Seagreen Wind Energy Limited

SeaGreen Offshore WindFarm
Gateway documentation:
Stage 2 Develop and Assess

2A(i): Airspace Change Design Options

Publication history

Issue	Month/Year	Change Requests in this issue
Issue 1	July 2019	First issue released to SARG.
Issue 1.1	July 2019	Changes to Annex B (non-airspace change options)

Contents

1. Introduction

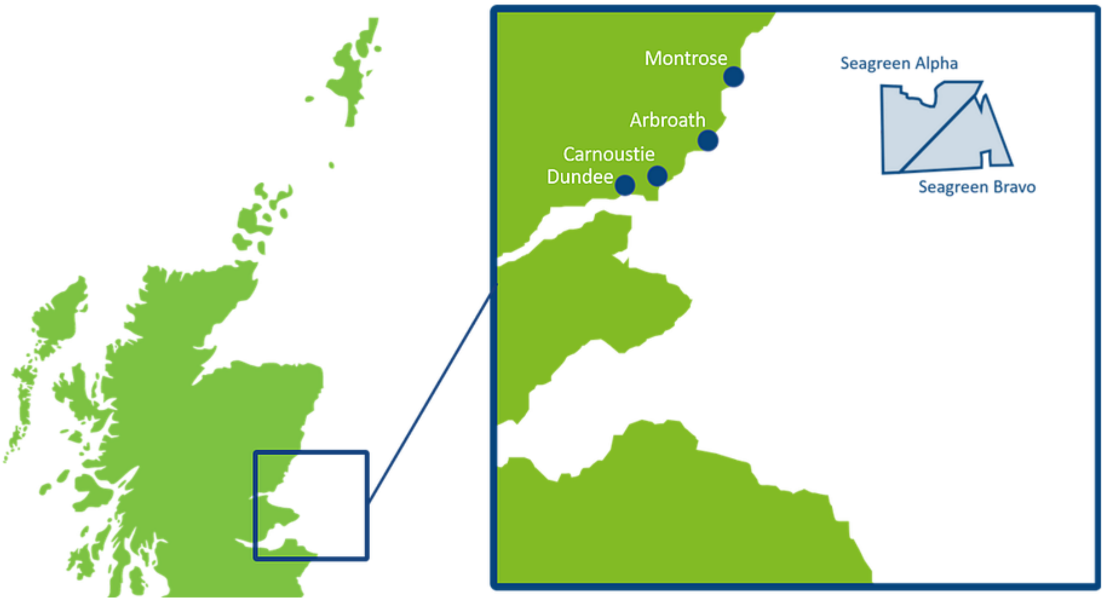
1.1 This document forms part of the document set required in accordance with the requirements of the CAP1616 airspace change process.

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

2. Options development – brief history

2.1 In total, the proposed windfarm will cover an area of approx. 400km^2. The site is located around 27km from the Angus coastline, with offshore consent for this project granted in 2014.

Figure 1 Seagreen Phase 1 wind farm location



2.2 Planning consent was granted in 2014 for Seagreen Phase 1, with development subject to Section 36 Planning Consent Condition 23 due to the impact of this development on the Perwinnes Radar. As such, a Primary Radar Mitigation Strategy is required to be approved to meet this condition[1]:

Condition 23	**NERL Perwinnes: PSR Mitigation Scheme ("PRMS")**	The Company must ensure that no turbine shall be erected until a Primary Radar Mitigation Scheme ("PRMS") agreed with the Operator has been submitted to and approved in writing by the Scottish Ministers in order to mitigate the impact of the Development on the Primary Radar Installation at Perwinnes and associated air traffic management operations. No blades shall be fitted to any turbine unless and until the approved Primary Radar Mitigation Scheme has been implemented and the development shall thereafter be operated fully in accordance with such approved Scheme.

2.3 Detection on the radar would have the potential to cause false radar returns to be displayed to an Air Traffic Controller. This radar "clutter" could obscure primary returns from actual aircraft and could also

[1] At the time these were 2 sites known as Seagreen Alpha and Seagreen Bravo. Planning consent was awarded for both sites separately, but at the same time, and Condition 23 was replicated in the consents for both sites. Alpha and Bravo have now been amalgamated into one site, now known as Seagreen Phase 1.

interfere with radar tracking. This could affect an air traffic controller's ability to identify primary radar aircraft returns and increases the risk of the controller not detecting a conflict between aircraft. Large numbers of turbines could also lead to saturation of the radar processing systems.

