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# Norfolk Vanguard Offshore Wind Farm

# Offshore Ornithology

## Deterministic Collision Risk Modelling for revised layout scenarios and increased draught height

Applicant: Norfolk Vanguard Limited
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*Photo: Kentish Flats Offshore Wind Farm*

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## EXECUTIVE SUMMARY

This note presents an update to the seabird collision risk estimates for the Norfolk Vanguard Offshore Wind Farm (the Project). Following requests from the Examining Authority (ExA), Natural England and the Royal Society for the Protection of Birds (RSPB) to explore options to mitigate potential seabird impacts from the project, three separate mitigation measures have been applied by the Applicant throughout the course of the examination, thereby significantly reducing the collision risk predictions for the Project. This note presents an update to reflect the most recent additional mitigation proposed by the Applicant in response to submissions from stakeholders at Deadline 7, and has been applied through an increase in the turbine draught height of 5m, from 22m to 27m for all wind turbine generators across the Project.

The collision risk predictions for the Project have been significantly reduced since submission of the DCO application through the adoption of three separate mitigation measures:

1. The removal of the 9MW turbine from the design envelope (submitted at Deadline 6, ExA; AS;10.D6.15). This recued the worst case scenario from 200 x 9MW wind turbine generators (WTGs) to 180 x 10MW WTGs as the new worst case scenario; this reduced collisions by approximately 10%;
2. Revision of the worst case wind farm layout across the Norfolk Vanguard East and West sites (submitted on the 17th April 2019, ExA; CRM; 10.D6.5.1), which further reduced predicted collisions by an average of 34% (compared with the previous worst case scenario with all turbines in either Norfolk Vanguard East or Norfolk Vanguard West); and,
3. An increase in turbine draught height of 5m (from 22m to 27m) which yielded a further reduction in predicted collision risk of 41% on average (compared with those estimated at the previous turbine draught height of 22m).

The overall reduction in collision risk obtained through these mitigations is 65% (averaged across species, and including all three mitigations listed points above). The updates to the Project design have followed an iterative process of engagement with Natural England and the Royal Society for the Protection of Birds over the course of the examination, whereby the Applicant initially worked to agree modelling parameters and methods for the assessment and subsequently responded to requests to explore options for reducing collision predictions. The increase in turbine draught height has been made to address Natural England's comments submitted at Deadline 7 (EN010079-002878-DL7). The updated collision estimates have been submitted at this stage in the Examination in order to permit consideration by Natural England before Deadline 8.

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# Glossary

| | |
|---|---|
| CRM | Collision Risk Model |
| BDMPS | Biologically Defined Minimum Population Scale |
| EIA | Environmental Impact Assessment |
| ES | Environmental Statement |
| HAT | Highest Astronomical Tide |
| HRA | Habitats Regulations Assessment |
| MHWS | Mean High Water Springs |
| MSL | Mean Sea Level |
| MW | Megawatt |
| NAF | Nocturnal Activity Factor |
| NE | Natural England |
| NV | Norfolk Vanguard |
| RPM | Revolutions per minute |
| RSPB | Royal Society for the Protection of Birds |
| SPA | Special Protection Area |
| WTG | Wind Turbine Generator |

# 1 INTRODUCTION

1. This note provides an update to the collision risk modelling (CRM) for the Norfolk Vanguard Offshore Wind Farm (NV) reflecting an increase of 5m in the turbine draught height from 22m to 27m (the minimum distance between the lower rotor tip and the sea surface at mean high water springs (MHWS)). This design change will be applied to all turbines across Norfolk Vanguard Offshore Wind Farm and will be secured through the Schedules 9 and 10 Requirement 2(1)(e) of Deemed Marine Licences. This mitigation has been adopted, over and above previous mitigations in the project design (removal of the smallest 9MW turbine from the design; (ExA;AS;10.D6.15) and the revised layout across the NV East and NV West sites (ExA;CRM;10.D.6.5.1)), following requests from the Examining Authority, Natural England and the Royal Society for the Protection of Birds (RSPB) to explore options to minimise impacts as far as possible and in line with National Policy Statement EN-3:

   "*2.6.108 Subject to other constraints, wind turbines should be laid out within a site in a way that minimises collision risk, where the collision risk assessment shows there is a significant risk of collision*."

