Morecambe Offshore Windfarm: Generation Assets

Examination Documents

Volume 9
VHF, UHF, and DF Technical Safeguarding Assessment

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Prepared by:
NATS Safeguarding Office

Technical Safeguarding Assessment

Morecambe Offshore
Wind Farm Development
Blackpool Airport

NATS ref: SG36338

Issue 2.0

Contents

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1.0	February 2025	
2.0	April 2025	Addition of Appendix B to answer questions raised in relation to stand-alone versus multi-turbine analysis

Document Use

External use: Yes

Referenced Documents

1. Scope

This report is a bespoke technical assessment of the impact a proposed windfarm on the Communication and Navigation equipment at Blackpool Airport.

No attempt has been made to estimate the operational significance of any technical impact identified. It is felt this can only properly be determined by specialists at the airport who are actively engaged in providing the required air traffic service

2. Development Details

The proposed Morecambe Windfarm is a large offshore development to be located in the Irish Sea.

The turbine locations have not been finalised, however is not expected that the precise locations of the turbines within the overall development boundaries will change the conclusions of this report significantly.

Where required, in order to undertake an assessment, a set of representative turbine locations and dimensions have been used; these are detailed in Appendix A and shown in the diagram below.

Figure 1 – Representative Turbine Locations

3. Assessments Required

Details of the equipment to be assessed were provided via email by the airport and include:

- Navigation Aids
  - Runway 28 Localiser (28_LOC)
  - Runway 28 Glide Path (28_GP)
  - Distance Measuring Equipment (DME)
  - Non-directional Beacon (NDB)
- Three Air-ground-air Radio Sites
  - Transmitter Site (VHF_TX)
  - Receiver Site (VHF_RX)
  - Direction Finder Site (VHF_DF)

The diagrams below show the locations of the equipment to be assessed.

Figure 2 – On-airfield CNS equipment

3.1. Navigational Aid Assessment

A DME, NDB and the components of the instrument landing system; a localiser and glide path, were assessed against the criteria from ICAO EUR Doc 015.

The ICAO document provides restricted areas for turbine development in the vicinity of these types of equipment.

For all of the Navigational Aids the turbines are comfortably clear of the restricted areas as shown below.

Figure 3 – Localisers and glide path restricted area criteria

3.2. Radio Communication Assessment

3.2.1. CAP-670 Air Traffic Services Safety Requirements

CAP-670 Appendix A to GEN 02 provides the basis for air-ground radio assessments of turbines in the United Kingdom. The CAP-670 methodology involves two phases; an initial zonal assessment based on turbine classification and, if required, a more detailed carrier-to-interference ratio, C/I, assessment.

The CAP-670 turbine classifications range from "Small" to "Large Industrial" based on turbine characteristics such as hub and tip height.

Unfortunately the largest turbine class tops out at 158m to tip which is approximately half the size of the turbines being proposed and therefore the published red/amber/green volumes of the zonal assessment are not applicable.

In this scenario CAP-670 advises that *"Large developments i.e. turbine tip height greater than 110 metres AGL, and / or more than 10 turbines will require detailed assessment using the C/I prediction method"*

CAP-670 allows for the scaling of the C/I assessment by providing a formula to calculate a bi-static RCS outside the range of turbines provided in CAP670 tables 4 and 5, this RCS can then be used as the input to the C/I assessment.

Modelling all 25 turbines would be very computationally intensive and as these will not likely be the final locations would not yield a definitive result in any case.

It was therefore decided to model the best-case (T15), worst-case (T1) and randomly selected third (T7) turbine to get a feel for the likely volume of impact with the caveat that the cumulative effect of multiple turbines may inflate these volumes somewhat.

The software HTZ Communication (version 2024.2) was used to model the direct and indirect, via a reflection from the turbines, paths and compare the two signal strengths.

Based on the details provide for the actual Blackpool transmitter the radios themselves were modelled as 5W transmitting sites. It is understood that this is not representative of either the Receiver or DF site however the C/I assessments models the relative rather than absolute signal strengths and therefore the actual output power or the direction of the radio path should not affect the defined volume within which the C/I threshold is breached.

3.2.1. Results of Carrier to Interference Assessment

Noting that this is below the turbine hub height the <23dB C/I boundaries at 500ft show a radius of 0.5nm from each of the three turbines coupled with a shadow extending 2.7nm behind them.

Figure 4 – VHF Tx: site C/I <23dB at 500ft

Re-running the analysis at 1,000ft, still below the maximum height of the turbines, the radius shrinks to 0.3nm and the shadow to 1.2nm, this is shown as the red boundary below.

