REPORT

Collision Risk Estimates for Key Seabird Species at Inch Cape Offshore Wind Farm

Comparisons with consent design scenarios

Client: Inch Cape Offshore Limited

Reference: PB2991-RHD-ZZ-XX-RP-Z-0001

Status: S0/P01.01

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Confidential

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Acronyms

CRM	Collision risk modelling
EIAR	Environmental Impact Assessment Report
ICOL	Inch Cape Offshore Limited
LAT	Lowest Astronomical Tide
MSL	Mean sea level
SOSS	Strategic Ornithological Support Services
SPA	Special Protection Area

1 Introduction

In 2018, ICOL submitted a new application for the Inch Cape Offshore Wind Farm with a revised design that would allow the development of a project that could utilise progressions in turbine technology since the 2014 consent. The revised design was aimed at reducing the environmental impacts and increasing the cost competitiveness of the project, primarily by reducing the overall number of turbines and increasing the height of the turbines being installed. Section 36 and Marine Licence Consents for the revised design were granted by Scottish Ministers in 2019.

The Inch Cape Offshore Wind Farm Section 36 Consent sets out parameters, but provides by condition 7 that the Development must be constructed and operated in accordance with the Application (which includes the submitted EIAR). The ornithology chapter of the EIAR assessed two design scenarios (referred to as A and B). The two scenarios represent the extent of the design envelope, each giving a maximum rotor swept area below 50 m above mean sea level of 87,000 m2 (a commitment in the EIAR, see for example Table 11.4, “Worst Case Scenario Definition”). The Marine Licence sets out parameters for both of these assessed design scenarios (“Part 2 – The Works”), but provides that where the final design agreed through the Development Specification and Layout Plan (“DSLP”) falls between design scenarios A and B, the collision risk to birds must be no greater than assessed in the Appropriate Assessment (Marine Scotland 2019). The Marine Licence also provides by condition 3.1.1 that the works must be constructed and operated in accordance with the Application (which includes the EIAR). Both the Section 36 Consent and Marine Licence provide a condition requiring approval of the DSLP.

Since the revised design of the Inch Cape Offshore Wind Farm was consented1, a preferred design scenario (in terms of turbine numbers and dimensions) for the Wind Farm has been identified. It falls within a combination of the parameters from design scenarios A and B. For completeness, in order to ensure that for the proposed design scenario the collision risk to birds is no greater than as assessed in the Appropriate Assessment, CRM for the preferred design scenario is included within this report. For the avoidance of doubt, CRM will also be submitted along with the DSLP for approval under the Section 36 and Marine Licence conditions.

This report compares the predicted collision mortality for the current preferred design with the design scenarios on which the consent is based. This is undertaken for each of the three species of seabird for which collision mortality was considered to be relevant effect pathway in the assessment for the Project – i.e. gannet, kittiwake and herring gull (Marine Scotland 2017, ICOL 2018a).

2 Predicting collision mortality

2.1 Turbine parameters

The turbine parameters which are relevant to CRM are presented for the revised design and for the two designs assessed at consent in Table 1.

Table 1. Comparison of the turbine parameters relevant to the estimation of collision mortality using the SOSS offshore CRM (Band 2012) for the preferred design and for the two design scenarios assessed at consent.

[1] *Microsoft Word - ICOL Revised Design - ANNEX C Decision Notice and Conditions - V3 - FINAL (marine.gov.scot)*

Parameter	Preferred Design	Design Scenario A	Design Scenario B
Number of turbines	72	72	40
Number rotors per turbine	3	3	3
Hub height (m)[1]	152.7	116.1	152.6
Rotor radius (m)	118	83.5	125
Height to upper blade tip (m)[1]	270.7	199.6	277.6
Height to lower blade tip (m)[1]	34.7	32.6	27.6
Maximum blade width (m)	5.1	6.0	7.8
Rotor speed (rpm)[2]	7.19	8.72	5.72
Pitch (°)[2]	4.38	10	10
Monthly time operational (%)[2]	94	80	80

[1]Values are given relative to MSL because the CRM is calculated relative to MSL. MSL is taken as 2.9m above LAT for the development area.
[2]Presented as the annual average as calculated from monthly-specific estimates. The monthly and species-specific seasonal period values are given in Appendix A.

It is also the case that the nominal turbine spacing associated with the refined design (i.e. 1,025m) will decrease compared to the values set out for the two designs assessed at consent (i.e. 1,278m for both designs). However, turbine spacing does not affect collision estimates (as calculated by the SOSS offshore CRM) and is not included as a parameter in this model.

