Clash Gour Wind Farm ACP-2021-046

Design Principles Evaluation

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Acronyms

Acronym	
ACP	Airspace Change Proposal
agl	above ground level
ALARP	As Low as Reasonably Practical
ANSP	Air Navigation Service Provider
ATC	Air Traffic Control
ATCRMS	Air Traffic Control Radar Mitigation Scheme
ATS	Air Traffic Service
BMAA	British Microlight Aircraft Association
CAP	Civil Aviation Publication
CGH	Clash Gour Holdings
CO_2	Carbon Dioxide
DP	Design Principles
DPE	Design Principles Evaluation
EDFER	EDF Energy Renewables
FL	Flight Level
GA	General Aviation
IFR	Instrument Flight Rules
IOA	Initial Options Appraisal
m	metre
MAA	Military Aviation Authority
MAC	Mid-air Collision
MOD	Ministry of Defence

NM	Nautical Mile
NO_2	Nitrogen Dioxide
PSR	Primary Surveillance Radar
RA	Regulatory Article
RAF	Royal Air Force
RAG	Range Azimuth Gating
RDDS	Radar Data Display Screen
RMZ	Radio Mandatory Zone
RT	Radio Telephony
RW	Runway
SSR	Secondary Surveillance Radar
TMZ	Transponder Mandatory Zone
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
WAM	Wide Area Multilateration

Table 1 Acronyms

Terminology

Term	Meaning
Automatic Dependent Surveillance-Broadcast	An ADS-B system is a hardware equipment installed onboard aircraft. It transmits automatically the location (latitude, longitude) of the aircraft and its movement data (speed, heading, altitude) via a digital data link. These transmissions are received and can be used by other aircraft and Air Traffic Control (ATC) to display the aircraft's position.
Development Areas	The combination of the three distinct array areas of Clash Gour together with the array areas of the existing Berry Burn and consented Berry Burn 2 Wind Farms, which are located within the envelope of the Clash Gour Wind Farm.
Primary Surveillance Radar	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, weather phenomena, other environmental factors 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 rotating blades of the wind turbines. It indicates the position of targets but does not identify them. Because wind turbines 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 windfarm create multiple radar returns and these can appear as stationary or rapidly moving primary returns on the radar display.
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 Secondary Surveillance Radar (SSR).
Radar Mitigation Scheme	A scheme necessary and sufficient to prevent the operation of the Clash Gour wind turbines impacting adversely on the primary surveillance radar performance at RAF Lossiemouth and Inverness Airport. The scheme may be in

	combination, or individually and take the form of a hardware or software solution which will be implemented and maintained for the lifetime of the development or for such shorter period as may be agreed in consultation with the MOD and Inverness Airport as necessary to mitigate any such adverse impact.
SSR	Secondary Surveillance 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 (note that transponder equipage is mandatory for instrument flight, and flight above Flight Level (FL) 100 (approximately 10,000 feet above sea level). However, some aircraft may operate above FL100 subject to specific rules and areas of operation. As such all commercial aircraft and the vast majority of general aviation aircraft are transponder equipped).
TMZ	A Transponder Mandatory Zone is an area of defined dimensions wherein the carriage and operation of aircraft transponder equipment is mandatory. All flights operating in airspace designated by the competent authority as a TMZ shall carry and operate SSR transponders capable of operating on Modes S or, in exceptional circumstances, SSR Modes A and C. However, the advent and increasing affordability of technology such as Automatic Dependent Surveillance – Broadcast (ADS-B) means that the concept of a TMZ may now evolve to utilise alternate types of electronic conspicuity systems. A pilot wishing to operate in a TMZ without serviceable transponder equipment may be granted access subject to specific arrangements agreed with the TMZ Controlling Authority

Table 2 Terminology

1 Introduction

1.1 Project Overview

This document forms part of the document set required in accordance with the requirements of the CAP 1616 Airspace Change Proposal (ACP) process and aims to provide sufficient evidence to satisfy Stage 2 Design Principles Evaluation (DPE). The purpose of which is to assess each of the proposed options within the Suitable list against the Design Principles (DPs) established during Stage 1 of the CAP 1616 process. This document should be read in in conjunction with Stage 2 Design Options Engagement document which provides diagrams and description on a number of design options, the consideration of which is aimed to provide sufficient mitigation to the operational effects the radar detectable Clash Gour wind turbines will have on the Royal Air Force (RAF) Lossiemouth and Inverness Airport Primary Surveillance Radar (PSR) systems.

Force9 Energy (Force9), jointly with EDF Energy Renewables Limited (EDFER) is developing the Clash Gour Wind Farm (Clash Gour) in the name of its wholly owned subsidiary Clash Gour Holdings (CGH). Clash Gour will be a substantial onshore windfarm which will be located in the Moray Council Area, approximately 13 Nautical Miles (NM) southwest of RAF Lossiemouth and 15 NM southeast of Inverness Airport. Clash Gour will consist of 48 wind turbines with a maximum blade tip height of 180 metres (m) above ground level (agl). Figure 1 below provides the location of the three individual wind turbine array areas which will comprise Clash Gour.

Figure 1 Clash Gour Wind Farm Location

1.2 Section 36 Electricity Act Application

As part of the development consent process for Clash Gour, CGH, through Force9, engaged with relevant aviation stakeholders to determine the impact of Clash Gour's operational wind turbines on aviation radar systems and operations. In particular and relevant to the ACP, both the Ministry of Defence (MOD) and Inverness Airport have confirmed that, without mitigation, the development will have an operational effect due to an adverse impact on their ability to provide an Air Traffic Service (ATS) as a result of interference (radar clutter) caused by the detection of the operational wind turbines by the current PSR systems in operation at RAF Lossiemouth and Inverness Airport. as set out below.

Condition Number	Condition	Reason
5	No wind turbine shall be erected unless and until an Air Traffic Control Radar Mitigation Scheme (ATCRMS) to address the impact of the wind turbines upon air safety has been submitted to and approved in writing by Scottish Ministers. The ATCRMS is a scheme designed to mitigate the impact of the development upon the operation of the Primary Surveillance Radar at RAF Lossiemouth ("the Radar") and the air traffic control operations of the Ministry of Defence which are reliant upon the Radar. The ATCRMS shall set out the appropriate measures to be implemented to mitigate the impact of the development on the Radar and shall be in place for the lifetime of the development provided the Radar remains in operation. The development shall be implemented strictly in accordance with the details set out in the approved ATCRMS.	In the interests of aviation safety.
6	No wind turbine erected as part of this development shall be permitted to rotate its rotor blades about its horizontal axis, other than for the purpose of testing radar mitigation for this development for specific periods as defined in the approved ATCRMS or otherwise arranged in accordance with provisions contained in the approved ATCRMS, until: a) those mitigation measures required to be implemented prior to any wind turbine being permitted to rotate its rotor blades about its horizontal axis as set out in the approved ATCRMS have been implemented; and b) any performance criteria specified in the approved ATCRMS and which the approved	In the interests of aviation safety.

Condition Number	Condition	Reason
	ATCRMS requires to have been satisfied prior to any wind turbine being permitted to rotate its rotor blades about its horizontal axis have been satisfied and Scottish Ministers have confirmed this in writing. Thereafter the development shall be operated strictly in accordance with the details set out in the approved ATCRMS for the lifetime of the development, provided the Radar remains in operation.	
7	No wind turbine forming part of the Development shall operate, other than for testing and evaluation as agreed with the operator of Inverness Airport, unless and until a Radar Mitigation Scheme has been submitted to and approved in writing by the local planning authority, after consultation with the operator of Inverness Airport and the Civil Aviation Authority. No wind turbine(s) forming part of the Development shall be operational until and unless all measures required by the approved Radar Mitigation Scheme have been fully implemented. The Development shall thereafter be operated fully in accordance with the approved Radar Mitigation Scheme. In this condition "Radar Mitigation Scheme" means a scheme setting out measures to address and mitigate the impact of the wind turbines forming part of the development upon the operation and performance of the Primary Surveillance Radar at Inverness Airport. The scheme will include the appropriate measures to be implemented and that are to be in place for the operational life of the development provided the Radar remains in operation. It will also include provision for future and alternate agreement of the mitigation solution with the operator of Inverness Airport.	To secure mitigation of impacts and ensure the development does not affect the safe operation of Inverness Airport through interference with the Primary Surveillance Radar.

Table 3 Consent Conditions Relevant to Aviation Radar

The ACP, entitled 'Clash Gour Wind Farm', has been initiated to create a path for CGH to satisfy the aviation related conditions expected to be attached to the grant of any consent for the wind farm. It will provide a mitigation solution to the operational effects on Inverness Airport and RAF Lossiemouth created by visibility of wind turbines on PSR. Under the ACP, CGH will then be able to operate the wind farm to test technical mitigation solutions to fully discharge the relevant conditions.

1.3 Design Options

Stage 1 of CAP 1616 requires that the sponsor of the ACP and stakeholders, through a two-way process establish a set of Design Principles (DPs) which will subsequently steer and guide the development of the route options. CGH have successfully completed Stage 1 and the finalised prioritised DPs that passed through the CAP 1616 Stage 1 (DEFINE) Gateway.

CGH have considered a variety of design options in order to provide sufficient mitigation on the operational effects which radar detectable wind turbines will have on RAF Lossiemouth and Inverness Airport. The options are expected to be capable of allowing operation of Clash Gour which in turn will allow testing of technical mitigation solutions at each of the impacted surveillance radar systems, where required. The following options have been developed in accordance with the DPs.

Having received feedback from the CAA regarding the baseline, Option 0 (Baseline: Do Nothing) has been amended in the DPE Issue 2 (this document). For the avoidance of doubt, the scenario which was described in Issue 1 of the DPE known as Option 0 (Wind farm built with no radar mitigation solution) has now become the 'Do Minimum' scenario. As a result, the Do-Nothing scenario described in Option 0 in Issue 2 of the DPE is that no wind farm is built, which reflects the current situation. This is reflected in Table 4 below.

