






**KINCARDINE OFFSHORE
WINDFARM PROJECT**
**Project Environmental Monitoring
Plan**

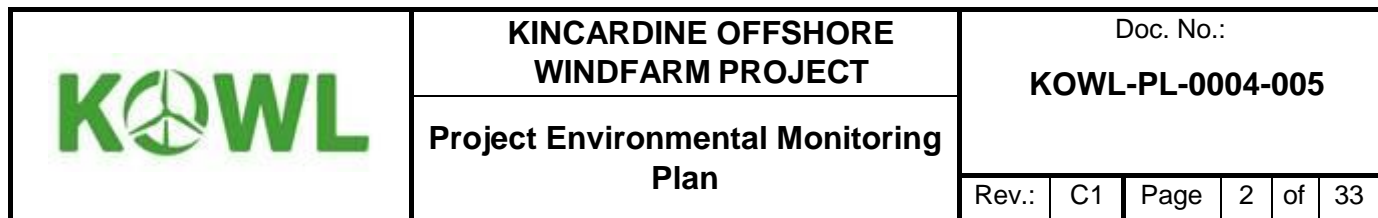
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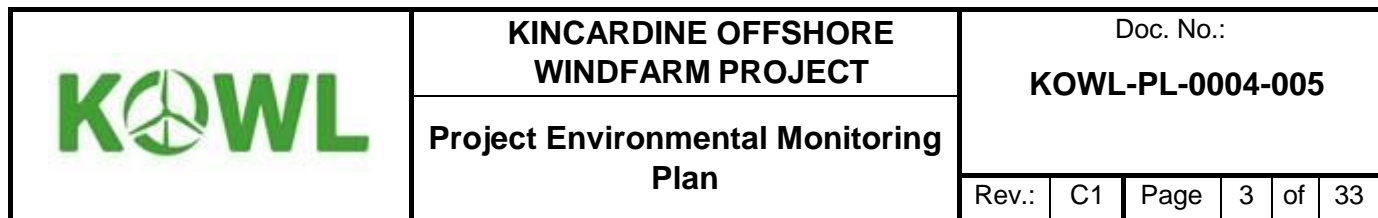
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Project Enviromental Monitoring Plan KINCARDINE OFFSHORE WINDFARM PROJECT

| Prepared | Checked | Reviewed | Approved |
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*Purpose of Issue: for information, for review, for approval

[illegible]

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ACRONYMS, ABBREVIATIONS and DEFINITIONS

| | |
|--------|---|
| dB | Decibel |
| ECoW | Ecological Clerk of Works |
| ECT | KOWL Environment and Consents Team |
| EIA | Environmental Impact Assessment |
| EOWDC | European Offshore Wind Deployment Centre |
| EMP | Environmental Management Plan |
| ES | Environmental Statement |
| GIS | Geographic Information Systems |
| GPS | Global Positioning System |
| HAT | Highest Astronomical Tide |
| HRA | Habitats Regulation Assessment |
| Hz | Hertz |
| KOWL | Kincardine Offshore Wind Ltd |
| LAT | Lowest Astronomical Tide |
| LMP | Lighting and Marking Plan |
| MHWS | Mean High Water Springs |
| MMO | Marine Mammal Observer |
| MS-LOT | Marine Scotland Licensing and Operations Team |
| MSS | Marine Scotland Science |
| MW | MegaWatt |
| NRMSD | National Research and Monitoring Strategy for Diadromous Fish |
| PEMP | Project Environmental Monitoring Plan |
| ROV | Remotely Operated Vehicle |
| RSPB | The Royal Society for the Protection of Birds |
| SAMS | Scottish Association for Marine Science |
| SNH | Scottish Natural Heritage |

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|---------|---|
| SPA | Special Protection Area |
| SpORRAn | Scottish Offshore Renewables Research Framework |
| SSMEG | Scottish Strategic Marine Environment Group |
| TBC | To be confirmed |
| WTG | Wind Turbine Generator |
| μPa | Micro Pascal |

| | | | | | | | | |
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1. Introduction

1.1. Purpose of the Document

This document has been authored to satisfy Condition 22 of the Section 36 Consent issued to Kincardine Offshore Windfarm Ltd (KOWL) for the Kincardine Offshore Windfarm (the Project). This document provides the current Project Environmental Monitoring Plan (PEMP). The overall aim of the PEMP is to outline and define the approach KOWL, its survey contractors and advisors will take with respect to the environmental monitoring of the Project required under the consent conditions. The programme sets out the approach to monitoring for each environmental topic listed.

The PEMP is designed to provide guidance to those involved in the Project, on the monitoring of potential environmental impacts associated with the installation, post-construction operational phases of the wind farm.

1.2. Scope of the Document

The PEMP provides the overarching framework for the offshore environmental monitoring required by the licences including:

- Birds (Kittiwake and Puffin);
- Diadromous fish;
- Marine mammals;
- The objectives and methodologies for the monitoring surveys;
- Evidence of consultation on and approval of the monitoring approach and survey methodology;
- The programme for proposed monitoring surveys and reporting.

1.3. Project Overview

The Project is considered a commercial demonstrator site, which will utilise floating foundation technology, and will be the second world's array of floating wind turbines. It has been included within the Survey, Deploy and Monitoring scheme for offshore renewable systems (similar to wave and tidal devices).

The Project is located south-east of Aberdeen approximately 8nm (15km) from the Scottish coastline and provides suitable water depth for a floating offshore wind demonstrator development (approximately 60-80m) (Figure 1-1).

The project is split into the following areas:

- The Development Area – the wind farm area including the Wind Turbine Generators (WTG) and inter-array cables.
- The Offshore Export Cable Corridor – the area within which the proposed export cables will be laid, from the perimeter of the Development Area to the onshore area at Mean High Water Spring (MHWS).
- The Onshore Area – the onshore area above MHWS including the underground cables connecting to the onshore substation at Redmoss.

This PEMP focuses on the offshore elements only as per the Section 26 Consent and Marine Licence granted.

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In April 2016 KOWL submitted applications for consent to construct and operate the Project, which included the Original ES. In September 2016 an addendum (referred to as the ES Addendum), of additional environmental information to the Original ES, was also submitted. In March 2017 consent under Section 36 and Section 36A of the Electricity Act 1989 was granted.

Since consent was granted, there have been several necessary changes to the Project. Therefore, an application for a variation of the Section 36 consent granted by the Scottish Ministers under S36C of the Electricity Act 1989 was applied for in December 2017 (the 'Variation Application').

The table below outlines the application dates, relevant ES Documents and the components of the Project as were included in the Original Application and the Variation Application.

Table 1-1 Summary of document timelines

| Original Documents | Addendums | Variation |
|---|--|--|
| Date Submitted: March 2016 | Date Submitted: September 2016 | Date Submitted: November 2017 |
| Original Application | Original Application | S36C Variation Application |
| Kincardine Offshore Windfarm ES (Original ES) | ES Additional Information Addendum (ES Addendum) | Section 36C Variation ES (Variation ES) |
| Maximum generation capacity: 50MW | Maximum generation capacity: 50MW | Maximum generation capacity: 50MW |
| WTGs: 8 x 6MW | WTGs: 8 x 6MW | WTGs: 1 x 2MW and 6 x 8.4MW |
| Substructures: semi-submersible | Substructures: semi-spar | Substructures: combination of semi-submersible and semi-spar |
| Cables: 33kv inter-array and export cables | Cables: 33kv inter-array and export cables | Cables: 33kv inter-array and export cables |

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Project Components

As noted in the table above, the maximum generation capacity of the windfarm is capped at 50MW, the main difference between the various stages of the applications have been the number and size of the turbines, and the substructure type.


As applied for in the Varied Application, the Project will now consist of the following offshore components:

- WTGs: 1 x 2MW and 6 x 8.4MW
- Substructures: semi-submersible Windfloat™ design
- 33kv inter-array and two export cables

Onshore, the following construction activities will also take place (under permissions granted by Aberdeen City Council):

- Onshore substation
- Horizontal Directional Drilling landfall and onshore cable route.

The first WTG to be deployed will be a WTG and associated substructure, anchors and mooring lines with a generating capacity not exceeding 2MW ('Turbine 1'), A condition in the existing marine licence requires Third Party Certification or Verification (or suitable alternative as agreed, in writing, with the Licensing Authority) for all WTGs, mooring systems and WTG platform structures prior to the commencement of the works. The initial period sought for such certification / verification / suitable agreed alternative of the WTG platform substructure for Turbine 1 will be limited (expected to be three years or less). This is due to the engineering life of the substructure (ten years from initial substructure construction in 2011). At the expiry of the WTG platform substructure certification, Turbine 1 will only be re-deployed if (i) the platform structure is re-certified following inspection (and only for so long as valid certification is in place) and (ii) if MS-LOT (in consultation with SNH, Historic Environment Scotland, Aberdeen City Council and Aberdeenshire Council) is satisfied that the re-deployment at the proposed location within the Site would not give rise to new or materially different likely significant effects to those identified in the seascape, landscape and visual assessment of the Variation ES. Any further re-certification would follow the same process. If Turbine 1 is not re-deployed within 6 months, it will be decommissioned (in line with condition 5 of the S36 consent on Redundant turbines). It is anticipated this position will be secured by a condition in the marine licence (and if considered necessary, also in the S36 consent).

