ORJIP Project 4, Phase 1
Use of Deterrent Devices and Improvements to Standard Mitigation during Piling
Research Summary
Offshore Renewables Joint Industry Programme (ORJIP)

Assignment Number: L300100-S00
Document Number: L-300100-S00-TECH-004

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Client: ORJIP
Document Type: Technical Note
Document Number: L-300100-S00-TECH-004

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A02	06/11/2013	Issued for Use	AH	FP	AH	
A01	31/10/13	Issued for Use	AH	FP	AH	
R01	23/10/13	Issued for Client Review	AH	FP	SJS	
Rev	**Date**	**Description**	**Issued by**	**Checked by**	**Approved by**	**Client Approval**

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RESEARCH SUMMARY

Background

Offshore wind is expected to make a significant contribution to meeting the UK's 2020 renewable energy target and to decarbonisation ambitions beyond 2020. The central range for offshore wind deployment in DECC's Renewable Energy Roadmap[1] (2011) indicated up to 18 GW of offshore wind could be deployed by 2020. This would equate to approximately £36 billion of investment in new offshore wind farms (OWF). Uncertainty about impacts on marine mammals due to piling noise and the efficacy of mitigation presents a significant risk to this deployment target.

The UK Government has a legal obligation to adequately transpose the Habitats Directive[2] and enforce the strict protection afforded to cetacean species as European Protected Species (EPS), as well as Annex II species associated with Special Areas of Conservation. Failure to do so could expose the UK to legal action by the European Commission (EC) with a consequent risk, if failure is not addressed, of incurring infraction fines. Offshore wind farm developers have a legal obligation to carry out robust Environmental Impact Assessments (EIA) of their potential projects and, on Award of Consent, to monitor and manage potential impacts on marine mammals as specified in their Marine Licences. Failure to do so may result in fines or the revocation of said Marine Licences. The regulators and statutory nature conservation bodies (SNCB) have an overarching duty to oversee compliance with UK and EC regulations and directives. Breach of such requirements by any of these interested parties may ultimately create unacceptable financial and reputational risk to the UK taxpayer and offshore wind farm industry.

Consent conditions and the transposed environmental management measures must therefore strike a careful balance, be appropriate and proportional to the risks posed by the development of the project, allow the delivery of offshore wind projects which are technically and economically viable, have acceptable levels of environmental impact, and ultimately comply with legal requirements to maintain populations of EPS and Annex II species at a 'favourable conservation status' (effected through processes such as EPS licensing and Habitats Regulations Appraisal). There is therefore a high level of interest from all parties to have the right marine mammal mitigation protocols (MMMP) and guidance in place.

UK Guidance

To date the Marine Licences issued to OWFs within the English and Welsh territories have focused on the current piling protocol (JNCC, 2010b), which forms part of the more general guidance on EPS (JNCC, 2010a in prep). The JNCC protocol, which was considered best practice when produced, outlines three principal mitigation measures: two involve monitoring of a mitigation zone to ensure no animals are present, either visually using Marine Mammal Observers (MMO) or acoustically, using Passive Acoustic Monitoring (PAM), while the other one involves gradually ramping up the pile-driving force (soft start) to allow marine mammals to vacate the area. Each of these measures imposes inherent financial, schedule and health and safety risks during their implementation. There is also significant uncertainty among OWF developers and other stakeholders as to the effectiveness of these mitigation measures as they are currently employed.

Notwithstanding those uncertainties, the JNCC protocol is still generally considered fit for purpose for current small scale piling operations. The UK is however rapidly approaching the construction phase of its Round 3 (R3) and Scottish Territorial Waters (STW) OWFs, which have larger turbines, larger footprints, are more numerous and are located further offshore than previous rounds of OWF development. As a result, the potential impacts of piling on marine mammals are likely to be more complex, as are the risks associated with their mitigation. Partially in response to this evolution in scale of the UK OWF sector, the current EPS guidance (JNCC, 2010a in prep) is

[1] *The Renewables Roadmap indicates a central range that up to 18GW of offshore wind could be deployed by 2020. Figures from the 2011 DECC RO Banding Report show that 1 MW of installed capacity represents approximately £3million of investment. Note that an update to the roadmap is scheduled for release in November 2013.*

[2] *The EC Habitats Directive drives marine mammal protection, under which all species of cetaceans are listed on Annex IV as European Protected Species (EPS) and bottlenose dolphin, harbour porpoise, minke whale, grey and harbour seals are listed on Annex II. This legislation is transposed into the UK territories and offshore waters by respective Habitats Regulations (0 – 12 nautical miles) and the Offshore Marine Regulations (as amended 2009 and 2010) (> 12 nautical miles).*

being revised by Defra and Marine Scotland (separately due to the distinction between a disturbance offence in Scotland and the English and Welsh nearshore and UK offshore territories). It is therefore timely given the pending Rounds of OWFs and greatly expanded evidence base to revisit the current piling mitigation guidance (JNCC, 2010b) and develop a roadmap of research and policy related recommendations towards future-proofing any subsequent revisions to the JNCC marine mammal mitigation protocol (MMMP).