2. The CRM has been undertaken using the deterministic Band (2012) model, summed across Norfolk Vanguard East (NV East) and Norfolk Vanguard West (NV West) using the species-specific worst case scenarios for the two sites resulting from the revised turbine layout options. With the exception of the hub height value which has been increased by 5m (thereby increasing the turbine draught height by the same amount), all other parameter values remain the same as those submitted in ExA;CRM;10.D6.5.1.

3. This note only provides the results of the modelling. Updated assessment for the revised collision estimates is provided in ExA;CRM;10.D7.21.version 2.

## 2 RESULTS

4. The worst case annual collision estimates presented at Deadline 6 (ExA;AS;10.D6.15), submission on the 17th April 2019 (ExA; CRM; 10.D6.5.1) and those for the revised Project Design Envelope including the 5m draught height increase are compared in Table 1, including the total percentage reduction in worst case annual mortality achieved for each species. The reductions for the revised layout and increased draught height vary between 42% (lesser black-backed gull) and 82% (Arctic skua), with an average reduction of 61%. The variation between species reflects their relative abundance across the NV East and NV West sites. When the reduction for the removal of the 9MW turbine is also accounted for the average reduction is increased to 65%.

**Table 1. Comparison of worst case annual mortality estimates between those presented at Deadline 6 (ExA; AS; 10.D6.15), Submission on the 17th April 2019(ExA;CRM;10.D.6.5.1) and the revised estimates including the 5m draught height increase (this note).**

| Species | Deadline 6 Estimate (for the 10MW turbines) | Update of 17/04/2019 (for the revised layout) | 5m draught height increase (current assessment) | Percentage reduction since Deadline 6 |
|---|---|---|---|---|
| Red-throated diver | 4.66 (0-15.83) | 3.65 (0.14-9.28) | 1.8 (0.07-4.56) | 61.4 |
| Fulmar | 9.61 (0.27-27.94) | 6.92 (2.18-13.24) | 2.19 (0.69-4.2) | 77.2 |
| Gannet | 177.08 (29.43-431) | 111.66 (62.66-174.18) | 66.31 (37.21-103.44) | 62.6 |
| Arctic skua | 0.56 (0-3.37) | 0.26 (0-0.66) | 0.1 (0-0.26) | 82.1 |
| Great skua | 1.97 (0-9.86) | 1.29 (0.12-3.52) | 0.63 (0.06-1.73) | 68.0 |
| Kittiwake | 317.79 (34.52-837.99) | 186.09 (107.89-281.79) | 115.4 (66.9-174.75) | 63.7 |
| Black-headed gull | 4.94 (0-20.1) | 4.35 (0-11.58) | 2.68 (0-7.12) | 45.7 |
| Little gull | 15.76 (0-55.4) | 8.26 (2.78-15.68) | 5.09 (1.71-9.66) | 67.7 |
| Common gull | 14.95 (0-51.81) | 11.9 (1.81-27.75) | 8.16 (1.24-19.02) | 45.4 |
| Lesser black-backed gull | 39.62 (1.91-110.46) | 31.7 (8.95-65.16) | 23.05 (6.51-47.38) | 41.8 |
| Herring gull | 37.45 (0-144.67) | 17.93 (9.65-30.33) | 13.45 (7.24-22.75) | 64.1 |
| Great black-backed gull | 100.52 (2.07-339.63) | 61.94 (29.99-103.25) | 46.84 (22.68-78.08) | 53.4 |

5. Monthly estimates for each species are provided in Table 2. The relevant project input parameters are provided in Table 3 (Appendix 1) for reference. As noted above, the only value which has been revised is hub height, from 22m to 27m from MHWS.

