Norfolk Vanguard & Boreas Windfarms

Vanguard and Boreas Windfarms

Gateway documentation:

Stage 2 Develop and Assess

2A(ii): Design Principle Evaluation, Options Assessment

Action	Role	Date
Produced	**Airspace Change Specialist** NATS	July 2020
Reviewed Approved	**Manager, Airspace Change Compliance and Delivery** NATS	July 2020
Reviewed Approved	**Senior Strategy Advisor- Aviation** Vattenfall Wind Power	August 2020
Reviewed Approved	**Aviation Consultant** Osprey Consulting Services	August 2020

Publication history

Issue	Month/Year	Change Requests in this issue
Issue 1.0	August 2020	Initial version submitted to CAA

Contents

1. Introduction

1.1 This document forms part of the document set in accordance with the requirements of the Civil Aviation Publication (CAP) 1616 airspace change process.

1.2 This document aims to provide adequate evidence to satisfy Stage 2 Develop and Assess Gateway, Step 2A Design Principle Evaluation.

1.3 It is advised to read this document alongside the Stage 2A(i) Design Options Document which gives diagrams and descriptions of each option and includes a Glossary of acronyms.

1.4 The following options to provide airspace mitigation are proposed for consideration:

- Option 0: Do Nothing
- Option A: Range and Azimuth Gating (RAG) Blanking and Transponder Mandatory Zone (TMZ) over the proposed windfarm locations.
- Option B: RAG Blanking over the proposed windfarm locations with the TMZ extended to include a 2 NM buffer.
- Option C: RAG Blanking over the proposed windfarm locations. Simplified polygon TMZ "rubber banded" around proposed windfarm locations with no buffer.
- Option D: RAG Blanking over the proposed windfarm locations. Simplified polygon TMZ "rubber banded" around the proposed windfarm locations extended to include a 2 NM buffer.

2. Options Assessment: Design Principle Evaluation

2.0.1 Table 1, 2, 3, 4 and 5 below summarises the impacts/ benefits of the options evaluated. This table is based on the pro-forma CAP1616 Appendix E, page 187. The degree to which the design principle has been met is indicated by the following colour coding:

Green	MET
Yellow	PARTIAL
Red	NOT MET (Design Principle not met or change represents a detriment)

2.1 Baseline (do nothing) – Option 0 Design Principle Evaluation

Design Principle Evaluation			
Do Nothing Option			REJECT
No mitigation against radar clutter. This option assumes that the wind farm is built but no measures are implemented to prevent radar clutter & interference.			
Design Principle		Summary of assessment	MET?
DP1	Safety: Maintain or enhance current levels of safety.	The wind farm would result in unacceptable radar clutter/ interference. This would have an impact on Air Traffic Control (ATC) Surveillance and aviation safety	NOT MET
DP2	Operational: Minimise negative impact on other airspace users, specifically GA and helicopters in support of UK Oil, Gas and Renewables industries.	Aircraft without an operating transponder would not be restricted to where they could fly. However they could be lost amongst wind farm clutter on ATC surveillance equipment resulting in a reduced level of service from ATC.	PARTIAL
DP3	Operational: Airspace change will maintain or enhance operational resilience of the ATC network.	The negative impact of the wind farm on primary surveillance radar would reduce the resilience of the ATC Network	NOT MET
DP4	Operational: ANSP alignment: ensure agreement between stakeholder/impacted ANSPs that the design concept being progressed suits all operations to mitigate the impact on surveillance systems	Primary radar surveillance would be ineffective in the vicinity of the wind farms. Aircraft without an operating transponder would be difficult to resolve on surveillance equipment. In the worst case, the wind turbine generators (WTGs) could saturate the primary radar returns resulting in aircraft without an operating transponder not appearing at all on ATC surveillance equipment.	NOT MET