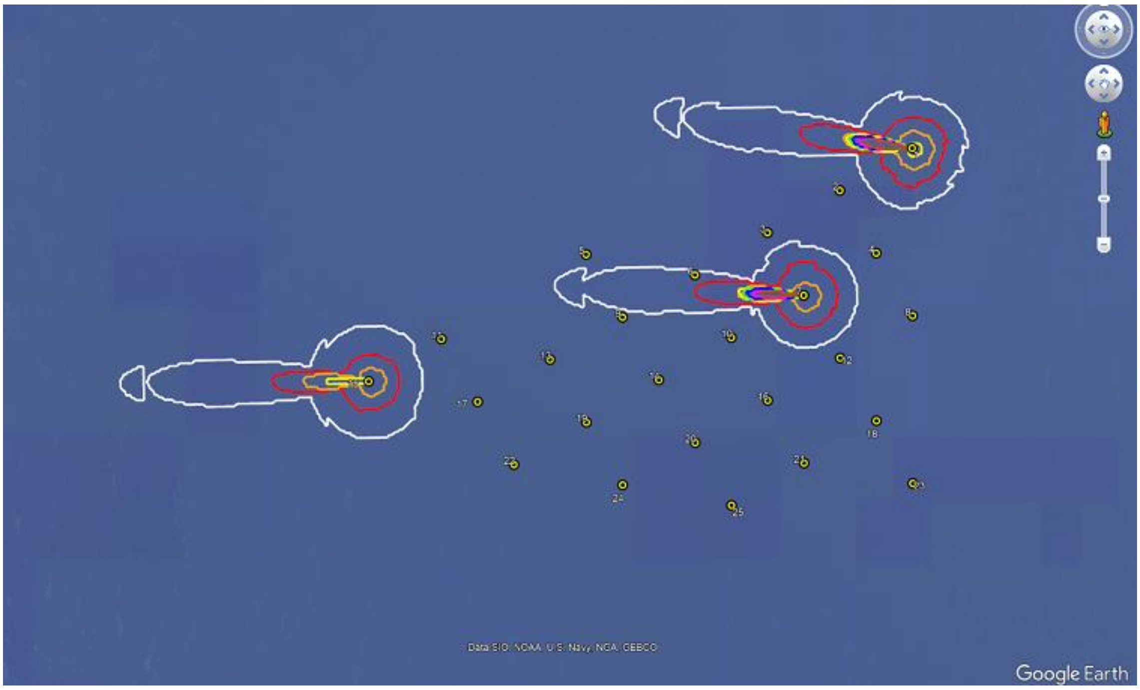

Figure 5 – VHF Tx site: C/I <23dB at 500ft – 4,000ft

Repeating at 500ft intervals sees these distances shrink further with no impact from T15 noted above 2,000ft but with affects from T1 felt up to 4,000ft.

Figure 5 – VHF Tx site Turbine 1: C/I <23dB at 1,000ft – 4,000ft

Repeating the analysis for the receiver site yielded slightly smaller areas with the highest altitude impact recorded within a small area behind Turbine 1 at 3,000ft

Figure 6 – VHF Rx site: C/I <23dB at 500ft – 4,000ft

The results for the DF site closely resembled those of the receiver site with no impact noted on any analysis run above 2,500ft

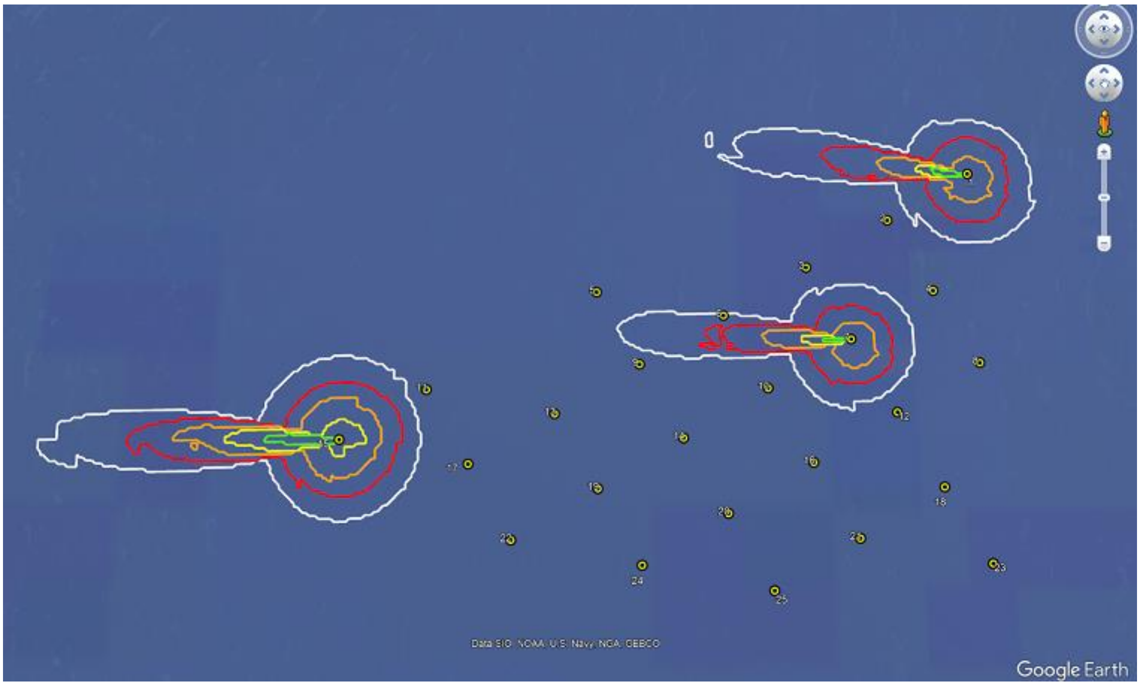

Figure 7 – VHF DF site: C/I <23dB at 500ft – 4,000ft

4. Conclusions

4.1. Navigational Aids

No impact is expecting on any of the airport's navigational aids.

4.2. Communications

Current guidance does not extend to turbines of this size however existing assessment techniques can scaled and conclusions drawn. Using the CAP670 C/I technique it appears there could be degradation in AGA signal quality (C/I < 23dB) in the area around and behind the turbines at low altitude but that this reduces as the height above the turbines increases.

Given the extents of the single turbine zones it can be assumed that these merge, particularly at lower altitudes into a single cumulative volume, slightly larger than the sum of its parts around the windfarm as a whole. It should not be expected however that there would be any cumulative impact from neighbouring developments.

Prepared by:
NATS Safeguarding Office

Technical Safeguarding Assessment

Morecambe Offshore
Wind Farm Development
Warton Aerodrome

NATS ref: SG36338

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Referenced Documents

1. Scope

This report is a bespoke technical assessment of the impact a proposed windfarm on the Communication and Navigation equipment at Warton Aerodrome.

No attempt has been made to estimate the operational significance of any technical impact identified. It is felt this can only properly be determined by specialists at the airport who are actively engaged in providing the required air traffic service

2. Development Details

The proposed Morecambe Windfarm is a large offshore development to be located in the Irish Sea.

The turbine locations have not been finalised, however is not expected that the precise locations of the turbines within the overall development boundaries will change the conclusions of this report significantly.