Old Option 0 (DPE Issue 1) Scenario	New Option 0 (DPE Issue 2) Scenario
Clash Gour Wind Farm constructed with no radar mitigation solution.	Clash Gour Wind Farm is not constructed (current situation).

Table 4 Option 0 Update Clarification

It must be stressed that the 'Old Option 0' (now the 'Do Minimum' scenario) is not a viable option because the wind farm cannot proceed to construction without discharging the Section 36 conditions described in Table 3 (see Section 1.2 above). If construction was initiated without discharging the relevant conditions the project could be subject to enforcement stopping working proceeding.

Option 0 below is unviable as in this scenario, there is no airspace solution (and therefore no ACP) required. However, Option 0 shall be carried forward into subsequent stages of the CAP 1616 process for comparative purposes only as the baseline for the Initial Options Appraisal and future environmental assessments.

The following comprehensive list of design options to provide the required mitigation are proposed for consideration.

Option 0: Baseline (Do nothing).

Option 1: Temporary wind turbine suspension of operation.

Option 2: SSR Alone operations.

Option 3: The use of In-fill radar.

Option 4: Introduction of Class D, E

Option5: Class E+ Controlled Airspace.

Option 6: Radio Mandatory Zone (RMZ).

Option 7: Range Azimuth Gating (RAG) blanking and Transponder Mandatory Zone (TMZ) which falls into six possibilities of implementation as follows:

A. RAG blanking of the RAF Lossiemouth and Inverness Airport PSRs.
B. TMZ (without RAG blanking) over the windfarm array locations.
C. RAG blanking and TMZ over the proposed windfarm array locations.
D. RAG blanking and TMZ over the proposed windfarm array locations. TMZ extended to include a 2 NM buffer.
E. RAG blanking over the proposed windfarm array locations. Simplified polygon TMZ 'rubber banded[1]' around the proposed windfarm locations with no buffer.
F. RAG blanking over the proposed windfarm array locations. Simplified polygon TMZ 'rubber banded' around the proposed wind farm locations extended to include a 2 NM buffer.

1.3.1 Technical Criteria

Please note that the option which is eventually chosen for implementation shall be compliant with the appropriate technical criteria defined in CAP 1616, Appendix F and shall form the basis for the change sponsor formal ACP submission.

[1] Rubber banded - shortest perimeter fully enclosing the wind farm development. It is used to smooth an irregular perimeter.

2 Design Principle Evaluation Assessment

2.1 Options Development

CGH developed a list of design options; from comprehensive options through to specific lateral options, which supported both the Statement of Need and aligned with the DPs. These were shared with stakeholders to ensure that stakeholder interests, expressed through the design principles had been properly understood and accounted for in designing these options.

2.2 Options Assessment

CAP 1616 provides a standardised format for the completion of the DPE however, this format can be expanded as necessary to take account of the change sponsors DPs. The degree to which the DPs have been met is indicated by the following colour coding as listed in Table 5.

Colour	Code Meaning
Green	Met – All the conditions within the DP are met or there is no change.
Yellow	Partial – Some of the conditions within the DP are met or there is a minimal/limited change.
Red	Not Met – None of the conditions within the DP are met.

Table 5 DP Colour Coded Evaluation

The change sponsor has taken the view that any option, with a DP assessed as Not Met (Red) shall be rejected. The following sections include the detailed evaluations for each of the options.

2.3 Baseline (Do Nothing) – Design Principle Evaluation

Design Principle Evaluation			
Do Nothing Option		**Reject**	
Clash Gour Wind Farm is not constructed.			
Design Principle		**Summary of Assessment**	**Evaluation**
DP1	Safety: Ensure an acceptable level of safety for aircraft within and displaced by any proposed airspace solution.	This option does not alter the extant airspace arrangements which are assumed to be safe and shall remain so.	Met
DP2	Operational (Resilience): Minimise negative impact on all airspace users.	This option has no negative impact on airspace users as it maintains the extant airspace arrangements.	Met
DP3	Operational: Airspace change shall have no impact on operations/capacity of airport operators and Air Navigation Service Providers (ANSPs).	This option has no impact on the operations and capacity of airports and ANSPs as it maintains the extant airspace arrangements.	Met
DP4	Operational: Maintain operational resilience of the Air Traffic Control network.	This option has no impact on ATC operational resilience as it maintains the extant airspace arrangements.	Met
DP5	Environmental: Minimise environmental impacts to stakeholders on the ground.	This option has no additional environmental impact as it maintains extant airspace arrangements.	Met
DP6	Economic: Endeavour to minimise economic impact on aircraft operators.	This option has no economic impact on aircraft operators as it maintains the extant airspace arrangements.	Met
DP7	Technical: Base the airspace change on the latest technology available. • This technology could relate to navigation, radar enhancements or radar data processing etc. • The volume of airspace affected should be the minimum necessary to deliver requirements, whilst providing optimal safety buffer.	As this option maintains extant airspace arrangements, there is no change in technology to assess.	Met

	• Seek to create simple, easily definable solution.		

Table 6 Do Nothing Evaluation

2.3.1 Do Nothing Option Conclusion

Although at first glance, Option 0 may appear to be an attractive option in terms of meeting the DPs, it is unviable as it does not consist of any airspace solution and therefore annuls the CAP 1616 process. Each of the DPs have been assessed as Met (green) for this option, simply because there is no airspace solution (and therefore no change to extant circumstances). However, as there is no airspace solution and it is unviable, this option has been rejected but shall be taken forward into subsequent stages of the process for comparative purposes only.

2.4 Temporary Wind Farm Suspension of Operation – Design Principle Evaluation

Design Principle Evaluation Option			
Temporary Wind Farm Suspension of Operation		**Reject**	
Intermittent mitigation against radar clutter. ANSPs would tactically request the suspension of the wind farm operation subject to aircraft traffic levels and routings.			
Design Principle		**Summary of Assessment**	**Evaluation**
DP1	Safety: Ensure an acceptable level of safety for aircraft within and displaced by any proposed airspace solution.	As the implementation of the instruction to stop the Clash Gour wind turbines is not likely to be immediate, there is uncertainty over the time it would take for the wind turbines to stop turning and the subsequent removal of radar clutter. This would lead to confusion, ATC delays and increased workload in the effort to maintain safe operation of air traffic. However, this option would be compliant with the required technical criteria and will be consistent and compatible with the appropriate regulatory requirements.	Not Met
DP2	Operational (Resilience): Minimise negative impact on all airspace users.	Airspace users under an ATS from Lossiemouth or Inverness may experience delay in transit across the area of the Clash Gour Wind Farm clutter however, it is likely that a re-route would be required due to the time it would take to remove the radar clutter effect by stopping the rotation of the wind turbines. Other airspace users not in receipt of an ATS would not be impacted.	Partial
DP3	Operational: Airspace change shall have no impact on operations/capacity of airport operators and Air Navigation Service Providers (ANSPs).	The process of stopping wind turbines to remove radar clutter in an attempt to safely manage impact will be unmanageable from an ATC operational perspective, leading to increased workload,	Not Met

		would be difficult to manage, be time-consuming and create an additional task especially during high ATC workload.	
DP4	Operational: Maintain operational resilience of the Air Traffic Control network.	Control of the wind turbines would remain with the respective developer, and the time taken in initiating the request and the cessation of wind turbine operations would introduce delay and increased workload at a time when speed is of the essence to ATC. Due to the unpredictable nature of operations within uncontrolled airspace, in which the wind turbines are located, this option is unviable, as it would be unable to be sufficiently robust for the dynamic ATC operational environment.	Not Met
DP5	Environmental: Minimise environmental impacts to stakeholders on the ground.	It is likely that airspace users receiving an ATS from Inverness or Lossiemouth would require a re-route due to the time it would take to remove the radar clutter effect by stopping the rotation of the wind turbines. This will lead to greater noise exposure to communities, greater fuel burn and an increase in NO_2 and CO_2 emissions through extended routing around the wind turbine induced radar clutter. Other airspace users not in receipt of an ATS would not be impacted.	Partial
DP6	Economic: Endeavour to minimise economic impact on aircraft operators.	No change to aircraft operators; however, dependent on whether a radar service was being provided by RAF Lossiemouth or Inverness ATC, aircraft are likely to be rerouted around radar clutter rather than wait for the cessation of wind turbine rotation, which may increase	Partial

		economic costs to the aircraft operator.	
DP7	Technical: Base the airspace change on the latest technology available. • This technology could relate to navigation, radar enhancements or radar data processing etc. • 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.	Electrical generators have a ramp down rate: this is the limit at which the machine can safely reduce its power output to zero, without causing significant aging and/or damage to the equipment. The electrical machines and mechanical equipment need to brake and reduce speed in a controlled manner and emergency stop procedures should only be implemented in emergency conditions. The option is not an easily definable option and is also not practical from a technical point of view.	Not Met

Table 7 Temporary Wind Farm Suspension of Operation Evaluation

2.4.1 Temporary Wind Farm Suspension of Operation Conclusion

This option would not be acceptable to the windfarm developers; furthermore, in the fast moving, dynamic world of ATC operations, this option would be operationally unmanageable, and unacceptable to the ANSPs. Consequently, the temporary suspension of wind turbine operation is rejected as it provides insufficient mitigation for the effects on the Lossiemouth and Inverness PSR systems.

