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FGS Review of NNB Appeal to Removal the Requirement to Install an Acoustic Fish Deterrent at Hinkley Point C

Permit application number EPR/HP3228XT/V004

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1. Introduction

Fish Guidance Systems Ltd (FGS) has reviewed the documents submitted by NNB Generation Company (HPC) Limited (NNB) as part of its Appeal to the Planning Inspectorate to remove the Acoustic Fish Deterrent (AFD) from the scope of the protection measures originally specified for the intake.

This response document focuses on the 'Statement of Case' (NNB Document NNB Genco HPC Statement of Case 230920) and the 'Case for Removal of the Requirement to Install an Acoustic Fish Deterrent - Summary of the Engineering Optioneering Process' (NNB Document Reference NNB-308-REP-000710, Version 2.0). Citations shown are just examples from the reports, since the same comments are repeated throughout the reports, as well as being repeated in different forms in the other documents. We would make the following general comments –

The 'Statement of Case' Document

Many of NNB's concerns over the AFD are based on a fundamental misunderstanding of the purpose of the technology. The AFD and Fish Recovery and Return (FRR) systems are designed to work in tandem, and without the AFD the FFR will result in the mass mortality of the delicate pelagic species that enter the cooling water system. Further details can be found in the bullets below.

NNB has also failed to work with industry experts to deliver a viable solution, leading them to profess misunderstandings of the size and dangers of an AFD system.

- **Failure to highlight AFD systems protect the most fragile fish, including sprat:** The 'Statement of Case' document states that the effectiveness of an Acoustic Fish Deterrent (AFD) is dependant upon the hearing ability of the fish species concerned. It notes that eels have no hearing ability and other reports elsewhere refer to only fish of limited hearing ability. It fails to state that the fish most sensitive to an AFD include sprat, which in its own report (NNB reference HPC-DEV024-XX-000-RET-100122 'The effect of not fitting an AFD system at HPC on the operation of the HPC FRR systems'), NNB accepts "**Delicate pelagic species such as sprat are expected to have 100% mortality within the FRR system**", and during peak periods can account for "76% of total fish impingement at HPB".

  The Environment Agency Best Practice Guide for the Screening of Intakes and Outfalls recommends a combined approach, combining AFD and Fish Recovery and Return (FRR) systems to achieve a complementary effect. **The AFD deters the most fragile and acoustically sensitive of fish, such as sprat, herring and shad,** and to lesser degrees other

fish species that are less sensitive to sound, while a FRR system returns the fish not deterred by the AFD to the estuary. Neither system can achieve the required goal of protecting the maximum possible range of fish species without the other, and an FFR system on its own will lead to the death of all fragile fish that enter the intakes over the expected 60-year life of the plant.

As the document states "**without an AFD in place, an increased number of fish will enter the cooling water system and there will be greater fish mortality than if an AFD was deployed**."

- **Failure to work with AFD suppliers:** The document also states that AFD systems have not before been installed in an offshore environment, and are easier to construct and maintain near the shoreline or in inland waters, which is true. However, NNB chose the location and design of the Intake Heads, having had multiple options to choose from. NNB has had at least three years since the optioneering assessment to work with suppliers and design engineers to develop and test the deployment and maintenance systems required for the AFD, but has chosen not to do so, preferring just to say it hasn't been done before, and implying that it can't be done now. **FGS has a system that meets all of the published requirements**, has 25 years' experience designing and installing AFD systems and is willing to work with NNB and other support companies to install and maintain the required system.
- **Over emphasis of size of AFD system:** The 'Statement of Case' also notes that the AFD system at Hinkley Point C (HPC) requires 288 Sound Projectors, 72 projectors on each Intake Head. This is the same number (72) that are already deployed at Pembroke Power Station**,** so the site just requires four systems of the same size, which will be installed, operated and maintained separately. As a result, the number of projectors required for the system is not excessive, and can be fully supported by FGS. Pembroke abstracts a maximum of 40 cumecs cooling water flow, i.e. just over a quarter of the required flow for HPC.
- **Factually incorrect Health and Safety Statements:** The document states that "Health and safety legislation requires the Appellant to reduce risks to workers to a level that is as low as is reasonably practicable (ALARP)", and implies that the system can only be maintained by divers. The statement fails to mention that Remotely Operated Vehicles (ROVs) are used extensively in offshore locations, for example in the North Sea oil and gas industry, and the suppliers have significant experience and ability to provide and if necessary, adapt and improve ROVs to meet the requirements of the site. **NNB has chosen not to engage with ROV suppliers** over the last three years, **even though this would reduce the risk to its workers,** but rather rely on an argument that maintaining the AFD system with divers will be difficult, and potentially dangerous. **However, there is an alternative to using divers, which NNB has failed to pursue.**