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Construction Programme Overview

The construction of the Project is anticipated to occur in 'Tranches' in-line with the indicative Programme outlined below. A final Construction Programme for each tranche will be provided to Scottish Ministers prior to commencement of construction as a requirement of the consent conditions.

Table 1-2 Indicative construction programme

| Tranche | Activities | Indicative Dates | Start |
|-----------|---|------------------|-------|
| Tranche 1 | Onshore works and HDD drilling | March 2018 | |
| | Mooring installation Turbine Location 1 | May 2018 | |
| | Export cable 1 installation | June 2018 | |
| | Installation of 2MW turbine to Location 1 | June 2018 | |
| Tranche 2 | Export cable 2 installation | April 2019 | |
| | Mooring installation Turbine Locations 5-7 | April 2019 | |
| | Installation of inter-array cables Locations 5-7 | Aug 2019 | |
| | Installation of turbines to Locations 5-7 | Aug 2019 | |
| Tranche 3 | Mooring installation Turbine Locations 1-3 | March 2020 | |
| | Installation of inter-array cables Locations 1-3 and 8 | June 2020 | |
| | Move 2MW to Location 8 (dependent on recertification and consultation as noted above) | June 2020 | |
| | Installation of turbines to Locations 1-3 | June 2020 | |

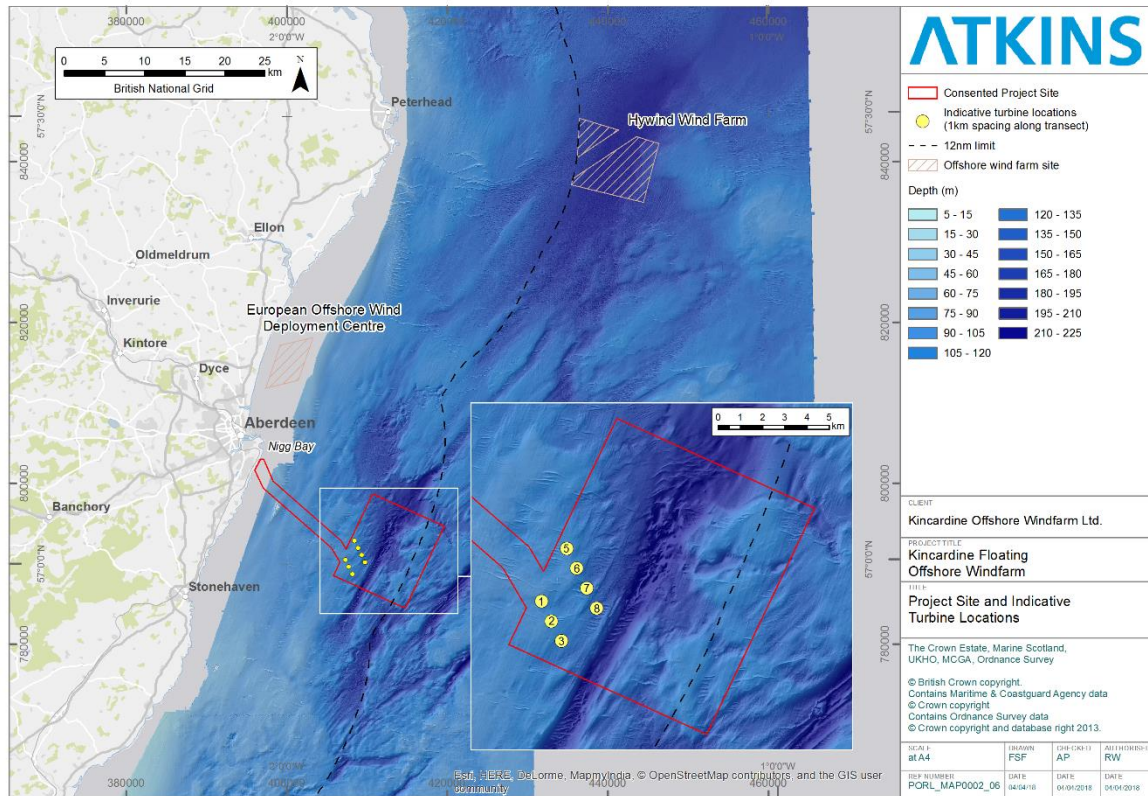


Figure 1-1 Project site and indicative turbine locations

1.4. Approach to Amending and Updating this PEMP

This document is a live document, and will be updated as necessary during the installation of the Project as deemed necessary to scope in or out relevant monitoring. This approach has been agreed with all relevant stakeholders during consultation on this PEMP.

In the first iteration of the issued PEMP (submitted prior to Tranche 1 of installation), all potential monitoring options are outlined for the full operational life of the windfarm (25 years). The PEMP will then be reviewed and updated as necessary at the following times:

- 6 months prior to Tranche 2 of installation;
- 3 months prior to final commissioning; and
- When a significant change to a methodology is identified that warrants an update to this document

1.5. Consent Conditions

The following consent conditions are taken from the S36 Consent which form the requirements for this PEMP.


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Table 1-3 Licence conditions relevant to the PEMP

| Licence | Condition Number | Name | Details | Where Addressed in this Document |
|---------|------------------|--|--|---|
| S36 | 22 | Project Environmental Monitoring Programme | <p>The Company must, no later than 6 months, or at such a time as agreed with the Scottish Ministers, prior to the Commencement of the Development, submit a Project Environmental Monitoring Programme (“PEMP”), in writing.</p> <p>The PEMP must cover, but not be limited to, the following matters:</p> <p>a. pre-construction, construction (if considered appropriate by the Scottish Ministers) and post-construction monitoring or data collection as relevant in terms of the ES and ES Addendum and any subsequent monitoring or data collection for:</p> <p>i) birds. This should include, but not be limited to, a detailed entanglement monitoring and reporting schedule, as well as a post-consent monitoring plan for bird strike;</p> <p>ii) marine mammals. This should include, but not be limited to, a detailed entanglement monitoring and reporting schedule, particularly of load on the moorings from derelict fishing gear; and</p> <p>iii) diadromous fish;</p> | <p>a. Monitoring plans are outlined in Sections 2, 3 and 4</p> <p>i. Detailed in Section 2</p> <p>ii. Detailed in Section 3</p> <p>iii. Detailed in Section 4</p> |



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| Licence | Condition Number | Name | Details | Where Addressed in this Document |
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| | | | <p>b. the methodology to record and report noise levels from construction and sound profiles from operational floating turbines to be carried out in relation to marine mammals; and</p> <p>c. the participation and contribution to be made by the Company to data collection or monitoring of wider strategic relevance, identified and agreed by the Scottish Ministers, and may include but not necessarily be limited to:</p> <p>i) the avoidance behaviour of breeding seabirds around turbines;</p> <p>ii) flight height distributions of seabirds at wind farm sites; and</p> <p>iii) effects on survival and productivity at relevant breeding colonies.</p> <p>The Company must submit written reports and associated raw data of such monitoring or data collection to the Scottish Ministers at timescales to be determined by them.</p> | <p>b. Detailed in Section 3.4</p> <p>c. Bird monitoring plans has been agreed in discussions with RSPB and detailed in Section 2.</p> <p>Reporting timelines of data collected are detailed in Section 2, 3 and 4.</p> |
| S36 | 23 | Regional Advisory Group | The Company must participate in any Regional Advisory Group, or any successor group, established by the Scottish Ministers for the purpose of advising the Scottish Ministers on research, monitoring and mitigation programmes | At the time of writing this PEMP there have been no active groups for KOWL to participate in. KOWL will however, participate in the future, if a group was to become active again. |



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| Licence | Condition Number | Name | Details | Where Addressed in this Document |
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| | | | for, but not limited to, ornithology, marine mammals, and diadromous fish. The extent and nature of the Company's participation is to be agreed by the Scottish Ministers. | |
| S36 | 28 | SpORRAn (Scottish Offshore Renewables Research Framework) | The Company must, to the satisfaction of the Scottish Ministers, participate in the monitoring requirements as laid out in the 'SpORRAn' (Scottish Offshore Renewables Research Framework) for Diadromous Fish'. The extent and nature of the Company's participation is to be agreed by the Scottish Ministers. | At the time of the writing this PEMP there has been no active research undertaken under the SpORRAn framework for KOWL to participate in. KOWL will however, participate in the future, if SpORRAn becomes active again. |
| S36 | 29 | Marine Mammal Observer | Prior to the Commencement of the development, the Company must confirm the appointment of a Marine Mammal Observer ("MMO"). When appointed, the MMO must, as a minimum, maintain a record of any sightings of marine mammals and maintain a record of the action taken to avoid any disturbance being caused to marine mammals during pre-construction and geophysical surveys and construction activities. | An MMO will be appointed prior to the commencement of works of Tranche 1, and provide reports as appropriate. The geophysical site investigations undertaken to date were carried out under an EPS licence specifically for the surveys. The reports from these surveys will be provided in accordance with the conditions of the licence. |



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| Licence | Condition Number | Name | Details | Where Addressed in this Document |
|---------|------------------|---|--|---|
| S36 | 30 | Scottish Strategic Marine Environment Group | The Company must participate in any Scottish Strategic Marine Environment Group ("SSMEG") established by the Scottish Ministers for the purposes of advising the Scottish Ministers on research, monitoring and mitigation programmes for, but not limited to, ornithology, diadromous fish, marine mammals and commercial fish. | <p>KOWL attended a Scoping Workshop on 06/03/2018 'Sectoral Marine Plan for Offshore Wind Energy' organised by Marine Scotland Planning and the Scottish Crown Estate to input into the next round of offshore wind developments in Scotland. An element of this workshop was discussion research and monitoring programmes.</p> <p>KOWL will continue to participate in future meetings, or any other groups established by the Scottish Ministers as appropriate.</p> |

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1.6. Compliance

Compliance with this PEMP will be monitored by KOWL Environment and Consents Team (ECT) and the KOWL Ecological Clerk of Works (ECoW), and report to the Licensing Authority (MS-LOT) on behalf of the Scottish Ministers.

