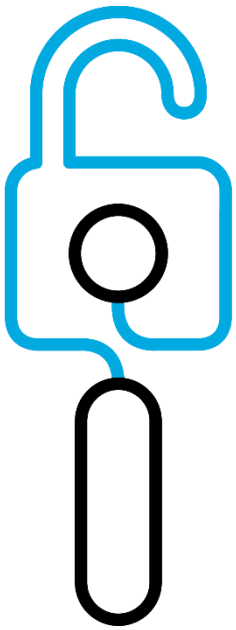
Sofia Offshore Wind Farm

Annex B – Consultation with the MMO

February 2020

Ecodoc Reference: 003230672-01



1 Introduction

This Annex contains the two most relevant consultation outputs with the MMO undertaken on the original 5,500kJ hammer energy increase non-material amendment in 2018. The consultation outputs contained within this Annex comprise:

- SOWL response to MMO comments on the main hammer energy increase proposals; and
- Final MMO response to BEIS on the 5,500kJ hammer energy increase proposal.

The Statement of Common Ground (SoCG) between SOWFL and the MMO is also provided within this application (Document Reference 002766144-04).

Marine Management Organisation

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Harriet Thomas
Innogy Renewables UK Ltd
(by email only)

Our reference: DCO/2013/00011

11 December 2018

Dear Harriet,

RE: REQUEST TO INCREASE HAMMER ENERGY FOR SOFIA OFFSHORE WIND FARM (SOWF) (FORMERLY DOGGER BANK TEESSIDE A&B).

Thank you for submitting your request to increase the maximum hammer energy for foundation installation at SOWF to 5,500kJ. This request was originally submitted to the Marine Management Organisation (MMO) on 15 June 2018, and following continued engagement between the MMO was accompanied by the supporting documentation listed in table 1 of the Statement of Common Ground (SoCG) which was agreed with the MMO on 20 November 2018, and the updated noise modelling which was provided in Appendix A to the (SoCG), The MMO has reviewed the request and the supporting documentation in consultation with its technical advisors at the Centre for Environment, Fisheries and Aquaculture Science (Cefas) and has the following comments to make, outlined below.

Furthermore, the MMO acknowledges that as part of the discussions around this request, specific questions were submitted to the MMO via email on 31 October 2018, regarding methods for modelling underwater noise (UWN) impacts on fish. A summary of these questions and the response is provided in Appendix A.

1. Marine Mammals

1.1. The MMO is satisfied that SOWF has adequately demonstrated there will be no significant change in impact for marine mammals from what was assessed in the original Environmental Statement (ES).

2. Fish

The following comments provided in the section are made in specific reference to the updated noise modelling provided in Appendix A to the SoCG:

2.1. Major Comments

2.1.1. The MMO maintains its position that the 186 dB SELcum threshold, as per the Popper et al. (2014) criteria, for assessing the onset of Temporary Threshold Shift (TTS) should not be used as a substitute for assessing behaviour.

2.1.2. The MMO welcomes the updated modelling that was provided in Appendix A to the SoCG that modelled predicted impact ranges for TTS based on a stationary receptor. This was provided response to MMO's comments set out in point 8 of Appendix B to the SoCG. The MMO acknowledges SOWF's position that a stationary fish model is not representative of how an active fish such as herring is likely to respond if disturbed. However, in the absence of empirical scientific evidence to support the assumption that a fleeing response to noise occurs in fish, the MMO considers it appropriate to adopt the precautionary principle and undertake modelling based on a stationary receptor.

2.1.3. The MMO acknowledges that a direct comparison cannot be made between the updated modelling and original modelling used to inform the Environmental Statement (ES), due to the different metrics and impact criteria. Nonetheless, using the updated modelling, the MMO considers that the updated impact ranges for fish predicted for a 5,500 kJ hammer energy scenario are greater than those ranges predicted within the ES, as the potential effects can be expected at much larger distances than what was originally predicted.

2.1.4. The impact ranges presented in Figure 1 of the SoCG predict that effects of noise and vibration will extend to the outer areas of broad-scale habitat for herring spawning, based on Coull *et al.* (1998).

2.1.5. However, by taking an evidence based approach using 10 years of International Herring Larvae Surveys (IHLS) data, herring larvae are shown to be in their highest concentrations further west, towards Flamborough Head.

2.1.6. Using the modelled data presented in Appendix A to the SoCG, the distance between the closest point of predicted impact range and the higher concentrations of herring larvae is approximately 20-30km. The MMO considers that the distance offers gravid herring and their eggs and larvae some additional buffer against potential impacts of noise at the SOWF. However, MMO also recognises that herring spawning grounds can be recolonised over time, and the exact locations for herring spawning change year on year, so there is potential for spawning activity to extend eastwards towards SOWF.

2.1.7. Consequently, the MMO does not agree that the impact of underwater noise is negligible, and that impacts to gravid herring and their eggs and larvae are still possible. However, the MMO does consider that the supporting information adequately demonstrates that the risk of a significant impact is unlikely to be high, and is therefore is content that the increased hammer energy of 5,500kj

can be used in the construction method statement.

2.2. **Minor comments**

2.2.1. It would be useful if the MMO is informed of the results of underwater noise monitoring using the 5,500kJ hammer energy on commencement of piling events at the Sofia OWF site, so that comparisons between results and the modelled predictions could be made.

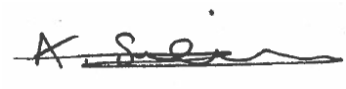
2.2.2. The MMO recognises that the applicant has provided modelling in Appendix A based on a stationary receptor due to lack of evidence available to support a fleeing response in fish, however MMO notes that the impact on eggs and larvae has also been considered, which would also be considered as stationary receptors.