2.2 Methods and approach

To determine the predicted collision mortality associated with the refined turbine parameters, CRM was undertaken exactly as for the assessment with only the turbine parameters changed in line with the details in Table 1 (ICOL 2018a). Thus, the 'Band spreadsheet' version of the SOSS offshore CRM was used (Band 2012), with the model options, avoidance rates, nocturnal activity rates and bird parameters consistent with what was used in the assessment and as detailed in Table 2. The mean monthly bird flight densities for each species were also unaltered from the values used in the submission (compare Appendix A with Annex 11C.1 in ICOL 2018a). Recent advice from Marine Scotland and NatureScot on undertaking CRM continues to advocate the use of the 'Band spreadsheet' version of the SOSS offshore CRM (Marine Scotland 2022, NatureScot 2021).

Table 2. Model options and avoidance rates used in the CRM for each species, together with species-specific flight behaviour and morphological parameters.

Species	Band model option[1]	Avoidance rate[2]	Nocturnal activity score	Bird length (m)[3]	Wingspan (m)[3]	Flight speed ($m.s^{-1}$)[4]	Flight type
Gannet	2	98.9%	1 (=0%)	0.94	1.73	14.9	Flapping
Kittiwake	2	98.9%	2 (=25%)	0.39	1.08	13.1	Flapping

Herring gull[5]	3	99.5%	2 (=25%)	0.60	1.44	12.8	Flapping

[1]Details of model options are provided in Band (2012), with the flight height data of Johnston *et al.* (2014a,b) used in each case.
[2]Avoidance rates used for each species are as advised for the relevant model option by SNCBs (2014).
[3]From BTO Birdfacts (https://www.bto.org/about-birds/birdfacts) [Accessed 10/05/2018].
[4]From Pennycuik (1997) for gannet and Alerstam *et al.* (2007) for kittiwake and herring gull.
[5]CRMs for herring gull were undertaken using both options 2 and 3 in the assessment for the revised design of the Inch Cape Offshore Wind Farm but with the assessment based on the option 3 outputs (ICOL 2018b,c).

2.3 Collision estimates

The collision estimates calculated for the preferred design are lower than the worst-case design on which the consent was based for each of the three species considered (Table 3). This is the case irrespective of whether the estimates are considered for the full annual period or for the breeding season of each species[2] (noting that the effects apportioned to the key SPA populations of the these three species are substantially higher for the breeding than non-breeding season – ICOL 2018c). For all three species, the collision estimates for the preferred design are close to the lower of the estimates for the two designs assessed at consent, representing a reduction of approximately 10 – 15% from the worst-case estimates for gannet and kittiwake.

Table 3. Comparison of annual and breeding season collision estimates for the preferred design and for the two designs assessed at consent (with the worst-case on which consent based shown in bold). Comparisons are undertaken for the three species for which collision mortality was considered a relevant effect pathway in the assessment for the Project.

Species	Preferred design		2018 EIAR design scenarios			
			A		B	
	Annual	Breeding season	Annual	Breeding season	Annual	Breeding season
Gannet	105	98	105	96	**117**	**108**
Kittiwake	61	36	64	36	**72**	**40**
Herring gull	2	1	**3**	**1**	2	1

3 Conclusions

The turbine parameters for the Inch Cape Offshore Wind Farm have been refined in relation to the detailed specification of the turbine model to be deployed by the Project. The collision estimates associated with the preferred design are lower than the worst-case for collision mortality assessed at consent for each of the three seabird species for which collision mortality was considered a relevant effect pathway in the assessment for the Project. Therefore, for the preferred design the collision risk to birds is no greater than assessed in the Appropriate Assessment.

[2] *As defined by NatureScot in Guidance note - Seasonal definitions for birds in the Scottish Marine Environment.pdf (nature.scot)*

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Appendix A: Excel worksheets showing the input parameters used for the collision risk models undertaken for the refined turbine design

Gannet

COLLISION RISK ASSESSMENT			used in overall collision risk sheet								used in available hours sheet													
Sheet 1 - Input data			used in migrant collision risk sheet								used in large array correction sheet													
			used in single transit collision risk sheet or extended model								not used in calculation but stated for reference													
	Units	**Value**		**Data sources**																				
Bird data																								
Species name		**Gannet**																						
Bird length	m	0.94																						
Wingspan	m	1.73																						
Flight speed	m/sec	14.9																						
Nocturnal activity factor (1-5)		1																						
Flight type, flapping or gliding		flapping																						
				Data sources																				
Bird survey data				Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec									
Daytime bird density	birds/sq km			0.1505	0.556	0.5785	2.1745	4.328	3.7765	3.6285	5.134	1.512	1.0355	0.193	0									
Proportion at rotor height	%	1.1%																						
Proportion of flights upwind	%	50.0%																						
				Data sources																				
Birds on migration data																								
Migration passages	birds			0	0	0	0	0	0	0	0	2000	4000	0	0									
Width of migration corridor	km																							
Proportion at rotor height	%																							
Proportion of flights upwind	%	50.0%																						
	Units	**Value**		**Data sources**																				
Windfarm data																								
Name of windfarm site		**IC - Large**																						
Latitude	degrees	56.49																						
Number of turbines		72																						
Width of windfarm	km	6.774																						
Tidal offset	m																							
	Units	**Value**		**Data sources**																				
Turbine data																								
Turbine model																								
No of blades		3		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec									
Rotation speed	rpm	7.01		7.51	7.51	7.25	7.03	6.90	6.84	6.86	7.01	7.19	7.27	7.39	7.56									
Rotor radius	m	118																						
Hub height	m	152.7		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec									
Monthly proportion of time operational	%			94.49%	95.56%	93.99%	93.06%	90.03%	90.08%	90.49%	92.91%	93.31%	95.52%	96.90%	96.42%									
Max blade width	m	5.100																						
Pitch	degrees	3.57		6.20	5.81	4.84	3.26	3.62	3.51	2.79	3.17	3.84	4.32	5.01	6.16									