DP5	Operational: Airspace change will have minimal impact on operations/capacity of AO and ANSPs.	No Change to the airspace. However, ATC workload would increase as aircraft without an operating transponder could be lost amongst the windfarm clutter. Interference from the windfarm could saturate the radar picture leading to a loss of surveillance capability and delays.	NOT MET
DP6	Environmental: Minimise impact on CO_2 emissions	No Change	MET
DP7	Environmental: Minimise environmental impacts to stakeholders on the ground, including the impact of noise below 7,000ft *(note: due to the offshore location of the proposed changes, it is not expected that there will be any significant environmental impacts to stakeholders on the ground due to noise, visual intrusion and local air quality)*	No Change	MET
DP8	Economic: Minimise economic impact on aircraft operators.	No Change	MET
DP9	Economic: Ensure costs and resources are proportionate to ensure appropriate safety mitigation.	There would be no change to the costs. However, aircraft without an operating transponder would not be restricted to where they could fly. They could be lost amongst wind farm clutter on ATC surveillance equipment resulting in a reduced level of service from ATC.	PARTIAL
DP10	Technical: Base the airspace change on the latest technology widely available. • This technology could relate to navigation, surveillance enhancements, radar data processing, etc	No Change	MET
DP11	Technical: The volume of airspace affected should be the minimum necessary to deliver requirements, whilst providing optimal safety buffer. • Seek to create simple, easily definable solution.	No Change	MET
DP12	Technical: The airspace change should be compatible with the requirements of the MOD (if required).	No Change	MET
DP13	Policy: The proposed airspace change will take account of government policy documents (such as the Air Navigation Guidance).	No Change	MET

DP14	Technical: The airspace change should be compatible with the requirements of the offshore helicopter operation supporting the UK Oil, Gas and Renewables industries.	Aircraft operating in support of the offshore operation are transponder equipped and should not be affected. Aircraft without an operating transponder would not be restricted to where they could fly. These aircraft could be lost amongst wind farm clutter on ATC surveillance equipment leading to ATC having an incomplete traffic picture and offering a reduce service.	PARTIAL

Table 1: Design Principle evaluation of the "Do Nothing" option.

2.1.1 Do Nothing Option Conclusion

Unless appropriate mitigation to prevent radar clutter and interference is put in place the suspensive planning "condition 34" will not be discharged, and construction of the Norfolk Vanguard and Norfolk Boreas Wind farms will not be able to proceed. For this reason, the "Do nothing" option is rejected.

2.2 Option A – RAG Blanking and TMZ over the proposed windfarm locations.

Design Principle Evaluation			
Option A: RAG Blanking and TMZ over the proposed windfarm locations.			REJECT
Mitigation against radar clutter, with smallest area of TMZ covering only the RAG blanked area. See Stage 2A(i) document for detailed description of Option A			
Design Principle		Summary of assessment	MET?
DP1	Safety: Maintain or enhance current levels of safety.	While the WTGs are blanked to prevent radar clutter, this option has no buffer around the RAG blanked area. Hence, in the case of an aircraft without an operating transponder infringing the TMZ, ATC will have no warning to identify and react to the situation. The infringing aircraft would simply disappear as soon as the TMZ boundary is crossed. This would increase ATC workload where non-transponder equipped aircraft are flying close to/ along the TMZ boundary.	NOT MET
DP2	Operational: Minimise negative impact on other airspace users, specifically GA and helicopters in support of UK Oil, Gas and Renewables industries.	Most aircraft would be unaffected. Only aircraft without an operating transponder would be unable to transit the windfarm. Increased ATC workload due to the requirement of heightened awareness and monitoring of non-transponding aircraft close to the TMZ boundary would reduce capacity and could lead to delays for other airspace users.	PARTIAL
DP3	Operational: Airspace change will maintain or enhance operational resilience of the ATC network.	Radar clutter due to the WTGs will be removed. However due to the lack of buffer, increased ATC workload due to the requirement for heightened awareness & monitoring of non-transponder equipped aircraft close to the TMZ boundary would reduce capacity and could lead to delays for other airspace users.	PARTIAL
DP4	Operational: ANSP alignment: ensure agreement between stakeholder/impacted ANSPs that the design concept being progressed suits all operations to mitigate the impact on surveillance systems	Radar blanking will mitigate against the interference caused by the WTGs on surveillance systems.	MET
DP5	Operational: Airspace change will have minimal impact on operations/capacity of AO and ANSPs.	Increase in ATC workload as described above will have a knock-on effect on ATC capacity. In busy periods this could lead to delays	NOT MET