2.2.3. The MMO also notes that an assumption that fish will flee if disturbed overlooks biological drivers including spawning and migration which result in a necessity to spawn at a certain time or in a particular location.

Conclusion

Based on the updated modelling based on a stationary fish receptor, and having regard to best available evidence to consider the impact on spawning herring at Flamborough Head, the MMO considers that the risk of a significant impact is sufficiently low that a maximum hammer energy of 5,500 kJ can be used in the construction method statement.

Yours sincerely,



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Appendix A

Questions raised by Innogy on underwater noise assessments on fish receptors

The questions below were raised during a teleconference on 7 November 2018 with Innogy discussing the modelling that would be required to support the request to increase the maximum hammer energy to a maximum of 5,500kJ, following concerns that were raised by the MMO regarding the likely impacts on spawning fish, and following a request to model impacts based on a stationary receptor.

During the call, Innogy agreed to explore the option to undertake collaborative work with Cefas to develop realistic parameters for modelling the impact ranges of underwater Nosie on fish.

On the basis of this, Innogy have asked the following questions.

- Can CEFAS clarify the objective of the proposed methodology? For example, are they aiming to provide threshold underwater noise levels for TTS and behaviour specific to piling to use in assessments (currently not available with the Popper et al (2014) criteria as TTS values for piling are based on seismic airgun studies and there are no threshold values for behaviour)? Are they proposing a different approach?

- What specifically are Cefas concerned about that isn't already provided for (lethal / injury / behaviour)? We do have the relevant information for injury and damage to eggs and larvae through latest Popper et al 2014 report. More recently data on disturbance on sensitive species (herring) from air guns has been used to define behavioural effects in some cases.

- We note that CEFAS has identified that modelling using a stationary receptor should be undertaken if no evidence can be provided for fish fleeing speeds. However, we consider that modelling for a stationary receptor would provide over-precautionary unrealistic output and as such an approach is likely to require bespoke computational modelling (with associated cost and time implications) based on agreement of parameters and this would require further research and discussion to progress. How do CEFAS see this modelling approach being appropriately defined and what input is required from developers as part of the model development?

- What is the evidence to suggest that this approach is better than the existing approaches taken? Is it 'better science'?

- Are Cefas seeking to undertake specific experiments relevant to piling within UK waters to provide greater empirical basis for informing threshold assumptions?

- Are Cefas seeking to identify a useful metric that aids in identifying the proportion of individuals that may react but for which habituation or context may limit duration and/or extent of effect…some sort of measure that takes account of species sensitivity…or a contour that identifies likely strong avoidance reaction by all individuals?

- What is going to be the starting point for this – previous thresholds (e.g. McCauley et al 2000, Popper et al 2014) or will it be a completely new start?

- How will the known differences in fish reactions when engaged in specific activities be taken into account (there are plenty of studies already show that fish are less responsive to noise/vessels when spawning or feeding than if they are just swimming around)?

- Is it going to be a fixed threshold or will they attempt to define dose response curves?

- Which species are the focus of the study?

- What information would be needed from the Developer to conduct the assessment?

If Cefas are developing the methodology, once the method has been drafted, will interested parties (including industry) be able to comment again? Will it be peer reviewed?

MMO Response

Major Comments

1. Cefas are not currently developing any new methodology for modelling underwater noise impact on fish. Cefas do not currently have any plans to undertake specific experiments relevant to piling within UK waters. Nor is Cefas currently seeking to identify a useful metric that aids in identifying the proportion of individuals that may react but for which habituation or context may limit duration and/or extent of effect.

2. The primary concern is that the underwater noise modelling for fish is based on a fleeing, rather than a stationary receptor. It is recognised that fish will likely respond to a loud noise source, and reactions have been observed such as schooling more closely or moving to the bottom of the water column, burying in substrate. Hawkins et al. (2014) for example, report changes in density of fish within a school, or a depth change in pelagic species in response to noise (percussive pile driving playback).

3. However, the responses highlighted in point 2 do not provide evidence to support fleeing (which, under the current assumptions in the assessment, requires a receptor to flee directly and consistently from the source over the large effect distances predicted). In the absence of evidence to support the fleeing assumption, the MMO cannot be confident that modelling that assumes a fleeing response will

not produce unrealistically small impact ranges. Given this uncertainty, the MMO considers that modelling should be based on a static receptor.

4. Furthermore, consideration should also be given to eggs and larvae which are vulnerable to barotrauma and have reduced mobility, and developmental effects have also been observed (see Hastings and Popper, 2005).

5. MMO acknowledges the developer's position that modelling for a stationary receptor would provide over-precautionary unrealistic output, and that a more realistic model is likely to require bespoke computational modelling (with associated cost and time implications) based on agreement of new parameters. The MMO advises that as the modelling based on a static receptor has now been reviewed and accepted, further development of such a model is not required for this project.

6. The MMO acknowledges there may be some potential in the future to develop bespoke modelling, as scientific understanding of fish responses to noise and the implications of any responses to noise advances. This may indeed take into account factors such as behavioural responses and dosage dependency, depending on the evidence available. Until such a time, it is recommended that modelling is undertaken based on a stationary receptor.

7. The MMO previously discussed the potential for assessing potential behavioural effects for fish, by providing the received levels of single pulse Sound Exposure Level (for example, at a particular spawning ground or habitat of concern) based on the worst-case scenario. An assessment can then be made on the potential risk of impact, with reference to the peer-reviewed literature.