**Table 2. Norfolk Vanguard monthly worst case collision risk mortalities for the 10MW turbine with a 5m draught height increase to 27m from MHWS. For each species only the worst case collision predictions (either scenario (a) two-thirds turbines in NV West and one-third in NV East, or (b) half the WTGs in each of NV East and NV West) is shown.**

| Species | Scenario | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Red-throated diver | a | 1.02 (0-2.47) | 0.2 (0-0.59) | 0.1 (0-0.29) | 0 (0-0) | 0 (0-0) | 0 (0-0) | 0 (0-0) | 0 (0-0) | 0 (0-0) | 0 (0-0) | 0.27 (0.07-0.6) | 0.21 (0-0.61) | **1.8 (0.07-4.56)** |
| Fulmar | b | 0.16 (0.04-0.35) | 0.09 (0.01-0.21) | 0.12 (0.01-0.28) | 0.12 (0.03-0.25) | 0.33 (0.15-0.57) | 0.18 (0.04-0.34) | 0.08 (0.01-0.16) | 0.33 (0.12-0.58) | 0.14 (0.03-0.31) | 0.34 (0.18-0.51) | 0.17 (0.04-0.35) | 0.14 (0.04-0.27) | **2.19 (0.69-4.2)** |
| Gannet | b | 0.53 (0-1.5) | 0.86 (0-2.34) | 0.98 (0-2.52) | 0.46 (0-1.24) | 1.1 (0-2.69) | 4.61 (1.3-9.12) | 1.74 (0.26-4.05) | 4.06 (0.74-8.11) | 4.02 (1.5-7.42) | 7.17 (3.65-11.44) | 31.27 (23.12-40.33) | 9.5 (6.64-12.68) | **66.31 (37.21-103.44)** |
| Arctic skua | b | 0 (0-0) | 0 (0-0) | 0 (0-0) | 0 (0-0) | 0 (0-0) | 0 (0-0) | 0 (0-0) | 0.03 (0-0.1) | 0.07 (0-0.16) | 0 (0-0) | 0 (0-0) | 0 (0-0) | **0.1 (0-0.26)** |
| Great skua | b | 0 (0-0) | 0 (0-0) | 0.06 (0-0.18) | 0 (0-0) | 0 (0-0) | 0 (0-0) | 0 (0-0) | 0 (0-0) | 0.47 (0.06-1.25) | 0.1 (0-0.29) | 0 (0-0) | 0 (0-0) | **0.63 (0.06-1.73)** |
| Kittiwake | b | 26.88 (20.05-34.82) | 11.78 (7.12-17.44) | 17.24 (11.32-24.15) | 8.23 (5.03-12.44) | 7.77 (2.23-14.4) | 5.99 (1.86-11.14) | 2.52 (0.54-5.4) | 2.06 (0.22-4.76) | 1.45 (0.21-3.17) | 3.1 (0.92-6.19) | 18.71 (11.69-26.5) | 9.67 (5.7-14.34) | **115.4 (66.9-174.75)** |
| Black-headed gull | a | 0.15 (0-0.37) | 0.51 (0-1.2) | 0.38 (0-1.14) | 0.41 (0-1.03) | 0.12 (0-0.35) | 0 (0-0) | 0.35 (0-0.97) | 0 (0-0) | 0 (0-0) | 0.65 (0-1.75) | 0.1 (0-0.31) | 0 (0-0) | **2.68 (0-7.12)** |
| Little gull | b | 0 (0-0) | 0.08 (0-0.23) | 0 (0-0) | 0 (0-0) | 1.95 (0.65-3.57) | 0 (0-0) | 0 (0-0) | 1.98 (1.06-3.04) | 0.32 (0-0.96) | 0 (0-0) | 0.77 (0-1.86) | 0 (0-0) | **5.09 (1.71-9.66)** |
| Common gull | a | 0.54 (0-1.33) | 0.71 (0-1.78) | 1.25 (0-3.07) | 0 (0-0) | 0 (0-0) | 0 (0-0) | 0 (0-0) | 0 (0-0) | 0.36 (0-1.07) | 1.34 (0.13-3.9) | 3.84 (1.11-7.51) | 0.12 (0-0.36) | **8.16 (1.24-19.02)** |