DP6	Environmental: Minimise impact on CO_2 emissions	There would be no impact on commercial aircraft. Less than 1% GA aircraft, those without an operating transponder, will be affected	MET
DP7	Environmental: Minimise environmental impacts to stakeholders on the ground, including the impact of noise below 7,000ft *(note: due to the offshore location of the proposed changes, it is not expected that there will be any significant environmental impacts to stakeholders on the ground due to noise, visual intrusion and local air quality)*	There would be no change to the noise impact as a result of this option. The windfarm is 47 km offshore so will not impact any population	MET
DP8	Economic: Minimise economic impact on aircraft operators.	"Option A" will have no economic impact on aircraft operators.	MET
DP9	Economic: Ensure costs and resources are proportionate to ensure appropriate safety mitigation.	These costs are proportionate and ensure appropriate safety mitigation.	MET
DP10	Technical: Base the airspace change on the latest technology widely available. • This technology could relate to navigation, surveillance enhancements, radar data processing, etc	Less than 1% of aircraft using this airspace do so without an operating transponder. SSR transponder technology is widely available.	MET
DP11	Technical: The volume of airspace affected should be the minimum necessary to deliver requirements, whilst providing optimal safety buffer. • Seek to create simple, easily definable solution.	"Option A" uses the minimal volume of airspace to deliver a solution. However, the perimeter of the "Option A" TMZ is irregular and not easy to comprehend.	PARTIAL
DP12	Technical: The airspace change should be compatible with the requirements of the MOD (if required).	This option should be compatible with the MOD.	MET
DP13	Policy: The proposed airspace change will take account of government policy documents (such as the Air Navigation Guidance).	This option takes account of government policy documents (such as the Air Navigation Guidance).	MET
DP14	Technical: The airspace change should be compatible with the requirements of the offshore helicopter operation supporting the UK Oil, Gas and Renewables industries.	This Option should be compatible with the requirements of the offshore helicopter operation supporting the UK Oil, Gas and Renewables industries	MET

Table 2: Design Principle evaluation of "Option A".

2.2.1 "Option A" Conclusion

Whilst the WTGs are blanked to prevent clutter, this option has no buffer surrounding the RAG blanked area. Hence in the case of non-transponding aircraft infringing the TMZ, ATC would have no warning or time to identify and prevent the infringement. Infringing aircraft would simply disappear from the radar as soon as the TMZ boundary was crossed. This would increase ATC workload where non-transponding aircraft are flying (legitimately) close to/along the TMZ boundary and therefore represents a reduced level of safety. The increase in workload on ATC could also lead to an increase in delays, unnecessarily impacting on airspace users. For these reasons "Option A" is rejected.