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Department: Consents
Your reference: DCO/2014/00013
Date: 28 September 2018
Our reference: ECO DOC No. 002753118-01
Contact: Harriet Thomas
Phone: +44 (0) 7827 982935
E-mail: harriet.thomas@innogy.com

DRAFT

Dear Ms Opel,

Re: Sofia Offshore Wind Farm – Non material change application to the Development Consent Order (DCO)

We are writing in reply to the Marine Management Organisation's (MMO) consultation response on the Sofia Offshore Wind Farm (OWF): Non Material Change (NMC) Application dated 14 August 2018. This letter provides our response to the points raised.

Innogy had a teleconference with Natural England on 26 September where are number of key points related to the assessments undertaken for the NMC were agreed. Where appropriate, this letter refers to the agreements that have been reached with NE which will be confirmed in Innogy's written response to NE's comments on the NMC application.

General marine mammal comment

The response from the MMO for marine mammals principally refers to mitigation for reduction of impacts from the cumulative exposure to piling noise. Innogy would like to refer to the requirement under the deemed Marine Licences (dMLs) (schedules 9 and 11 of the DCO) for the production of the Marine Mammal Mitigation Protocol (MMMP).. Within the dML conditions, there is a requirement for the MMMP to ensure that the undertaker demonstrates that measures are in place (if required) to ensure there will be no adverse effect on integrity of the (Southern North Sea Site of Community Importance) SNS SCI[1]. As part of the preparation of this MMMP consideration of available mitigation will be required to ensure that it adequately mitigates the risk to marine mammals. The MMMP will need to demonstrate that it includes whatever mitigation necessary to reduce the risk of Permanent Threshold Shift (PTS) effects to acceptable (negligible) levels. This will also involve, as appropriate, applications for

[1] "A marine mammal mitigation protocol with appropriate monitoring surveys in accordance with the offshore in principle monitoring plan, to be agreed in writing by the MMO in consultation with the relevant statutory nature conservation body and the Royal Society of Wildlife Trusts(**a**), the intention of which is to prevent, amongst other things,…….
…..adversely affecting the integrity, within the meaning of the Offshore Marine Conservation (Natural Habitats, &c.) Regulations 2007(**a**), of a European offshore marine site or a European site (defined in regulations 15 and 24 of those Regulations respectively), to the extent that marine mammals are a protected feature of that site"

European Protected Species (EPS) licences with the necessary supporting information to meet the three legal tests.

It should be noted that this mitigation would have been required if no change was proposed to the hammer energy levels secured within the DCO. It is appropriate that the MMMP is developed post-consent and during the detailed design phase of the project such that the actual up-to-date effects of construction and operation can be appropriately mitigated. This is supported by paragraph 12.21 of the Secretary of State's (SoS) Appropriate Assessment (AA) (2015) where it is stated "*NE, in their written response on the 20th November 2014, highlighted that due to the use of a Rochdale envelope the eventual project design may alter and the proposed mitigation allows them to ensure appropriate mitigation in accordance with final details at a later date*". The MMMP will also consider the output of the ongoing BEIS Review of Consents for the Southern North Sea Special Area of Conservation (SAC) if available. The MMMP will be prepared in consultation with regulators.

During the teleconference on 26 September between Innogy and Natural England, Natural England advised that they are satisfied that the MMMP, required under the DCO and deemed Marine Licence, will address mitigation for noise propagation for the project alone and cumulatively/in combination and note that this may include noise reduction measures.

Detailed responses to comments

Innogy notes that most of the comments from the MMO relate to the consideration of effects on fish receptors. The MMO should note that the purpose of the Sofia Offshore Wind Farm Appendix C: Environmental Appraisal of Increased Hammer Energy Addendum: Assessment of fish receptors report (referred to as the Environmental Appraisal) is to establish whether the conclusions of the original Environmental Impact Assessment (EIA), Habitats Regulation Assessment (HRA) and AA remain valid given the proposed increase in hammer energy for monopole foundation solutions.

Innogy would highlight, as cited within the Environmental Appraisal report, that the MMO agreed with the assumption in the ES that installation of pin piles represents the worst case scenario for fish (when compared to monopole foundations) on the basis that the greater temporal effect but slightly reduced propagation range associated with a high number of pin pile foundations was more significant in EIA terms than a greater propagation range but reduced temporal effect associated with the monopoles.

Innogy refers the MMO to the Statement of Common Ground that was signed during the Dogger Bank Teesside A & B (as Sofia was known at that stage) DCO examination. The document can be found here: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010051/EN010051-001322-Forewind%20-%20SocG%20with%20MMO.pdf . The agreed statement referred to is ID 5-D-1 within the SoCG.

Given that the total consented number of pin piles has not changed and that the hammer energy for pin piles is not increasing, the worst case assumptions and assessment as presented in the ES remain valid and no further assessment was needed for the NMC application.

However, following consultation with the MMO further information on noise propagation for fish for the increase in hammer energy was presented in the Environmental Appraisal for context only. The

modelling work undertaken to inform the assessment presented within the Environmental Appraisal followed a 'like for like' approach (as far as reasonably practicable),using methods used within the EIA which the MMO agreed for the DCO through the pre-application and Examination stages.