The Optioneering Report

NNB's assessments of inadequate technology related to AFDs are based on outmoded and outdated information. This is due to NNB having no contact with FGS since May 2017. During that time, and over its 25 year plus history, FGS has innovated constantly and we are in position to meet all of the minimum criteria, as outlined below -

- **Out of date information:** Overall, **the optioneering report**, and thus the 'Statement of case' document, **is based upon out of date and inaccurate information and assumptions**, and does not reflect the systems currently available from FGS. NNB has not contacted FGS for updates since the optioneering phase ended in May 2017.

- **Continuing development of FGS AFD systems:** The optioneering report states on a number of occasions that the technology and techniques being discussed are only at the concept stage of development (Para. 1.2.3, p11). This is incorrect. As noted above, FGS has been involved in the design, installation and maintenance of AFDs for over 25 years, and has a proven track record of installing AFD systems that meet specific site requirements. FGS has an active R&D department that is responsible for the continuing improvement and upgrade of the components of existing systems, as well as developing novel systems and techniques to assist fisheries managers with conserving fish stocks.
- **FGS AFD system meets HPC minimum criteria:** The optioneering report also states that no supplier is currently able to meet all of the HPC Project's minimum criteria (Para. 4.3.22, p29). This is also incorrect, as the **latest MkIV 30-600 Sound Projector based AFD system available from FGS meets all of the system requirements**.
- **Position of Intake Heads:** While there are challenges associated with the HPC Intake Heads being 3 km off shore, FGS does have system components and experience of installing systems at less accessible sites, and so this should not be considered a reason to discount the requirement for an AFD.
- **Diver Assessment**: The diver assessment at the end of the document is overly pessimistic, and **fundamentally flawed**, as it is based upon overly conservative assumptions (Para. 7.4.17, p76), that don't allow for any improvements through diver familiarity with the system, nor any attempt of achieving efficiencies by managing tasks more effectively.
- **Development of ROVs**: ROVs are potentially available that can carry out the required maintenance work, and NNB should be encouraged to work with potential suppliers to develop a suitable ROV, if one is not already available.

2. Latest FGS System Developments

Highlighted below are the system developments that FGS have developed and refined since our last discussions with NNB in May 2017.

- **Active Pressure Compensation System (APCS)** - Hinkley is one of a number of sites where the Sound Projectors are less accessible, and as a result FGS has developed an Active Pressure Compensation System (APCS). This system replaces the standard 'airbag' of the Pressure Compensation System, and –
  - provides continuous monitoring and adjustment of the compensating pressure in the Sound Projector housing.
  - removes all of the operational, maintenance and reliability issues associated with the old passive pressure compensation system.
  - extends the service interval of the Sound Projectors out to a minimum of 18 months, with the option of longer service intervals, if required.
  - enables pressure compensation over any range that is required, with the current system designed for tidal ranges up to 30m.
  - offers a number of different configurations with Sound Projectors, so can be configured to fit with the proposed deployment system at HPC.