2.5 SSR Alone Operations – Design Principle Evaluation

Design Principle Evaluation			
SSR Alone Option			**Reject**
Non-transponding aircraft would remain undetectable throughout the entire area of coverage of the Inverness and Lossiemouth PSR systems. The Military Aviation Authority (MAA) provide Regulatory Articles (RA) to provide a framework of policy, rules, directives, standards, processes and the associated direction, advice and guidance, which governs military aviation activity and against which air safety is assessed. RA 3241 covers contingency arrangements for the continued provision of ATS utilising SSR alone by military ATC. Inverness ATC have confirmed that the use of SSR Alone is not supported, a procedural (non-radar) service is provided in the event of primary radar failure.			
Design Principle		**Summary of Assessment**	**Evaluation**
DP1	Safety: Ensure an acceptable level of safety for aircraft within and displaced by any proposed airspace solution.	As non-transponding aircraft would not be able to be tracked by radar, ATC would not be aware of their position which would lead to a decrease in aircraft safety to an unacceptable level. However, this option would be compliant with the required technical criteria and will be consistent and compatible with the appropriate regulatory requirements.	Not Met
DP2	Operational (Resilience): Minimise negative impact on all airspace users.	The British Microlight Aircraft Association (BMAA) have stated that in their opinion the vast majority of General Aviation (GA) aircraft are not SSR equipped. Those aircraft unable to provide secondary information to ATC will not be able to be provided a radar-based ATC service. A limitation in the radar service being provided to participating aircraft by RAF Lossiemouth ATC may be experienced. Inverness ATC would be unable to provide a radar based ATS.	Not Met
DP3	Operational: Airspace change shall have no impact on operations/capacity of airport	Inverness ATC will be unable to provide a radar based ATS to pilots requesting a radar	Not Met

	operators and Air Navigation Service Providers (ANSPs).	service including civil air transport which is likely to prove unacceptable to those operators. Although Clash Gour wind turbine induced radar clutter would be removed, the use of SSR Alone would have a detrimental impact on ATC surveillance capability and aviation safety.	
DP4	Operational: Maintain operational resilience of the Air Traffic Control network.	RAF Lossiemouth ATC have stated that the use of SSR Alone would not be an As Low As Reasonably Practicable (ALARP) and tolerable solution and would significantly increase air safety and mid-air collision risk. Inverness ATC would not be able to provide a radar based ATS.	Not Met
DP5	Environmental: Minimise environmental impacts to stakeholders on the ground.	SSR Alone is simply a different surveillance (and associated airspace) mechanism which will provide a more holistic picture of traffic in the vicinity of the wind farm. As a result, there is no anticipated change to aircraft routings and therefore minimal environmental impact.	Met
DP6	Economic: Endeavour to minimise economic impact on aircraft operators.	Aircraft operators may be financially disadvantaged if operators of those aircraft not fitted with transponders feel that they are obliged to fit them.	Partial
DP7	Technical: Base the airspace change on the latest technology available. • This technology could relate to navigation, radar enhancements or radar data processing etc. • The volume of airspace affected should be the minimum necessary to deliver requirements, whilst providing optimal safety buffer.	The unilateral use of SSR Alone will be applied across all of the airspace covered by PSR systems in use at RAF Lossiemouth and Inverness ATC. This will adversely affect the range of ATS available and would not be acceptable to both ATC units for safety and operational reasons.	Not Met

	• Seek to create simple, easily definable solution.		

Table 8 SSR Alone Evaluation

2.5.1 SSR Alone Operations Conclusion

Within SSR Alone operations and without radar blanking, the primary radar would be deselected to remove wind turbine induced clutter. Since it is not possible to deselect PSR for a specific area, this would mean that the entire area of operations for the air traffic controller would be without primary radar data displayed. This means that it will not only be impossible to detect any aircraft entering the airspace above the Development Area, but any aircraft operating within the coverage of the effected radar system without a transponder fitted and activated, leading to an unacceptable loss of situational awareness for the controller. SSR Alone operations are not employed at Inverness Airport whilst RAF Lossiemouth ATC have stated that SSR Alone would not be ALARP or a tolerable solution and would increase the safety risk with a possibility of mid-air collision. Consequently, the use of SSR Alone operations is rejected as it provides insufficient mitigation for the effects on the Lossiemouth and Inverness PSR systems.

2.6 Use of Infill Radar – Design Principle Evaluation

Design Principle Evaluation Option			
Use of Infill Radar		**Reject**	
Use of existing or new radar data from a source which does not detect the Clash Gour wind turbines and provides sufficient low-level coverage above the development to be operationally acceptable to both Inverness and RAF Lossiemouth ATC. If this solution was accepted by the impacted ANSPs, configuration of PSR would be outside of the airspace change process.			
Design Principle		**Summary of Assessment**	**Evaluation**
DP1	Safety: Ensure an acceptable level of safety for aircraft within and displaced by any proposed airspace solution.	Infill radar will remove clutter provided by the detection of the Clash Gour Wind Farm and dependent on size of the infill patch will also remove existing radar clutter contained within it. The use of infill radar has seen success in the civilian ATC environment and may be appropriate for mitigation of the Inverness PSR. However, one infill solution does not fit all and will be required to be accepted, provide the required range and radar coverage, be safety assessed, flight checked and will require regulatory approval. Currently no infill solution has been utilised in the military ATC radar environment. RAF Lossiemouth will replace the existing Watchman PSR with the Thales STAR NG PSR. The Clash Gour Wind Farm is theoretically detectable by both the RAF Lossiemouth and Inverness PSR systems however not all wind turbines are theoretically detectable by both, the possibility of Inverness and RAF Lossiemouth providing infill data to each other may require further investigation, a workstream which is outside the scope of this ACP. However, this option would be compliant with the required technical criteria and will be consistent	Partial

		and compatible with the appropriate regulatory requirements.	
DP2	Operational (Resilience): Minimise negative impact on all airspace users.	The successful addition of infill radar either as a standalone/replacement or radar infill option has seen success in the mitigation of windfarm effect to radar in civilian ATC. Airspace users should see no difference in the service provided to them. However, the mitigation principle requires further research on acceptability to each ANSP. As such, the change sponsor is unable to determine what impact this option may have at this stage.	Partial
DP3	Operational: Airspace change shall have no impact on operations/capacity of airport operators and Air Navigation Service Providers (ANSPs).	The MOD response to Stage 2 engagement indicated that an infill option is an appealing option to the MOD however, during a clarification call to the MOD (11 May 2022), the MOD confirmed that whilst they recognised the need for an airspace solution to be found in order for this ACP to progress, additional engagement is required to determine the MODs developing position. The MOD will continue to contribute to the process as it moves into the consultation phase. Inverness Airport have not provided any feedback regarding this option however, the successful use of infill in civilian ATC to mitigate windfarms provides some confidence that this may be a viable option in mitigation of the effect to the Inverness PSR.	Partial
DP4	Operational: Maintain operational resilience of the Air Traffic Control network.	Introduction of a new radar source has been successfully installed at a civilian Scottish international airport in the mitigation of one of the largest wind farms in Scotland. This	Met

		solution has been publicised by the airport as 'able to (be) capable of supporting air traffic control requirements and mitigating the impact of the turbines' and as such is considered to maintain the operational resilience of the airport with the windfarm in place.	
DP5	Environmental: Minimise environmental impacts to stakeholders on the ground.	The use of infill will not impact stakeholders on the ground as no displacement of aircraft will occur.	Met
DP6	Economic: Endeavour to minimise economic impact on aircraft operators.	Aircraft operators will not be impacted by the use of infill radar as no change to the fitment of additional equipment will be required.	Met
DP7	Technical: Base the airspace change on the latest technology available. • This technology could relate to navigation, radar enhancements or radar data processing etc. • 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.	This technology has been proven to mitigate civilian ATC PSR systems however, it has not been proven in the military ATC network of PSR. The RAF Lossiemouth Watchman PSR will be replaced under Project Marshall by a STAR NG version. The STAR NG is an S-Band PSR which has the potential to provide increased windfarm mitigation possibilities however it is not known if the STAR NG installed is able to accept an infill addition. Once the radar replacement has taken place, a potential solution could be to upgrade the STAR NG to include a 'Wind Farm Filter' which will require a software change to the new PSR. The new radar system will be assessed on an individual case-by-case basis, firstly to establish if the system can be optimised for subject targeted wind farms; followed by work to further upgrade and finally a full safety assessment, which is likely to involve a formal airborne flight	Partial

		check, a period of optimisation and acceptance by the regulator and the MOD.	

Table 9 Use of Infill Radar Evaluation

2.6.1 Use of Infill Radar Conclusion

The principle of radar infill is to find an existing radar or position a new radar where terrain screening prevents it from detecting the wind turbines while at the same time providing coverage of aircraft targets at low enough levels to be operationally satisfactory. The windfarm developer, the MOD and Inverness Airport require a high degree of certainty of a successful mitigation which infill radar may provide. Recently there has been development of a number of infill radar systems which have successfully mitigated the impact created by the detection of operational wind farms to civilian ATC PSR systems; no such solution has been applied to military airfield-based ATC PSR. This option requires a suitable site for the infill radar to be positioned, provision of power, and telecommunications links which may not be available. A new radar will itself require planning consent which may not be granted. Furthermore, it is estimated to have an upfront cost of at least £10.5m not including any land lease or utilities which may prove commercially unacceptable. It is considered that this option is not yet viable but could potentially replace an Air Traffic Control Radar Mitigation Scheme (ATCRMS).

The change sponsor considers this option to be a technical solution and outside the scope of CAP 1616, as such for the purposes of the CAP 1616, it has been rejected.