It should also be noted that Natural England in their response to the NMC application (24 July 2018 stated "*Natural England is content that the potential for fish and shellfish to be impacted by noise was adequately considered within the ES and it remains so. This decision is based on the fact that the maximum duration of piling events were considered in the original ES rather than the noise associated with a single piling event. In the ES, the maximum duration of piling events (202 days) was based on the piling duration for pin-pile (multi-leg) foundations which is significantly greater than the 71 day piling duration required for 200 WTG monopole foundations. We are therefore content that the impacts remain within the WCS assessed within the original ES".* During the teleconference on 26 September between Innogy and Natural England, Natural England further agreed no further assessment was required for the NMC application for fish and shellfish.

Given the nature of the NMC application and the previous agreements with the MMO regarding methodology and assessment conclusions Innogy does not consider it appropriate for the assessment of fish receptors to be reconsidered within the NMC application process. It is also important to note that the worst case assumption made in the ES which accompanied the DCO application has not been amended by the NMC application.

Notwithstanding this, Table 1 provides Innogy's detailed responses to matters raised by the MMO.

Yours faithfully,

Harriet Thomas
Offshore Consents Manager
Sofia Offshore Wind Farm Limited

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Table 1: Innogy's response to the Marine Management Organisation queries

MMO comment	Innogy Response
Underwater Noise: Appendix B – Environmental Appraisal of Increased Hammer Energy:	
1. There was only a small increase in impact ranges for low-frequency cetaceans for Permanent Threshold Shift (PTS) (60 m for 5,500 kJ compared to 50 m the 3,000 kJ). Clarification for this small increase should be provided.	The value provided for 3,000 kJ was "less than" 50 m: there is considerable uncertainty in acoustic modelling in this 'near field' of less than 50 m so the distance is not stated to a greater degree of accuracy. Thus the distance of "<50m" is likely to be around 30m to 40m and therefore the increase caused by the 5,500kJ hammer energy would be more likely to be around 20/30m rather than the apparent 10m increase that the model outputs would suggest.
2. It is appropriate that the new criteria as set out by the National Oceanic and Atmospheric Administration 2016 (NOAA) have been considered in the assessment, which reflects recent advances in the scientific literature. Tables 6.17-6.18, 6.20-6.21, 6.23-6.24 and 6.26-6.27 compare the NOAA c [remainder of sentence missing] 3. Criteria against the original ES criteria (e.g. Lucke or Southall) and show the percentage change between the maximum impact risk ranges. However, it should be noted that the assessment is comparing criteria which apply two different metrics (single strike SEL vs SPLpeak). Therefore, a straightforward comparison cannot be made.	Acknowledged, and Innogy agree that it is correct to state that the single pulse metrics of SEL_{ss} and SPL_{peak} describe a sound in a different way, although they both attempt to derive a range for the same effect using a single sound impulse. The National Marine Fisheries Service (NMFS) criteria (i.e., NOAA criteria) represent the most up to date criteria dataset. Innogy are conscious of the limitations of comparing different modelled metrics (as it does not provide an exact like for like exercise), however, Innogy believe that the approach taken is consistent with standard industry practice (as applied on a number of recent Projects that are in a similar position to the Sofia Offshore Wind Farm such as Triton Knoll (i.e., consented but as yet constructed projects whose ES' were developed pre- NOAA criteria)) and is the best available option to enable a comparison between original modelling and contemporary modelling. The direct comparison of the 3,000kJ and 5,500kJ hammer has been made in Section 6.3 of the Environmental Appraisal report. However, given that the assessment criteria have been updated by NOAA, Innogy considered this was a useful comparison to make. Innogy would stress that the key point is whether the change in hammer energy results in a significant change in the impact assessed between the original application and NMC application and this has

MMO comment	Innogy Response
	been demonstrated not to be the case.
Appendix B – Auditory Injury Assessment: cumulative exposure to piling noise:	
4. The proposed mitigation to reduce the risk of impact includes the standard 500 m mitigation zone and the use of acoustic deterrent devices (ADDs). For harbour porpoise, the report highlights that "ADDs have been shown to substantially reduce the number of harbour porpoise up to 5 km to 10 km from the ADD, with a complete deterrence range of at least 1.1 km and a deterrence efficiency of 88% out to 15 km". For minke whales, the report states that "ADDs have been shown to successfully deter minke whales at ranges of at least up to 1.5km (and possibly larger ranges as whale were not tracked beyond this range)". 5. Whilst ADDs may be effective in reducing the risk of PTS for harbour porpoise for the 5,000 kJ monopile scenario (impact range of 930 m), there is uncertainty over the larger impact ranges for the 2,300 kJ pin pile scenario, where distances of 6.5 km are predicted. Similarly, ADDs cannot be relied upon as an appropriate mitigation measure for minke whales, given the predicted impact ranges (9.5 km for PTS). Large Temporary Threshold Shifts (TTS) ranges are predicted for all marine mammals, particularly low frequency cetaceans. ADDs will simply not be effective out to these ranges.	Innogy maintain their position with regard to efficacy of ADDs on marine mammals and welcome the recognition that they may be effective at adequately mitigating PTS risk for harbour porpoise with a 5,500kJ hammer. It should be noted that this NMC document relates to a hammer energy increase for monopoles only and therefore, comments relating to pin pile (i.e., the 2,300kJ scenario) are not strictly relevant to the application. Notwithstanding that Innogy note the concerns with regard to the 2,300kJ hammer energy PTS ranges for harbour porpoise with jacket foundations and would emphasise that the studies that identified 88% efficiency at 15km also noted (Brandt et al 2012[2]) significant deterrence out to 7.5km and therefore, ranges equal to or below this should be considered within mitigation range. Innogy do not consider that complete deterrence is the threshold for the MMMP, rather it is considered standard practice for them to reduce impacts to acceptable (negligible) levels. Innogy recognise that under a 5,500kJ hammer energy scenario for minke whale, a detailed consideration of risk will be required when developing the MMMP, and if necessary measures will be taken to ensure that appropriate mitigation is applied under the MMMP to adequately reduce the PTS risk. The nature of any such mitigation will be developed in consultation with the MMO and its advisors at that juncture (which will not be until after the project has secured a CfD and the specifics of the proposed likely construction methodology and programme is better known).