2.3 Option B – RAG Blanking over the proposed windfarm locations. TMZ extended to include a 2 NM buffer.

Design Principle Evaluation			
Option B: RAG Blanking over the proposed windfarm locations. TMZ extended to include a 2 NM buffer.			REJECT
Mitigation against radar clutter, with 2 NM TMZ buffer around RAG blanked area. See 2A(i) document for detailed description of Option B			
Design Principle		Summary of assessment	MET?
DP1	Safety: Maintain or enhance current levels of safety.	The WTG area is RAG blanked to prevent radar clutter. The introduction of a 2 NM TMZ buffer around the blanked region will ensure only transponder equipped aircraft enter the radar blanked region.	MET
DP2	Operational: Minimise negative impact on other airspace users, specifically GA and helicopters in support of UK Oil, Gas and Renewables industries.	Most aircraft would be unaffected. Only non-transponder equipped aircraft would be required to transit around the windfarm. The 2 NM TMZ buffer around the blanked area provides ATC with the warning they need, should a non-transponding aircraft infringe the TMZ, before it enters the RAG blanked area and disappears from the radar screen.	MET
DP3	Operational: Airspace change will maintain or enhance operational resilience of the ATC network.	Operational resilience of the ATC network will be maintained	MET
DP4	Operational: ANSP alignment: ensure agreement between stakeholder/impacted ANSPs that the design concept being progressed suits all operations to mitigate the impact on surveillance systems	Radar blanking will mitigate against the interference caused by the WTGs on surveillance systems.	MET
DP5	Operational: Airspace change will have minimal impact on operations/capacity of AO and ANSPs.	The introduction of a radar blanked region with TMZ buffer should have minimal impact on operations/capacity of Aircraft Operators and ANSPs.	MET
DP6	Environmental: Minimise impact on CO_2 emissions	There would be no impact on commercial aircraft. Less than 1% GA aircraft, those without an operating transponder, will be affected	MET
DP7	Environmental: Minimise environmental impacts to stakeholders on the ground, including the impact of noise below 7,000ft *(note: due to the offshore location of the proposed changes, it is not expected that there will be any significant environmental impacts to stakeholders on the ground due to noise, visual intrusion and local air quality)*	There would be no change to the noise impact as a result of this option. The windfarm is 47 km offshore so will not impact any population	MET
DP8	Economic: Minimise economic impact on aircraft operators.	"Option B" will have minimal economic impact on aircraft operators.	MET

DP9	Economic: Ensure costs and resources are proportionate to ensure appropriate safety mitigation.	These costs are proportionate and ensure appropriate safety mitigation.	MET
DP10	Technical: Base the airspace change on the latest technology widely available. • This technology could relate to navigation, surveillance enhancements, radar data processing, etc	Less than 1% of aircraft using this airspace do so without an operating transponder. This technology is widely available.	MET
DP11	Technical: The volume of airspace affected should be the minimum necessary to deliver requirements, whilst providing optimal safety buffer. • Seek to create simple, easily definable solution.	Radar blanking of the windfarm area is required to remove clutter from the radar screen. The addition of a 2 NM TMZ around the blanked region provides ATC with the reassurance they need to monitor non-transponding aircraft and prevent these aircraft from entering the blanked region. However, the perimeter of the "Option A" TMZ is irregular and not easy to comprehend.	PARTIAL
DP12	Technical: The airspace change should be compatible with the requirements of the MOD (if required).	The proposed "Option B" radar blanking with TMZ should be compatible with the requirements of the MOD	MET
DP13	Policy: The proposed airspace change will take account of government policy documents (such as the Air Navigation Guidance).	The proposed "option B" radar blanking TMZ takes account of government policy documents (e.g. the Air Navigation Guidance).	MET
DP14	Technical: The airspace change should be compatible with the requirements of the offshore helicopter operation supporting the UK Oil, Gas and Renewables industries.	The proposed "Option B" radar blanking with TMZ should be compatible with the requirements of offshore helicopter operation supporting the UK Oil, Gas and Renewables industries	MET

Table 3: Design Principle evaluation of "Option B".

2.3.1 "Option B" Conclusion

The "Option B" design nearly meets all the design principles. The WTGs are blanked from the radar screen preventing clutter and interference. This option benefits from a 2 NM buffer surrounding the RAG blanked area which allows ATC to spot infringement of the TMZ by non-transponding aircraft before they enter the RAG blanked area. This option is therefore a feasible design option. However, the shape of the TMZ proposed in this design option is complex which could lead to pilot confusion as to the boundary position. This increases the possibility of an aircraft infringing the TMZ. For this reason, option B is rejected in preference for option D.

2.4 Option C – RAG Blanking over the proposed windfarm locations. Simplified polygon TMZ "rubber banded" around proposed windfarm locations with no buffer.