2.7 Introduction of Controlled Airspace (Class D or E) – Design Principles Evaluation

Design Principle Evaluation Option			
Introduction of Controlled Airspace (Class D or E)		**Reject**	
The introduction of Class D controlled airspace provides a known traffic environment which allows aircraft to operate under both under Visual Flight Rules (VFR) and Instrument Flight Rules (IFR). Class E controlled airspace enables flight under both IFR and VFR. IFR flights must obtain an ATC clearance before entering Class E airspace and comply with ATC instructions.			
Design Principle		**Summary of Assessment**	**Evaluation**
DP1	Safety: Ensure an acceptable level of safety for aircraft within and displaced by any proposed airspace solution.	Safety will be compromised as radar clutter presented by the detection of the Clash Gour wind turbines will still be produced onto RAF Lossiemouth and Inverness ATC radar displays leading to a loss of situational awareness by controllers and a detrimental impact to safety. However, this option would be compliant with the required technical criteria and will be consistent and compatible with the appropriate regulatory requirements.	Not Met
DP2	Operational (Resilience): Minimise negative impact on all airspace users.	Those airspace users unable or unwilling to comply with the rules required to operate in the various classes of controlled airspace will reroute around it. This will create displacement and funnelling of aircraft as aircraft reroute leading to an increased risk of mid-air collision.	Not Met
DP3	Operational: Airspace change shall have no impact on operations/capacity of airport operators and Air Navigation Service Providers (ANSPs).	The controlling authority of controlled airspace will require agreement which would lead to an increase in workload and a demand on resource for that authority. A negative impact to ANSPs will still be provided through the production of wind turbine	Not Met

		induced radar clutter overhead the location of Clash Gour.	
DP4	Operational: Maintain operational resilience of the Air Traffic Control network.	The creation of controlled airspace does not include blanking of the RAF Lossiemouth and Inverness Airport PSR systems, wind turbine induced radar clutter will still be encountered from detectability of Clash Gour leading to the lack of situational awareness, seduction of radar tracks and other radar effect mentioned earlier of previous design options. The creation of controlled airspace is not a viable solution to successfully mitigate the operational effects on RAF Lossiemouth and Inverness Airport caused by wind turbine induced clutter on the PSRs.	Not Met
DP5	Environmental: Minimise environmental impacts to stakeholders on the ground.	If controlled airspace was introduced, rerouting of aircraft not able to comply with requirements is likely to take place but is expected to be minimal. High ground to the south of Clash Gour and dependent on prevailing weather conditions, may dictate that non-compliant aircraft and those aircraft unable to fly in controlled airspace reroute to the north of Clash Gour to avoid the airspace above Clash Gour. This could potentially lead to aircraft funnelling and a subsequent increase in environmental impacts to those stakeholders on the ground.	
DP6	Economic: Endeavour to minimise economic impact on aircraft operators.	Rerouting of aircraft will create a negative impact to payloads, fuel burn and efficient routing of aircraft. Those aircraft which can be modified to meet the requirements of flying in	Not Met

		controlled airspace will attract a cost to those operators. Furthermore, controlled airspace is likely to restrict some users who are not in possession of a Radio Telephony (RT) licence.	
DP7	Technical: Base the airspace change on the latest technology available. • This technology could relate to navigation, radar enhancements or radar data processing etc. • 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.	This option does not include radar blanking of the RAF Lossiemouth and Inverness Airport PSR systems and is therefore not considered to be a viable solution to successfully mitigate the operational impact created by the radar detectability of Clash Gour.	Not Met

Table 10 Establishment of Controlled Airspace Evaluation

2.7.1 Introduction of Controlled Airspace (Class D or E) conclusion

Without the creation of controlled airspace as mitigation, Clash Gour would sit within uncontrolled Class G airspace which is established above the development to FL195 (approximately 19,500 feet above sea level). If the classification of airspace was to change as a mitigation solution of the windfarm to controlled airspace and under Class D airspace rules, ATC will separate IFR aircraft from each other. Aircraft operating Visual Meteorological Conditions (VMC) can request a VFR transit through the airspace. ATC will pass traffic information to VFR aircraft about IFR aircraft; separation between VFR and IFR traffic is based on "see and avoid".

Under Class E controlled airspace rules, VFR traffic does not require clearance to enter Class E airspace but must comply with ATC instructions (if they are under a service). Class E does not currently extend to the surface in the UK.

There is a precedent for a Class E+ airspace solution. However, there is currently no provision to deploy Class E down to surface level in the UK. Under this airspace solution, the conspicuity element would be provided by the concept of compliance with a TMZ as described in the Terminology table. Establishing controlled airspace in the region of Clash Gour will adversely impact other airspace users which are incapable of flying in controlled airspace and would potentially restrict the free flow of aircraft. A radar detrimental affect created by the detection of the Clash Gour Wind Farm would still be in place and therefore this option is rejected as not providing the required mitigation solution.

2.8 Introduction of Controlled Airspace (Class E+) – Design Principles Evaluation

Design Principle Evaluation Option 5			
Introduction of Controlled Airspace (Class E+)		**Reject**	
Class E+ controlled airspace which also includes a TMZ has already been deployed in the UK (for example to replace Class F airways).			
Design Principle		**Summary of Assessment**	**Evaluation**
DP1	Safety: Ensure an acceptable level of safety for aircraft within and displaced by any proposed airspace solution.	Safety will be compromised as radar clutter presented by the detection of the Clash Gour wind turbines will still be produced onto RAF Lossiemouth and Inverness ATC radar displays leading to a loss of situational awareness by controllers and a detrimental impact to safety. However, this option would be compliant with the required technical criteria and will be consistent and compatible with the appropriate regulatory requirements.	Not Met
DP2	Operational (Resilience): Minimise negative impact on all airspace users.	Those airspace users unable or unwilling to comply with the rules required to operate in the various classes of controlled airspace will reroute around it. This will create displacement and funnelling of aircraft as aircraft reroute leading to an increased risk of mid-air collision.	Not Met
DP3	Operational: Airspace change shall have no impact on operations/capacity of airport operators and Air Navigation Service Providers (ANSPs).	The controlling authority of controlled airspace will require agreement which would lead to an increase in workload and a demand on resource for that authority. A negative impact to ANSPs will still be provided through the production of wind turbine induced radar clutter overhead the location of Clash Gour.	Not Met

DP4	Operational: Maintain operational resilience of the Air Traffic Control network.	The creation of controlled airspace does not include blanking of the RAF Lossiemouth and Inverness Airport PSR systems, wind turbine induced radar clutter will still be encountered from detectability of Clash Gour leading to the lack of situational awareness, seduction of radar tracks and other radar effect mentioned earlier of previous design options. The creation of controlled airspace is not a viable solution to successfully mitigate the operational effects on RAF Lossiemouth and Inverness Airport caused by wind turbine induced clutter on the PSRs.	Not Met
DP5	Environmental: Minimise environmental impacts to stakeholders on the ground.	If controlled airspace was introduced, rerouting of aircraft not able to comply with requirements is likely to take place but is expected to be minimal. High ground to the south of Clash Gour and dependent on prevailing weather conditions, may dictate that non-compliant aircraft and those aircraft unable to fly in controlled airspace reroute to the north of Clash Gour to avoid the airspace above Clash Gour. This could potentially lead to aircraft funnelling and a subsequent increase in environmental impacts to those stakeholders on the ground.	Partial
DP6	Economic: Endeavour to minimise economic impact on aircraft operators.	Rerouting of aircraft will create a negative impact to payloads, fuel burn and efficient routing of aircraft. Those aircraft which can be modified to meet the requirements of flying in controlled airspace will attract a cost to those operators.	Not Met

		Furthermore, controlled airspace is likely to restrict some users who are not in possession of a Radio Telephony (RT) licence.	
DP7	Technical: Base the airspace change on the latest technology available. • This technology could relate to navigation, radar enhancements or radar data processing etc. • 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.	This option does not include radar blanking of the RAF Lossiemouth and Inverness Airport PSR systems and is therefore not considered to be a viable solution to successfully mitigate the operational impact created by the radar detectability of Clash Gour.	Not Met

Table 11 Establishment of Controlled Airspace Evaluation

2.8.1 Introduction of Controlled Airspace (Class E+) conclusion

Without the creation of controlled airspace as mitigation, Clash Gour would sit within uncontrolled Class G airspace which is established above the development to FL195 (approximately 19,500 feet above sea level).

There is a precedent for a Class E+ airspace solution. However, there is currently no provision to deploy Class E down to surface level in the UK. Under this airspace solution, the conspicuity element would be provided by the concept of compliance with a TMZ as described in the Terminology table. Establishing controlled airspace in the region of Clash Gour will adversely impact other airspace users which are incapable of flying in controlled airspace and would potentially restrict the free flow of aircraft. A radar detrimental affect created by the detection of the Clash Gour Wind Farm would still be in place and therefore this option is rejected as not providing the required mitigation solution.