ORJIP Project 4

Marine Scotland, the Department of Energy and Climate Change (DECC), the Carbon Trust and The Crown Estate, along with the offshore wind development community are working together to implement an Offshore Renewables Joint Industry Programme (ORJIP) of works to fund and deliver strategic research projects to reduce consenting risk for offshore wind projects in UK waters. Addressing strategic evidence gaps is a high priority for the offshore wind sector as it will play a significant role in 'de-risking' future projects. The outputs of this proposed programme are required to inform both consent and licence applications and advice and decisions by the UK regulatory authorities.

ORJIP Project 4 is the first of the ORJIP programme of projects to be progressed. The specific aim of ORJIP Project 4 is to:

- Review, test and/or develop acoustic deterrent devices (ADDs) or other deterrent devices for multiple marine mammal species, thus reducing reliance on visual observations and increasing construction time available by removing daylight/sea state restrictions on piling activity;
- Conduct field tests in realistic conditions to provide evidence that such devices will provide the required level of risk reduction for the species concerned; and
- Develop protocol(s) for the use of ADD(s) as agreed with industry, advisors, regulators and Non Governmental Organisations (NGOs).

In June 2013, ORJIP commissioned Xodus Group, and partners SMRU Marine, to carry out Phase 1 of Project 4, the scope of which was to carry out an independent review of the available evidence base and through consultation with interested parties make recommendations for suggested research programmes, study sites and preliminary costings to guide the ORJIP Project 4 Phase 2 research into the utility of Acoustic Deterrent Devices (ADD) as mitigation.

Note that mitigation was assessed only in terms of its ability to reduce the risk of direct and indirect injury from noise during turbine installation related piling. The ability for ADD to mitigate disturbance/behavioural effects as a result of piling specifically was not considered. The potential for disturbance to arise as a result of the mitigation measure itself, rather than the piling noise, was however included in the assessment; for example, the potential for noise emitted by an ADD to cause additional disturbance of marine mammals during OWF construction.

Approach

In recognition of the large amount of existing research and development and primary and grey literature reviews on this topic (such as Gordon *et al.,* 2007, Coram *et al.,* 2013) and the collaborative and cooperative ethos of ORJIP, the project built upon existing work, capturing (through an interview process) lessons from European projects, as well as extracting and synthesising relevant data from existing industry reports (MMO reports, MMMPs, Environmental Statements, Marine Licenses) and acoustic modelling. To ensure that the project balanced the broad range of considerations, a formalised decision making process was used. This process entailed an initial workshop during the early stages of the project, at which the end users (including developers, consenting bodies, health and safety representatives and piling equipment operators) identified and discussed the specific criteria for evaluating the current and potential future mitigation solutions. This approach was designed to ensure that the study focused on the most important topics, and ensured that recommendations made as part of this study fully capture the needs of the target end users.

While there were site specific issues and uncertainties surrounding the efficacy of certain mitigation techniques used to date, it was possible to identify seven key generic drivers and supporting parameters important to interested parties (regulators, statutory advisors, offshore developers, NGOs, service providers and researchers) in

the development of offshore wind projects. The drivers were: efficacy; unintended consequences, regulation & legislation; installation schedule; cost; and H & S. Of these seven primary drivers, efficacy was identified as the key criteria for consideration in the development of MMMP.

The five species/functional groups prioritised by the ORJIP for inclusion in Project 4 were harbour porpoise, bottlenose dolphin, minke whale, and harbour and grey seals. For the purpose of this review these species were grouped into four sub-groups due to their priority status and functional hearing grouping (Southall *et al.,* 2007).