2.4 Previous windfarm developments have explored a variety of options to mitigate this risk, with Range Azimuth Gating (RAG) (known commonly as Radar Blanking) implemented in previous developments, alongside a Transponder Mandatory Zone (TMZ). The other potential mitigation options which have been considered are technical, non-airspace options, which are explained in Annex B. These other potential mitigation options do not involve change to airspace, and hence are outside of the CAA CAP1616 Airspace Change Process. None of the options in Annex B are viable. Three of the options (extending Allanshill radar; Project RM Raytheon, and additional in-fill radar system projects) fail to meet the safety design principle. The remaining option (new primary radar) could not be implemented within the required timescales so therefore is also not viable.   They are included for information in Annex B but are not evaluated as airspace change options within the CAP1616 framework.

2.5 This document evaluates the options considered against the design principles and presents the basis upon which decisions to proceed or reject options has been made. This document provides 1 proposal for mitigating the radar clutter associated with wind farm turbines (TMZ plus RAG blanking), with 4 options as to how this could be implemented:

1. Option A: TMZ in line with proposed wind turbine locations
2. Option B: TMZ in line with proposed wind turbine locations plus 2nm buffer
3. Option C: simplified polygon TMZ "rubber banded" around proposed wind turbine locations with no buffer
4. Option D: TMZ aligned to smoothed/rounded off boundary plus 2nm buffer

2.6 The design principles used to evaluate these options are as described in detail in the Design Principles document (Stage 1 Gateway Assessment).

3. Stakeholder Engagement on Options Development

3.1 Engagement has been primarily with the following three key stakeholders:

- NATS
- MOD (DAATM)
- Aberdeen ATC

Other stakeholders involved include North Sea Helicopter operators, National Air Traffic Management Advisory Committee (NATMAC) members.

3.2 The full list of stakeholder engagement is included as Annex D.

4. Proposal – Radar blanking with associated Transponder Mandatory Zone (TMZ)

Description:

Radar Range Azimuth Gating (RAG) (commonly referred to as Radar Blanking), is the mitigation solution which is being proposed (please see Annex A for a full description of this). RAG will need to be deployed over the area of the consented wind farm before it is constructed to prevent detection of radar returns from the turbines. However, radar blanking will also remove primary radar returns from aircraft within the blanked area. To mitigate this removal of primary radar data, it is necessary establish a Transponder Mandatory Zone (TMZ) over the consented wind farm so that only aircraft equipped with a transponder will be permitted to overfly the wind farm (RAG blanked area). Secondary Surveillance Radar (SSR), which picks up the electronic signature emitted by the transponder on board the aircraft, will display all transponder equipped aircraft within the RAG blanked area. Hence all transponder equipped aircraft in the area will be visible to ATC. All commercial and military aircraft are transponder equipped. Only a small proportion of private General Aviation aircraft (e.g. vintage aircraft) are not transponder equipped. Note: analysis of 1 month of radar data (Sept 2018) in the Seagreen windfarm area showed that out of 1270 aircraft transiting the region only two did not operate a transponder and hence were only detected by primary radar. This represents 0.15% of flights.

Options Considered:

4.1 Do nothing

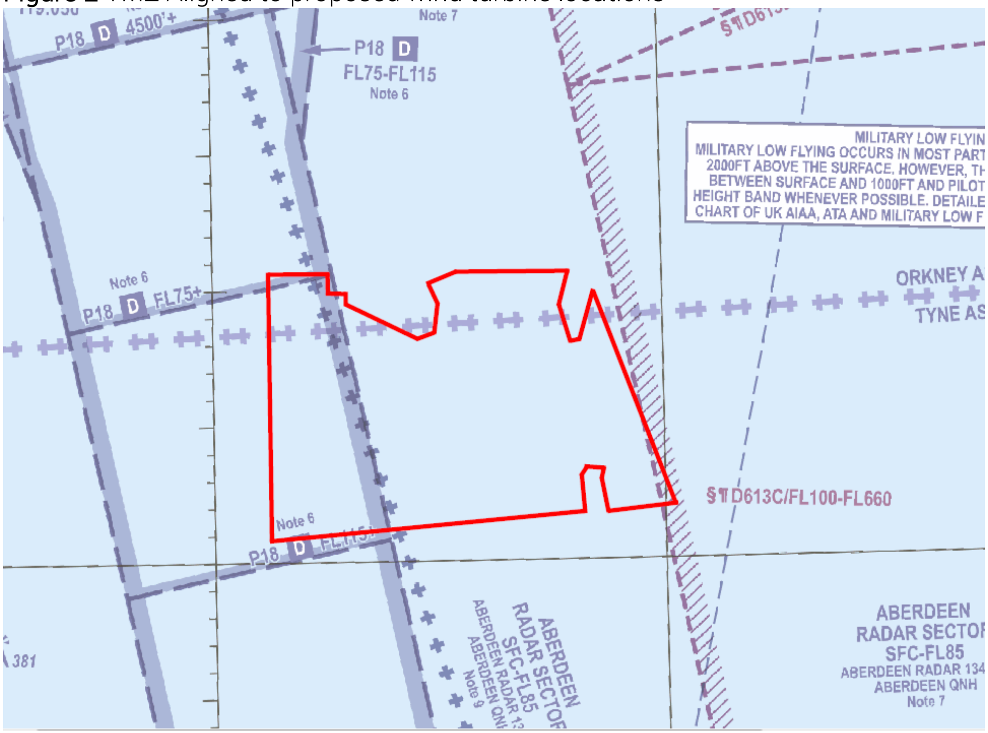
No mitigation against radar clutter. This option assumes that the wind farm is built but no measures are implemented to prevent radar clutter & interference.

4.2 Option A: TMZ in line with proposed wind turbine locations.

Figure 2 below shows the proposed Option A TMZ which aligns with proposed wind turbine locations. This option provides the minimum TMZ cover required. However, the irregular shape creates a more complex option and may make it overly complicated for pilots and ATC operators (potential Human Factors issue).

Note this is the same area that would be blanked on the Radar system by the RAG blanking. Hence a non-transponder equipped aircraft (primary radar return only) would disappear from the radar screen as soon as it crosses the red line and enters the RAG blanked region.

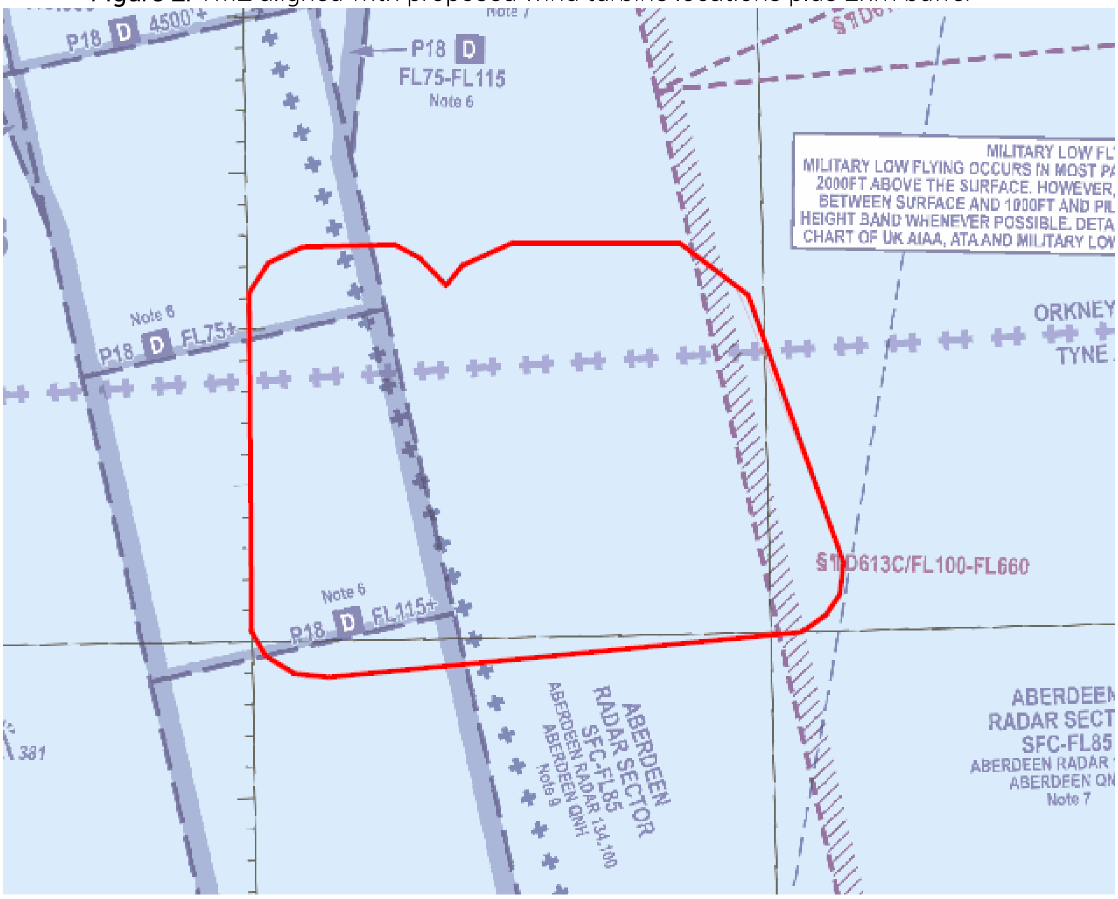
Figure 2 TMZ Aligned to proposed wind turbine locations