  The APCS system has undergone significant in-house testing, simulating the tidal changes at Hinkley over three full years, and the system has recently been supplied to USFWS for installation at Barkley Lock in Kentucky, USA.

Plate 1 –MkIV 30-600 Sound Projector with APCS fitted for deployment at Barkley Lock, USA (access side panel removed for photograph)

- **Underwater Power and Communication Hubs** – The existing Underwater Power and Communication Hubs provide the network 'nodes' for a system, linking the individual Sound Projectors to the Control Equipment. The internal PCB monitors and controls the communications within the system, and the unit also distributes the power to the Sound Projectors.

  While the existing Hubs can be deployed at HPC, FGS has developed a new version of its Underwater Hub that will be available to deploy at HPC, as well as other sites where there is a greater distance between the Hub and the Control Equipment. The new Hubs use the existing proven PCB while incorporating internal Power Supply Units, and if required 100% redundancy. This offers two main benefits –

  - It reduces the size of the power cables required between the Control Equipment and the Sound Projectors, reducing installation costs and making the connections more flexible.
  - It enables the projectors to be located at greater distances from the Control Equipment without any significant drop in power.

3. Existing Capabilities and Specification

Although the Intake Heads are located 3km offshore, the issues associated with the power and communication systems outlined by NNB have already been addressed above. In addition, a number of the statements (Para. 4.3.23, p29 – 4.3.48, p31) made about the existing system are incorrect, as the system already has the following capabilities: -

- **Remote Operation and Monitoring** - FGS systems already offer, as an optional feature, the remote operation and monitoring of the system, and can be operated and monitored remotely via the internet irrespective of their location. This enables the site operator to operate and monitor the system from its Control Room on site, FGS to provide supporting operation and monitoring of systems from its offices, and if required the Regulator will be able to monitor the operation of the system from its own facilities. The level of operation and monitoring access can be controlled for different users, as well as associated daily reporting emails of

the condition of the system. If required, immediate feedback is available via a SMS texting unit.

- **Control Software** – the proposed system on the four Intake Heads at Hinkley will be operated as four separate systems, and so the Control Software that has been available from FGS for the last 10 years is already suitable to operate the proposed systems. With 72 Sound Projectors proposed for each Intake Head each system will be the same size as the system installed at Pembroke Power Station. As a result, the AFD at HPC represents four separate systems the size of Pembroke, not one system four times the size of Pembroke. The distinction is important, as HPC should not be viewed as a much larger and more complex system due to its size.

  It should also be noted that FGS systems are modular and if required the systems at HPC can be significantly larger than those that have been proposed. The current system available from FGS can have a maximum of 31 Hubs, which represents a capacity of 248 Sound Projectors on each Intake Head.

  FGS has already installed systems larger than Pembroke elsewhere, with 96 Sound Projectors being deployed at Georgiana Slough in California, USA.

  If NNB wishes the four Intake Heads to be run as one system then this can be provided as an additional upgrade to the existing system, but is not an overly large task, as a 'Master' Control Unit can be incorporated into the current system. NNB will just need to specify their requirement as part of the final design phase for the system.

- **Change of Signal** – The latest systems available from FGS incorporate multi-signal units, with the fish deterrent signals being changed remotely.

- **Connectors** – all FGS systems use offshore industry grade underwater mateable connectors, albeit that the majority of service work on the HPC Deployment Frames will be carried out once they have been brought to the surface, and so will be carried out on the deck of the service vessel / on shore. The possible use of Remote Operated Vehicles (ROV)s to service the system may require the use of specialist ROV connectors, but this is standard technology available from a number of suppliers, having been used extensively around the world in the oil and gas industry for many years.

- **Inbuilt Diagnostics** – the inbuilt diagnostics in both the Sound Projectors as well as the Underwater Hubs is already capable of monitoring over 10 different parameters, and so already provides the most detailed feedback available from any AFD system. The diagnostics enable continuous real time monitoring of the system, both from site and remotely. The status of the system is displayed with traffic light coloured icons to easily see when each component is operating correctly (green), when one of the monitored parameters is outside the normal limits (yellow), and when there is a fault (red).