2.9 Radio Mandatory Zone – Design Principles Evaluation

Design Principle Evaluation Option 6			
Radio Mandatory Zone		**Reject**	
A Radio Mandatory Zone (RMZ) would require aircraft to be in two-way communication with ATC and provide information pertinent to the flight prior to entering the designated airspace.			
Design Principle		**Summary of Assessment**	**Evaluation**
DP1	Safety: Ensure an acceptable level of safety for aircraft within and displaced by any proposed airspace solution.	Clutter created by detection of the Clash Gour wind turbines will not be removed leading to desensitisation, track seduction and degradation of the RAF Lossiemouth and Inverness PSR systems. However, this option would be compliant with the required technical criteria and will be consistent and compatible with the appropriate regulatory requirements.	Not Met
DP2	Operational (Resilience): Minimise negative impact on all airspace users.	Not all pilots are in possession of a Radio Telephony (RT) license. The Highland Gliding Club have stated that 'only about half of the glider pilots on site have an RT licence' which would preclude their (and others without an RT licence) entry to the RMZ unless approval has been granted by the controlling authority. The Deeside Gliding Club consider the area of Clash Gour a 'safe territory' for inexperienced pilots and for those without an RT licence completing cross-country flights.	Not Met
DP3	Operational: Airspace change shall have no impact on operations/capacity of airport operators and Air Navigation Service Providers (ANSPs).	RAF Lossiemouth are of the opinion that an RMZ will have 'little benefit'. A RMZ created in the airspace above the Clash Gour Wind Farm would provide a degree of situational awareness to the controller about the nature of the aviation within the airspace however, it would not prevent the generation and display of	Not Met

		false tracks with the associated loss of situational awareness.	
DP4	Operational: Maintain operational resilience of the Air Traffic Control network.	Although ATC would be able to provide some level of service to traffic in the area, it would not prevent wind turbine generated radar returns from being displayed on the radar display and has little benefit, with the effect of limiting service provision and requiring the re-routing of aircraft to avoid the clutter under specific types of radar service being provided. An RMZ also permits access to aircraft that are not transponder equipped. This makes it difficult to identify them and maintain track identity for the purposes of providing traffic information and separation.	Not Met
DP5	Environmental: Minimise environmental impacts to stakeholders on the ground.	If an RMZ was provided, rerouting of aircraft not able to comply with requirements is likely to take place. High ground to the south of Clash Gour and dependent on prevailing weather conditions, may dictate that non-compliant aircraft reroute to the north of Clash Gour to avoid the RMZ. This could potentially lead to aircraft funnelling and a subsequent increase in environmental impacts to those stakeholders on the ground.	
DP6	Economic: Endeavour to minimise economic impact on aircraft operators.	Where applicable, financial outlay in both the acquisition of RT license and radio equipment will be required if the basic requirements of an RMZ are to be met by aircrews.	Not Met
DP7	Technical: Base the airspace change on the latest technology available. • This technology could relate to navigation, radar	An RMZ would allow an increased amount of protection for ATC RAF Lossiemouth and Inverness Airport however, radar clutter presented by the	Not Met

	enhancements or radar data processing etc. • 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.	detection of the Clash Gour wind turbines would still be produced onto ATC radar displays at the two airfields which would negate any benefit an RMZ may bring as radar contact would likely to be lost within the clutter produced.	

Table 12 Radio Mandatory Zone Evaluation

2.9.1 Radio Mandatory Zone conclusions

A RMZ is an area of defined dimensions within which a pilot must be in two-way communication with the airspace owner, prior to entry. Pilots must also provide information pertinent to the flight, for example, route required and altitude/height. A RMZ created in the airspace above the Development Areas would provide a degree of situational awareness to the controller about the nature of the aviation within the airspace. Although ATC would be able to provide some level of service to aviation operating within the RMZ, it would not prevent the generation and display of false tracks/clutter created from the radar detection of Clash Gour with the associated loss of situational awareness to air traffic controllers. An RMZ carries no requirement to operate a transponder in the airspace and no requirement to identify aircraft operating in the RMZ. This mitigation does not go far enough to reduce the risk of collision, as ATC would potentially not detect all aircraft within the clutter and would not be able to provide any prescribed separation between aircraft. For these reasons it is considered that this option is not a viable mitigation solution as it provides insufficient mitigation for the operational effects caused by wind turbine induced clutter on radar.

2.10 Design Option 7: Range Azimuth Gating (RAG) blanking and Transponder Mandatory Zone (TMZ)

2.10.1 Explanation

Clash Gour consists of three distinct areas where wind turbines will be placed. These three areas surround the Berry Burn Wind Farm which consists of 29 wind turbines and has been operational since 2014. An application was submitted to extend the Berry Burn Wind Farm consisting of an additional nine wind turbines. This Extension, known as Berry Burn 2 was consented by Ministers of the Scottish Government in December 2021.

It would be difficult for a pilot to make a visual distinction between the Clash Gour and Berry Burn and Berry Burn 2 Wind Farm wind turbines. Therefore, from an airspace user's visual perspective and the physical locality of Berry Burn and Berry Burn 2 to Clash Gour, CGH consider that if mitigation involves a change to local airspace arrangements, then it is simpler to encompass all of the wind turbines of Clash Gour, Berry Burn and Berry Burn 2 within a single airspace boundary, rather than three individual TMZs surrounding the Clash Gour arrays areas. The benefit of a single airspace boundary rather than consideration of three individual TMZ areas over the three distinct areas of array development for Clash Gour is that a single array boundary would produce a regularly shaped TMZ which will make it easier to define from the air and would be simpler for air traffic controllers to display on their respective RDDS and monitor. The perception and benefit of a single airspace boundary encompassing Clash Gour and Berry Burn/Berry Burn 2 is considered in all the options for design and implementation of a TMZ which will measure Proposed TMZ, (excluding a 2 NM buffer), 4.32 NM west to east, and 3.24 NM north to south.

Option 7 falls into six possibilities of implementation:

A. RAG blanking of the RAF Lossiemouth and Inverness Airport PSRs.
B. TMZ (without RAG blanking) over the windfarm array locations.
C. RAG blanking and TMZ over the proposed windfarm array locations.
D. RAG blanking and TMZ over the proposed windfarm array locations. TMZ extended to include a 2 NM buffer.
E. RAG blanking over the proposed windfarm array locations. Simplified polygon TMZ 'rubber banded[2]' around the proposed windfarm locations with no buffer.
F. RAG blanking over the proposed windfarm array locations. Simplified polygon TMZ 'rubber banded' around the proposed wind farm locations extended to include a 2 NM buffer.

Option 7 has been divided into six sub-options. For clarity, each of the sub-options has been evaluated against the DPs on an individual basis.

[2] Rubber banded - shortest perimeter fully enclosing the wind farm development. It is used to smooth an irregular perimeter.

2.11 RAG blanking of the RAF Lossiemouth and Inverness Airport Primary Surveillance Radar Systems – Evaluation

Design Principle Evaluation Option 7A			
Introduction of RAG onto the Lossiemouth and Inverness Airport PSRs		**Reject**	
Introduction of RAG blanking in the area of the radar above Clash Gour which would remove the Clash Gour wind turbine induced radar clutter from showing on radar displays.			
Design Principle		**Summary of Assessment**	**Evaluation**
DP1	Safety: Ensure an acceptable level of safety for aircraft within and displaced by any proposed airspace solution.	Radar clutter would be removed in the radar cells subject to RAG blanking however, all radar contacts including those from aircraft will also be removed in the cells subject to RAG. This would have a detrimental impact on ATC surveillance and aviation safety as a full 'air picture' would not be provided to air traffic controllers. However, this option would be compliant with the required technical criteria and will be consistent and compatible with the appropriate regulatory requirements.	Not Met
DP2	Operational (Resilience): Minimise negative impact on all airspace users.	No ATC radar surveillance capability would be available from RAF Lossiemouth or Inverness Airport in the airspace above and surrounding the Clash Gour Wind Farm to aviators requesting it.	Not Met
DP3	Operational: Airspace change shall have no impact on operations/capacity of airport operators and Air Navigation Service Providers (ANSPs).	The deliberate blanking of fixed areas on the radar display ensures that clutter caused by the wind turbine development is not presented to the controller. An ATC radar service in the region of the Clash Gour Wind Farm is provided below a certain flight level by RAF Lossiemouth and Inverness. A degraded level of radar service available from the two ANSPs	Not Met

		will be experienced in the area surrounding the Clash Gour Wind Farm due to radar blanking leading to an increased level of mid-air collision.	
DP4	Operational: Maintain operational resilience of the Air Traffic Control network.	The presence of the blanked area will be close and just south of the extended centreline of Runway 05 at RAF Lossiemouth which will unacceptably impact both aircraft recoveries to that runway together with departures from Runway 23. Furthermore, a radar based ATS will not be available to pilots requesting it in the area of Clash Gour. Blanking of the Inverness PSR will also adversely impact radar capability provided by the airport, especially during the hours that RAF Lossiemouth is closed, and the Inverness ATC area of operation is extended.	Not Met
DP5	Environmental: Minimise environmental impacts to stakeholders on the ground.	If a TMZ was provided, rerouting of aircraft not able to comply with requirements is likely to take place, however, this is expected to be minimal. High ground to the south of Clash Gour and dependent on prevailing weather conditions, may dictate that non-compliant aircraft reroute to the north of Clash Gour to avoid the TMZ. This could potentially lead to aircraft funnelling and a subsequent increase in environmental impacts to those stakeholders on the ground.	Not Met
DP6	Economic: Endeavour to minimise economic impact on aircraft operators.	Rerouting of aircraft will create a negative impact to payloads, fuel burn and efficient routing of aircraft with an associated negative economic impact to aircraft operators.	Not Met

DP7	Technical: Base the airspace change on the latest technology available. • This technology could relate to navigation, radar enhancements or radar data processing etc. • 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.	RAG, commonly referred to as RAG blanking, can be fitted to radar systems when local clutter conditions are considered detrimental to the provision of a radar service by ATC. However, RAG blanking will also remove primary radar returns from the area of the RAG; hence, in isolation it would not provide sufficient mitigation.	Not Met

Table 13 RAG Blanking of the RAF Lossiemouth and Inverness Airport Evaluation

2.11.1 RAG Blanking of the RAF Lossiemouth and Inverness Airport PSRs conclusion

Range Azimuth Gating involves blanking the clutter (created by the detection of the Clash Gour wind turbines on a PSR) from showing on radar displays. It blanks the area of the source of clutter on the Radar Data Display Screen (RDDS) and removes it from the controller's display. This means that, within the area of the RAG the PSR will not detect any primary radar contacts (from wind turbines, aircraft or other contacts).

Blanking of the RAF Lossiemouth and Inverness Airport PSR systems without an associated TMZ is not considered a viable option for mitigation. RAG blanking effectively creates a 'black hole' in the radar coverage overhead the windfarm location in which no primary radar returns would be created and therefore the use of RAG blanking in isolation will not provide the required mitigation.