Design Principle Evaluation			
Option C: RAG Blanking over the proposed windfarm locations. Simplified polygon TMZ "rubber banded" around proposed windfarm locations with no buffer			REJECT
Mitigation against radar clutter with simplified shape and small area of TMZ. See 2A(i) document for detailed description of Option C			
Design Principle		Summary of assessment	MET?
DP1	Safety: Maintain or enhance current levels of safety.	While the WTGs are blanked to prevent radar clutter, this option has no buffer around the RAG blanked area. Hence, in the case of a non-transponder equipped aircraft infringing the TMZ, ATC will have no warning to identify and react to the situation. The infringing aircraft would simply disappear as soon as the TMZ boundary is crossed. This would increase ATC workload where non-transponder equipped aircraft are flying close to/ along the TMZ boundary.	NOT MET
DP2	Operational: Minimise negative impact on other airspace users, specifically GA and helicopters in support of UK Oil, Gas and Renewables industries.	Most aircraft would be unaffected. Only non-transponder equipped aircraft would be unable to transit the windfarm. However due to the lack of buffer, Increased ATC workload due to the requirement of heightened awareness of non-transponder equipped aircraft close to the TMZ boundary could lead to delays for other airspace users.	PARTIAL
DP3	Operational: Airspace change will maintain or enhance operational resilience of the ATC network.	Radar clutter due to the WTGs will be removed. However, due to the lack of buffer, increased ATC workload due to the requirement for heightened awareness & monitoring of non-transponder equipped aircraft close to the TMZ boundary would reduce capacity and could lead to delays for other airspace users.	PARTIAL
DP4	Operational: ANSP alignment: ensure agreement between stakeholder/impacted ANSPs that the design concept being progressed suits all operations to mitigate the impact on surveillance systems	Radar blanking will mitigate against the interference caused by the WTGs on surveillance systems.	MET
DP5	Operational: Airspace change will have minimal impact on operations/capacity of AO and ANSPs.	Increase in ATC workload as described above will have a knock-on effect on ATC capacity. In busy periods this could lead to delays	NOT MET

DP6	Environmental: Minimise impact on CO_2 emissions	There would be no impact on commercial aircraft. Less than 1% GA aircraft, those without an operating transponder, will be affected	MET
DP7	Environmental: Minimise environmental impacts to stakeholders on the ground, including the impact of noise below 7,000ft *(note: due to the offshore location of the proposed changes, it is not expected that there will be any significant environmental impacts to stakeholders on the ground due to noise, visual intrusion and local air quality)*	There would be no change to the noise impact as a result of this option. The windfarm is 47 km offshore so will not impact any population	MET
DP8	Economic: Minimise economic impact on aircraft operators.	"Option C" will have no economic impact on aircraft operators.	MET
DP9	Economic: Ensure costs and resources are proportionate to ensure appropriate safety mitigation.	These costs are proportionate and ensure appropriate safety mitigation.	MET
DP10	Technical: Base the airspace change on the latest technology widely available. • This technology could relate to navigation, surveillance enhancements, radar data processing, etc	Less than 1% of aircraft using this airspace do so without an operating transponder. This technology is widely available.	MET
DP11	Technical: The volume of airspace affected should be the minimum necessary to deliver requirements, whilst providing optimal safety buffer. • Seek to create simple, easily definable solution.	"Option C" uses the minimum volume of airspace needed to deliver an easily understood PRMS boundary. However, without a buffer zone, safety could still be compromised.	PARTIAL
DP12	Technical: The airspace change should be compatible with the requirements of the MOD (if required).	"Option C" should be compatible with the MOD.	MET
DP13	Policy: The proposed airspace change will take account of government policy documents (such as the Air Navigation Guidance).	"Option C" takes account of government policy documents (such as the Air Navigation Guidance).	MET
DP14	Technical: The airspace change should be compatible with the requirements of the offshore helicopter operation supporting the UK Oil, Gas and Renewables industries.	"Option C" should be compatible with the requirements of the offshore helicopter operation supporting the UK Oil, Gas and Renewables industries	MET

Table 4: Design Principle evaluation of "Option C".