[2] Brandt, Miriam & Hoeschle, Caroline & Diederichs, Ansgar & Betke, Klaus & Matuschek, Rainer & Witte, Sophia & Nehls, Georg. (2013). Far-reaching effects of a seal scarer on harbour porpoises, Phocoena phocoena. Aquatic Conservation Marine and Freshwater Ecosystems. 23. 222-232. 10.1002/aqc.2311.

MMO comment	Innogy Response
	Innogy note that the function of a MMMP is to mitigate against PTS and not TTS effects.
6. ADDs introduce additional acoustic disturbance in the marine environment, and the extent of marine mammal displacement from ADDs may exceed the range of displacement from the activity itself if noise abatement measures are applied (Dähne et al., 2017). Noise abatement measures, such as big bubble curtains and acoustic barriers, reduce the amount of noise pollution emitted at source. The MMO expect to see such source mitigation considered as a primary means of reducing the potential acoustic impact of pile driving operations.	The regulation of underwater noise in the UK does not currently restrict specific levels of noise (as is the regulatory practice in countries such as Germany, for example). Rather, the EIA and HRA processes inform whether any specific mitigation is required. The work undertaken by Innogy with respect to this NMC application has demonstrated that (in EIA and HRA terms) the increase in hammer energy does not result in a change to the existing EIA, HRA and AA conclusions. On the basis of these conclusions (which it is noted are not disputed by the MMO in their response) and given that the MMO reached agreement with the applicant during the DCO Examination phase of the project that EIA, HRA and AA (with respect to underwater noise) were acceptable on the basis on which they were proposed (noting that potential use of ADDs were included as part of the mitigation options), then it is considered unnecessary to suggest new mitigation is merited as part of the NMC application.
Appendix C – Assessment of fish receptors:	Innogy reiterates that the purpose of the Sofia Offshore Wind Farm Appendix C: Environmental Appraisal of Increased Hammer Energy Addendum: Assessment of fish receptors report (referred to as the Environmental Appraisal)[3] is to establish whether the conclusions of the EIA and HRA remain valid given the proposed increase in hammer energy for monopole foundation solutions. Innogy points out, as cited within the Environmental Appraisal report, that the MMO agreed with the worst case assumption in the ES that installation of pin piles represent the worst case scenario for fish (when compared to monopole

[3] https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010051/EN010051-002279-SOWF-DCO%20NMC%20Application%20June%202018%20-%20Appendix%20C%20-%20Environmental%20Appraisal%20of%20Increased%20Hammer%20Energy%20Addendum%20Assessment%20of%20fish%20receptors.pdf

MMO comment	Innogy Response
	foundations) on the basis that the greater temporal effect but slightly reduced propagation range associated with a high number of pin pile foundations was more relevant in EIA terms than a greater propagation range but reduced temporal effect associated with the monopoles. Innogy refers the MMO to the Statement of Common Ground that was signed during the Dogger Bank Teesside A & B (as Sofia was known at that stage) examination. The document can be found here: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010051/EN010051-001322-Forewind%20-%20SocG%20with%20MMO.pdf. The agreed statement referred to is ID 5-D-1 within the SoCG. Given that the total consented number of pin piles has not changed and that the hammer energy for pin piles is not increasing, the worst case assumptions and assessment as presented in the ES remain valid and no further assessment was needed for the NMC application. However, following consultation with the MMO further information on noise propagation for fish for the increase in hammer energy was presented in the Environmental Appraisal for context only. The modelling work undertaken to inform the assessment presented within the Environmental Appraisal followed a 'like for like' approach (as far as reasonably practicable),using methods used within the EIA which the MMO agreed for the DCO through the pre-application and Examination stages. It should also be noted that Natural England in their response to the NMC application (24 July 2018 stated "*Natural England is content that the potential for fish and shellfish to be impacted by noise was adequately considered within the ES and it remains so. This decision is based on the fact that the maximum*

MMO comment	Innogy Response
	duration of piling events were considered in the original ES rather than the noise associated with a single piling event. In the ES, the maximum duration of piling events (202 days) was based on the piling duration for pin-pile (multi-leg) foundations which is significantly greater than the 71 day piling duration required for 200 WTG monopole foundations. We are therefore content that the impacts remain within the WCS assessed within the original ES". During the teleconference of the 26 September between Innogy and Natural England, Natural England further agreed no further assessment was required for the NMC application for fish and shellfish. Given the nature of the NMC application and the previous agreements with the MMO regarding methodology and assessment conclusions Innogy does not consider it appropriate for the assessment of fish receptors to be reconsidered within the NMC application process. It is also important to note that the worst case assumption made in the ES which accompanied the DCO application has not been amended by the NMC application.
7. Some clarifications are required for Table 5.3 (shown below for reference): a. There is no such thing as SELpeak, this should be the peak Sound Pressure Level (SPL). Note, the references to SELpeak should also be amended in the subsequent text. b. The second (white) rows showing the impact ranges for the peak SPL of > 207 dB re 1 µPa are presumably for fish with swim bladders not involved in hearing and fish with swim bladders involved in hearing (not fish with no swim bladder). This needs clarification.	a. Innogy note the comment raised by the MMO and confirm that the wording should have referred to SPLpeak and not SELpeak. b. This table is incorrectly labelled: the >207 dB SPL_{peak} thresholds are set for species of fish with a swim bladder, both where the swim bladder is and is not involved with hearing (see Table 5.1). Therefore, the white rows are for fish with swim bladder (all types) as distinct from the rows above.
8. Table 5.4 shows very small (<50 m) SELcum impact ranges for	The ranges modelled for recoverable injury or mortal injury are low as a