Where required, in order to undertake an assessment, a set of representative turbine locations and dimensions have been used; these are detailed in Appendix A and shown in the diagram below.

Figure 1 – Representative Turbine Locations

3. Assessments Required

Details of the equipment to be assessed were provided via email by the airport and include:

- Navigation Aids
  - Runway 25 Localiser (25_LOC)
  - Runway 25 Glide Path (25_GP)
  - Distance Measuring Equipment (DME)
  - Non-directional Beacon (NDB)
- Six Air-ground-air Radio Sites
  - Transmitter Site (VHF_TX)
  - Receiver Site (VHF_RX)
  - Direction Finder Site (VHF_DF)
  - Transmitter Site (UHF_TX)
  - Receiver Site (UHF_RX)
  - Direction Finder Site (UHF_DF).

The diagrams below show the locations of the equipment to be assessed.

Figure 2 – On-airfield CNS equipment

3.1. Navigational Aid Assessment

A DME, NDB and the components of the instrument landing system; a localiser and glide path, were assessed against the criteria from ICAO EUR Doc 015.

The ICAO document provides restricted areas for turbine development in the vicinity of these types of equipment.

For all of the Navigational Aids the turbines are comfortably clear of the restricted areas as shown below.

Figure 3 – Localisers and glide path restricted area criteria

3.2. Radio Communication Assessment

3.2.1. CAP-670 Air Traffic Services Safety Requirements

CAP-670 Appendix A to GEN 02 provides the basis for air-ground radio assessments of turbines in the United Kingdom. The CAP-670 methodology involves two phases; an initial zonal assessment based on turbine classification and, if required, a more detailed carrier-to-interference ratio, C/I, assessment.

The CAP-670 turbine classifications range from "Small" to "Large Industrial" based on turbine characteristics such as hub and tip height.

Unfortunately the largest turbine class tops out at 158m to tip which is approximately half the size of the turbines being proposed and therefore the published red/amber/green volumes of the zonal assessment are not applicable.

In this scenario CAP-670 advises that *"Large developments i.e. turbine tip height greater than 110 metres AGL, and / or more than 10 turbines will require detailed assessment using the C/I prediction method"*

CAP-670 allows for the scaling of the C/I assessment by providing a formula to calculate a bi-static RCS outside the range of turbines provided in CAP670 tables 4 and 5, this RCS can then be used as the input to the C/I assessment.

Modelling all 25 turbines would be very computationally intensive and as these will not likely be the final locations would not yield a definitive result in any case.

It was therefore decided to model the best-case (T15), worst-case (T1) and randomly selected third (T7) turbine to get a feel for the likely volume of impact with the caveat that the cumulative effect of multiple turbines may inflate these volumes somewhat.

The software HTZ Communication (version 2024.2) was used to model the direct and indirect, via a reflection from the turbines, paths and compare the two signal strengths.

Based on the details provide the VHF radios were modelled as 5W and the UHF as 25W transmitting sites. It is understood that this is not representative of either the Receiver elements however the C/I assessments models the relative rather than absolute signal strengths and therefore the actual output power or the direction of the radio path should not affect the defined volume within which the C/I threshold is breached.

3.2.1. Results of Carrier to Interference Assessment

Noting that this is below the turbine hub height the <23dB C/I boundaries at 500ft show a radius of 0.5nm from turbines coupled with a shadow extending behind them. T15 doesn't have a boundary and the others are truncated as they extend beyond the theoretical range of the radio at this altitude.

Figure 4 – VHF Tx: site C/I <23dB at 500ft

Repeating at 500ft intervals sees these distances shrink further with no impact from T15 noted above 1,500ft but with affects from T1 felt up to 2,000ft.

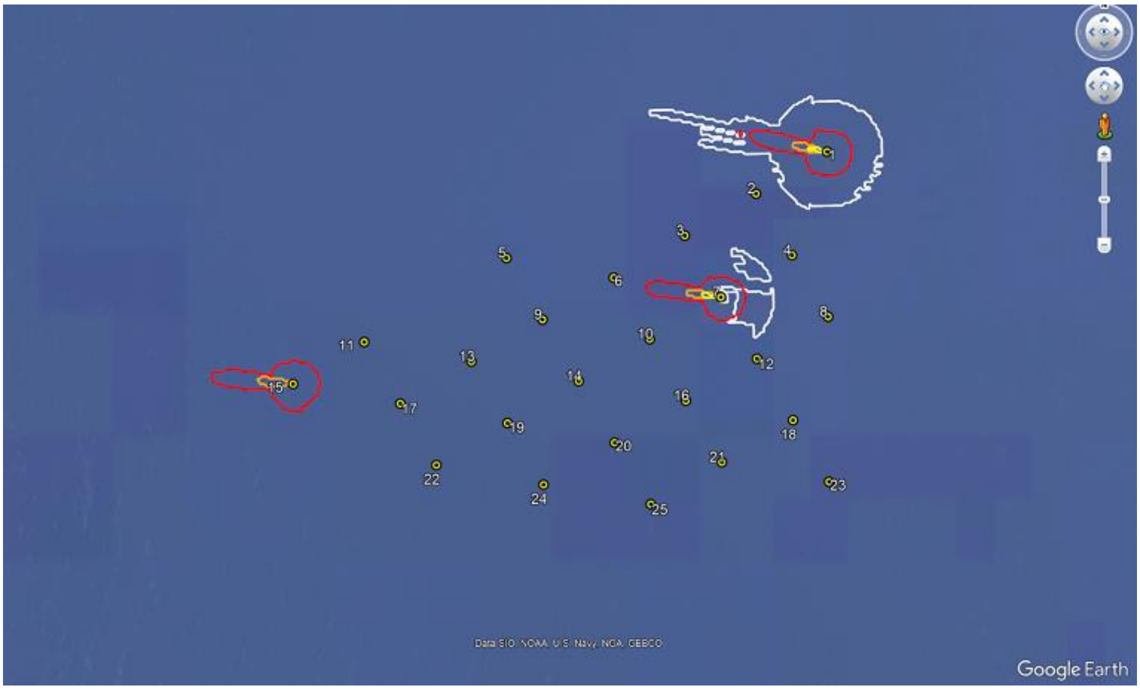

Figure 5 – VHF Tx site: C/I <23dB at 500ft – 4,000ft

Repeating the analysis for the receiver site yielded slightly larger areas but with the highest altitude impact still recorded within a small area behind Turbine 1 at 2,000ft