4.3 Option B: TMZ Aligned With Proposed Wind Turbine Locations Plus 2nm Buffer.

Figure 2 below shows the proposed Option B TMZ which is designed to be aligned with the proposed wind turbine locations plus a 2nm buffer. The 2nm buffer is intended to give ATC some delay (and hence time to react) between a non-transponder equipped aircraft infringing the TMZ and it disappearing from the radar screen. For example an aircraft travelling at 200kts will take 36 seconds if heading directly into the TMZ, from crossing the proposed TMZ boundary to entering the RAG blanked region (and then disappearing). Hence the air traffic controller monitoring the radar will have 36 seconds to notice that the aircraft has infringed the TMZ before it disappears from the radar display.

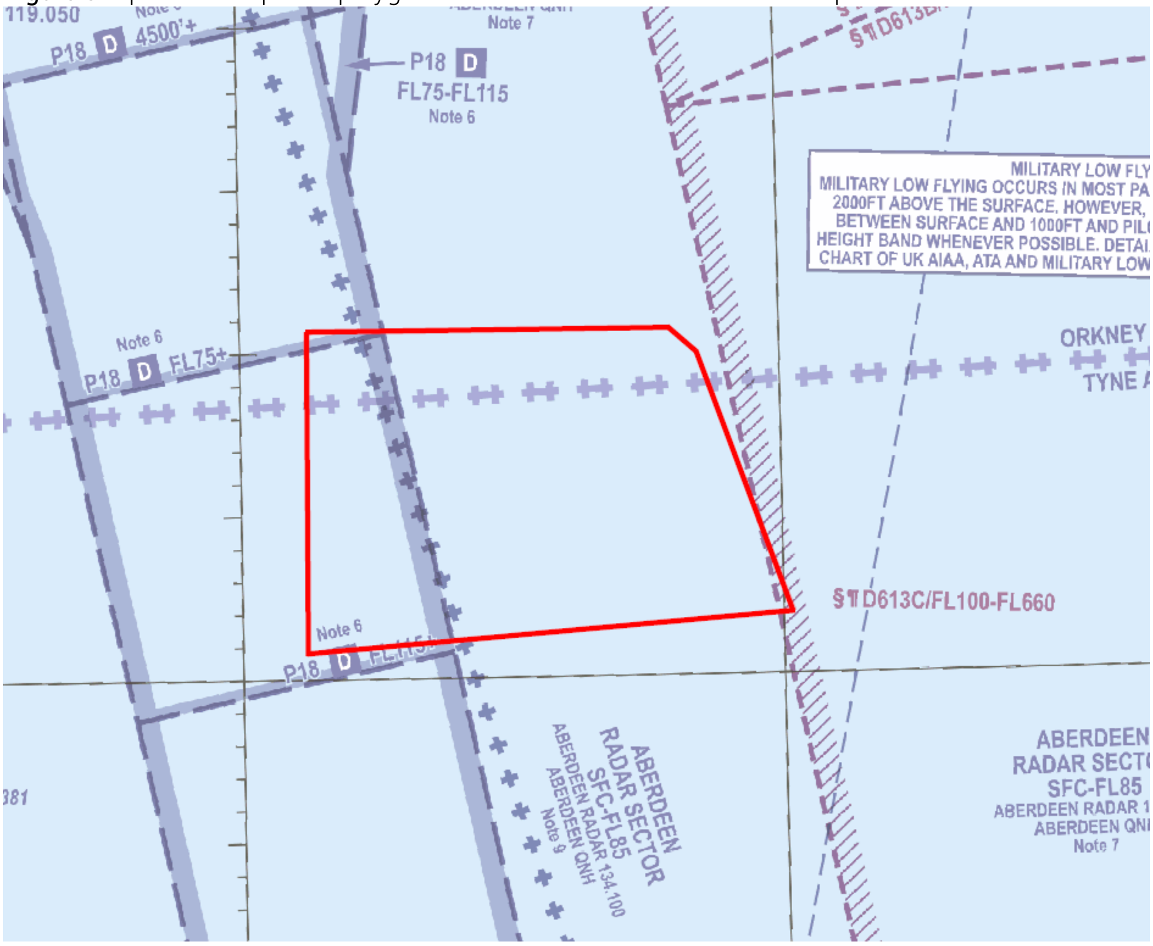
Figure 2: TMZ aligned with proposed wind turbine locations plus 2nm buffer