MMO comment	Innogy Response
mortality and recoverable injury for fish receptors (except for recoverable injury in fish with swim bladder involved in hearing), presumably because the model has assumed a fleeing speed of 1.5 ms-1. This fleeing speed has not been supported by references. However, the MMO is not aware of scientific evidence which would support fleeing in fish. Such evidence should be provided, or alternatively the effects on fish should be modelled for stationary animals. Sizeable effect zones are predicted for TTS in fish, up to 21.8 km for a hammer energy of 5,500 kJ.	consequence of both the relatively high noise thresholds (i.e. generally in excess of 200 dB SEL_{cum}) and the fleeing aspect. Clearly the TTS ranges for a stationary fish receptor will be considerably greater than those calculated for injury, although it is worth noting that the TTS ranges defined are for the most species most sensitive to sound, and others will be less than, or much less than, this calculated range (see response to point 19 d below).
9. Behavioural effects have been assessed using the Popper et al. (2014) TTS impact criterion and comparing the results to those predicted in the ES for demersal and pelagic species in response to a peak level of 173 dB re 1 µPa (based on data from McCauley et al. (2000) and Pearson et al. (1992) for behavioural response in fish). The following statement is made in the report: *In order allow for an examination of the impact of an increased hammer energy, the TTS impact criterion has been selected as the closest possible comparison to the possible avoidance response modelled by NPL. It has previously been demonstrated to and recognised by the MMO and Cefas (in relation to other offshore wind farm developments) that the modelled noise propagation contours for both the 186Db SELcum metric threshold and the 168dB SPLpeak metric threshold as identified by McCauley et al. (2000) and defined as representing the outer limit for moderate disturbance, are comparable in terms of spatial extent. Although the metrics themselves are not analogous, the areas of potential effect generated by the modelling can be used to inform the assessment of both criteria in general terms. This comparative approach has been developed in relation to other offshore wind farm developments where it has not been possible to carry out exactly like-for-like modelling.*	Innogy recognise the constraints of comparing different metrics. However, Innogy consider it (in the context of the Environmental Appraisal and its purpose i.e. to identify if new, materially different, likely significant effects are occurring as a result of the proposed change) to be a reasonable, robust approach. Innogy consider that it is important to recognise the full statements made in Appendix C to the Environmental Appraisal in relation to behavioural effects rather than the selected statement provided here. For avoidance of doubt the full statement read: *As Popper et al. (2014) concluded that there is insufficient data available to apply quantitative thresholds for behavioural effects of noise on fish, a direct comparison of the NPL and INSPIRE model output is not possible, given that different metrics were calculated. Therefore, in order allow for an examination of the impact of an increased hammer energy, the TTS impact criterion has been selected as the closest possible comparison to the possible avoidance response modelled by NPL. It has previously been demonstrated to and recognised by the MMO and Cefas (in relation to other offshore wind farm developments) that the modelled noise propagation contours for both the 186dB SELcum metric threshold and the 168dB SPL metric threshold as*

MMO comment	Innogy Response
10. It is possible that for another wind farm, similar contours were produced. However, these are different metrics and to be clear, a threshold to assess TTS in fish cannot be used as a substitute for assessing behaviour. Furthermore, and more importantly, the cumulative exposure will vary depending on the location and the exposure time.	*identified by McCauley et al. (2000) and defined as representing the outer limit for moderate disturbance, are comparable in terms of spatial extent. Although the metrics themselves are not analogous, the areas of potential effect generated by the modelling can be used to inform the assessment of both criteria in general terms. This comparative approach has been developed in relation to other offshore wind farm developments where it has not been possible to carry out exactly like-for-like modelling. Using the INSPIRE model, the maximum range of TTS (all fish) unwtd SELcum of 186 re 1 µPa^{2}s was found to be 21.8 km for a hammer energy of 5,500 kJ, which is within the range of propagation distances predicted within the ES modelling for both demersal and pelagic species in response to a peak level of 173 dB re 1µPa (Table 4.1, above). As previously stated, the ES considered that the temporal disturbance from construction noise has a greater effect on fish and shellfish than the maximum range disturbance. The worst case scenario outlines a piling duration of 202 days for pin pile installation, which is significantly greater (185%) than the 71 days required for monopole installation and therefore, this component of the impact magnitude will be greatly reduced.* *Accordingly, it is the conclusion of this assessment that there is no evidence to suggest that the magnitude of effect on fish receptors (as presented in the original ES and agreed to by the MMO) would increase as a result of the proposed increased maximum hammer energy to 5,500 kJ. As a result the impact assessment as presented in the original ES and summarized in Table 4.2 above, remains a valid worst case assessment.* Accordingly, Innogy reasserts its position that the agreed worst case scenario (based on jacket foundations) remains valid and that a detailed assessment into effects on fish from monopole foundations is not necessary. Furthermore, and notwithstanding this point, even when monopole foundations with a hammer energy of 5,500kJ are considered, a sound justification has been presented to demonstrate that no greater impacts would occur on fish receptors than presented in the ES (which as presented within Section 6.9 of