2.12 TMZ (without RAG blanking) over the windfarm array locations – Evaluation

Design Principle Evaluation Option 7B		
Introduction of a TMZ without the use of RAG blanking on the RAF Lossiemouth and Inverness PSR systems		**Reject**
Placement of a TMZ over the windfarm areas without the use of RAG blanking to remove associated wind turbine induced radar clutter from RAF Lossiemouth and Inverness ATC displays.		
Design Principle		**Summary of Assessment**	**Evaluation**
DP1	Safety: Ensure an acceptable level of safety for aircraft within and displaced by any proposed airspace solution.	Without the use of RAG blanking applied to the TMZ area, wind turbine induced primary radar clutter will negatively affect the degree, accuracy and timeliness of the instructions, advice and information a controller is able to provide to pilots within the TMZ, with consequent impacts on safety. However, this option would be compliant with the required technical criteria and will be consistent and compatible with the appropriate regulatory requirements.	Not Met
DP2	Operational (Resilience): Minimise negative impact on all airspace users.	A TMZ without blanking will not remove the radar clutter associated with the detection of the Clash Gour wind turbines. Dependent on the level of ATS being provided, ATC may request the re-routing of aircraft around the radar clutter in order to maintain a safe radar service.	Not Met
DP3	Operational: Airspace change shall have no impact on operations/capacity of airport operators and Air Navigation Service Providers (ANSPs).	There will be an increase in controller workload, resultant radar clutter will result in poor radar performance as a result of processing saturation and desensitisation or shadowing, resulting in loss of radar detection of aircraft within the vicinity of the TMZ leading to a negative safety impact in the operational provision of an	Not Met

		ATS by RAF Lossiemouth and Inverness.	
DP4	Operational: Maintain operational resilience of the Air Traffic Control network.	Clutter produced by the windfarm would reduce the flexibility of the ANSPs within their Area of Responsibility (AOR) as aircraft (dependent on radar service being provided) are offered a route to avoid the clutter leading to delays, increased fuel burn and in the case of RAF Lossiemouth, limitation of radar approaches to a northerly feed to Runway 05 to avoid the area of clutter.	Not Met
DP5	Environmental: Minimise environmental impacts to stakeholders on the ground.	Re-routing of aircraft to avoid the area of clutter will increase traffic flow above certain areas leading to an increase in environmental affect to stakeholders on the ground.	Not Met
DP6	Economic: Endeavour to minimise economic impact on aircraft operators.	Not all aircraft are equipped with a transponder however, a procedure will be in place and managed by the controlling authority to enable non-transponding aircraft to enter and transit the TMZ. However, without the removal of clutter, a loss in reduction of ATS and the potential of a re-route of aircraft in avoidance of the clutter remains a possibility leading to increased controller and aircrew workload and a decrease in the effective and efficient use of available airspace.	Not Met
DP7	Technical: Base the airspace change on the latest technology available. • This technology could relate to navigation, radar enhancements or radar data processing etc. • The volume of airspace affected should be the minimum necessary to deliver requirements,	The mitigation of a TMZ alone without radar blanking will not provide the required robust mitigation solution of the windfarm; radar clutter and the potential for radar desensitisation, shadowing and the appearance of false targets associated with the detection	Not Met

	whilst providing optimal safety buffer. • Seek to create simple, easily definable solution.	of wind turbines will still occur.	

Table 14 TMZ (without RAG blanking) over the windfarm array locations Evaluation

2.12.1 TMZ over the proposed windfarm array locations conclusions.

The objective of establishing a TMZ, which will be the minimum TMZ cover required to restrict non-transponder equipped aircraft overflying the Development Area, is not to prevent aircraft from operating near the wind turbines, merely to require that they operate a transponder when entering the TMZ. A TMZ alone (without the removal of wind turbine clutter through blanking) will not provide sufficient mitigation as demanded by the expected conditions which will be associated with development consent. For these reasons, the TMZ only option is considered insufficient in providing the required mitigation and is not considered a viable option for mitigation.

2.13 RAG blanking and TMZ over the proposed windfarm array locations - Evaluation

Design Principle Evaluation Option 7C			
RAG blanking and TMZ over the proposed windfarm array locations		**Accept**	
Placement of a TMZ over the windfarm array locations including the use of RAG blanking to remove associated wind turbine induced radar clutter from RAF Lossiemouth and Inverness ATC displays but without a buffer.			
Design Principle		**Summary of Assessment**	**Evaluation**
DP1	Safety: Ensure an acceptable level of safety for aircraft within and displaced by any proposed airspace solution.	The provision of RAG blanking applied to the TMZ area allows for any wind turbine induced primary radar clutter to be reduced meaning that there is a reduced effect on the instructions, advice and information a controller can provide to pilots within the TMZ. Therefore, safety is unlikely to be compromised. The controlling authority may wish to introduce a procedure that enables non-transponder equipped aircraft to transit through the TMZ, thus reducing the risk of aircraft without a transponder entering the TMZ without the knowledge of controllers. This option will be compliant with the required technical criteria and will be consistent and compatible with the appropriate regulatory requirements.	Met
DP2	Operational (Resilience): Minimise negative impact on all airspace users.	A TMZ with RAG blanking will remove the radar clutter associated with the detection of the Clash Gour wind turbines. Dependent on the level of ATS being provided, it is therefore unlikely that ATC would require aircraft to re-route around the wind farm on the assumption that said aircraft are fitted with a transponder. For those that are not equipped with a	Partial

		transponder, the controlling authority may develop a procedure which will still allow non-transponder equipped aircraft to transit the TMZ. Given the size of the proposed TMZ, any re-routing required for aircraft that are not equipped with a transponder and are not in radio contact with ATC would be minimal. Having said that, the complex design of the TMZ boundaries may also lead to increased complexity and workload for pilots.	
DP3	Operational: Airspace change shall have no impact on operations/capacity of airport operators and Air Navigation Service Providers (ANSPs).	The provision of a TMZ accompanied by a RAG blanking solution would reduce the amount of radar clutter visible on a controller's radar screen, which in turn minimises the controller's workload. It is acknowledged that any procedure introduced to manage aircraft that are not equipped with a transponder would have a very minor impact on controller workload. Furthermore, it is acknowledged that there may be an impact to IFR arrivals/departures at Lossiemouth. Further work in Stage 3 and 4 of the CAP 1616 process will be required to confirm this. This is also applicable to understanding whether Wide Area Multilateration (WAM) will be affected, as this level of information is currently unknown as it is not yet in service. In addition, the complex geographic dimensions of this option would make it more complex for controllers to manage, potentially leading to a minor increase in workload.	Partial

DP4	Operational: Maintain operational resilience of the Air Traffic Control network.	It is anticipated that a solution involving a TMZ, and RAG blanking would mitigate primary radar clutter appearing on controller's radar screens, which is expected to maintain the level of flexibility experienced by ANSPs today. However, at this stage it is not possible to determine whether IFR arrivals/departures at Lossiemouth would require re-routing which would have an impact on capacity, workload and fuel burn, particularly for RW05 operations.	Partial
DP5	Environmental: Minimise environmental impacts to stakeholders on the ground.	If a TMZ was provided, rerouting of aircraft not able to comply with requirements is likely to take place, however, this is expected to be minimal. High ground to the south of Clash Gour and dependent on prevailing weather conditions, may dictate that non-compliant aircraft reroute to the north of Clash Gour to avoid the TMZ. This could potentially lead to aircraft funnelling and a subsequent increase in environmental impacts to those stakeholders on the ground.	Met
DP6	Economic: Endeavour to minimise economic impact on aircraft operators.	The provision of a TMZ with a RAG blanking solution in place would mean that, assuming participating aircraft are equipped with a transponder, no re-routing would be required, leading to no additional economic impact to aircraft operators. The controlling authority may introduce an appropriate procedure to allow aircraft without a transponder to enter the TMZ. Given the size of the proposed TMZ, any re-routing required for aircraft that are not equipped with a	Met

		transponder and are not in radio contact with ATC would be minimal.	
DP7	Technical: Base the airspace change on the latest technology available. • This technology could relate to navigation, radar enhancements or radar data processing etc. • 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.	The mitigation of RAG blanking and a TMZ will provide appropriate level of mitigation for the wind farm. However, this solution does not make use of an additional buffer zone, which may result in non-transponder equipped aircraft disappearing from radar screens if it entered the RAG blanking area. In addition, this option is a complex geographical shape which may make it more complex to manage.	Partial

Table 15 RAG blanking and TMZ over the proposed windfarm array locations Evaluation

2.13.1 TMZ over the windfarm array locations including the use of RAG blanking conclusions

The combination of a TMZ and RAG blanking means that this solution reduces the amount of primary radar clutter visible to controllers at Inverness and Lossiemouth. The main objective of this option is to provide a known traffic picture within the immediate vicinity of the wind farm through the use of aircraft transponders. Additional procedural mitigation may be developed by the controlling authority to allow aircraft that are not fitted with a transponder to transit through the airspace. Stakeholder engagement has also identified that additional work to assess the impact of a TMZ on IFR traffic operating into/from Lossiemouth may be required in subsequent stages of the CAP 1616 process. This is also applicable to any possible impact on WAM, which has not yet been introduced. Furthermore, this design option provides a more complex TMZ layout which may have a minor impact on controller and pilot workload.