- At the premises of any agent, contractor or sub-contractor acting on behalf of KOWL; and
- All site offices dealing with marine operations.

Subcontractors will comply with the Environmental Management Plan (EMP) as approved by the Scottish Ministers (and as updated as necessary). The EMP is also in compliance with the overarching Company Health, Safety and Environment (HSE) systems and standards, the HSE legislation and such other relevant legislation and guidance to ensure the safety of all personnel and other third parties.

When instructing monitoring, KOWL require compliance with all other relevant legislation and require that all necessary licences and permission are obtained either by KOWL, or where relevant, by contractors through condition of contract.

1.7. Roles and Responsibilities KOWL Environment and Consents Team

The ECT will have overall responsibility for the following:

- Maintaining and updating the PEMP document in consultation with, by relevant statutory and non-statutory consultees,
- Ensuring that all environmental monitoring required under the PEMP is undertaken at the appropriate time,
- Reviewing the monitoring reports and submitting reports to SpORRAn and other appropriate advisory groups before submission to the Scottish Ministers,
- Liaising with the relevant consultees on any matters that arise related to the PEMP.

KOWL Environmental Clerk of Works

The independent Environmental Clerk of Works (ECoW) appointed in line with S36 condition 25, will ensure that the PEMP is prepared and implemented in compliance with the consent conditions and any other relevant Consent Plans.

The ECoW will monitor and report on compliance with the PEMP to the Licencing Authority as part of the regular compliance reporting as detailed in the EMP.

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Key Monitoring Contractors

Table 1-4 Licence conditions relevant to the PEMP

| Topic | Contractor | Contact Detail |
|-----------------|------------|--|
| Bird monitoring | DTBird | Agustín Riopérez Edificio Indubuilding Avd. Democracia, 7, N 209 Madrid - 28031 (Spain) Tel: +34 91 344 90 86 arioperez@dtbird.com - www.dtbird.com |
| Bird Tagging | RSPB | TBC |
| Noise Profiling | SAMS | Paul Jowitt SAMS Research Services Ltd, Malin House, The European Marine Science Park, Oban, Argyll, PA37 1SZ UK Tel: +44 (0)1631 559470 Paul.Jowitt@sams.ac.uk |
| ROV | TBC | TBC |
| Load Cell | TBC | TBC |

Key Contractors and Subcontractors


Whilst Key Contractors and Subcontractors undertaking construction and maintenance will comply with this PEMP and the EMP.

1.8. Structure

Under each monitoring topic heading the following structure is followed:

- Consent Conditions;
- Approach to Monitoring;
- Aims and Objectives;
- Methodology;
- Reporting; and
- Programme.

This PEMP is not intended to present the full detail of the monitoring proposals, but to summarise the agreed approach.

| | | | | | | | | |
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In line with the rationale for post-consent monitoring presented in the Marine Management Organisation's (MMO) strategic review of offshore wind farm environmental monitoring (MMO, 2014) the monitoring proposals set out in this document aim to:

- Validate, or reduce uncertainty in predications on environmental impacts recorded in the ES and HRA,
- Provide evidence on the effectiveness of mitigation measures,
- Allow identification of any unforeseen impacts.

The Consent Conditions also require KOWL to undertake and or participate in strategic, regional and project specific monitoring. Whilst the focus for the PEMP is on project specific monitoring, under each of the section heading commitments to participate in regional and strategic monitoring are also captured where relevant.

2. Birds Monitoring Plan

2.1. Consent Conditions

As detailed in the Section 1.5, the relevant Consent conditions to birds are:

PEMP:

The PEMP must cover the following matters:

- a. pre-construction, construction (if considered appropriate by the Scottish Ministers) and post-construction monitoring or data collection as relevant in terms of the ES and ES Addendum and any subsequent monitoring or data collection for:
 - i) birds. This should include a detailed entanglement monitoring and reporting schedule, as well as a post-consent monitoring plan for bird strike;
- c. the participation and contribution to be made by the Company to data collection or monitoring of wider strategic relevance, identified and agreed by the Scottish Ministers, will include:
 - i) the avoidance behaviour of breeding seabirds around turbines;
 - ii) flight height distributions of seabirds at wind farm sites; and
 - iii) effects on survival and productivity at relevant breeding colonies.

The Company must submit written reports and associated raw data of such monitoring or data collection to the Scottish Ministers at timescales to be determined by them.

Regional Advisory Group:

The Company must participate in any Regional Advisory Group, or any successor group, established by the Scottish Ministers for the purpose of advising the Scottish Ministers on research, monitoring and mitigation programmes for ornithology, marine mammals, and diadromous fish. The extent and nature of the Company's participation is to be agreed by the Scottish Ministers.

Scottish Strategic Marine Environment Group:

The Company must participate in any Scottish Strategic Marine Environment Group ("SSMEG") established by the Scottish Ministers for the purposes of advising the Scottish Ministers on research, monitoring and mitigation programmes for ornithology, diadromous fish, marine mammals and commercial fish.

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2.2. Approach to Bird Monitoring

At the time of writing, no Regional Advisory Group had been established by the Scottish Ministers. Therefore, to discuss and agree the principals of the monitoring requirements for the Project, KOWL has organised and chaired 1 meeting to date with SNH, RSPB, MS-LOT and MSS inclusive to allow for decisions to be agreed between all organisations.

A summary of the discussions had in these meetings is provided in Table 2-11 below.

Table 2-1 Summary of bird monitoring discussions in PEMP meetings held with SNH, RSPB, MS-LOT and MSS

| Date | Summary of key discussions and agreements |
|------------|---|
| 05/05/2017 | <p>Kittiwake: Agreed that focus of monitoring for Kittiwake was regarding collision risk.</p> <p>Puffin: Agreed that focus of monitoring for Puffin was displacement.</p> <p>Bird Tagging: Agreed that tagging Kittiwake would not provide data specific to assessing collision risk and therefore was not considered necessary.</p> <p>Agreed that tagging of Puffins could offer some benefit, and should be considered as part of the PEMP from 2018 onwards (tagging in 2017 was not possible).</p> <p>Collision sensors in WTG blades: It was agreed that installing collision sensors in the blades of the WTGs would be the most appropriate way to monitor collision risk. However, it was agreed that due to the timescales involved before construction of Unit 1 is due to being KOWL would not be able to install sensors in Unit1, but that they will be included for consideration in the PEMP for the larger turbines.</p> <p>Cameras/Radar: It was agreed that installation of cameras would also be beneficial for detecting bird collisions and species identification. It was discussed the KOWL would explore available 'off the shelf' camera systems for Unit 1 and work with the manufacturer to develop a more sophisticated system for Units 2-8, including radar if possible.</p> <p>Aerial Surveys: A discussion was had as to the cost/benefit of aerial surveys in terms of what the results can provide i.e. presence/absence rather than flight path etc. It was concluded that tagging is more useful and flight data from cameras/radars from the turbine and monitoring focus should be on these instead of aerial surveys. Agreed that Aerial Surveys will be included in the PEMP to start with as a potential option which could be taken forward or removed from the scope as other methods are developed over the next two years of construction.</p> <p>Adaptive PEMP: All parties agreed to KOWL taking an Adaptive approach to the PEMP to reflect the Tranches in overall Project programme. The First Iteration of the PEMP will present</p> |

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| | the overarching principles of the monitoring as agreed above and all likely technologies that may be considered for each tranche of WTG installation and once the whole farm is operational. Over time, the PEMP will then be revised at times to be agreed going forward. |
|--|--|

Further discussions have been had, and are on-going with individual consultees to determine the more detailed monitoring methodologies outlined below.

2.3. Aims and Objectives

Pre-Construction:

No further pre-construction monitoring is required for birds than that already undertaken for the Environmental Impact Assessment (EIA).

Construction:

The construction of the substructures will be undertaken at a port, and therefore the activities on site will be limited to installation of the substructures and WTGs including towing, hook up and commissioning only. Installation on site is expected to take less than 1 week (tow to site, hook up to moorings and export cables), and therefore, monitoring during construction and installation is not considered necessary as agreed during consultation with RSPB and SNH.

Post-Construction:


The objectives of the bird monitoring post-construction are to improve understanding of seabird interactions with offshore windfarms, and particularly floating offshore windfarms which are located further offshore than fixed foundations windfarms, and validate the assumptions made in the Original ES, ES Addendum and Variation ES.

