cod and whiting) that are impinged on the station drum and band screens safely back to sea. A state-of-the-art FRR system has been designed for Hinkley Point C and received regulatory approval. This system was subject to intensive design scrutiny and complies with Environment Agency guidelines for such systems. The system is a highly engineered and improved version of earlier fish return systems such as the one in operation at SZB. The design of the FRR system at SZC will replicate that approved at HPC, although site specific differences allow for significant improvements in the SZC design. The tidal range at Sizewell is less than at Hinkley Point and it has, therefore, been possible to improve the 'fish friendliness' of the SZC FRR. The drum screens will be smaller at SZC due to the reduced tidal range, meaning screen rotation times are reduced (so fish are held in the buckets for a shorter period compared with HPC). The reduced tidal range also means that there is no need for an Archimedes screw, which is required at HPC to raise the fish to platform level in order to flow back to sea under gravity. At SZC water levels allow fish to be discharged back to sea directly from the base of the debris recovery building, removing the additional handling stage of an Archimedes screw and significantly reducing the transit time back to sea.

The predicted values of FRR mortality applied in the impingement assessments at DCO were based on Environment Agency (2005) guidance for species specific survival through FRR systems, modified for the SZC specific trash racks, band screens and drum screens. A description of the approach is provided in BEEMS Technical Report TR406.v7 [AS-238].

The Environment Agency has recently reviewed FRR survival studies based on Sizewell B, Le Blayais (on the Gironde Estuary) and Pembroke (Milford Haven) power stations and provided an uncertainty range giving best- and worst-case mortality estimates for a range of species (Environment Agency 2020[2]). The FRR uncertainty range was incorporated into sensitivity analyses for impingement predictions for SZC in BEEMS Scientific Position Paper SPP116 [REP6-028]. This latter report supports the original Environmental Statement assessments that the SZC station would not have significant effects on the population sustainability of any of the key species assessed [APP-317].

The MTF has requested information to be gathered relating to the operational efficiency of the FRR system at SZC and the survival predictions used in the ES. This section considers the potential for FRR survival studies.

4.1 Approach and Limitations

Fish would be collected from the culverted fish sampling point in the debris recovery building. By this point they would have transited through the cooling water intakes, tunnels, forebay and, following impingement on the fine mesh drum or band screens, transported to the debris recovery but not yet exited into the FFR tunnel. Although at this point the fish would not have passed the entire FRR system, they would have been subject to the main stressors of impingement including barotrauma and the drum screens. Sampling is not possible at the FRR outfalls.

Experimental fish would be removed from the sampling point in nets and transferred to temporary experimental tanks, using best practice handling techniques to minimise any additional stress from experimental handling.

[2] As part of the Hinkley Point Water Discharge Activity (WDA) Appeal Inquiry (8-25 June 2021); doc ref TB008

Survival studies would be similar in principle to those completed recently at the Pembroke power station (Jacobs 2015, 2016). Fish would be collected during impingement monitoring and assigned to one of three criteria:

1) Dead on collection – recently deceased fish that died in the FRR system.
2) Experimental mortality – fish that died during the experimental period.
3) Experimental survival - fish that survived the experimental period.

A proportion of fish dead on collection would be weighed, measured for TL and inspected for damage. A proportion of fish that were live on collection would be transferred straight to experimental tanks and maintained for a period of 24 hours. Fish subject to experimental mortality would be removed from the experimental tanks and weighed, measured, and inspected for damage. The approximate time of death would be recorded. Fish that survive the experimental procedure would be weighed, measured, and inspected for damage at the end of the 24-hour period to minimise handling during the experiment.

Sources of damage would be recorded and may include:

- Abrasions or lacerations.
- Fin damage.
- Scale loss.
- Incidence of red eye which is a sign of barotrauma.
- Haemorrhaging or signs of swim bladder damage.

The FRR survival studies would provide further evidence for the short-term survival following passage through the FRR system. Reductions in fitness or potential increases in the risk of predation once in the receiving waters due to damage or sub-lethal effects is not, and cannot be, accounted for. Furthermore, any additional mortality associated with sampling and survival studies is unknown. This may include increases in mortality due to barotrauma as the fish would not be able to repressurise to the same extent in experimental tanks as those discharged into deeper waters at the FRR outfall.

4.2 Species

To allow statistically robust data to be collected fish need to be seasonally abundant to allow a sufficient sample size. It is therefore not practical or achievable to conduct FRR survival studies on all species likely to be impinged at SZC as this would necessitate continued utilisation of experimental tanks.

The species of interest and survivability experimental design details will be the subject of consultation with the SZC Marine Technical Forum. The focus of FRR survival studies would be on species with high impingement rates and moderate survival predictions, or conservation species with predictable seasonal abundance. Examples of such species include:

- **Whiting** the third most commonly impinged species at SZB and a species with a wide FRR uncertainty range estimated by the Environment Agency (2020). The species is commonly impinged during the winter months.
- **Sea bass** the fourth most impinged species at SZB and a species with a wide FRR uncertainty range (Environment Agency, 2020). The species is commonly impinged during the winter months.

- **Cod** a routinely impinged demersal species during the winter period coinciding with whiting and sea bass.
- **Smelt** a conservation species impinged primarily during the summer months. Limited information is available on FRR survival and assessments assume the species had the same high mortality estimates as the clupeids. As a pelagic species with no specific data available, impingement assessments during the DCO assumed 100% impingement mortality [APP-317]. Further evidence may help inform this assumption.