| Species | Scenario | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lesser black-backed gull | a | 0.82 (0-1.89) | 0.22 (0-0.55) | 0.56 (0-2.23) | 0.67 (0-2.15) | 0 (0-0) | 3.03 (0.43-6.5) | 4.22 (1.72-8.02) | 7.65 (2.82-13.78) | 2.5 (0.78-4.67) | 2.75 (0.76-5.98) | 0.33 (0-0.89) | 0.29 (0-0.72) | **23.05 (6.51-47.38)** |
| Herring gull | b | 10.33 (7.04-14.12) | 0.29 (0-0.88) | 0.3 (0-1.18) | 0.46 (0-1.62) | 0 (0-0) | 0 (0-0) | 0 (0-0) | 0 (0-0) | 0 (0-0) | 0 (0-0) | 1.39 (0.2-3.35) | 0.68 (0-1.59) | **13.45 (7.24-22.75)** |
| Great Black-backed Gull | b | 24.69 (17.48-33.39) | 2.76 (0.33-6.07) | 0.65 (0-1.95) | 0.56 (0-1.4) | 0.43 (0-1.3) | 0 (0-0) | 0.88 (0-2.19) | 5.57 (1.72-9.85) | 3.59 (1.05-6.58) | 0.75 (0-1.89) | 3.73 (1.26-7.08) | 3.23 (0.84-6.39) | **46.84 (22.68-78.08)** |

## 3 CONCLUSIONS

6. Following a review of the Project design in order to minimise the potential risks of seabird impacts from the Project (and in order to address requests by the Examining Authority, Natural England and the Royal Society for the Protection of Birds to explore options for project mitigation), revised turbine layouts were developed which reduced the maximum proportion of turbines which will be installed in Norfolk Vanguard East and Norfolk Vanguard West (ExA;CRM;10.D6.5.1). This reduced the collision risk by an average of 34% across all species compared with the previous worst case assumption that all turbines would be installed in either Norfolk Vanguard East or Norfolk Vanguard West.

7. Following specific requests for further impact reduction through raising the turbine draught height from Natural England and the RSPB, and in response to Natural England's submission at Deadline 7 (EN010079-002878-DL7), the Applicant has also agreed to raise the turbine draught height by 5m (from 22m to 27m).

8. The Applicant has now offered three separate forms of mitigation since submission of the DCO application; the removal of the 9MW turbine from the design envelope, the revised turbine layout and a 5m increase in draught height. Combined, these measures reduce the collision risk for all species, with an overall average collision mortality reduction of 65%.

9. A corresponding revised Environmental Impact Assessment of collision risk for the Project alone and cumulatively and a Habitats Regulations Assessment of collision risk for the Project alone and in-combination has also been provided alongside this submission in ExA; AS; 10.D7.21.version 2 (this updates the assessment submitted at Deadline 7 to reflect the additional reductions presented in this note).

# 4 REFERENCES

Band, W. 2012. Using a collision risk model to assess bird collision risk for offshore wind farms. The Crown Estate Strategic Ornithological Support Services (SOSS) report SOSS-02

# Appendix 1. Wind farm input parameters

**Table 3. Wind farm and turbine input parameters.**

| Model (MW) | Number | Rotor radius (m) | Hub height (m) | RPM | Max. blade width (m) | Blade pitch (°) | Tidal offset (m; difference between MSL and MHWS)* | Operational period (%) | Latitude (°) | | Windfarm width (km) | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | East | West | East | West |
| 10 | 180 | 95 | 122 | 8.3 | 7.5 | 15 | 0.8 | 90 | 52.2 | 52.9 | 22.3 | 17.7 |

*NB: in previous submission the offset was erroneously labelled as the difference between Highest Astronomical Tide (HAT) and Mean High Water Spring (MHWS). This was only an error in labelling (corrected here) and the values used in the modelling are unaffected.