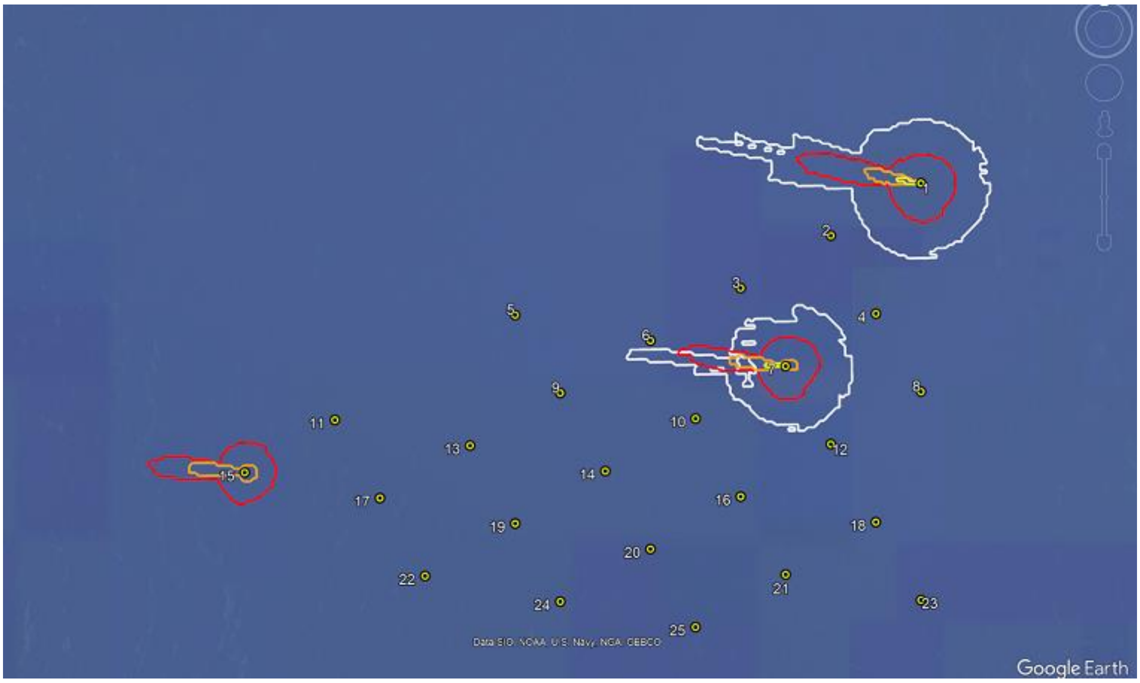

Figure 6 – VHF Rx site: C/I <23dB at 500ft – 4,000ft

The results for the DF site closely resembled those of the other two with no impact noted on any analysis run above 2,000ft

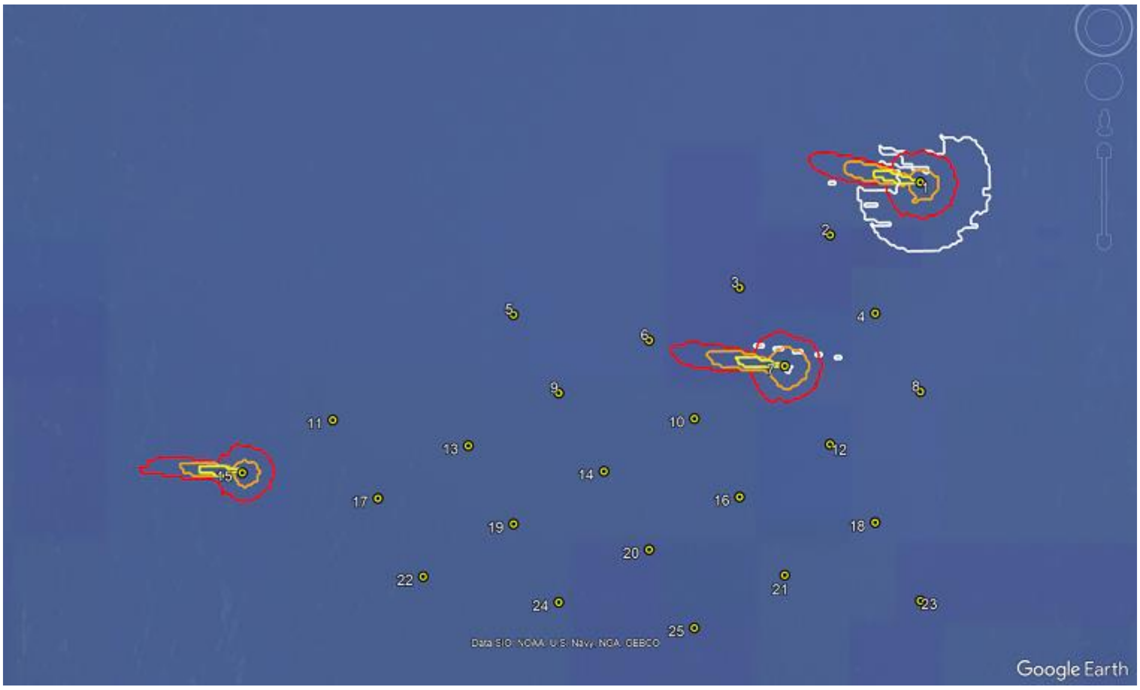

Figure 7 – VHF DF site: C/I <23dB at 500ft – 4,000ft

Following the CAP-670 process at UHF frequencies leads to higher RCS values but with these focussed into tighter shadow zones behind the turbines. This is most noticeable at 500ft where the shadow zone for T1 extends for some 10nm before being truncated by the radio's maximum theoretical range.