2.4.1 "Option C" Conclusion

With the "Option C" design the WTGs are blanked from the radar screen preventing clutter. The proposed "rubber banded" TMZ shape is simpler than both the "option A or B" designs, reducing the likelihood of accidental infringements. However, this option does not benefit from a TMZ buffer zone surrounding the radar blanked area. Similarly, to the "Option A" design, if a non-transponding aircraft infringes the TMZ, it will simply disappear from the radar as it crossed the TMZ boundary. This would increase ATC workload where non-transponding aircraft are flying (legitimately) close to/along the TMZ

boundary and therefore represents a reduced level of safety. The increase in workload on ATC could also lead to delays, unnecessarily impacting on airspace users. For these reasons Option C is rejected.

2.5 **Option D – RAG Blanking in line with proposed windfarm locations. Simplified polygon TMZ "rubber banded" around proposed windfarm locations extended to include a 2 NM buffer.**

Design Principle Evaluation			
Option D: RAG Blanking in line with proposed windfarm locations. Simplified polygon TMZ "rubber banded" around proposed windfarm locations extended to include a 2 NM buffer			Accept
Mitigation against radar clutter with a TMZ extended to include a 2 NM buffer around the simplified "rubber banded" shaped RAG blanked area. See 2A(i) document for detailed description of Option D			
Design Principle		Summary of assessment	MET?
DP1	Safety: Maintain or enhance current levels of safety.	The "rubber banded" WTG area is RAG blanked to prevent radar clutter. The introduction of a 2 NM TMZ buffer around the blanked region will ensure only transponder equipped aircraft enter the radar blanked region. The simplified shape of the TMZ further enhances safety as the perimeter is easier to understand, reducing the possibility of an aircraft infringing the TMZ.	MET
DP2	Operational: Minimise negative impact on other airspace users, specifically GA and helicopters in support of UK Oil, Gas and Renewables industries.	Most aircraft would be unaffected. Only non-transponder equipped aircraft would be required to transit around the windfarm. The rubber-banded 2 NM TMZ buffer around the blanked area provides ATC with the warning they need, should a non-transponding aircraft infringe the TMZ, before it enters the RAG blanked area and disappears from the radar screen.	MET
DP3	Operational: Airspace change will maintain or enhance operational resilience of the ATC network.	Operational resilience of the ATC network will be maintained	MET
DP4	Operational: ANSP alignment: ensure agreement between stakeholder/impacted ANSPs that the design concept being progressed suits all operations to mitigate the impact on surveillance systems	Radar blanking will mitigate against the interference caused by the WTGs on surveillance systems.	MET
DP5	Operational: Airspace change will have minimal impact on operations/capacity of AO and ANSPs.	The introduction of a radar blanked region with TMZ buffer should have minimal impact on operations/capacity of Aircraft Operators and ANSPs.	MET
DP6	Environmental: Minimise impact on CO_2 emissions	There would be no impact on commercial aircraft. Less than 1% GA aircraft, those without an operating transponder, will be affected.	MET

DP7	Environmental: Minimise environmental impacts to stakeholders on the ground, including the impact of noise below 7,000ft *(note: due to the offshore location of the proposed changes, it is not expected that there will be any significant environmental impacts to stakeholders on the ground due to noise, visual intrusion and local air quality)*	There would be no change to the noise impact as a result of this option. The windfarm is 47 km offshore so will not impact any population	MET
DP8	Economic: Minimise economic impact on aircraft operators.	"Option D" will have minimal economic impact on aircraft operators.	MET
DP9	Economic: Ensure costs and resources are proportionate to ensure appropriate safety mitigation.	These costs are proportionate and ensure appropriate safety mitigation.	MET
DP10	Technical: Base the airspace change on the latest technology widely available. • This technology could relate to navigation, surveillance enhancements, radar data processing, etc	Less than 1% of aircraft using this airspace do so without an operating transponder. This technology is widely available.	MET
DP11	Technical: The volume of airspace affected should be the minimum necessary to deliver requirements, whilst providing optimal safety buffer. • Seek to create simple, easily definable solution.	Radar blanking of the windfarm area is required to remove clutter from the ATC radar screen. The addition of a 2 NM TMZ around the blanked region provides ATC with the reassurance they need to monitor non-transponder equipped aircraft and prevent these aircraft from entering the blanked region. The simplified polygon of the rubber-banded perimeter of the "Option D" TMZ will be easy for pilots to identify.	MET
DP12	Technical: The airspace change should be compatible with the requirements of the MOD (if required).	The proposed "Option D" radar blanking with TMZ should be compatible with the requirements of the MOD	MET
DP13	Policy: The proposed airspace change will take account of government policy documents (such as the Air Navigation Guidance).	The proposed "Option D" radar blanking and TMZ takes account of government policy documents (e.g. the Air Navigation Guidance).	MET
DP14	Technical: The airspace change should be compatible with the requirements of the offshore helicopter operation supporting the UK Oil, Gas and Renewables industries.	The proposed "Option D" radar blanking with TMZ should be compatible with the requirements of offshore helicopter operation supporting the UK Oil, Gas and Renewables industries	MET