- **Maintenance Requirements -** The report is incorrect when it states the Sound Projectors require cleaning every 6-9 months (Para. 4.4.21, p35). The MkII 30-600 Sound Projector, last produced over 10 years ago, did require servicing every 6 months, but the MkIII 30-600 Sound Projectors produced over the last 10 years have a recommended 12-month service interval. With the new APCS the service interval of the new MkIV 30-600 Sound Projector will extend out to a minimum of 18 months.

- **Maintenance Regime** - As already noted, the recommended service interval of a MkIV 30-600 Sound Projector is currently 18 months however, the frequency of service visits to a site will be more frequent than this if there is not a full set of spare Sound Projectors. Typically, a

client will have a set of spare Sound Projectors that are used to swap out some of the projectors on site. These are then returned to the workshop to be refurbished, and then returned to site to swap out with another set of projectors. As a result, a rolling program of servicing is established, with the frequency of visits being dependent upon the number of projectors on a site, and the number of spares available.

The service interval of the Sound Projectors at Doel and Pembroke, including the cleaning and replacement of the projectors with service units, is 12 months at both sites, and not the 6-9 months stated in the report (Table 4.8, p37), albeit that a number of service visits are made to Pembroke over the year as part of the rolling program of maintaining the AFD system.

As the service interval for the MkIV Sound Projector is 18 months, the maintenance regime to be implemented at HPC will require less visits to site than at Doel and Pembroke, but the final maintenance regime will need to be agreed as part of the final design stage of the system.

- **Required System Specification –** in addition to the existing capabilities, the current system already meets all of the key requirements specified in the report
  - The AFD system is based upon proven technology
  - The Sound Projectors generate a sound level in excess of 160 dB re 1µPa
  - The Sound Projectors are programmable and can store and produce multiple signals in the required range of 30-2000Hz
  - The current FGS MkIV 30-600 Sound Projector with optional Active Pressure Compensation System (APCS) is suitable for deployment in tidal locations of 25m in depth, and current speeds between 0 – 1.8 m/s
  - The Service Interval of the FGS MkIV 30-600 Sound Projector is 18 months, so the system can be maintained on an 18-month replacement cycle for the Sound Projectors
  - Acoustic modelling using FGS's proprietary model, PrISM, has demonstrated –
    - a system can be installed that will provide the required sound pressure level of 160 dB re 1µPa across the whole surface of the intake screens (at the entrance to the intake heads) with minimal interference and acoustic nulls.
    - the sound field generated by the system produces a strong acoustic gradient, with the sound pressure level reducing with distance from the intake screens.
    - the sound pressure level can be maintained for all states of tide.
  - The system is capable of being powered from onshore via submarine cable(s)
  - The following items can be incorporated into the system, but will need to be finalised as part of the detailed design of the Deployment System –
    - Maintenance activities of the AFD systems and associated mechanical and electrical power supply infrastructure, so that it does not interfere with, or risk damage to, the cooling water intake structures.
    - A Deployment Design to minimise diving activities.
    - Compliance of the Deployment Structure with a SC2 seismic requirement.
  - The requirement for the system to meet a minimum availability of 90%, including downtime for both planned and unplanned maintenance can be incorporated into the final design of the system, including any additional redundancy that may be required to meet

this requirement. We assume the Environment Agency will also specify what level of component redundancy it requires, which can also be incorporated into the final design.