Figure 8 – UHF Tx: site C/I <23dB at 500ft

At higher altitudes the areas tighten up and resemble those for VHF with small shadow zones theoretically present up to 5,000ft.

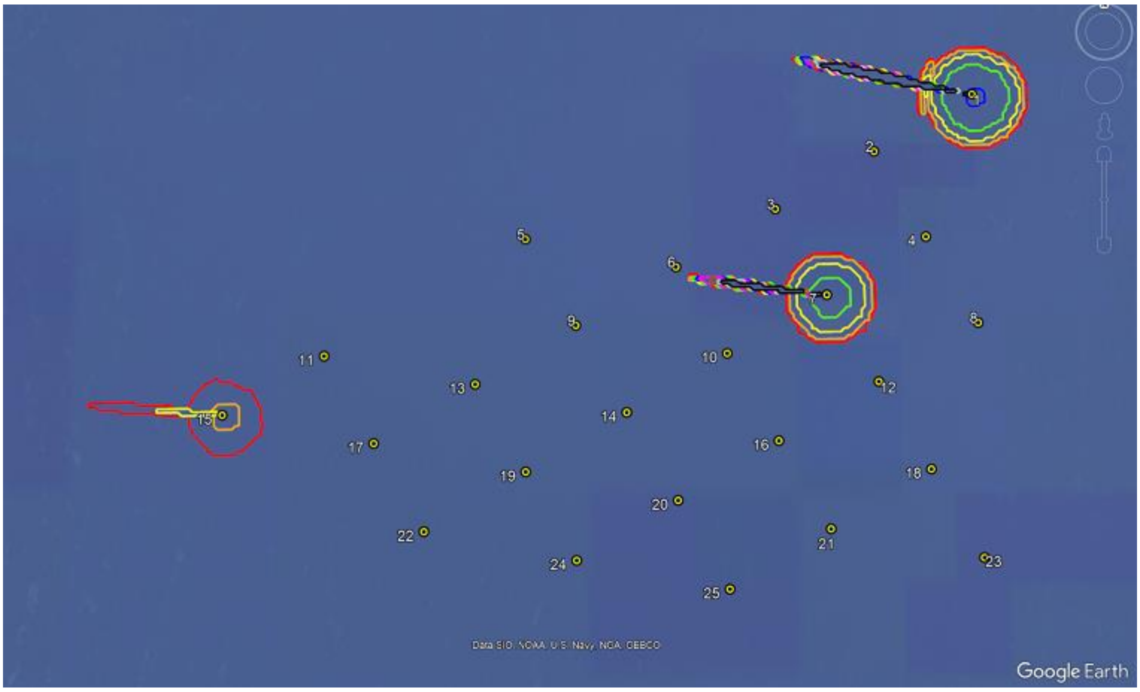

Figure 9 – UHF Tx site: C/I <23dB at 1,000ft – 5,000ft

The results for the Receiver and DF areas are similar to those calculated for the Transmitter site with both sets shrinking rapidly with height and disappearing completing at altitudes above 5,000ft

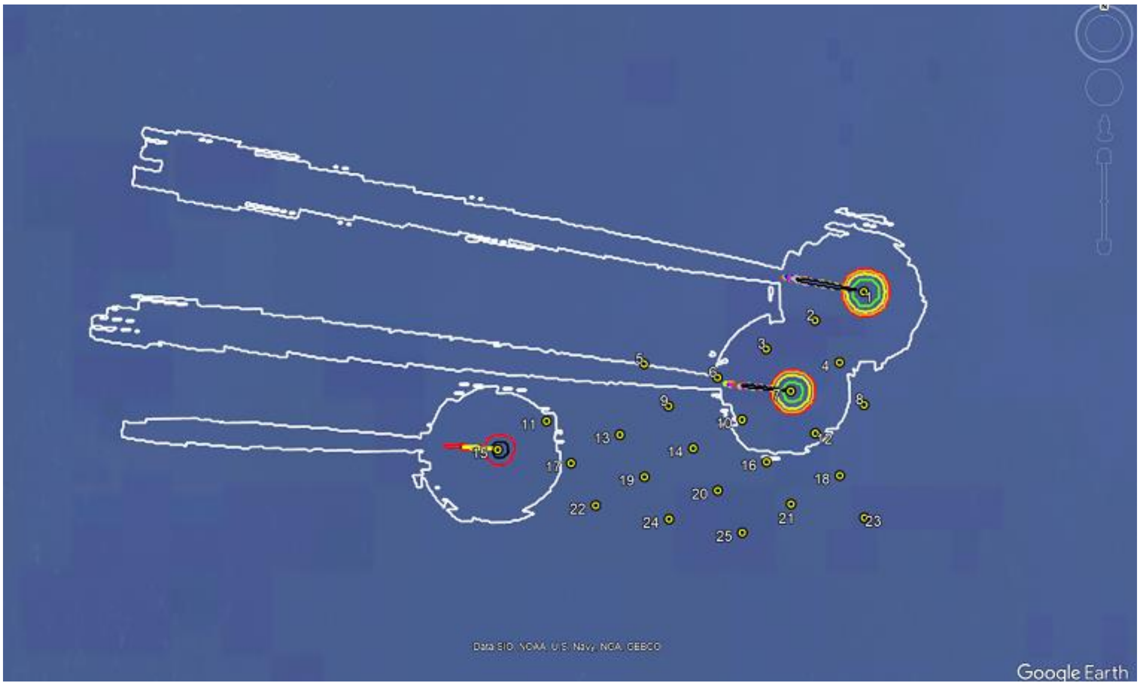

Figure 10 – UHF Rx site: C/I <23dB at 500ft – 4,000ft

Figure 11 – UHF DF site: C/I <23dB at 500ft – 4,000ft

4. Conclusions

4.1. Navigational Aids

No impact is expecting on any of the airport's navigational aids.