Murray Grant:
Not relevant: No option 1 models run

RPM		
Breeding	Aut Pass	Spr Pass
7.01	7.33	7.46

Pitch		
Breeding	Aut Pass	Spr Pass
3.57	4.66	5.75

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Kittiwake

COLLISION RISK ASSESSMENT			used in overall collision risk sheet							used in available hours sheet				
Sheet 1 - Input data			used in migrant collision risk sheet							used in large array correction sheet				
			used in single transit collision risk sheet or extended model							not used in calculation but stated for reference				
	Units	**Value**	**Data sources**											
Bird data														
Species name		Ki												
Bird length	m	0.39												
Wingspan	m	1.08												
Flight speed	m/sec	13.1												
Nocturnal activity factor (1-5)		2												
Flight type, flapping or gliding		flapping												
			Data sources											
Bird survey data			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Daytime bird density	birds/sq km		0.2	0.048	0.569	0.612	0.839	1.998	3.682	0.487	2.495	1.591	0.628	0.347
Proportion at rotor height	%	0.80%												
Proportion of flights upwind	%	50.0%												
			Data sources											
Birds on migration data														
Migration passages	birds		0	0	0	4000	2000	0	0	0	2000	4000	0	0
Width of migration corridor	km	8												
Proportion at rotor height	%	75%												
Proportion of flights upwind	%	50.0%												
	Units	**Value**	**Data sources**											
Windfarm data														
Name of windfarm site		Inch Cape												
Latitude	degrees	56.49												
Number of turbines		72												
Width of windfarm	km	6.774												
Tidal offset	m	0												
	Units	**Value**	**Data sources**											
Turbine data														
Turbine model		Large turbine												
No of blades		3	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rotation speed	rpm	6.93	7.51	7.51	7.25	7.03	6.90	6.84	6.86	7.01	7.19	7.27	7.39	7.56
Rotor radius	m	118												
Hub height	m	152.7	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Monthly proportion of time operational	%		94.49%	95.56%	93.99%	93.06%	90.03%	90.08%	90.49%	92.91%	93.31%	95.52%	96.90%	96.42%
Max blade width	m	5.100												
Pitch	degrees	3.27	6.20	5.81	4.84	3.26	3.62	3.51	2.79	3.17	3.84	4.32	5.01	6.16

murray.grant:
Not relevant: No option 1 models run

RPM		
Breeding	Aut Pass	Spr Pass
6.93	7.28	7.32

Pitch		
Breeding	Aut Pass	Spr Pass
3.27	4.50	5.03

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Herring gull

COLLISION RISK ASSESSMENT			used in overall collision risk sheet							used in available hours sheet					
Sheet 1 - Input data			used in migrant collision risk sheet							used in large array correction sheet					
			used in single transit collision risk sheet or extended model							not used in calculation but stated for reference					
	Units	**Value**	**Data sources**												
Bird data															
Species name		**Herring gull**													
Bird length	m	0.60													
Wingspan	m	1.44													
Flight speed	m/sec	12.8													
Nocturnal activity factor (1-5)		2													
Flight type, flapping or gliding		flapping													
			Data sources												
Bird survey data			Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Daytime bird density	birds/sq km		0.1001021	0.0484165	0	0	0.0244738	0.1218324	0	0.0242601	0	0.0252525	0.0483092	0.1472915	
Proportion at rotor height	%	5.0%													
Proportion of flights upwind	%	50.0%													
			Data sources												
Birds on migration data															
Migration passages	birds		0	0	0	0	0	0	0	0	2000	4000	0	0	
Width of migration corridor	km														
Proportion at rotor height	%														
Proportion of flights upwind	%	50.0%													
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Max blade width	m	5.100													
Pitch	degrees	3.27	6.20	5.81	4.84	3.26	3.62	3.51	2.79	3.17	3.84	4.32	5.01	6.16	

Murray Grant:
Not relevant: No option 1 models run

RPM	
Breeding	Non-breed
6.93	7.42

Pitch	
Breeding	Non-breed
3.27	5.39