With regards to a 'detailed entanglement monitoring plan' for birds as outlined within the S36 Condition 22, following consultation with MS-LOT it has been agreed that an entanglement plan for marine mammals is sufficient and an entanglement plan for birds is not required.

The key seabird concerns identified in the Original ES and HRA were collision risk for Black-Legged Kittiwake from Fowlsheugh Special Protection Area (SPA) and displacement risk for Puffins from Forth Island SPA.

The aim of the monitoring surveys is to address these key questions:

1. In relation to Atlantic Puffin; is there connectivity between Forth Island SPA and the Project?
2. In relation to Black-legged Kittiwake; are there detectable effects of collisions occurring at the Project site?
3. Are the impacts sufficiently large to influence the populations of kittiwake?

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This will be done using several monitoring techniques and equipment which may include:

- GPS Tagging;
- Collision Sensors;
- Cameras;
- Radar; and
- Aerial Surveys.

These techniques are described in more detail in Table 2-2 below.

Table 2-2 Methodology Aims for Bird Monitoring

| Method | Primary Aim |
|---|---|
| GPS Tagging | <ul style="list-style-type: none"> • Use foraging distribution data obtained through tag deployment to investigate the extent of connectivity between the Project and Forth Island SPA populations and potentially finer scale movements in relation to the turbines; and • Build on the previous tagging work conducted by RSPB. |
| Collision sensors in WTG blades (only to be considered for turbines 2- 8) | <ul style="list-style-type: none"> • Collect direct measurements of collisions with WTG blades to assess number of collisions per year and compare to estimates used in collision risk modelling. |
| Cameras | <ul style="list-style-type: none"> • Real time detection of birds in the vicinity of the windfarm; • Video and audio recordings of bird collisions; and • Species identification of bird collisions recorded by collision sensors (if using). |
| Radar (where suitable deck space and engineering parameters permit) | <ul style="list-style-type: none"> • Provide accurate bird flight and behaviour monitoring around the windfarm. |
| Aerial Surveys | <ul style="list-style-type: none"> • Collect seabird distribution and estimation of abundance to compare against baseline survey collected pre-construction to estimate displacement resulting from avoidance of the windfarm; and • Estimate the extent of connectivity between the Project and Fowlsheugh and Forth Island SPA through analysis of flight directions. |

2.4. Methodology

GPS Tagging (Puffin monitoring):

KOWL will fund a tagging programme designed and managed by RSPB or a sub-contractor. It is proposed that a single pilot project will be undertaken in year one with the full scope of the programme to be developed and agreed by Autumn 2018. It is anticipated that the tagging work will be undertaken during May/June 2019. The programme will include tagging of individual puffins from the Forth Islands SPA using remote download GPS tags. High resolution location data is collected by the tags which

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will provide information on trip distances and duration with the potential to infer foraging locations via further analysis of the data. Data is downloaded remotely each time the bird returns to the colony. Subsequent years of tagging to be undertaken on the Forth Islands SPA/other relevant colonies may also be considered as appropriate, following a review of the initial pilot programme.

This monitoring work will better establish the connectivity of the KOWL Project site to relevant puffin breeding colonies. This data will also contribute towards improving the understanding of colony specific distributions. This information is pertinent to KOWL, other existing projects and potential future projects.

Cameras:

Eight HD cameras will be initially installed on the 2MW turbine which will continuously record video and sounds of every flight that is made within the vicinity of the turbine. The system being deployed is DTBird which is a self-working system that monitors bird activity in real-time, and detects any bird species flying during the day or night, all year round. The system uploads video and audio recordings of every bird flight detected to DTBird online Data Analysis Platform, access is protected with a username and password. Recorded data can include location, flight ID, flight time data, flight video records with embedded audio. This system should enable bird identification based on bird shape, flight pattern and wing beat frequency from both the video and the audio files. In addition, the system takes HD camera snapshots every hour. There are environmental sensors on the DTBird units to collect information on light, temperature, humidity, rain, fog, wind speed and direction. See Appendix A for the full DTBird Specification.

Cameras will have limited capability during hours of darkness, however, thermal cameras could be mounted to ensure night detection of bird activity on the six 8.4MW turbines.

Collision Sensors:

Where appropriate, acoustic sensors could be installed inside the WTG blades of a number of the later turbine units to detect collisions at all times of day. The decision to install such sensors can be made following the initial twelve months of site data collected from the cameras on the 2MW turbine. The data from the collision sensors coupled with the data from the cameras will provide accurate data of bird collisions on all the turbines which can then be used to provide evidence to support/amend bird collision models used for the project HRA, and future offshore windfarm projects.

Radar:

Monitoring by radar would provide accurate bird flight and behaviour monitoring around structures. This will provide real-time data (day and night) on any macro-avoidance around the turbines. However due to the size and power requirements of such bird monitoring devices, any decision on installing such units on later turbines will be deferred until the initial 12 months of monitoring has been collated.

Aerial Surveys:

An aerial survey could be undertaken one-year post installation of all seven turbines, utilising the same flight paths from pre-construction survey detailed in the ES. The data from the post construction survey can then be compared to the pre-construction survey to estimate displacement.

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2.5. Reporting

KOWL will aim to submit survey reports and raw data to MS-LOT on behalf of the Scottish Ministers in support of the discharge of conditions were appropriate within three months of receiving the data from survey contractors or equivalent.


Meetings will also be held with SNH and RSPB before iterations to PEMP are due to review any available data and agree any amendments to the strategy.

2.6. Programme

The following programme includes all potential monitoring options and will be reviewed at subsequent intervals as also outlined in the table below.

Table 2-3 Programme for Bird Monitoring

| Project Phase | Proposed Activity | Reason |
|---|---|---|
| Tranche 1 | Cameras – 2MW | Collisions and macro-avoidance behaviour around the 2MW turbine |
| Pre-Tranche 2 Data Review and PEMP Update | Meeting with SNH and RSPB | To discuss data collected from Tranche 1 and agree any amendments to PEMP |
| Tranche 2 | GPS Tagging (Puffins) 2019 breeding season | Puffin locations and movements, flight data including flight height and speed |
| | Cameras – six x 8.4MW | Collisions and macro-avoidance behaviour around the first turbine |
| | Potentially collision sensors – six x 8.4MW | Collisions |
| | Radar | Flight and flight behaviour around windfarm (can also operate at night whereas cameras will be limited during darkness) |
| Pre-O&M (prior to final commissioning) | Meeting with SNH and RSPB | To discuss data collected and agree Final PEMP for O&M |

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|-----|---|---|
| O&M | Aerial Survey similar to 2012 survey 1 year after final commissioning | Seabird distribution and estimation of abundance to compare against baseline survey collected pre-construction to estimate displacement |
|-----|---|---|

3. Marine Mammals Monitoring Plan

3.1. Consent Conditions

As detailed in Section 1.5, the relevant Consent conditions to marine mammals are:

PEMP:

The Company must, no later than 6 months, or at such a time as agreed with the Scottish Ministers, prior to the Commencement of the Development, submit a Project Environmental Monitoring Programme (“PEMP”), in writing.

The PEMP must cover the following matters:

a. pre-construction, construction (if considered appropriate by the Scottish Ministers) and post-construction monitoring or data collection as relevant in terms of the ES and ES Addendum and any subsequent monitoring or data collection for:

ii) marine mammals. This should include a detailed entanglement monitoring and reporting schedule, particularly of load on the moorings from derelict fishing gear.

b. the methodology to record and report noise levels from construction and sound profiles from operational floating turbines to be carried out in relation to marine mammals.

The Company will submit written reports and associated raw data of such monitoring or data collection to the Scottish Ministers.

Regional Advisory Group:


The Company must participate in any Regional Advisory Group, or any successor group, established by the Scottish Ministers for the purpose of advising the Scottish Ministers on research, monitoring and mitigation programmes for, but not limited to, ornithology, marine mammals, and diadromous fish. The extent and nature of the Company’s participation is to be agreed by the Scottish Ministers.

Marine Mammal Observer:

Prior to the Commencement of the development, the Company must confirm the appointment of a Marine Mammal Observer (“MMO”). When appointed, the MMO must, as a minimum, maintain a record of any sightings of marine mammals and maintain a record of the action taken to avoid any disturbance being caused to marine mammals during pre-construction and geophysical surveys and construction activities.

Scottish Strategic Marine Environment Group:

The Company must participate in any Scottish Strategic Marine Environment Group (“SSMEG”) established by the Scottish Ministers for the purposes of advising the Scottish Ministers on research,

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monitoring and mitigation programmes for ornithology, diadromous fish, marine mammals and commercial fish.

3.2. Approach to Monitoring

No Regional Advisory Group had been established/currently operating by the Scottish Ministers. Therefore, to discuss and agree the principals of the monitoring requirements for the Project, KOWL has organised and chaired 1 meeting to date with SNH, RSPB, MS-LOT and MSS inclusive to allow for decisions to be agreed between all organisations.

A summary of the discussions had in these meetings is provided in Table 3-1 below.