4.2. Communications

Current guidance does not extend to turbines of this size however existing assessment techniques can scaled and conclusions drawn. Using the CAP670 C/I technique it appears there could be degradation in AGA signal quality (C/I < 23dB) in the area around and behind the turbines at low altitude but that this reduces as the height above the turbines increases.

Given the extents of the single turbine zones it can be assumed that these merge, particularly at lower altitudes into a single cumulative volume, slightly larger than the sum of its parts around the windfarm as a whole. It should not be expected however that there would be any cumulative impact from neighbouring developments.

Prepared by:
NATS Safeguarding Office

Technical Safeguarding Assessment

Morecambe Offshore
Wind Farm Development
Walney Aerodrome

NATS ref: SG36338

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Referenced Documents

1. Scope

This report is a bespoke technical assessment of the impact a proposed windfarm on the Communication and Navigation equipment at Walney Aerodrome.

No attempt has been made to estimate the operational significance of any technical impact identified. It is felt this can only properly be determined by specialists at the airport who are actively engaged in providing the required air traffic service

2. Development Details

The proposed Morecambe Windfarm is a large offshore development to be located in the Irish Sea.

The turbine locations have not been finalised, however is not expected that the precise locations of the turbines within the overall development boundaries will change the conclusions of this report significantly.

Where required, in order to undertake an assessment, a set of representative turbine locations and dimensions have been used; these are detailed in Appendix A and shown in the diagram below.

Figure 1 – Representative Turbine Locations

3. Assessments Required

Details of the equipment to be assessed were provided via email by the airport and include:

- Navigation Aids
  - Runway 35 Localiser (35_LOC)
  - Runway 35 Glide Path (35_GP)
  - Distance Measuring Equipment (DME)
  - Non-directional Beacon (NDB)
- Two Air-ground-air Radio Sites located on the Air Traffic Tower roof.

The diagrams below show the locations of the equipment to be assessed.

Figure 2 – On-airfield CNS equipment

3.1. Navigational Aid Assessment

A DME, NDB and the components of the instrument landing system; a localiser and glide path, were assessed against the criteria from ICAO EUR Doc 015.

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The CAP-670 turbine classifications range from "Small" to "Large Industrial" based on turbine characteristics such as hub and tip height.

Unfortunately the largest turbine class tops out at 158m to tip which is approximately half the size of the turbines being proposed and therefore the published red/amber/green volumes of the zonal assessment are not applicable.

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It was therefore decided to model the best-case (T15), worst-case (T1) and randomly selected third (T7) turbine to get a feel for the likely volume of impact with the caveat that the cumulative effect of multiple turbines may inflate these volumes somewhat.

The software HTZ Communication (version 2024.2) was used to model the direct and indirect, via a reflection from the turbines, paths and compare the two signal strengths.

Based on the details provide for the actual transmitter the radios themselves were modelled as 5W transmitting sites. It is understood that this is not representative of either the Receiver elements however the C/I assessments models the relative rather than absolute signal strengths and therefore the actual output power or the direction of the radio path should not affect the defined volume within which the C/I threshold is breached.

3.2.1. Results of Carrier to Interference Assessment

Noting that this is below the turbine hub height the <23dB C/I boundaries at 500ft show a radius of 0.7nm from each of the three turbines coupled with a shadow extending 3.1nm behind them. The T15 shadow is truncated as it extends beyond the theoretical range of the radio at this altitude.

Figure 4 – VHF Tx: site C/I <23dB at 500ft

Re-running the analysis at 1,000ft, still below the maximum height of the turbines, the radius shrinks to 0.3nm and the shadow to 1.2nm, this is shown as the red boundary below.

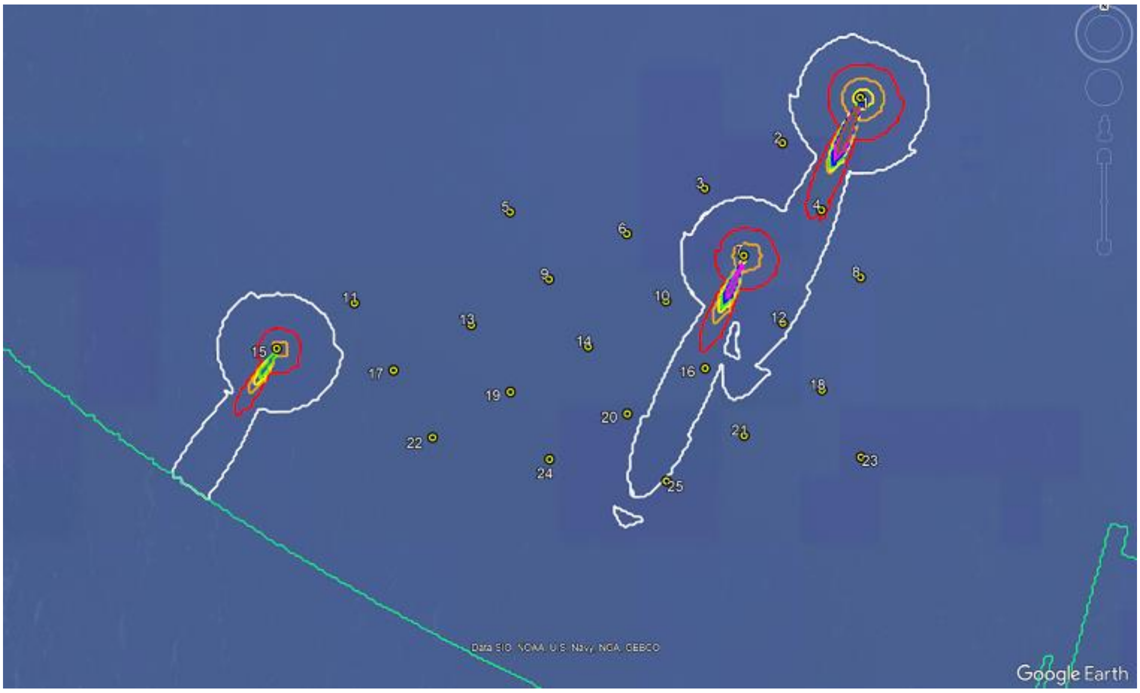

Figure 5 – VHF Tx site: C/I <23dB at 500ft – 4,000ft

Repeating at 500ft intervals sees these distances shrink further with no impact from T15 noted above 2,500ft but with affects from T1 felt up to 4,000ft.