4.4 Option C: TMZ Aligned to a "Rubber-Band" Boundary With No Buffer

Figure 3 below shows the proposed Option C TMZ. This is designed to be a simplified polygon surrounding the locations of the proposed wind turbines with no buffer. The proposed area is similar to option A, but provides a simplified boundary shape. This is advantageous for display to pilots on in-cockpit electronic flight information system (EFIS) displays and ATC operators on radar displays. As such this is preferable for Human Factors reasons.

Figure 3: Option C simplified polygon TMZ "Rubber Banded" Around Proposed Wind Turbine Locations



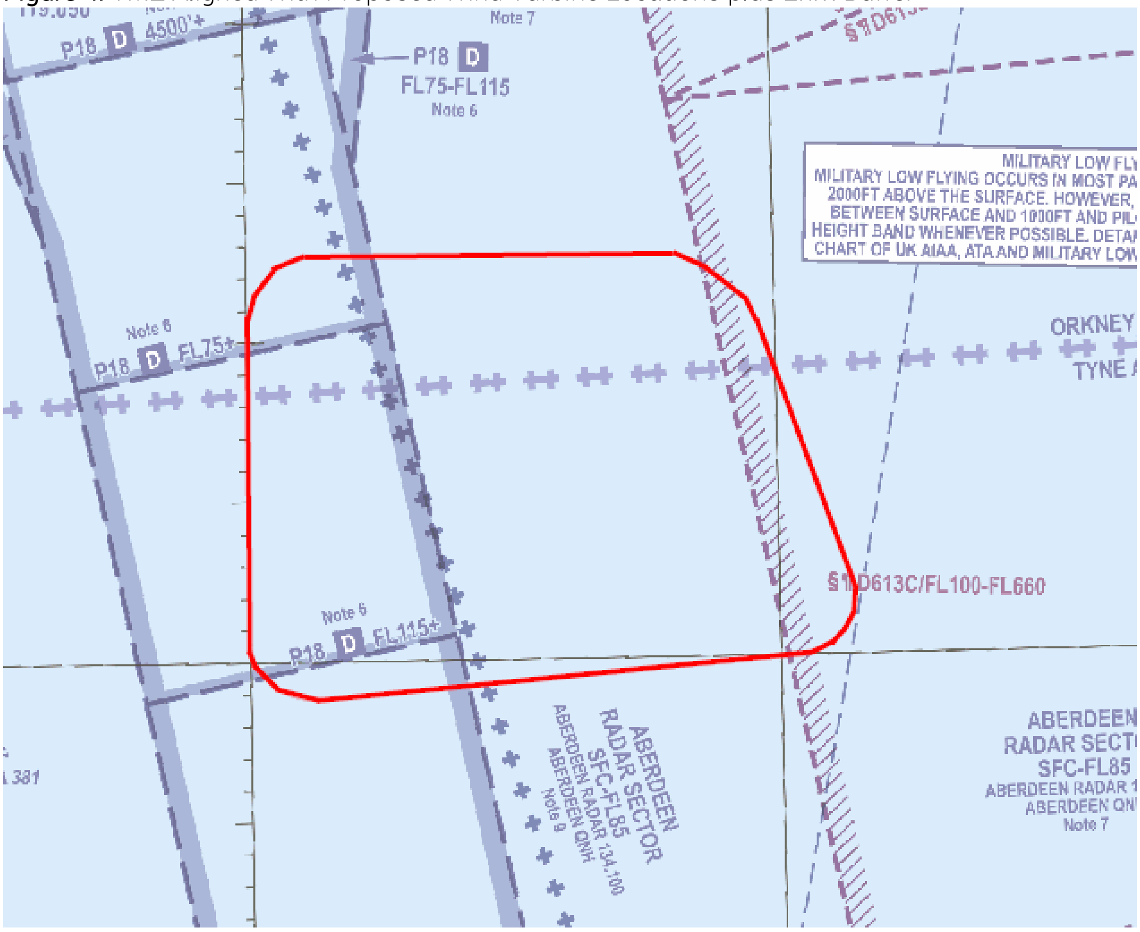
4.5 Option D: TMZ Aligned to a Smoothed/Rounded off Boundary plus 2nm Buffer