Table 5: Design Principle evaluation of "Option D".

2.5.1 "Option D" Conclusion

"Option D" meets all the design options. The WTGS are blanked from the radar screen preventing clutter. This option benefits from a minimum 2 NM buffer surrounding the "rubber banded" RAG blanked area. This buffer will allow ATC to spot infringement of the TMZ by non-transponder equipped aircraft, before they enter the RAG blanked area. The simplified boundary of this TMZ for this design option would be easy to comprehend on charts, pilot navigation aids and ATC. This option is therefore a

feasible design option and is our preferred choice. For these reasons "Option D" is accepted as the sole option and will be taken forward.

3. Safety Assessment – Option D TMZ (preferred)

3.1 Safety analysis (Hazard Identification) has been performed as follows. The primary list of hazards identified is:

- WTGs cause clutter on primary radar displays;
- RAG blanking of the Cromer Primary Surveillance Radar (PSR) over the WTGs will leave an area where no PSR data is displayed to the Air Traffic Control Officer (ATCO);
- Aircraft which are non-transponder equipped will not be visible to the ATCO within the RAG blanked area;
- Aircraft which are not operating their transponders will not be visible to the ATCO within the RAG blanked areas.

3.2 These hazards will be mitigated by:

- The promulgation of a TMZ over the RAG blanked area will mandate that aircraft within the TMZ area must be transponder equipped and hence will be visible on secondary radar.
- The extension of the TMZ 2 NM around the RAG blanked area (buffer zone) will ensure that ATC have sufficient time to identify when an infringement of the TMZ is taking place and take appropriate action.

3.3 Experience from previous wind farm developments has demonstrated that the implementation of radar RAG coupled with an associated TMZ provides effective and safe mitigation against the radar issues associated with WTGs.

3.4 Initial qualitative assessment from NATS safeguarding has confirmed that the proposed Option D TMZ design would provide adequate mitigation to fulfil the requirements required of the NERL Cromer: PSR Mitigation Scheme.

3.5 Detailed safety analysis will be undertaken in due course by NATS based on the TMZ Option D proposed herein.

4. High Level Qualitative Cost Assessment

4.1 The costs associated with implementing the required airspace measures are relatively small when compared to the substantial environmental benefits enabled by permitting the wind farm development to proceed. Hence this assessment incorporates all these factors. The headline figures are:

- Cost of implementing TMZ + RAG blanking: c £900,000.
- Enabled savings of ~6.3 MT CO_2 emissions per annum.
- Clean electricity provided by the Norfolk Vanguard and Boreas windfarms to ~3.9 M houses.

4.2 The Option D TMZ solution has been evaluated as beneficial due to the mitigation it provides against the impacts of the proposed Norfolk Vanguard and Boreas Wind farms on radar systems. The relatively small expenditure required to implement this mitigation solution will enable significant benefits (including environmental benefits of substantial savings in CO_2e emissions). These benefits justify the cost associated with progressing this change, and hence it will be progressed.

5. Conclusion and Shortlist

5.1 Only option D ("Rubber banded" WTG locations RAG blanked, with a minimum 2 NM TMZ buffer) meets all the design principles. Option D benefits from a simpler shaped TMZ with 2 NM buffer creating an easily definable solution. As such only "Option D" will be progressed.

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