Table 3-1 Summary of marine mammals monitoring discussions in PEMP meetings held with SNH, RSPB, MS-LOT and MSS

| Date | Summary of key discussions and agreements |
|------------|--|
| 05/05/2017 | <p>Noise Profiling: Noise Profile – all parties agreed that any data on the noise profile of floating offshore windfarms will be invaluable as this data does not currently exist.</p> <p>Entanglement: All parties agreed that load cells and ROV surveys were sufficient methods for monitoring impacts to marine mammals, however, it was suggested that ROV survey frequency may need to be increased in the purpose of marine mammals monitoring to start with, and then over time, the frequency could be reduced.</p> <p>Adaptive PEMP: All parties agreed to KOWL taking an Adaptive approach to the PEMP to reflect the Tranches in overall Project programme. The First Iteration of the PEMP will present the overarching principles of the monitoring as agreed above and all likely technologies that may be considered for each tranche of WTG installation and once the whole farm is operational. Over time, the PEMP will then be revised at times to be agreed going forward.</p> |

Further discussions are on-going with individual consultees to determine the more detailed monitoring methodologies outlined below.

3.3. Aims and Objectives

Pre-Construction:

Pre-construction noise profiling has been agreed with SNH and MS-LOT. The purpose of the measurements is to provide good quality, reliable measurements of the baseline underwater noise to determine the pre-existing acoustic environment prior to the installation of the 2MW turbine.

Construction:

The construction of the substructures will be undertaken in ports, and therefore the activities on site will be limited to installation of the units (substructures and WTGs) including towing, hook up and commissioning only. Installation of the units on site is expected to take less than one week (tow to sites, hook up to moorings and export cables), and therefore, monitoring during construction and

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installation of the units is not considered necessary as agreed during consultation with the key stakeholders.

Post-Construction:

As part of the project HRA no marine mammal impacts were identified from the proposed construction approach (no piling being the main reduction factor), therefore, the primary aim of the monitoring is to improve the understanding of the noise profile from floating windfarms.

The aim of the monitoring surveys is to address these key questions:

1. What is the noise profile of floating offshore wind turbines?
2. Does the presence of the mooring lines cause a potential hazard to marine mammals in the vicinity of the Project?

This will be done using a number of monitoring techniques and equipment outlined in Table 3-2 below.

Table 3-2 Methodology Aims for Marine Mammal Monitoring

| Method | Primary Aim |
|----------------------------|---|
| Noise Profiling | <ul style="list-style-type: none"> Collect data on noise emitted into the water column from a floating turbine, to determine the noise profile around the structure. |
| Load cells and ROV Surveys | <ul style="list-style-type: none"> Monitor for any large strains on mooring lines; Identify if entanglement of marine mammals is a cause for strain on mooring lines. |


3.4. Methodology

Pre-Construction Noise Profiling:

The purpose of noise profiling pre-construction is to provide good quality, reliable measurements of the baseline underwater noise to determine the pre-existing acoustic environment prior to the installation of the 2MW turbine.

It has been agreed with SNH and MS that a one-day (eight hours of survey data) boat based survey is sufficient to provide information for both background noise (pre-installation) to provide baseline information and to be repeated as exactly as possible during operation.

Noise monitoring will be undertaken using the Scottish Association for Marine Science (SAMS) own designed Drifting Ear. The Drifting Ear deployment methodology was specifically designed by SAMS for noise measurements in high flow tidal sites. The basic principal of the Drifting Ear design is to keep a free-floating drogue mounted hydrophone fixed to a moving body of water rather than the seabed. The devices are connected to a surface float which contains an Iridium based satellite communication system for field-based tracking, as well as a GPS unit to record precise location information. The recorded satellite and GPS data monitor the tracks and drift rate of each Drifting Ear unit for subsequent analysis. Hydrophones are suspended within the drogues approximately six meters below the surface and connected near the recorder to reduce the introduction of cable-related noise.

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The drifter mounted hydrophones (RESON TC4014-5) are broadband omnidirectional units characterized by low internal noise and high sensitivity (180 dB \pm 3 dB re 1V/ μ Pa) with a frequency response of 25 Hz – 250 kHz \pm 3 dB. Acoustic data is recorded using a compact digital underwater recorder (EA-SDA14), with resulting sound files stored internally on SD cards.

The recorders will be set up to sample at 312.5 kHz with 32-bit resolution to cover a broad frequency band and allow interpretation of all likely noise sources without aliasing risks. The Drifting Ear method does not require any license as the equipment will not be deposited on the seabed.

Two Drifting Ears units will be prepared for mobilisation to cover for the unlikely eventuality of equipment failure. The SAMS Project Manager will liaise with the vessel to identify a suitable weather window for mobilisation. The equipment and two field scientists will mobilise from SAMS facilities in Oban and transit in a van to site the day before the survey.

The field scientists will carry out the deployment and retrieval of the field equipment with support of the vessel crew. Risk assessments and safe working procedures will be reviewed once the vessel is known, and will be followed during operations. The weight of the unit means that it can be deployed and retrieved manually. The scientists will monitor the deployed unit throughout the survey period. If the unit drifts outside a pre-defined area, the vessel can intervene and recover the unit, and then re-deploy it. SAMS aims for a deployment time of 8 hours, regardless whether this is as a single or multiple deployment. During the deployment the field scientists will collect and record auxiliary data such as environmental conditions (e.g. sea state, swell, current speed, current direction, etc.) during the noise monitoring event at frequent intervals.

Post-Construction (2MW turbine) Noise Profiling:

The purpose of noise profiling post-construction is to provide good quality, reliable measurements of the acoustic environment following the installation of the 2MW turbine. Post construction monitoring will collect data on noise emitted into the water column from a floating turbine, to determine the noise profile around the structure. The methodology for post construction monitoring is yet to be determined, however, this will be confirmed in coming months and the PEMP will be updated accordingly.

Load cell:

It is currently expected that load cells will be attached to the mooring lines for continuous monitoring of significant loading to the lines for the larger turbines. It is acknowledged that the function of the load cells is predominantly to assess the performance of the mooring lines during operational conditions, however, they may also offer a potential method for detecting entanglement from fishing equipment. To prevent ghost fishing.

ROV Surveys:

As with the load cells, periodic maintenance ROV surveys are also primarily to be used for monitoring the integrity of the inter-array cables, mooring lines and anchors, however, the surveys also offer the opportunity to monitor the presence of ghost fishing nets lodged on the mooring system.

MMO:

A MMO will be appointed by KOWL before commencement of Tranche 1.

3.5. Reporting

KOWL will aim to submit survey reports and raw data to MS-LOT on behalf of the Scottish Ministers in support of the discharge of conditions were appropriate within three months of receiving the data from survey contractors or equivalent.


Meetings will also be held with SNH before iterations to PEMP are due to review any available data and agree any amendments to the strategy.

3.6. Programme

The following programme includes all potential monitoring options and will be reviewed at subsequent intervals as also outlined in Table 3-3 below.

Table 3-3 Programme for Marine Mammals Monitoring

| Project Phase | Proposed Activity | Reason |
|--|--|---|
| Pre-construction | Noise profiling (One 1-day survey) | Create a baseline noise profile prior to installation |
| Tranche 1 | Noise profiling (One 1-day survey) | Create a noise profile for the turbine |
| Pre-Tranche 2 Data Review and PEMP Update for Final PEMP | Meeting with SNH | To discuss data collected from Tranche 1 and agree any amendments to PEMP |
| Tranche 2 and O&M | Load cells | Continuous monitoring for strains on the mooring lines |
| | ROV surveys (initially every six months and then reduced frequency over the life of the project) | Visual inspection of the mooring lines including for entanglement of marine mammals |

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4. Diadromous Fish Monitoring Plan

4.1. Consent Conditions

As detailed in the Section 1.5, the relevant Consent conditions to diadromous fish are:

PEMP:

The Company must, no later than 6 months, or at such a time as agreed with the Scottish Ministers, prior to the Commencement of the Development, submit a Project Environmental Monitoring Programme (“PEMP”), in writing.

The PEMP must cover, but not be limited to, the following matters:

- a. pre-construction, construction (if considered appropriate by the Scottish Ministers) and post-construction monitoring or data collection as relevant in terms of the ES and ES Addendum and any subsequent monitoring or data collection for:

iii) diadromous fish;

The Company must submit written reports and associated raw data of such monitoring or data collection to the Scottish Ministers at timescales to be determined by them.

Regional Advisory Group:

The Company must participate in any Regional Advisory Group, or any successor group, established by the Scottish Ministers for the purpose of advising the Scottish Ministers on research, monitoring and mitigation programmes for, but not limited to, ornithology, marine mammals, and diadromous fish. The extent and nature of the Company’s participation is to be agreed by the Scottish Ministers.

SpORRAn:

The Company must, to the satisfaction of the Scottish Ministers, participate in the monitoring requirements as laid out in the ‘SpORRAn’ (Scottish Offshore Renewables Research Framework) for Diadromous Fish’. The extent and nature of the Company’s participation is to be agreed by the Scottish Ministers.

4.2. Approach to Monitoring

At the time of writing, no Regional Advisory Group had been established by the Scottish Ministers. Therefore, to discuss and agree the principals of the monitoring requirements for the Project, KOWL organised and chaired 1 meeting with SNH, RSPB, MS-LOT and MSS inclusive to allow for decisions to be agreed between all organisations.

A summary of the discussions had in these meetings is provided in the Table 4-1 below.