Figure 4 below shows the proposed TMZ aligned to a smoothed/rounded off boundary plus 2nm buffer. This option is a combination of options B and C. As such it presents the advantages of the simplified shape coupled with the additional reaction time for ATC to identify infringers, afforded by the 2nm buffer region.

This option was utilised in previous wind farm TMZ mitigations (i.e. Beatrice/Moray East). The 2nm buffer is intended to give ATC some delay (and hence time to react) between a non-transponder equipped aircraft infringing the TMZ and it disappearing from the radar screen. For example an aircraft travelling at 200kts will take 36 seconds if heading directly into the TMZ, from crossing the proposed TMZ boundary to entering the RAG blanked region (and disappearing). Hence the air traffic controller monitoring the radar will have 36 seconds to notice that the aircraft has infringed the TMZ before it disappears from the radar display.

The simplified TMZ boundary shape is advantageous for the simplicity of display to pilots on in-cockpit electronic flight information system (EFIS) displays and ATC operators on radar displays. As such this is preferable for Human Factors reasons.

Figure 4: TMZ Aligned With Proposed Wind Turbine Locations plus 2nm Buffer



The options presented above are evaluated against the design principles in the accompanying Stage 2A(ii): Design Principle Evaluation, Options Assessment document.

5. Annex A: Background Information

Background information

Primary Surveillance Radar (PSR): a conventional radar sensor that illuminates a large portion of space with an electromagnetic wave and receives back the reflected waves from targets within that space. Primary radar detects all aircraft (and other objects, such as flocks of birds and wind turbines) without selection, regardless of whether or not they possess a transponder. It can also detect and report the position of anything that reflects its transmitted radio signals, including the blades of the wind turbines. It indicates the position of targets, but does not identify them. Because wind turbine blades are moving targets, it is hard for a radar to distinguish them from aircraft. Radar data processing connects returns from successive sweeps of the radar, and from this infers speed. Multiple wind turbines in a wind farm create multiple radar returns and these can appear as stationary or rapidly moving primary returns on the radar display.

Secondary Surveillance Radar (SSR): Secondary radar works together with transponders which are installed on the aircraft. The ground based SSR radar interrogates the transponder which transmits a signal which is captured by the radar. The information transmitted by the transponder identifies the aircraft, along with details as to aircraft altitude etc. (note that transponder equipage is mandatory for instrument flight, and flight above FL100. As such all commercial aircraft and the vast majority of general aviation aircraft are already transponder equipped.)

Composite Radar. The radar displays used by ATC have feeds from multiple primary and secondary radar sensors. Hence a non-transponder-equipped aircraft will still be picked up by primary radar and displayed. Those with transponders are picked up by both primary and secondary radar, and hence more information with enhanced accuracy is provided to ATC.

Primary Radar RAG blanking. Range-Azimuth Gate (RAG) radar blanking blocks *any* primary radar return within selected ranges and azimuth sectors. This can be mapped to suppress plots within wind turbine clutter regions. However the primary blanking in any given area is complete, hence the primary return from any aircraft entering this area would also be suppressed. Thus the aircraft would not appear on the radar unless they were operating with a transponder, and hence detected by the SSR.

Transponder Mandatory Zone. Where a Transponder Mandatory Zone (TMZ) is implemented it helps to ensure that aircraft are equipped with a transponder, so that they can continue to be detected over a RAG blanked area (e.g. above a wind farm). Non-transponding aircraft would not be allowed within the confines of the TMZ.