Further evidence of the operational efficiency of the FRR system for these species would help to reduce uncertainty in operational impingement losses.

4.3 Adaptive measures to the FRR

The FRR system replicates the Hinkley Point C design, which underwent considerable regulatory scrutiny and engineering refinement to ensure compliance with Environment Agency (2010) best practice. However, at Sizewell C two site specific improvements will provide additional benefits:

1) drum screens of smaller diameter meaning transit times on the fish buckets will be reduced compared with the HPC design;
2) a smaller tidal range at Sizewell compared with Hinkley Point also leads to shorter periods in the drum and band screen fish buckets;
3) tidal levels and platform height mean that fish can drain back to sea directly from the base of the debris recovery building without the need for an Archimedes screw which, at Hinkley Point C, introduces another ‘fish handling’ phase; and,
4) direct discharge from the debris recovery building also reduces the transit time before fish are discharged to sea as the tunnel is much shorter compared with Hinkley Point C.

Although the FRR is designed to be compliant with Environment Agency (2010), where feasible components will be visually monitored for efficiency best practice, including efficacy of the fish buckets on the drums screens, performance of the fish friendly (<1bar pressure) washing sprays which flush fish from the buckets, and flow rates along the FRR gutters. Where feasible adjustment for elements seen to be operating sub-optimally will be adjusted. However, for the avoidance of doubt, opportunities to alter the FRR design or operability are limited because the gutters etc are set in concrete.

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5 Further monitoring, mitigation and enhancements

5.1 Response to monitoring results

As explained in this draft plan, in the case that monitoring demonstrated that impingement and/or entrainment is statistically significantly greater than predicted in the ES, when compared with impingement and entrainment numbers at SZB at the same time, comparisons would be made with the baseline to determine whether the losses caused by Sizewell C were having a significant effect on fish populations. This assessment would be made by converting the impinged and entrained organism into Equivalent Adults and comparing them with the relevant baseline comparator (e.g. Spawning Stock Biomass) for the relevant year.

Should impacts from SZC be above the 1% of stock precautionary trigger threshold, a report will be provided to the MTF with an analysis and explanation of the results. Any further monitoring and action in response to the report will be discussed with the MTF. The appropriate response to the report will depend on the results and explanation of the monitoring but may include:

- For migratory fish species: installation of fish passes on appropriate rivers. However, two fish pass schemes (at Snape Maltings and Blythford Bridge) will be delivered by the Sizewell C project in any event. The benefit of these fish pass schemes will need to be considered prior to implementing further, similar measures.
- For species such as sea bass: habitat creation or a managed realignment scheme (such as Steart Marshes at the mouth of the River Parrett). Saltmarsh and other shallow sub-tidal/intertidal habitats are used as nursery grounds by a number of fish species.
- For other marine species (e.g. cod), however, there are no identified means to offset any significant adverse effects demonstrated by the impingement and entrainment monitoring. However, it should be noted that, for commercial species, fishing restrictions are imposed when a stock is deemed to be under threat and such action typically occurs at impact levels considerably greater than those predicted by Sizewell C. Sizewell C only acts as a 'passive sampler' compared with fishing vessels that are mobile and seek out particular fish species. If numbers of a particular species have diminished to the point that fishing restrictions are imposed the by association Sizewell C will be abstracting far fewer numbers based on that reduced population size. Therefore, although direct offsetting measures are not available for these commercial species, impacts from Sizewell C on populations are not considered plausible. Indirect offsetting measures might include clearance of marine litter (e.g. "ghost gear").

5.2 Further mitigation and enhancement

As part of the ongoing consultation in relation to the Eels Regulations and Water Framework Directive (WFD), SZC Co. has held discussions with the Environment Agency with the purpose to investigate the potential to monitor smelt *in-situ*, and to explore the possible installation of fish passes in relevant local rivers.

As mentioned in section 5.1 and in recognition of the importance of these species, Schedule 11 DoO SZC Co. has committed to contribute funding two fish pass systems to be constructed by the Environment Agency (one at Snape Maltings (River Alde) and one at Blythford Bridge (River Blyth)) to enhance upstream eel passage.

In response to discussions with the Environment Agency, SZC Co. has committed to preparing a smelt monitoring and mitigation plan for approval by the MMO prior to any water abstraction (DML Condition 51). The smelt monitoring plan must then be implemented as approved. Further SZC Co. has committed to a smelt contingency fund (Sch 11 DoO). The MTF will approve how this fund is spent in accordance with the smelt monitoring plan.

The smelt monitoring plan will be additional to ongoing WFD monitoring and will focus on:

- Determining the presence of gravid fish above the tidal limit during the main spawning season (February – April) in the River Alde.
- Identifying the presence of suitable spawning substrate in the River Alde.
- Monitor the presence of eggs/newly hatched larvae in the River Alde.

Similar sampling methods have been used at the River Blyth. That sampling indicated that the lack of suitable spawning habitat, a barrier to upstream migration and the lack of evidence of spawning fish or eggs indicates the River Blyth does not support a spawning population (BEEMS Technical Report TR382). In agreement with the Environment Agency, smelt monitoring in the River Alde will act as a surrogate for the River Blyth also.

Sampling will occur prior to implementation of the proposed fish passage enhancement schemes so that beneficial gains from the installation of fish passes can be determined.

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