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Table 4-1 Summary of marine mammals monitoring discussions in PEMP meetings held with SNH, RSPB, MS-LOT and MSS

| Date | Summary of key discussions and agreements |
|------------|--|
| 05/05/2017 | It was noted during the meeting that the likely impacts to diadromous fish were of lesser significance than other organisms, namely Kittiwake and Puffin and therefore the level of monitoring should reflect that. It was suggested that KOWL could provide a contribution to the Scottish Government Strategy that is currently being conducted and this would constitute sufficient monitoring for diadromous fish. |

Further discussions have been had, and are on-going with individual consultees to determine the more detailed monitoring methodologies outlined below.

4.3. Aims and Objective

Pre-Construction:

No pre-construction monitoring or data collection on diadromous fish has been considered necessary as agreed during consultation with key stakeholders

Construction:

The construction of the substructures will be undertaken a port, and therefore the activities on site will be limited to installation of the units (substructures and WTGs) including towing, hook up and commissioning only. Installation of the units on site is expected to take less than 1 week (tow to sites, hook up to moorings and export cables), and therefore, monitoring during construction and installation of the units is not considered necessary as agreed during consultation with key stakeholders.

Post-Construction:


KOWL are planning a monitoring programme with Dee District Salmon Fishery Board & River Dee Trust and the River Don Trust which will contribute to the National Research and Monitoring Strategy for Diadromous Fish (NRMSD) which aims to investigate the potential for interactions between diadromous fish and wind, wave and tidal renewable energy developments.

4.4. Methodology

For information on the NRMSD, please refer to the Scottish Government website.

KOWL is currently exploring the potential to contribute to a monitoring programme regarding tagging adult salmon and/or sea trout and investigating adult returns to the Rivers Dee and Don Trusts and in conjunction with other on-going monitoring programmes. The programme will aim to establish migration pathways of adult diadromous fish will help to inform potential for interaction with offshore windfarm developments. The project would build upon the European Offshore Wind Deployment Centre (EOWDC) smolt tagging programme. This project would provide valuable information for offshore development in terms of where adult fish may be encountered, the scale of interaction and whether the fish follow a narrow migration pathway or cover a wider area.

The details of the programme will be confirmed in coming months and agreed with MS-LOT. Once confirmed this PEMP will be updated as noted in Section 1.4.


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4.5. Reporting

Confirmation of the contribution given from KOWL to the programme will be provided to MS-LOT in order to discharge the licence conditions, thereafter there will not be any further reporting requirements from KOWL, but it will be agreed the data from the programme will be provided to the Scottish Government as a requirement of the programme.

4.6. Programme

No further monitoring requirements are expected to be undertaken at this stage, however, during further PEMP meetings, this will be discussed along with the monitoring scopes for bird and marine mammals, and the PEMP update accordingly if required.

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Appendix A – DTBird Specification

DTBird[®] System Specifications for Wind Turbines

Day & Night
On & Offshore

DTBIRD TEAM

November 2017.

Ref.: DTB0516SPWTG.Rev2

Fulfilled: Marcos Puente
Reviewed: Javier Díaz
Approved: Agustín Riopérez

13/11/17
14/11/17
16/11/17

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| DTBird® Day Detection Module | | V4 | V8 |
|--|---|---------------------|----|
| Service description | Automatic and real-time ¹ detection in daylight of bird flights in the airspace surrounding a Wind Turbine (WTG). Video and audio recordings of every bird flight detected uploaded to DTBird online Data Analysis Platform with Username and Password protected access, ensuring bird flight traceability. | ✓ | |
| Installation site | Wind Turbines (WTGs) - On & Offshore. | ✓ | |
| Module specifications | | | |
| Components | HD cameras: 4 units/WTG. | ✓ | |
| | 8 units/WTG. | | ✓ |
| | Environmental sensors: Light, Temperature and Humidity. Optional: Rain and Fog. From the WTG: Wind Speed and Wind Direction. | | |
| | Cabinet (1/WTG): Analysis Unit, Detection Software, Electrical and Lighting Protection Systems and Communications Hardware. | ✓ | |
| | Mounting System (not intrusive on WTG). | | |
| Location on the facility | Cables & Connections. | | |
| | HD Cameras + Environmental Sensors + Mounting System (patented): outdoors on the WTG tower, from 5 to 80 m height (Project specific). | ✓ | |
| | Cabinet: indoors, normally inside the tower. | | |
| Cabinet | | | |
| Dimensions | 51x65x25 cm, WxHxD. | ✓ | |
| | 51x130x25 cm, WxHxD. | | ✓ |
| Weight | 10 Kg. | ✓ | |
| | 20 Kg. | | ✓ |
| Power supply | 110-250 AC monophasic 50/60Hz (Power Grid Connection). | ✓ | |
| Power consumption | 55 W. | ✓ | |
| | 95 W. | | ✓ |
| Operation conditions | Daylight (>50 lux). | ✓ | |
| Weatherproof | Outdoor components: IP 66 / -30° to 50° C. Falling blocks of ice protection system (optional). | ✓ | |
| | Cabinet components: IP 65 / 0° to 40° C. Heating or Cooling (optional). | | |
| Communications | Wind Farm Network/Mobile Router 4G/ADSL/Optic Fiber/Satellite Internet. | ✓ | |
| Service specifications | | | |
| Detectable bird Species/Groups | All bird Species/Groups. | ✓ | |
| Bird Species/Group identification | Yes, through the review of bird flight video and audio recordings. | ✓ | |
| Surveillance area | 360° around the WTG. See pages 7-8 (Examples of the Surveillance Area of DTBird Detection Module models V4 and V8). | ✓ | |
| Radius around the WTG | Bird wingspan | Set up range | |
| | >150 cm | 200-320 m | ✓ |
| | | 350-600 m | ✓ |
| | 75-150 cm | 100-200 m | ✓ |
| | | 175-350 m | ✓ |
| | <75 cm | 25-100 m | ✓ |
| | | 25-175 m | ✓ |
| Simultaneous detection of multiple bird flights | Yes (360° around WTG), detection of an unlimited number of flights and birds at the same time. | ✓ | |
| Bird flight detectability | >80% ² | ✓ | |
| Bird flight traceability³ | Video and audio recordings of every bird flight stored in the Wind Farm online Data Analysis Platform, with Username and Password protected access. | ✓ | |
| False Positive rate (recording with no bird) | 0.5 - 5.5 FP/day (yearly average). | ✓ | |
| Recorded data | Location. | | |
| | Flight ID. | | |
| | Flight time data: Init time and total length. | | |
| | Flight video records, with embedded audio record. | ✓ | |
| | Online Snapshots of HD cameras every hour. | | |
| | Environmental data, and WTG operational parameters during bird flight. | | |
| Online Data Analysis Platform | Species/group and bird behavior analysis from video and audio recordings. | | |
| | Bird flights videos with audio storage for 2 years (up to 50 Gb/Year/DTBird unit) and data storage for 5 years, in DTBird® Server in Data Center Classified Tier 4. Optional one-year extensions. | ✓ | |
| | Flight Analysis tools: review of video and audio records, flight analysis, data export, video download and automatic service reports. | | |
| Service Control | Self-checking and daily verification done remotely from DTBird Headquarters. | ✓ | |
| Warranty | 2-year worldwide. | ✓ | |

¹ Real-time means that time from image capture by the HD Camera to bird detection, is <1 second.

² Norwegian Institute for Nature Research (NINA). 2012. Evaluation of the DTBird video-system at the Smola wind-power plant. Detection capabilities for capturing near-turbine avian behavior.