Impact. Transponding aircraft should be unaffected by the windfarm. However, non-transponding aircraft would not be permitted to overfly the windfarm since they would be invisible to radar due to the sector blanking. Risks associated with non-transponding aircraft infringing the TMZ are very small.

Viability. This is a viable mitigation.

6. Annex B:Non-airspace Options:

Additional options that have been considered which do not require airspace change are as follows.

6.1 Extending the radar coverage of the Allanshill PSR to provide infill coverage for the Perwinnes PSR (and included live flight trials)

This involves extending the range of another radar station located at Allanshill and blanking out the affected area at Perwinnes Hill. This option was investigated via a flight trial.

Impact. Block the Seagreen Phase One project area from the Perwinnes Hill radar and extend the Allanshill radar from 60Nm to 80Nm, so that it covers the area blanked out at Perwinnes Hill. This is then mosaiced into the air traffic control picture to maintain a radar picture over the wind farm. The reason that the Allanshill radar is not affected by the wind farm is that the terrain blocks out the view of the wind farm, and so is not affected by it.

Viability. A flight trial completed in June 2015 using 3 altitudes to identify performance against the operational criteria found the range extension is assessed as unsuitable. Future trials are difficult to set-up and costly. As this would not meet the safety design principle, it is not a viable option.

6.2 Project RM - Raytheon upgrade to the Perwinnes PSR

This involves converting the Perwinnes Hill radar to one that is not affected by wind farm turbines

Impact. At an early stage of development and testing, this project is not easy to implement and requires limited new hardware and substantial software and set-up changes. The cost of this option would be in the range of £12 – 15 million

Viability. This is an expensive option and at the current time does not have sufficient operational assurance to meet the safety design principle, so is not a viable option.

6.3 Installation of a new PSR

This option is to install a new radar, probably to the south of Aberdeen, but within 50 nautical miles of the furthest reaches of the development, and further inland to provide terrain shielding of the wind farm turbines that could provide cover for the area blanked out at Perwinnes Hill.

Impact. The criteria for ensuring acceptable operation of the new radar limits the locations for radar siting, as suitable land for siting the radar may not be available to purchase or lease for the lifetime of the wind farm. Planning consents will also be required for any new radar.

Viability. This requires the purchase of land, provision of power, and telecommunications links suitable for the new primary radar and the most expensive option at approx. £20 million. It could not be achieved in the required timescales so is not a viable option.

6.4 In-fill Radar System options

There are several short range (40Nm) in-fill radar system projects, which have the aim of not being affected by wind farm turbines and that could in future be used to provide cover for the area blanked out at Perwinnes Hill – Terma Systems Radar; Aveillant Holographic Radar, and C Speed Lightwave Radar.

Impact. These systems are untested or unknown technology, with no current regulatory approval.

Viability. This is not currently suitable for this project due to the immaturity of the potential solutions and the unknown operational risk, so would not meet the safety design principle, and is not a viable option.

Annex C: Glossary

ACP	Airspace Change Proposal
AIP	UK Integrated Aeronautical Information Package
AIRAC	Aeronautical Information Regulation and Control
ANSP	Air Navigation Service Provider
ATC	Air Traffic Control
ATCO	Air Traffic Control Officer
ATM	Air Traffic Management
ATS	Air Traffic Service
CAA	Civil Aviation Authority
CAP	Civil Aviation Publication
CAS	Controlled Airspace
DAATM	Defence Airspace and Air Traffic Management
DfT	Department for Transport
DME	Direction Measuring Equipment
FIR	Flight Information Region
GA	General Aviation
ICAO	International Civil Aviation Organization
IFP	Instrument Flight Procedure
IFR	Instrument Flight Rules
LOS	Line of Sight
MOD	Ministry of Defence
NATMAC	National Air Traffic Management Advisory Committee
NATS	National Air Traffic Services
NERL	NATS En-route plc
nm	nautical miles
PD	Probability of detection
PSR	Primary Surveillance Radar
RAG	Radar Range Azimuth Gating
RCS	Radar Cross Section
SARG	Safety and Airspace Regulation Group (Department of the CAA)
SSR	Secondary Surveillance Radar
TMZ	Transponder Mandatory Zone
VFR	Visual Flight Rules
VOR	VHF Omni-directional Radio Range
WTG(s)	Wind Turbine Generator(s)

7. Annex D: Record of Stakeholder Engagement

See separate document.

End of document.