Key Research Findings & Recommendations

Current mitigation

The evidence base of UK and European industry reports (available at the time of the review) and Phase 1 specific consultation highlighted some important distinctions between the mitigation policies implemented for OWF developments in Europe versus the UK, including:

- Live monitoring and enforcement of a mitigation zone during piling via MMO and/or PAM is not widely used outside of the UK. Instead, alternative mitigation strategies are required, ranging from relatively basic (e.g. ADDs and pingers in Denmark) to much more onerous, such as the noise abatement techniques necessary to meet the stringent noise limits in Germany (e.g. bubble curtains, piling sleeves), or the seasonal restrictions for marine mammals in the Netherlands. It is however noteworthy to mention that visual observers have been employed outside of the UK in other industries, for example; during seismic surveys in the territorial waters of the United States (Compton *et al.*, 2008), Brazil (Parente & Araujo, 2011), Ireland and Greenland (personal communication, anon.), as well as during naval sonar exercises in some parts of the United States (Dolman *et al.*, 2009);
- Soft starts are widely used throughout Europe, but do not adhere to a defined protocol, except in the UK (i.e. prescribed minimum period of soft start – see JNCC, 2010b);
- Outside the UK mitigation measures are generally deployed from installation vessels (or in some instances noise abatement vessels), and do not generally require an additional passive mitigation team;
- ADDs are voluntarily used in the UK as a supplementary measure during darkness or periods of low visibility to account for not being able to visually monitor a mitigation zone. Conversely, elsewhere in Europe, ADDs are applied as standard during all piling activity (however, there is some variability in the placement of the devices and periods they are run for); and
- Much of the reporting on these issues outside of the UK comes from focused research projects as opposed to actual construction reports.

Efficacy

The evidence base of industry reports, academic research and consultation with interested parties further highlighted that the use of MMOs and PAM are not considered by industry to be the most practical solution and that they have limitations, such as detection rates, visibility and weather restrictions; however their use may still be considered to be the most suitable by SNCBs for preventing injury to EPS.

The only quantitative study available to inform the review was an Internal Communication report by the Ministry of Defence (MoD UK), which calculated a 'Measure of Effectiveness' (MoE) for MMO and PAM to detect, identify and localise individuals from different species. The findings although discussion provoking – a 15% MoE for visual monitoring and 5% MoE for PAM across all species[3] over a 2 km range - were only partially relevant as the study covered a range of species which are known to be highly insensitive to PAM.

[3] *The calculation involved a degree of subjectivity in the assessment and evaluation of the parameters owing to lack of data and available data being averaged over all seasons, times of day and conditions. The range over which this was estimated was 2 km therefore the value for a 250 m range would be higher than this, though by how much is uncertain.*

The Phase 1 commissioned acoustic modelling emphasised that soft start procedures do not eradicate all possibility of injury occurring. In particular, it is possible that for very large piles, injury could occur during the very first hammer blow over a fairly wide area even during soft start. However, soft start will still reduce the potential injury range compared to no soft start and therefore "unintended consequence" is not an additional consequence of the soft start, but rather a question of efficacy.

It is clear that there are some promising devices available for use in providing reliable marine mammal deterrence (for some species) at OWF sites and that those devices are currently being used during wind farm construction in the UK and Europe. These devices are likely to be resulting in a real reduction in risk of injury, for harbour porpoises in particular (the exact quantification of reduction is however highly dependent on total extent of impact zone overall).

In terms of the efficacy of ADD for use in UK OWF developments, ADD use is likely to be relatively short term, unlikely to add significantly to the overall duration of emitted noise during OWF construction, and unlikely to increase the proportion of days in which noise levels exceed any thresholds defined under the Marine Strategy Framework Directive (MSFD) for impulsive sound. There is however uncertainty about the marine mammal responses that are likely to be achieved at sites typical of future OWF projects; the effective ADD ranges (distance that the ADD will elicit a direct response from source) reported to date; and the evidence base available of responses for the priority species of concern in the UK.

Note although there is considerable potential for ADD and tailored soft start to be adopted as the primary and preferred best practice MMMP mitigation option in the UK, neither are universally applicable (e.g. the type of soft start that can be applied (if at all) may be affected by the nature of the substrate).

ADD development

Of the 34 devices from 22 manufacturers initially reviewed, six were identified as either being currently used or marketed for offshore use, or with the potential to do so, namely: 'off-the-shelf' devices Airmar, Lofitech, Ace Aquatech and Terecos, plus two devices currently in development, namely Genuswave (currently in development by the University of St Andrews) and the Sea Life Guard system (currently in development by SEAMARCO). These six were further down-selected to two devices for consideration in Phase 2. The selected devices (Lofitech and Genuswave) were felt to have the greatest potential to provide a multispecies solution for mitigation at offshore wind farms. Note the Sea Life Guard device was also shortlisted but was felt to require further development before it could be considered appropriate for this application.