| DTBird® Night Detection Module | | |
|---|---|--------------|
| Service description | Automatic and real-time detection at night of bird flights in the airspace surrounding a Wind Turbine (WTG). | |
| | Video and audio recordings of every bird flight detected uploaded to DTBird online Data Analysis Platform with Username and Password protected access, ensuring bird flight traceability. | |
| Installation site | Wind Turbines (WTGs) - On & Offshore. | |
| Module specifications | | |
| Components | Thermal Cameras: Variable number per WTG (Project specific). | |
| | Environmental sensors: Light, Temperature and Humidity. Optional: Rain and Fog. From the WTG: Wind Speed and Wind Direction. | |
| | Cabinet (1/WTG): Analysis Unit, Detection Software, Electrical and Lighting Protection Systems and Communications Hardware. | |
| | Mounting System (not intrusive on WTG). | |
| | Cables & Connections. | |
| Location on the facility | Thermal Cameras + Environmental Sensors + Mounting System (patented): outdoors on the WTG tower, from 5 to 80 m height (Project specific). | |
| | Cabinet: indoors, normally inside the tower. | |
| | Cables & Connections: outdoors on the WTG tower, and inside the WTG tower. | |
| Cabinet | | |
| Dimensions | 51x65x25 cm, WxHxD. | |
| Weight | 10 Kg. | |
| Power supply | 110-250 AC monophasic 50/60Hz (Power Grid Connection). | |
| Power consumption | 55 W. | |
| Operation conditions | Night (<50 lux). | |
| Weatherproof | Outdoor components: IP 66 / -30° to 50° C. Falling blocks of ice protection system (optional). | |
| | Cabinet components: IP 65 / 0° to 40° C. Heating or Cooling (optional). | |
| Communications | Wind Farm Network/Mobile Router 4G/ADSL/Optic Fiber/Satellite Internet. | |
| Service specifications | | |
| Detectable bird Species/Groups | All bird Species/Groups. | |
| Bird Species/Group identification | The review of bird flight video and audio records, allows the indentification based on bird shape, flight pattern, and wing beats frequency. | |
| Surveillance area | 45° horizontal and 33° vertical per HD Camera. | |
| Radius around the WTG | Bird wingspan | Set up range |
| | >150 cm | 140-230 m |
| | 75-150 cm | 70-140 m |
| | <75 cm | 20-70 m |
| Simultaneous detection of multiple bird flights | Yes, detection of an unlimited number of flights and birds at the same time. | |
| Bird flight detectability | Under evaluation. | |
| Bird flight traceability ¹ | Video and audio recordings of every bird flight stored in the Wind Farm online Data Analysis Platform, with Username and Password protected access. | |
| False Positive rate (recording with no bird) | 1 - 4 FP/day (yearly average)/Camera. Based on preliminary test. | |
| Recorded data | Location. | |
| | Flight ID. | |
| | Flight time data: Init time and total length. | |
| | Flight video records, with embedded audio record. | |
| | Environmental data, and WTG operational parameters during bird flight. | |
| Online Data Analysis Platform | Species/group and bird behavior analysis from video and audio recordings. | |
| | Bird flights videos with audio storage for 2 years (up to 50 Gb/Year/DTBird unit) and data storage for 5 years, in DTBird® Server in Data Center Classified Tier 4. Optional one-year extensions. | |
| | Flight Analysis tools: review of video and audio records, flight analysis, data export, video download and automatic service reports. | |
| Service Control | Self-checking and daily verification done remotely from DTBird Headquarters. | |
| Warranty | 2-year worldwide. | |

¹ Traceability: Ability to verify bird flights' location, time and Species/Group identification by means of recorded video and data.

| DTBird® Collision Avoidance Module | |
|--|--|
| Service description | Automatic emission of Warning/Discouraging sounds from the WTG linked to real-time bird flight detection in collision risk. Video and audio recordings of every bird flight detected uploaded to DTBird online Data Analysis Platform with Username and Password protected access, ensuring bird flight traceability. |
| Installation site | Wind Turbines (WTGs) - On & Offshore. |
| Module specifications | |
| Components | DTBird® Detection Module V4 or V8. 1 Amplifier & 4 – 10 Speakers per WTG. Sound signal: Frequency range: 250-12,500 Hz Maximum Power: 120 W RMS Mounting System (not intrusive for WTG). Cables & Connections. |
| Location on the WTG | Amplifier: DTBird® Cabinet inside the WTG tower. Speakers: outdoors on the WTG tower, from 10 to 130 m height and occasionally on the nacelle (Project specific). Cables & Connections: outdoors on the WTG tower, and inside the WTG tower. |
| Dimensions | Amplifier 26x43x9 cm, WxHxD Speaker 25x25x35 cm, WxHxD |
| Weight | 20 – 30 Kg. |
| Power supply | Standard Power Grid Connection: 110-250 AC monophasic 50/60Hz |
| Power consumption | Including DTBird® Detection Module: 135 – 240 W |
| Weatherproof | Outdoor components: IP 66 / -30° to 50° C. Falling blocks of ice protection system (optional). Cabinet components: IP 65 / 0° to 40° C. |
| Service specifications | |
| Sound type: | Adjustable to target Species. Emission of Warning sounds to bird flights with Potential Collision Risk. Emission of Discouraging sounds to bird flights in High Collision Risk Area & Rotor Swept Area. |
| Sound power | Adjusted to legal requirements and bird sensitivity (Project specific). Maximum power location: Rotor Swept Area. Attenuation proportional to distance from the Rotor Swept Area. |
| Sound coverage | 360° around WTG. |
| Sound trigger | Automatic and in real-time, <2 s after flight detection with Potential Collision Risk. Standard sound emission only with the WTG operating. No sound or low sound emission with the WTG stopped. |
| Sound emission traceability ¹ | Sound recordings of every trigger uploaded to online Data Analysis Platform, with Username and Password protected access. |
| Collision Risk Reduction ² | Reduction of the bird flight time in the danger zone, especially larger birds, by 61-87%. Change of the bird flights' direction in 88% of cases where the bird is on a collision course with the wind turbine. ² |
| False Positive rate (sound trigger by DTBirdV4 with no bird) | 0.2 – 4.0 FP/day, with a total duration of 0.1 - 2.5 min/day (yearly average). |
| Recorded data | Location. Flight with sound trigger ID. Sound time data: Init time and total length. Flight video records, with embedded audio record. Flight video with environmental data and WTG operational parameters. Species/group and bird behavior analysis from video and audio recordings. |
| Online Data Analysis Platform | Bird flights videos with audio storage for 2 years (up to 50 Gb/Year/DTBird unit) and data storage for 5 years, in DTBird® Server in Data Center Classified Tier 4. Optional one-year extensions. Flight Analysis tools: review of video and audio records, flight analysis, data export, video download and automatic service reports. |
| Service Control | Self-checking and daily verification done remotely from DTBird Headquarters. |
| Warranty | 2-year worldwide. |

¹ Traceability: Ability to verify location, time and sound emission by means of recorded sound, video and data.

² Ecom AB. 2016. "Pilotinstallation av DTBird-systemet i Sverige. Möjligheter med skyddssystem för fågelfaunan vid vindkraftanläggningar – erfarenheter från Sveriges första installation av DTBird.". Report's summary translated by DTBird available in <http://www.dtbird.com/index.php/downloads-3> Experiences From Sweden's first DTBird Installation. Ecom AB. December 2016.

| DTBird® Stop Control Module | |
|--|--|
| Service description | Automatic and real-time WTG Stop triggered by bird flights detected with Collision Risk. Video recordings of the entire WTG Stop uploaded to DTBird Data Analysis Platform, with Username and Password protected access, ensuring bird flight and stop traceability. |
| Installation site | WTGs (On & Offshore). |
| Module specifications | |
| Components & Location | DTBird® Detection Module V4 or V8 + Stop Control Software installed within DTBird® cabinet. |
| Dimensions/Weight/Power supply/Power consumption/Operation conditions/Weatherproof | Within DTBird® Detection Module. See DTBird Detection Module specifications for day or night (pages 2 and 3). |
| Communications | Connection with WTG PLC/Scada. |
| Service specifications | |
| Species/Group Stop trigger sensitivity (true positives) and specificity (true negatives) | Variable, depending on target Species/Group and bird community inhabiting the installation site. |
| Surveillance area | 360° around WTG. |
| Radius of the Surveillance area around the wind turbine | DTBird® Detection Module V4 or V8. |
| Simultaneous detection of multiple bird flights | Yes (360° around WTG), detection of an unlimited n° of flights and birds at the same time. |
| Bird flight detectability | >80% |
| Stop trigger | Automatic and linked to real-time bird flight detection with collision risk. Collision risk calculation according to bird flight features. |
| Rotor Stop init time | Depending on WTG manufacturer, 2 – 18 s after DTBird® stop trigger ¹ . |
| Complete rotor Stop | Depending on WTG manufacturer, 15 – 35 s after WTG Stop init ¹ . |
| Stop length | Linked to real-time bird flight detection in collision risk. Automatic restart of WTG when the collision risk disappears. |
| Stop & bird flight traceability ² | Video recordings of every Stop & bird flight uploaded to DTBird Data Analysis Platform with Username and Password protected access. Automatic e-mail notification of every Stop: trigger time (first e-mail), end time and duration (second e-mail). |
| False Positive rate (Stops with no bird triggered by DTBirdV4) | 0.5 – 10 hours/year/WTG |
| Recorded data | Flight with Stop trigger ID. Stop time data: Init time and total length. Stop video records, with embedded audio record. Environmental data and WTG operational parameters of every stop event. Species/group, bird behavior and Stop analysis from video and audio recordings. |
| Online Data Analysis Platform | Bird flights videos with audio storage for 2 years (up to 50 Gb/Year/DTBird unit) and data storage for 5 years, in DTBird® Server in Data Center Classified Tier 4. Optional one-year extensions. Flight Analysis tools: review of video and audio records, flight analysis, data export, video download and automatic service reports. |
| Service Control | Self-checking and daily verification done remotely from DTBird Headquarters. |
| Warranty | 2-year worldwide. |

¹ The lowest wind turbine Stop time technically feasible should be used to achieve the maximum collision risk reduction. For individual bird flight efficient stops values below 30 s are recommended (species and site specific). DTBird stop protocol based on bird flight thresholds can be very efficient depending on the local bird activity.