MMO comment	Innogy Response
	Chapter 13 Fish and Shellfish Ecology (Application Ref 6.13) were concluded to be between negligible and minor).
11. The Popper criteria do not quantitatively address behavioural responses. Behavioural effects are particularly difficult to assess, since they are highly dependent on behavioural context (Ellison et al. (2012) and responses may not scale with received sound level (Gomez et al., 2016). Thus, there is considerable uncertainty in assessing the risk of behavioural responses, and it is recommended that the application of simplistic sound level thresholds for behaviour should be avoided. Nevertheless, generally speaking, we can expect behavioural impact ranges to be larger than those presented for TTS	It is agreed that the behavioural effect ranges may well extend beyond that of TTS, although at distances of beyond 10 km, the behavioural effect is likely to be limited. Popper *et al.* (2014) states the risk of behavioural effects in relation to offshore pile driving for most species of fish at these ranges is low. The uncertainty, recognised by the MMO for further evaluation of disturbance using the application of simplistic sound threshold levels, is noted.
12. Eggs and larvae have not been considered although the relevant thresholds for this group have been modelled in Tables 5.3 and 5.4 (thresholds are the same as for fish with swim bladders not involved in hearing).	It is noted that "Eggs and larvae" were not considered within the original ES and the scope of that assessment was agreed with the MMO. All effect ranges presented within Table 5.3 and 5.4 for fish with no swim bladders are within a few hundred metres of the noise source, and therefore, if any eggs or larvae were present in the region of the development, significant impacts would not be anticipated (given the context of the likely wide spread distribution of such receptors, as indicated in the ES). Please also refer to our response to comment 19.a below.
13. The report concludes that the significance of these impacts will be no greater than that concluded within the original ES, when a 5,500 kJ maximum hammer energy is applied for monopile foundations. Given the uncertainty over the SELcum assessment and potential effects on behaviour, the MMO is unable to say at this time that we agree with the conclusion.	Innogy refer the MMO back to the original agreed position reached during the DCO Examination as set out in the Statement of Common Ground (see above) where it was established that pin pile effects related to the worst case scenario for fish (i.e. the greater temporal effect but slightly reduced propagation range associated with a high number of pin pile foundations was more relevant in EIA terms than a greater propagation range but reduced temporal effect associated with the monopoles). As no change to the total number of pin piles has been proposed through the NMC application, the worst case assessment

MMO comment	Innogy Response
	still stands. The conclusion that the greater temporal effect but slightly reduced propagation range associated with the higher number of pin pile foundations should remain valid as a worst case, is further supported by the outputs of the modelling of increased hammer energy as presented within the Environmental Appraisal. The modelling has demonstrated that the noise propagation ranges from the increase in hammer energy to 5,500kJ are not materially different from the outputs for 3,000kJ. This clearly demonstrates that there will be no new, or materially different, likely significant effects from the increase in hammer energy. SELcum outputs were all within 50m of the piling noise source (see Table 5.4). Even given the uncertainties associated with SELcum outputs, it would take an increase well in excess of 100% in the 5,500kJ hammer energy outputs for them to exceed the SPLpeak outputs for the 3,000kJ (Table 5.3). The SPLpeak outputs (for the 5,500kJ hammer energy) are comparable with the original ES and those conclusions were considered not to be significant in EIA terms (a conclusion to which the MMO agreed in the DCO Examination).
Fisheries:	
14. The use of pin piles will result in a longer period of piling (202 days), and whilst the MMO agree that the use of pin piles could result in a potential overlap with more than one spawning season of some fish species, the MMO do not currently agree with the statement that the temporal aspect of underwater noise is considered to have the greatest effect on fish and shellfish species, as it does not consider the particular sensitivities of individual receptor groups or species.	As noted above, Innogy refers the MMO to the signed Statement of Common Ground for the Dogger Bank Teesside A& B (as Sofia was known at that stage) examination. The document can be found here: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010051/EN010051-001322-Forewind%20-%20SocG%20with%20MMO.pdf. The agreed statement referred to is ID 5-D-1 within the SoCG.

MMO comment	Innogy Response
15. During the pre-application and application stage, herring was identified as a main species of concern in terms of impacts from noise and vibration from piling operations. Here the Flamborough Head herring spawning ground located off the coast of Yorkshire is considered the main spawning area for the central North Sea Banks herring stock. 16. The impact ranges shown in Tables 5.3 and 5.4 are not discussed in the context of their proximity to the Flamborough Head spawning grounds. Noise contours must be presented, ideally in map form, with the spawning and nursery grounds of herring presented alongside or overlaid. Ten years of International Herring Larval Survey (IHLS) data should be used to inform this, and data is now available up to 2018. 17. Alternatively, as a minimum, the distance (in m/km) between the Flamborough Head spawning grounds and the nearest point where piling operations will take place should be described and discussed in the context of the predicted impact ranges shown in Tables 5.3 and 5.4. 18. Information on the requirements for pin piling/monopiling for offshore substations along the export cable route is also required, either as part of the discussion, or shown in a contour map. You should also consider whether piling requirements associated impact ranges for offshore converter stations, offshore collector platforms, met masts and accommodation platforms will potentially overlap with herring spawning grounds.	The noise contours cited in Table 5.3 and 5.4 extend to a maximum of 21.8km (TTS all fish uwtd SELcum in Table 5.4). The Project lies in excess of 80km from the Flamborough Head grounds (as identified in Figure 6.5 of the fish chapter of the ES, located here: https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010051/EN010051-000288-6.13%20ES%20Chapter%2013%20Fish%20and%20Shellfish%20Ecology.pdf). This is a significant distance (greater than 58km) from the maximum possible extent modelled within Table 5.4, and therefore, Innogy confirm that there will be no effects on the herring grounds resulting from the piling within the array area. It is noted that concerns raised during the DCO Examination of the project, with regard to Flamborough Head herring spawning related solely to the cable installation works (that may pass through it) and not underwater noise from foundation piling. No changes to the location of offshore substations or works along the export cable are proposed within the NMC application and as such, no further assessment is required.
19. Table 5.4 presents predicted impact ranges for fish using criteria from Popper et al. (2014) using an assumed fleeing swimming speed of 1.5ms-1. There are a number of issues with this table; a. Eggs and larvae have not been included in the assessment using	a. The only quantitative SEL_{cum} criterion for eggs and larvae is for mortality. An INSPIRE run (undertaken internally by Subacoustech in 2018) assuming a stationary receptor suggests that this could occur over 1000 to 2000 metres. It should be noted based on the qualitative criteria for eggs and larvae, that there is only a “moderate” risk of recoverable injury near (i.e. tens of metres)