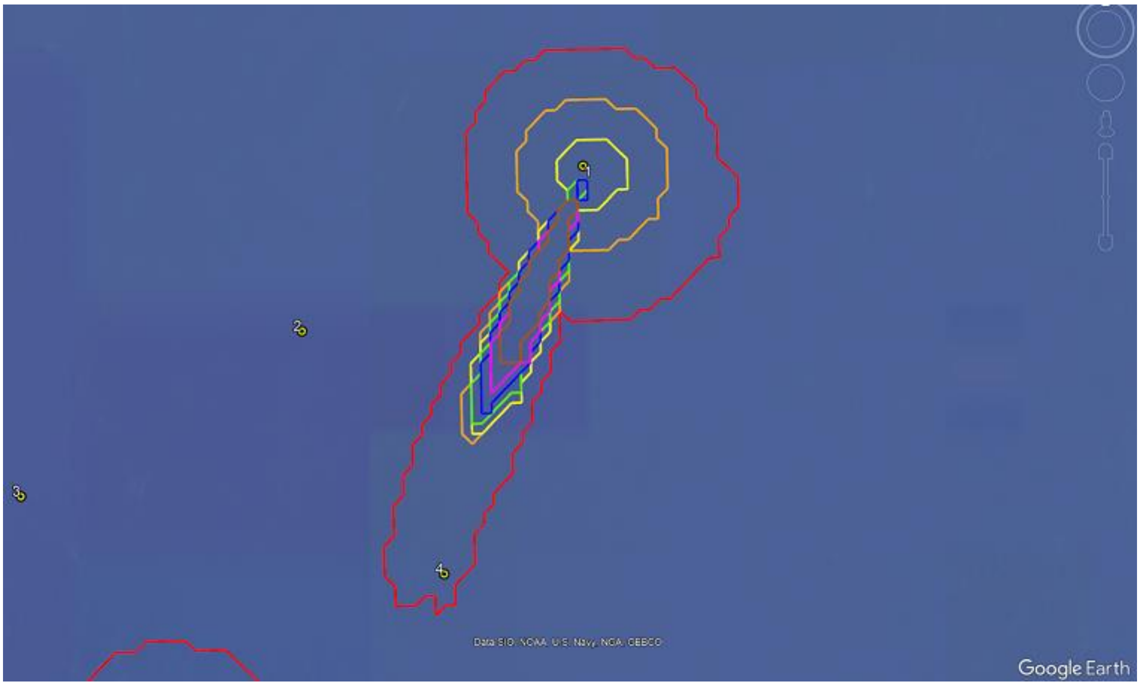

Figure 5 – VHF Tx site Turbine 1: C/I <23dB at 1,000ft – 4,000ft

The analysis was repeated from antenna located at other corners of the air traffic tower roof and the results were indistinguishable from those presented above.

4. Conclusions

4.1. Navigational Aids

No impact is expecting on any of the airport's navigational aids.

4.2. Communications

Current guidance does not extend to turbines of this size however existing assessment techniques can scaled and conclusions drawn. Using the CAP670 C/I technique it appears there could be degradation in AGA signal quality (C/I < 23dB) in the area around and behind the turbines at low altitude but that this reduces as the height above the turbines increases.

Given the extents of the single turbine zones it can be assumed that these merge, particularly at lower altitudes into a single cumulative volume, slightly larger than the sum of its parts around the windfarm as a whole. It should not be expected however that there would be any cumulative impact from neighbouring developments.

Appendix A – Turbine Details

A 25 turbine layout provided by the developer which represents a design proposal comprising 315m tall turbines has been used throughout this assessment

1	53.81740	-3.49939	16	53.77353	-3.54165
2	53.81002	-3.52066	17	53.77301	-3.62690
3	53.80262	-3.54193	18	53.77007	-3.50965
4	53.79917	-3.50990	19	53.76958	-3.59490
5	53.79868	-3.59522	20	53.76613	-3.56290
6	53.79523	-3.56318	21	53.76268	-3.53089
7	53.79178	-3.53117	22	53.76218	-3.61612
8	53.78831	-3.49914	23	53.75923	-3.49890
9	53.78783	-3.58444	24	53.75873	-3.58413
10	53.78438	-3.55241	25	53.75529	-3.55214
11	53.78386	-3.63769			
12	53.78092	-3.52040			
13	53.78042	-3.60567			
14	53.77698	-3.57367			
15	53.77645	-3.65892			

Maximum Blade Tip height = 315m AMSL

Hub Centre Height = 175m AMSL

Blade Length = 140m

Blade Chord = 7.2m

Tower Diameter = 8.5m

Appendix B – Stand-Alone versus Multi-Turbine Analysis

Following the release of Issue 1 of this report the focus on the analysis of each turbine as a stand-alone AGA interference source was questioned. The rationale behind the question is that CAP-670 suggests that both of the following cases should be considered:

- The worst single turbine - Acceptance criteria = > 23dB C/I ratio
- All turbine interferers added - Acceptance criteria = > 14dB C/I ratio

The response to this question by the author of the report is reproduced below:

CAP670 calls for single turbine checks at <23dB as well as a combined turbine check at <14dB.

Modelling every turbine at every altitude for every radio would have been very computationally intensive and would have added weeks of delay to the delivery of the results based on what remains a representative, rather than definitive set of turbine locations.