4. Additional Clarifications on AFD Systems

The Optioneering Report makes a number of points that are factually incorrect, as developers and innovators of AFD systems we believe FGS is uniquely placed to clarify the following:

- **Sound Projector Orientation** - Large tidal flows do not prevent the Sound Projectors being located perpendicular to the tidal flow (Para. 4.3.39, p31), and projectors (with any of FGS's Pressure Compensation Systems) can be located facing a high flow if required, although no intake should be designed to have an intake velocity greater than 0.3m/s[1]. However, Sound Projectors are typically arranged so that they are perpendicular to the flow entering an intake, and as part of designing the Intake Heads in accordance with the best the intakes at HPC have been designed to be parallel to the flow, so therefore the front face of the Sound Projectors will be located parallel to the tidal flow. This has no impact on the performance of the system, as demonstrated by the system installed at Doel nuclear power plant, which is subject to high tidal flows across the face of the intake, and yet still provides high deflection efficiencies.

  The report suggests that there may be issues with turbulence affecting the components, but there is no evidence to substantiate the claim, and over the 25 years that FGS has been installing and maintaining AFD systems it has not found any damage caused by turbulence.
- **Silt** - suspended solids can impact the performance of a light-based fish deterrent system however, the design of the AFD at Hinkley has been based upon an AFD system. The report notes that there is no evidence of silt affecting any existing AFD systems (Para. 4.3.44, p31), and this is because suspended solids do not affect the operation of acoustic Sound Projectors. With the new APCS units any possible issues associated with silt or biofouling have been reduced to even lower levels, so silt should not be of any concern, and any inference that the system will be adversely affected is incorrect.
- **Biofouling / Cleaning** – regular cleaning of a MkIV 30-600 Sound Projector is not required, albeit that the units will be cleaned as part of their 18-month maintenance refurbishment (Para. 4.3.46, p31).
- **Failures** - Occasional failures do occur (Para. 4.4.22, p36), and can be due to a number of different reasons, but these are typically dealt with as part of a routine service contract provided by FGS, since the inclusion of appropriate redundancy enables failures to occur without adversely impacting the performance of the system. The development of the APCS has eliminated the issue of the failure associated with the airbags for HPC. FGS continually reviews the performance of all of the components, and will continue to incorporate any possible advances into the system for HPC.

[1] TURNPENNY, A.W.H AND O'KEEFFE, N. 2005. Screening for intake and outfalls: a best practice guide. Environment Agency. Science Report. SC030231.

5. Design of the AFD System

As with all designs, considerations need to be made to ensure that the system operates effectively. We wish to highlight the following challenges, and how we believe they can be overcome.

Accessibility - While the current MkIV 30-600 Sound Projector based AFD system available from FGS meets the requirements of the project specification, the report does highlight that the design of the intake heads at HPC, and their lack of accessibility, has made the servicing of the AFD system more of a challenge. However, as already noted, the 18-month service interval of the MkIV Sound Projectors meets the required specification.

It has been proposed that the system will be maintained mostly by divers, as there are not any suitable ROVs available on the market (Para. 7.4.26, p77). Following personal conversations with an ROV company we understand that ROVs should be able to carry out the required work, and even if there is not one available at this moment in time, we assume if it wishes NNB can engage with ROV suppliers to develop a suitable unit. If there is not sufficient time to develop a unit before the AFD is installed then the divers may be required to carry out the maintenance during the initial years.

Diving Times – Associated with the accessibility of the projectors, NNB has concluded that divers will be required to maintain the system. Therefore, as part of the report NNB has employed a diving contractor to assess the time it will take to carry out the maintenance work underwater, and these assumptions have been used as the basis of the overall assessment of the practicality of maintaining the system (Para. 7.4.18, p77). However, the assessment does not take into account that times will be reduced as divers become familiar with the required operations, nor has it allowed for any efficiencies that will be introduced by carrying our more than one task at a time when a diver is underwater. Efficiencies could be created in a number of ways, including –

- by potentially increasing the number of projectors per cluster, thereby reducing the number of clusters that require replacing.
- having the divers work more efficiently, prepping for more than one cluster exchange on an Intake Head at a time.
- Increasing the redundancy in the system, and thereby allowing the service interval to extend beyond 18 months per projector.