MMO comment	Innogy Response
criteria from Popper et al. (2014). A revised assessment which includes this receptor group should be provided and this should be based on stationary response as they are an immobile receptor. b. Impact ranges are listed for; i. Mortality - fish with no swim bladder ii. Recoverable Injury – fish with no swim bladder iii. Mortality – fish with swim bladder not involved in hearing iv. Mortality – fish with swim bladder involved in hearing v. Recoverable injury – fish with swim bladder c. The impact ranges of recoverable injury for fish with swim bladder involved in hearing is missing from the table. The table should be amended to include this receptor group or an explanation provided as to why it has been omitted. d. An assumed fleeing swimming speed of 1.5ms-1 has been used for fish as a receptor. Evidence in the form of scientific publications must be presented to support the fleeing swimming speed of 1.5ms-1 (this is discussed in more detail under section 7).	to the pile and at all other ranges the risk is low. This range should therefore be considered highly precautionary. b. It should be noted that some noise thresholds apply for multiple categories: e.g. recoverable injury for "fish with swim bladder not involved in hearing" and recoverable injury for "fish with swim bladder involved in hearing" are both 203 dB SEL_{cum}. Hence "v. fish with swim bladder" does not discriminate whether the swim bladder is involved with hearing. c. See b. d. The reference is Hirata K (1999). Swimming speeds of some common fish. National Maritime Research Institute (Japan). Data sourced from Iwai T, Hisada M (1998). Fishes – Illustrated Book of Gakken (in Japanese). Knowing that there will be substantial variation between species, 1.5 m/s has been used as a 'generic' flee swim speed in most recent equivalent assessments (Triton Knoll being a recent example).
Additional comments:	
1. Better signposting is needed in order to find the correct documents and relevant sections for the assessment of fish receptors.	Innogy acknowledge that better signposting may have made the NMC application documents easier for the MMO to navigate.

MMO comment	Innogy Response
2. On page 14 of 'Sofia Offshore Wind Farm Non-Material Change Application', the report refers to Appendix B; 'A detailed environmental appraisal of the increased hammer energy including potential impacts on marine mammals and fish has been carried out by SOWFL and is included in Appendix B* to this report.' 3. On page 21 of this document, there is a page titled 'Appendix B* Environmental appraisal of increased hammer energy' but there is no text afterwards, it's a blank page. 4. Furthermore, on page 6 of 'Sofia Offshore Wind Farm, Appendix B: Auditory Injury Assessment: cumulative exposure to piling noise', the report states that 'A further supporting report (Technical Report**, Doc Ref; 002668403-01) considers the noise exposure implications for fish receptors.' 5. The assessment of fish receptors is in Appendix C (not Appendix B*) i.e. Appendix C: Environmental Appraisal of Increased Hammer Energy Addendum: Assessment of fish receptors (it is not titled as a Technical Report'**).	Innogy can confirm that the documents supporting the application are as set out in Table 2 below. In reference to points 2 and 3, on page 21 of Sofia Offshore Wind Farm Non-Material Change Application: Environmental report (Ecodoc Reference 002642083-03) the document referred to as Appendix B is Appendix B-Environmental appraisal of increased hammer energy (Ecodoc Reference 002636963-02). A blank page was provided to refer to Appendix B but keep all reports separate for submission. In reference to points 4 and 5, innogy acknowledges unhelpful referencing. The technical report referenced is Appendix C: Environmental Appraisal of Increased Hammer Energy Addendum: Assessment of fish receptors (Ecodoc Reference 002668403-01).

Table 2 Sofia Offshore Wind Farm NMC application supporting documents:

Document title	Ecodoc reference	Appendices	Ecodoc reference	Appendices	Ecodoc reference
Sofia Offshore Wind Farm Non-Material Change Application: Environmental report	002642083-03	Appendix A-Offshore ornithology: Updated impact assessment for increased wind turbine blade diameter	002632249-02		
		Appendix B-Environmental appraisal of increased hammer energy	002636963-02	Appendix A- Additional underwater noise modelling at Sofia offshore wind	002669687-01

Document title	Ecodoc reference	Appendices	Ecodoc reference	Appendices	Ecodoc reference
				farm, Dogger Bank	
				Appendix B - Auditory Injury Assessment: cumulative exposure to piling noise	002668408-01
				Appendix C - Environmental Appraisal of Increased Hammer Energy Addendum: Assessment of fish receptors	002668403-01

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