This however was not the only reason that I skipped over the combined turbine analysis in favour of treating each turbine as a stand-alone "worst single turbine interferer" at <23dB; It is the case for turbine as far apart as these that the individual impact dominates (see below the 500ft, 1,000ft and 1,500ft cases showing this and that the trend gets more pronounced as altitude increases) and therefore it is erring on the side of caution when checking 169 turbines against 12 different radio stations to assume each turbine has their own volume of interference based on the worst case CAP670 criteria and select a few representative samples for analysis.

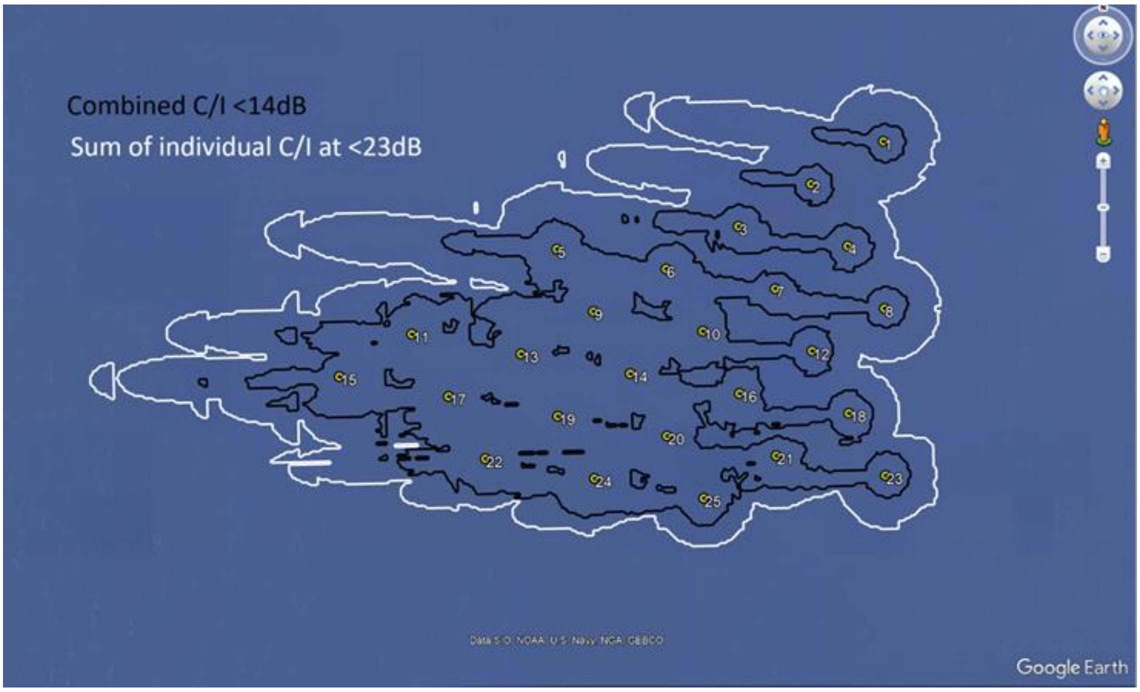

Figure B-1 –Combined vs Individual Interference Modelling at 500ft

Figure B-2 –Combined vs Individual Interference Modelling at 1,000ft

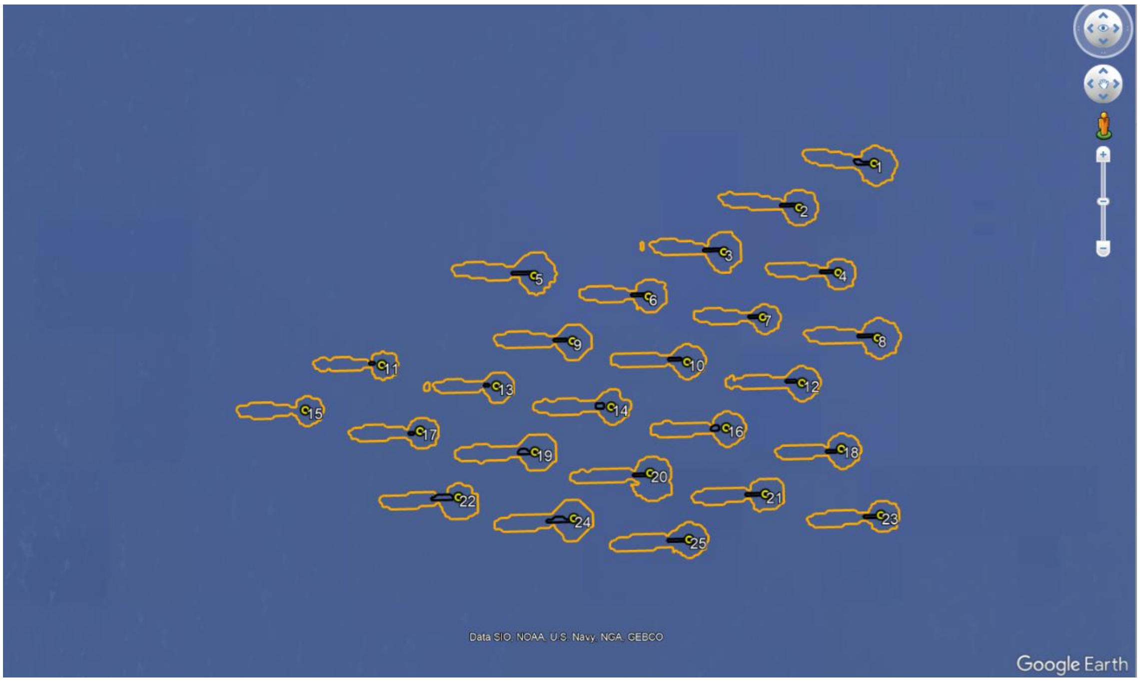

Figure B-3 –Combined vs Individual Interference Modelling at 1,500ft

It can therefore be assumed that the interference volumes presented in the body of this report, assuming that each turbine has a similar zone that potentially merge at lower altitudes, would represent a worst case overall interference volume in line with the CAP-670 guidance.