2.14 RAG blanking and TMZ over the proposed windfarm array locations. TMZ extended to include a 2 NM buffer

Design Principle Evaluation Option 7D			
RAG blanking and TMZ over the proposed windfarm array locations. TMZ extended to include a 2 NM buffer.		**Accept**	
Placement of a TMZ over the windfarm array locations including the use of RAG blanking to remove associated wind turbine induced radar clutter from RAF Lossiemouth and Inverness ATC displays with a 2 NM buffer.			
Design Principle		**Summary of Assessment**	**Evaluation**
DP1	Safety: Ensure an acceptable level of safety for aircraft within and displaced by any proposed airspace solution.	The provision of RAG blanking applied to the TMZ area allows for any wind turbine induced primary radar clutter to be reduced meaning that there is a reduced effect on the instructions, advice and information a controller can provide to pilots within the TMZ. This options also provides an additional 2 NM buffer which further enhances the safety benefits of the TMZ and RAG blanking. Therefore, safety is unlikely to be compromised. The controlling authority may wish to introduce a procedure that enables non-transponder equipped aircraft to transit through the TMZ, thus reducing the risk of aircraft without a transponder entering the TMZ without the knowledge of controllers. This option will be compliant with the required technical criteria and will be consistent and compatible with the appropriate regulatory requirements.	Met
DP2	Operational (Resilience): Minimise negative impact on all airspace users.	A TMZ with RAG blanking will remove the radar clutter associated with the detection of the Clash Gour wind turbines. Dependent on the level of ATS being provided, it	Partial

		is therefore unlikely that ATC would require aircraft to re-route around the wind farm on the assumption that said aircraft are fitted with a transponder. For those that are not equipped with a transponder, the controlling authority may develop a procedure which will still allow non-transponder equipped aircraft to transit the TMZ. However, should aircraft be required to fly around the TMZ due to the larger area covered once the buffer is considered, aircraft would be required to fly a greater distance around the TMZ and associated buffer, increased track length and fuel burn. In addition, the geographic layout of this option also adds an element of complexity for both controllers and airspace users alike.	
DP3	Operational: Airspace change shall have no impact on operations/capacity of airport operators and Air Navigation Service Providers (ANSPs).	The provision of a TMZ accompanied by a RAG blanking solution and a safety buffer would reduce the amount of radar clutter visible on a controller's radar screen, which in turn minimises the controller's workload. It is acknowledged that any procedure introduced to manage aircraft that are not equipped with a transponder would have a very minor impact on controller workload. Furthermore, it is acknowledged that there may be an impact to IFR arrivals/departures at Lossiemouth. As this option includes an additional buffer, there is an operational benefit to Lossiemouth as it provides a greater level of traffic certainty and the required warning/data processing time. Further work	Partial

		in Stage 3 and 4 of the CAP 1616 process will be required to confirm this. This is also applicable to understanding whether WAM will be affected, as this level of information is currently unknown as it is not yet in service. In addition, the complex geographic dimensions of this option would make it more complex for controllers to manage, potentially leading to a minor increase in workload.	
DP4	Operational: Maintain operational resilience of the Air Traffic Control network.	It is anticipated that a solution involving a TMZ, RAG blanking and a buffer would mitigate primary radar clutter appearing on controller's radar screens, which is expected to maintain the level of flexibility experienced by ANSPs today. However, at this stage it is not possible to determine whether IFR arrivals/departures at Lossiemouth would require re-routing which would have an impact on capacity, workload and fuel burn, particularly for RW05 operations. Having said that, the additional buffer would provide additional warning/processing time to the controller if a non-participating aircraft was to enter the TMZ.	Partial
DP5	Environmental: Minimise environmental impacts to stakeholders on the ground.	If a TMZ was provided, rerouting of aircraft not able to comply with requirements is likely to take place, however, this is expected to be minimal. High ground to the south of Clash Gour and dependent on prevailing weather conditions, may dictate that non-compliant aircraft reroute to the north of Clash Gour to avoid the TMZ. This could potentially lead to aircraft funnelling and a subsequent increase in	Partial

		environmental impacts to those stakeholders on the ground.	
DP6	Economic: Endeavour to minimise economic impact on aircraft operators.	The provision of a TMZ with a RAG blanking solution and buffer in place would mean that, assuming participating aircraft are equipped with a transponder, no re-routing would be required, leading to no additional economic impact to aircraft operators. The controlling authority may introduce an appropriate procedure to allow aircraft without a transponder to enter the TMZ. However, a non-participating aircraft may be required to route around the TMZ and associated buffer zone, leading to increased track length, fuel burn and therefore fuel costs.	Partial
DP7	Technical: Base the airspace change on the latest technology available. • This technology could relate to navigation, radar enhancements or radar data processing etc. • 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.	The mitigation of RAG blanking and a TMZ with a buffer will provide appropriate level of mitigation for the wind farm. However, this option is a complex geographical shape which may make it more complex to manage.	Partial

Table 16 RAG blanking and TMZ over the proposed windfarm array locations. TMZ extended to include a 2 NM buffer Evaluation

2.14.1 RAG blanking and TMZ over the proposed windfarm array locations. TMZ extended to including a 2 NM buffer conclusions

The combination of a TMZ, RAG blanking and a buffer means that this solution reduces the amount of primary radar clutter visible to controllers at Inverness and Lossiemouth. The main objective of this option is to provide a known traffic picture within the immediate and wider vicinity of the wind farm through the use of aircraft

transponders. Additional procedural mitigation may be developed by the controlling authority to allow aircraft that are not fitted with a transponder to transit through the airspace. It is acknowledged that should an appropriate procedure be unavailable, any non-participating aircraft would be required to route around the TMZ, leading to increased track length, fuel burn and fuel costs. Stakeholder engagement has also identified that additional work to assess the impact of a TMZ on IFR traffic operating into/from Lossiemouth may be required in subsequent stages of the CAP 1616 process. This is also applicable to any possible impact on WAM, which has not yet been introduced. On the other hand, the buffer element of this option offers an additional mitigation as it provides controllers with additional warning/processing time, should a non-participating aircraft enter the TMZ. Furthermore, this design option provides a more complex TMZ layout which may have a minor impact on controller and pilot workload.

2.15 RAG blanking over the proposed windfarm array locations. Simplified polygon TMZ 'rubber banded' around the proposed windfarm locations with no buffer.

Design Principle Evaluation Option 7E			
RAG blanking over the proposed windfarm array locations. Simplified polygon TMZ 'rubber banded' around the proposed windfarm locations with no buffer.		**Accept**	
Placement of a TMZ over the windfarm area (simplified shape) including the use of RAG blanking to remove associated wind turbine induced radar clutter from RAF Lossiemouth and Inverness ATC displays.			
Design Principle		**Summary of Assessment**	**Evaluation**
DP1	Safety: Ensure an acceptable level of safety for aircraft within and displaced by any proposed airspace solution.	The provision of RAG blanking applied to the TMZ area allows for any wind turbine induced primary radar clutter to be reduced meaning that there is a reduced effect on the instructions, advice and information a controller can provide to pilots within the TMZ. Therefore, safety and expedition are unlikely to be compromised. The controlling authority may wish to introduce a procedure that enables non-transponder equipped aircraft to transit through the TMZ, thus reducing the risk of aircraft without a transponder entering the TMZ without the knowledge of controllers. This option will be compliant with the required technical criteria and will be consistent and compatible with the appropriate regulatory requirements.	Met
DP2	Operational (Resilience): Minimise negative impact on all airspace users.	A TMZ with RAG blanking will remove the radar clutter associated with the detection of the Clash Gour wind turbines. Dependent on the level of ATS being provided, it is therefore unlikely that ATC would require aircraft to re-	Met

		route around the wind farm on the assumption that said aircraft are fitted with a transponder. For those that are not equipped with a transponder, the controlling authority may develop a procedure which will still allow non-transponder equipped aircraft to transit the TMZ. Given the size of the proposed TMZ, any re-routing required for aircraft that are not equipped with a transponder and are not in radio contact with ATC would be minimal.	
DP3	Operational: Airspace change shall have no impact on operations/capacity of airport operators and Air Navigation Service Providers (ANSPs).	The provision of a TMZ accompanied by a RAG blanking solution would reduce the amount of radar clutter visible on a controller's radar screen, which in turn minimises the controller's workload. It is acknowledged that any procedure introduced to manage aircraft that are not equipped with a transponder would have a very minor impact on controller workload. Furthermore, it is acknowledged that there may be an impact to IFR arrivals/departures at Lossiemouth. Further work in Stage 3 and 4 of the CAP 1616 process will be required to confirm this. This is also applicable to understanding whether WAM will be affected, as this level of information is currently unknown as it is not yet in service. In addition, the complex geographic dimensions of this option would make it more complex for controllers to manage, potentially leading to a minor increase in workload.	Partial

DP4	Operational: Maintain operational resilience of the Air Traffic Control network.	It is anticipated that a solution involving a TMZ, and RAG blanking would mitigate primary radar clutter appearing on controller's radar screens, which is expected to maintain the level of flexibility experienced by ANSPs today. However, at this stage it is not possible to determine whether IFR arrivals/departures at Lossiemouth would require re-routing which would have an impact on capacity, workload and fuel burn, particularly for RW05 operations.	Partial
DP5	Environmental: Minimise environmental impacts to stakeholders on the ground.	If an TMZ was provided, rerouting of aircraft not able to comply with requirements is likely to take place, however, this is expected to be minimal. High ground to the south of Clash Gour and dependent on prevailing weather conditions, may dictate that non-compliant aircraft reroute to the north of Clash Gour to avoid the TMZ. This could potentially lead to aircraft funnelling and a subsequent increase in environmental impacts to those stakeholders on the ground.	Partial
DP6	Economic: Endeavour to minimise economic impact on aircraft operators.	The provision of a TMZ with a RAG blanking solution in place would mean that, assuming participating aircraft are equipped with a transponder, no re-routing would be required, leading to no additional economic impact to aircraft operators. The controlling authority may introduce an appropriate procedure to allow aircraft without a transponder to enter the TMZ.	Met
DP7	Technical: Base the airspace change on the latest technology available.	The mitigation of RAG blanking and a TMZ will provide appropriate level of mitigation	Partial

	• This technology could relate to navigation, radar enhancements or radar data processing etc. • 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.	for the wind farm. However, this solution does not make use of an additional buffer zone, which may result in non-transponder equipped aircraft disappearing from radar screens if it entered the RAG blanking area. Furthermore, this option includes a simplified design which can easily be understood and interpreted by both controllers and pilots alike.	