In addition, we would note that the intake velocity into the Intake Head has been designed to be below 0.3m/s, and therefore the risk of a diver or their umbilical becoming entrained into the intake is very low.

As a result, the conclusions made must be read on the assumption that the aim of the diving assessment was to paint a worst-case picture, and in reality, the time required to carry out the work will be less than that stated.

Sound Projector Configuration - Acoustic (PrISM) modelling was carried out by FGS as part of the 'Optioneering' phase of the project, and it should be noted that while the projector configuration selected by NNB will protect the intake in accordance with NNB's specification, this was not the optimum solution, as it reduces the warning signal that could be generated by a 'stadium' configuration, with Sound Projectors located at the ends of the Intake Heads as well as along the face of the intakes. If the system is to be optimised following installation then the option for Sound Projectors being located at the ends of the Intake Heads will need to be included into the design of the Deployment Systems.

Sound Projector Deployment System - A number of Deployment Options have been considered by NNB, and we assume the AFD supplier will be involved with the final design of the Deployment System, to enable the maintenance task to be as efficient as possible.

As identified above, there are other areas that will also need to be considered, and so we assume this will include –

- Agreement on required system redundancy.
- Changes in existing system design proposal to meet redundancy requirements.
- Confirmation of final system specification, including Control Software requirements.
- Confirmation of proposed maintenance regime.
- Confirmation of optimum sound field and location and number of required Sound Projectors.
- Design of suitable Deployment System to minimise diver time.
- Associated with this, work with a ROV manufacturer to enhance an existing design and / or design a new ROV to meet the project requirements.
- Incorporation of ROV-type connectors into the Underwater Power and Communication Hubs.
- Review maintenance activities of the AFD systems and associated mechanical and electrical power supply infrastructure, so that it does not interfere with, or risk damage to, the cooling water intake structures.
- Compliance of the Deployment Structure with a SC2 seismic requirement

General Conclusions and Comments on Optioneering Report

- The Report prepared by NNB on available AFD systems is out of date, and does not reflect the systems currently available from FGS. NNB has not contacted FGS for updates since the optioneering phase ended in May 2017.
- The FGS MkIV 30-600 Sound Projector with the optional Active Pressure Compensation System, has an 18-month service interval, and is capable of being deployed in water depths of 25m and water velocities of up to 1.8m/s
- The Sound Projectors generate a sound level in excess of 160 dB re 1µPa, and are programmable with multiple signals between 30-2000Hz
- FGS systems are based upon proven technology, with over 25 years' experience designing systems to meet specific site requirements.
- The current AFD system available from FGS meets all of the system requirements specified by NNB.
- The design of the Intake Heads has made the Sound Projectors less accessible, and so divers or an ROV will be required to maintain the system.
- The diving assessment included in the report is based upon pessimistic assumptions, with no consideration of savings in time that will be made with diver familiarity of the system, nor efficiencies that can be achieved by planning the maintenance regime to be as efficient as possible. As a result, the conclusions of the diver assessment are flawed.
- The use of an ROV is the preferred method of accessing the Sound Projectors, and while to the report states that no ROVs are available, we have been advised that ROVs can carry out

the work. However, even if that is not the case, NNB should engage with ROV suppliers to develop a suitable ROV. Divers may be required to maintain the system in the short term due to NNB not engaging with the suppliers early enough, but the lack of preparatory engagement by NNB cannot be used as justification that the system should not be installed

- Prior to the AFD being installed it will be necessary to agree the redundancy that should be incorporated into the system, and also what enhancements can be included to enable the optimisation of the system. This should include a review of the optimum configuration of the Sound Projectors determined by the PrISM modelling
- The final design of the system can then be agreed, and final designs of the components can be completed to incorporate the specific site requirements for HPC.

Report Date – 26 October 2020