Research Recommendations

Any research recommendations taken forward for consideration during Phase 2 need to be realistic, focussed and able to help inform and support any (incremental) revisions to the current piling mitigation protocol (JNCC, 2010b) and site specific SNCB guidance. When developing the scope of Project 4, ORJIP also identified that the ideal outcome of this project would be the development of ADD devices that can be proven to be a best practice mitigation option for use for one or, ideally all, of the priority species identified in this study. The current theoretical construction schedules for R3 and STW OWFs (plus R2.5 and any remaining R2 sites) also limit the time available to carry out such research.

Given the differing characteristics and encounter rates of the priority species groups, there were several challenges to achieving this 'research ideal', for instance variable and context specific animal behavioural responses. It was therefore envisaged that one to two field seasons of data collection on seal species, harbour porpoise and bottlenose dolphin should provide sample sizes sufficient to provide confidence in the efficacy of the tested devices, and determine whether the effective ranges of devices can be manipulated to provide the required flexibility. Minke whales are rather more challenging to study because encounter rates are variable and unpredictable and survey methodologies are less developed, so instead opportunistic trials were recommended if/when minke whale are encountered during trials for other species. Selection of sites where minke whale sightings can be high (e.g. Dogger Bank or Moray Firth during summer) may improve the encounter rate.

The short-term practical industry-focussed research projects recommended to take forward as part of the Phase 2 were therefore as follows:

- **Harbour porpoise**: Testing candidate ADD signals using a combination of focal behavioural observations or static moored structures in the open sea and arrays of PAM to measure wider scale responses over a range greater than can be monitored visually. Long term effectiveness should be investigated in conjunction with construction monitoring programmes.
- **Grey and harbour seals**: A combination of seal tracking methods involving capturing and tagging of a sample of seals at haul out sites in proximity to the field trial sites, tracking them in time and carrying out targeted behavioural response trials from a boat using the candidate ADDs.
- **Bottlenose dolphin**: Testing candidate signals using a combination of focal behavioural observations or 3D hydrophone arrays deployed from boats or static moored structures in the open sea and arrays of PAM devices to measure wider scale responses. Concurrent acoustic recording of call types can add context to behaviour and trials can be focussed to determine differential responses in foraging animals versus those engaged in other behaviours. Individual recognition of some animals may allow the potential to study the effect of repeated exposure over time. Wider acoustic monitoring arrays could be used to examine wider scale responses of dolphins, outside of what can be monitored visually.
- **Minke whales**: Responses to playback from boats would be measured using visual tracking methods. Dedicated studies are unlikely to be cost effective for this species and they are best approached opportunistically during work tailored for other species.

It was also recommended that longer term effectiveness should be addressed as part of ADD field trials during the construction phase of planned OWF developments. However, if the short term trials into the effectiveness of signals demonstrate that ADD are unlikely to lead to habituation then there may be less need for an extensive industry trial prior to considering revising current mitigation guidance.

Discussion and Conclusions

The Phase 1 evidence base and acoustic modelling results highlighted that it is not considered viable at this time to recommend a “one size fits all” mitigation protocol. The current JNCC protocol (JNCC, 2010b) is generally considered by interested parties to be fit for purpose for current small scale piling operations, when supported by site specific mitigation guidance by SNCBs. There was also wide support for increased research and development to inform future revisions to the current JNCC protocol (JNCC, 2010b) and de-risk the evolution of scale proposed by UK OWF sector.

The following surmises the general recommendations raised during the Phase 1 process, many of which reflect the transitional support that may be required to reduce the current reliance on passive mitigation, for ADDs to gain widespread acceptance within the UK OWF industry, and ultimately, for the continuing improvement and optimisation of the UK piling mitigation guidance:

- An incremental approach to revising the current piling mitigation protocol (JNCC, 2010b) is recommended in order to allow time to develop and validate ADD as a viable and standard MMMP for UK offshore wind farms;
- There are a number of other mitigation techniques used elsewhere in Europe, such as noise abatement and alternative construction techniques, that may be worthy of consideration (but are not within the scope of this project);
- Further assessment to quantify the efficacy of MMO and PAM was also felt to be of benefit and would inform the selection of the most appropriate MMMP and future mitigation guidance and policy; and
- The ultimate outcome for ORJIP Project 4 would be the development of a standardised pre-consent risk based project specific MMMP Framework, that enables Developers to select and agree with Regulators the best mitigation options based on particular site characteristics (e.g. priority species present, water depth, pile size/hammer energy, substrate type, distance offshore, installation and support vessel set up); and

The next steps will be for ORJIP to review the Phase 1 recommendations and use them to progress a roadmap approach to research and (further) develop or validate potentially viable ADD options as part of Phase 2 and subsequent phases. The end point being to develop protocol(s) for the use of ADD(s) as agreed with industry, advisors, regulators and NGOs.

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