Table 17 RAG blanking over the proposed windfarm array locations. Simplified polygon TMZ 'rubber banded' around the proposed windfarm locations with no buffer Evaluation

2.15.1 RAG blanking over the proposed windfarm array locations. Simplified polygon TMZ 'rubber banded' around the proposed windfarm locations with no buffer conclusions

The combination of a TMZ, RAG blanking means that this solution reduces the amount of primary radar clutter visible to controllers at Inverness and Lossiemouth. The main objective of this option is to provide a known traffic picture within the immediate vicinity of the wind farm through the use of aircraft transponders. Additional procedural mitigation may be developed by the controlling authority to allow aircraft that are not fitted with a transponder to transit through the airspace. It is acknowledged that should an appropriate procedure be unavailable, any non-participating aircraft would be required to route around the TMZ, leading to increased track length, fuel burn and fuel costs. Stakeholder engagement has also identified that additional work to assess the impact of a TMZ on IFR traffic operating into/from Lossiemouth may be required in subsequent stages of the CAP 1616 process. This is also applicable to any possible impact on WAM, which has not yet been introduced. Furthermore, this design option provides a more complex TMZ layout which may have a minor impact on controller and pilot workload.

2.16 RAG blanking over the proposed windfarm array locations. Simplified polygon TMZ 'rubber banded' around the proposed wind farm locations extended to include a 2 NM buffer

Design Principle Evaluation Option 7F			
RAG blanking over the proposed windfarm array locations. Simplified polygon TMZ 'rubber banded' around the proposed wind farm locations extended to include a 2 NM buffer.		**Accept**	
Placement of a TMZ over the windfarm area (simplified shape) including the use of RAG blanking to remove associated wind turbine induced radar clutter from RAF Lossiemouth and Inverness ATC displays with a 2 NM buffer.			
Design Principle		**Summary of Assessment**	**Evaluation**
DP1	Safety: Ensure an acceptable level of safety for aircraft within and displaced by any proposed airspace solution.	The provision of RAG blanking applied to the TMZ area allows for any wind turbine induced primary radar clutter to be reduced meaning that there is a reduced effect on the instructions, advice and information a controller can provide to pilots within the TMZ. This options also provides an additional 2 NM buffer which further enhances the safety benefits of the TMZ and RAG blanking. Therefore, safety and expedition are unlikely to be compromised. The controlling authority may wish to introduce a procedure that enables non-transponder equipped aircraft to transit through the TMZ, thus reducing the risk of aircraft without a transponder entering the TMZ without the knowledge of controllers. This option will be compliant with the required technical criteria and will be consistent and compatible with the appropriate regulatory requirements.	Met

DP2	Operational (Resilience): Minimise negative impact on all airspace users.	A TMZ with RAG blanking and a buffer will remove the radar clutter associated with the detection of the Clash Gour wind turbines. Dependent on the level of ATS being provided, it is therefore unlikely that ATC would require aircraft to re-route around the wind farm on the assumption that said aircraft are fitted with a transponder. For those that are not equipped with a transponder, the controlling authority may develop a procedure which will still allow non-transponder equipped aircraft to transit the TMZ. However, should aircraft be required to fly around the TMZ due to the larger area covered once the buffer is considered, aircraft would be required to fly a greater distance around the TMZ and associated buffer, increased track length and fuel burn.	Partial
DP3	Operational: Airspace change shall have no impact on operations/capacity of airport operators and Air Navigation Service Providers (ANSPs).	The provision of a TMZ accompanied by a RAG blanking solution and a safety buffer would reduce the amount of radar clutter visible on a controller's radar screen, which in turn minimises the controller's workload. It is acknowledged that any procedure introduced to manage aircraft that are not equipped with a transponder would have a very minor impact on controller workload. Furthermore, it is acknowledged that there may be an impact to IFR arrivals/departures at Lossiemouth. As this option includes an additional buffer, there is an operational benefit to Lossiemouth as it provides a greater level of traffic certainty and the required warning/data	Partial

		processing time. Further work in Stage 3 and 4 of the CAP 1616 process will be required to confirm this. This is also applicable to understanding whether WAM will be affected, as this level of information is currently unknown as it is not yet in service.	
DP4	Operational: Maintain operational resilience of the Air Traffic Control network.	It is anticipated that a solution involving a TMZ, RAG blanking and a buffer would mitigate primary radar clutter appearing on controller's radar screens, which is expected to maintain the level of flexibility experienced by ANSPs today. However, at this stage it is not possible to determine whether IFR arrivals/departures at Lossiemouth would require re-routing which would have an impact on capacity, workload and fuel burn, particularly for RW05 operations. Having said that, the additional buffer would provide additional warning/processing time to the controller if a non-participating aircraft was to enter the TMZ.	Partial
DP5	Environmental: Minimise environmental impacts to stakeholders on the ground.	If an TMZ was provided, rerouting of aircraft not able to comply with requirements is likely to take place, however, this is expected to be minimal. High ground to the south of Clash Gour and dependent on prevailing weather conditions, may dictate that non-compliant aircraft reroute to the north of Clash Gour to avoid the TMZ. This could potentially lead to aircraft funnelling and a subsequent increase in environmental impacts to those stakeholders on the ground.	Partial

DP6	Economic: Endeavour to minimise economic impact on aircraft operators.	The provision of a TMZ with a RAG blanking solution and buffer in place would mean that, assuming participating aircraft are equipped with a transponder, no re-routing would be required, leading to no additional economic impact to aircraft operators. The controlling authority may introduce an appropriate procedure to allow aircraft without a transponder to enter the TMZ. However, a non-participating aircraft may be required to route around the TMZ and associated buffer zone, leading to increased track length, fuel burn and therefore fuel costs.	Partial
DP7	Technical: Base the airspace change on the latest technology available. • This technology could relate to navigation, radar enhancements or radar data processing etc. • 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.	The mitigation of RAG blanking and a TMZ with a buffer will provide appropriate level of mitigation for the wind farm. Furthermore, this option includes a simplified design which can easily be understood and interpreted by both controllers and pilots alike.	Met

Table 18 RAG blanking over the proposed windfarm array locations. Simplified polygon TMZ 'rubber banded' around the proposed wind farm locations extended to include a 2 NM buffer Evaluation

2.16.1 RAG blanking over the proposed windfarm array locations. Simplified polygon TMZ 'rubber banded' around the proposed wind farm locations extended to include 2 NM buffer conclusions

The combination of a TMZ, RAG blanking and a buffer means that this solution reduces the amount of primary radar clutter visible to controllers at Inverness and Lossiemouth. The main objective of this option is to provide a known traffic picture within the immediate and wider vicinity of the wind farm through the use of aircraft transponders. Additional procedural mitigation may be developed by the controlling authority to allow aircraft that are not fitted with a transponder to transit through the airspace. It is acknowledged that should an appropriate procedure be unavailable, any non-participating aircraft would be required to route around the TMZ, leading to increased track length, fuel burn and fuel costs. Stakeholder engagement has also identified that additional work to assess the impact of a TMZ on IFR traffic operating into/from Lossiemouth may be required in subsequent stages of the CAP 1616 process. This is also applicable to any possible impact on WAM, which has not yet been introduced. On the other hand, the buffer element of this option offers an additional mitigation as it provides controllers with additional warning/processing time, should a non-participating aircraft enter the TMZ. Furthermore, this design option provides a simpler geographical layout which can be easily interpreted by controllers and pilots a like.

3 DPE Outcome

3.1 Conclusion

The change sponsor has conducted the DPE by assessing each of the proposed design options within the Suitable List against the DPs produced during Stage 1 of the CAP 1616 process. This was completed based on the required format detailed within CAP 1616.

Table 19 below outlines the result of each option within the DPE.

Option	DPE Outcome
Option 0	Reject – To be carried forward for comparison purposes only.
Option 1	Reject
Option 2	Reject
Option 3	Reject
Option 4	Reject
Option 5	Reject
Option 6	Reject
Option 7A	Reject
Option 7B	Reject
Option 7C	Accept
Option 7D	Accept
Option 7E	Accept
Option 7F	Accept

Table 19 DPE Outcome Summary

It has been established that the remaining viable options involves the establishment of a TMZ of varying degrees.

3.2 Comprehensive List of Viable Options

Following the completion of the DPE, the sponsor is able to construct a Comprehensive List of Viable Options. This list shall be carried forward into Step 2B of the CAP 1616 ACP process which is the Initial Options Appraisal (IOA).

The Comprehensive List of Viable Options includes:

- Option 7C – TMZ over the windfarm array locations including the use of RAG blanking.
- Option 7D – RAG blanking and TMZ over the proposed windfarm array locations. TMZ extended to include a 2 NM buffer.
- Option 7E – RAG blanking over the proposed windfarm array locations. Simplified polygon TMZ 'rubber banded' around the proposed windfarm locations with no buffer.
- Option 7F – RAG blanking over the proposed windfarm array locations. Simplified polygon TMZ 'rubber banded' around the proposed wind farm locations extended to include 2 NM buffer.

Please note that although it has been rejected in the DPE, the Do-Nothing option shall be taken forward into the IOA for comparative purposes only as the baseline scenario.

3.3 Next Steps

The options contained within the Comprehensive List of Viable Options shall progress into Step 2B of the CAP 1616 process, the IOA. At this step, design options are assessed against a defined baseline with specific reference to pre-determined categories which are specified in CAP 1616, Appendix E, Table E2.