² Traceability: Ability to verify location, time and Stop of the rotor/blades by means of recorded documented identification.

| DTBird® Collision Control Module | |
|--|---|
| Service description | Automatic and real-time detection of bird flights in Collision Risk Areas, and collision check from video and sound recordings, including birds potentially injured that fly away. Video and audio recordings uploaded to DTBird online Data Analysis Platform, with Username and Password protected access, that ensure bird flight and collision traceability. |
| Installation site | WTGs - On & Offshore. |
| Module specifications | DTBird® <i>Detection Module V4 or V8</i> . See pages 7-8 (<i>Examples of the Surveillance Area of DTBird Detection Module models V4 and V8</i>). Simultaneous video and sound recording of interconnected cameras for every detected bird flight. Continuous video recording saved for 5-10 days. |
| Service specifications | |
| Detectable bird Species/Groups | All bird Species/Groups. |
| Bird Species/Group identification | Yes, through the review of bird flight video and audio recordings. |
| Surveillance area | Whole WTG (including blades, nacelle and tower). |
| Multiple bird flights track & detection | Yes. |
| Nº of bird collisions simultaneously recorded | Unlimited. |
| Bird flights detectability | >80% |
| Bird collision detectability in video recordings | >96% (within the bird flights detected). |
| Overall bird collision detectability | >77% $0.8 \text{ (bird flight detectability)} \times 0.96 \text{ (collision detectability in video recordings)} = 0.77$ |
| Collision traceability ¹ | Video with audio recordings of every bird flight and potential collision uploaded to DTBird online Data Analysis Platform, with Username and Password protected access. |
| Request of in situ inspection to verify a potential collision and/or to recover a potentially injured bird | E-mail notifications of potential collision events, including online video data of the bird flight. |
| Recorded data | Location. Collision ID. Collision time data: Init time and total length. Collision video records, with embedded audio record. Environmental data, and WTG operational parameters of the collision event. Species/group, bird behavior and collision event analysis from video and sound recordings. |
| Online Data Analysis Platform | Bird flights videos with audio storage for 2 years (up to 50 Gb/Year/DTBird unit) and data storage for 5 years, in DTBird® Server in Data Center Classified Tier 4. Optional one-year extensions. Flight Analysis tools: review of video and audio records, flight analysis, data export, video download and automatic service reports. |
| Service Control | Self-checking and daily verification done remotely from DTBird® Headquarters. |
| Warranty | 2-year worldwide. |

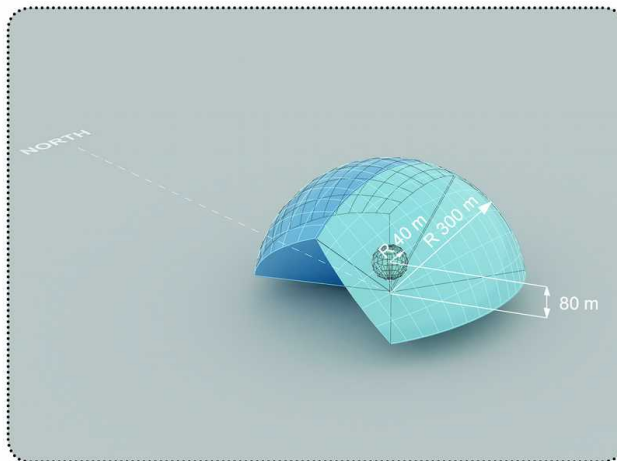
¹ Traceability: Ability to verify bird flight collision events, time and Species/Group identification by means of recorded video and sound.

Annex. Examples of the Surveillance Area of DTBird Detection Module models V4 and V8.

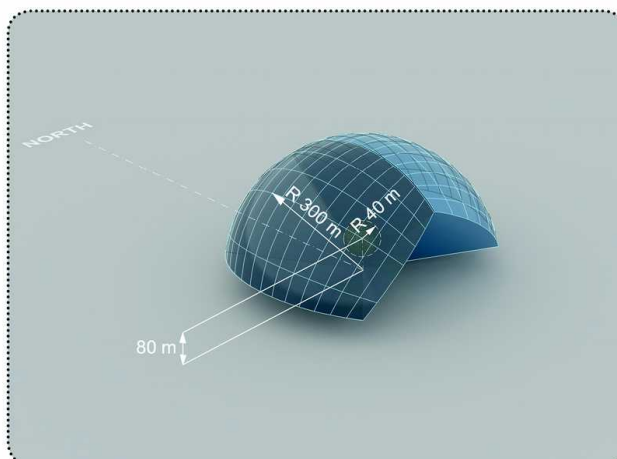
DTBird Detection Module V4

WTG: Tower height 80 m, Rotor diameter 80 m.
 Projection of the Surveillance Area at the Maximum Detection Distance.
 Target Species: *Aquila Chrysaetos*

3D Projection Cameras 1 & 3



3D Projection Cameras 2 & 4

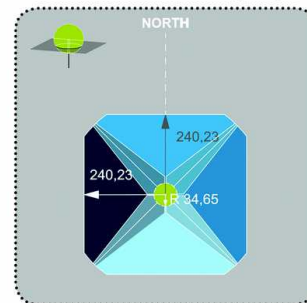


- Camera 1
- Camera 2
- Camera 3
- Camera 4
- Rotor Swept Area (RSA)

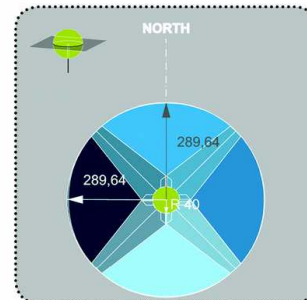
2D Sections

At $\frac{1}{4}$, $\frac{1}{2}$ and $\frac{3}{4}$ of the Rotor Swept Area height (RSA)

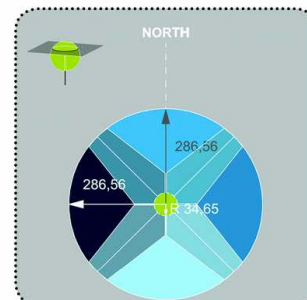
2D Section at $\frac{1}{4}$ RSA (60m)



2D Section at $\frac{1}{2}$ RSA (80m)



2D Section at $\frac{3}{4}$ RSA (100m)



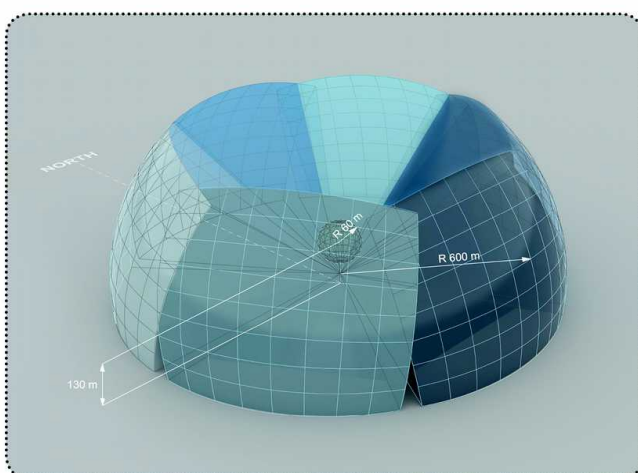
DTBird Detection Module V8

WTG: Tower height 130 m, Rotor diameter 120 m.

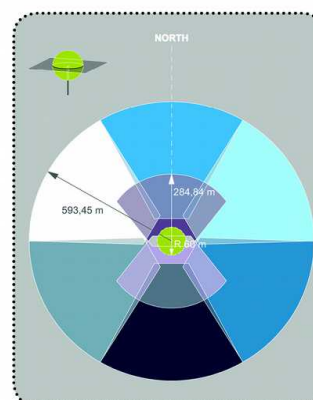
Projection of the Surveillance Area.

Target Species: . Golden Eagle (*Aquila chrysaetos*)
. WTE (*Haliaeetus albicilla*)**3D Projection**

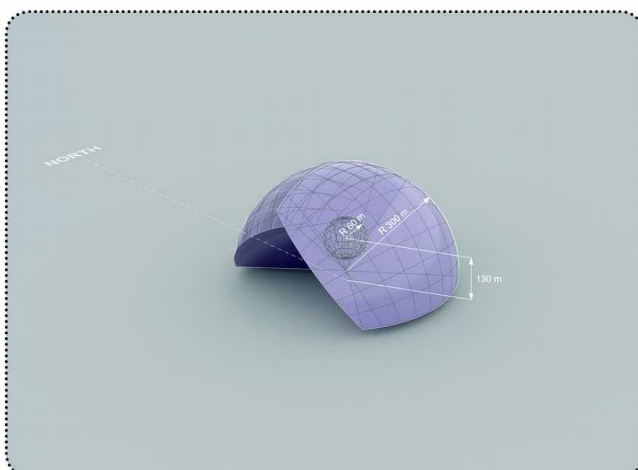
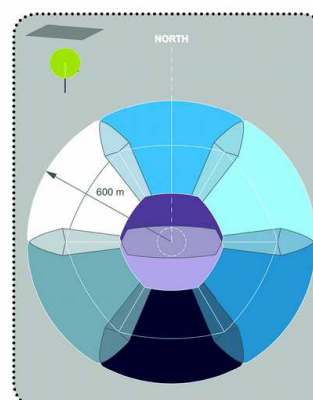
Long Distance Cameras 1-2-3-4-5 & 6

**2D Sections**

At ½ of the Rotor Swept Area height (RSA)

**3D Projection**

Medium to Short Distance Cameras 7 & 8

**2D Plan projection**

- Camera 1 ● Camera 2 ● Camera 3 ● Camera 4
- Camera 5 ● Camera 6 ● Camera 7 ● Camera 8
- Rotor Swept Area (RSA)