



Safety Case Part 1 – Safety Requirements

Clash Gour Airspace Change Proposal

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1 Introduction

1.1 Background

EDF Energy Renewables Ltd (EDFER) and Force 9 Energy (Force9) are jointly proposing the Clash Gour Wind Farm development, the site of which is located approximately 12 nautical miles (NM) southwest of Royal Air Force (RAF) Lossiemouth and 15 NM southeast of Inverness Airport.

As part of a scheme for mitigation of the predicted wind turbine effects on RAF Lossiemouth and Inverness Airport Primary Surveillance Radars (PSR), EDFER and Force9 are progressing with an Airspace Change Proposal (ACP) in accordance with Civil Aviation Authority (CAA) Civil Aviation Publication CAP1616 [Ref. 01]. This is to enable exploration of airspace-based mitigation options to successfully mitigate what is considered by the airports to be the unacceptable operational impact created by the wind farm on RAF Lossiemouth and Inverness Airport.

1.2 Purpose and Scope

CAP 1616 states that a Safety Assessment is one of four key compliance areas that the CAA will review when making its decision at Stage 5 of the seven-stage Airspace Change Proposal (ACP) process. An initial Safety Assessment (the Safety Case Part 1 – Issue 1) was presented at the “Initial Options Appraisal” stage. This document is now being updated in preparation for submission as part of the ‘Update Design and Final Options Appraisal’. Unlike the first iteration, which represented all potential options, this current version is tailored for the preferred option following the consultation process at Stage 3.

The Safety Assessment is an iterative process, with effort and timescales aligned to the Options Appraisal requirements of CAP 1616, as described in the Safety Programme Plan (SPP) [Ref. 02].

The purpose of this Part 1 Safety Case Report (SCR) is to provide the Safety Requirements for the Clash Gour ACP.

The scope of this document, and the activities described within, is limited to air operations that take place in the vicinity of the proposed Clash Gour Wind Farm.

1.3 Structure of this Document

This document is structured as outlined below:

- Section 1 – Introduction
- Section 2 – Operational Context
- Section 3 – Hazard Identification
- Section 4 – Safety Objectives and Requirements
- Section 5 – Safety Programme Requirements
- Section 6 – References
- Appendix A1 – Hazard Risk Assessment
- Appendix A2 – Risk Tolerability Criteria.

2 Operational Context

2.1 Airspace Structure around Clash Gour Wind Farm

In the UK Flight Information Region (FIR) and Upper Information Region (UIR), airspace is classified as A to G in accordance with International Civil Aviation Organisation (ICAO) standards. Airspace Classes A to E are variants of Controlled Airspace (CAS) in which aircraft require an Air Traffic Control (ATC) clearance. Class G Airspace is designated as uncontrolled airspace in which aircraft can operate without any ATC clearance being required, there is no Class B or F airspace within the UK.

The various airspace sectors in the region of the proposed Clash Gour Wind Farm are described and categorised as follows and where applicable, the controlling authority is identified:

- Class G Airspace up to Flight Level (FL) 195 immediately overhead the wind farm (approximately 19,500 feet (ft) above mean sea level (amsl)). Aircraft can operate in this area of uncontrolled airspace without any requirement to be in communication with an ATC Unit. Pilots operating in Class G airspace are ultimately responsible for seeing and avoiding other aircraft and obstructions.
- Temporary Reserved Area (TRA) 008B is established from FL 195 up to FL 245. Activity taking place within the TRA 008B includes Air Combat and training exercises and supersonic flight. Air Defence Units and other agencies using radar data supplied from the Buchan Air Defence Radar (ADR) (which does not theoretically detect the wind turbines) are responsible for navigation services and support to aircraft activity within the TRA during promulgated activity times.
 - Note: Outside the times that TRA 008B is active, the airspace reverts to Class C Controlled Airspace (CAS) where NATS is responsible for the provision of navigation services to aircraft in transit above FL 195 over the development area.
- Class C CAS is established above FL 245; all aircraft operating in this airspace must be in receipt of an air traffic service from NATS, military controllers located at a NATS Area Control Centre (ACC) or under the control of Military Air Defence.
 - Note: Directly above the site is TRA Gliding (G) Scottish Area North where gliders may operate under specific conditions above FL 195. TRA (G) is established to support the region's gliding operations and can be activated within a specific notification timeframe where required.

In addition, the proposed wind turbines would be located within Low Flying Area (LFA) 14, the largest LFA in the UK, covering mainland Scotland north of the Central Region, the Western Isles, Orkney and Shetland.

2.2 Impact of the Development on nearby PSR

As part of the development consent process, EDFER and Force9, through Force9, has engaged with all relevant aviation stakeholders to determine the impact of the Clash

Gour wind turbines on aviation radar systems and operations. Both the Ministry of Defence (MoD) and Inverness Airport have confirmed that, without mitigation, the development will have an adverse impact on their ability to provide Air Traffic Services (ATS) due to interference caused by the detection of the operational wind turbines to the RAF Lossiemouth and Inverness Airport PSRs.

The provision of an ATS provided by RAF Lossiemouth could be detrimentally affected. The clutter that would be associated with the wind farm would be in an area where the provision of ATS to aircraft departing from and approaching the aerodrome would take place. In addition, aircraft climbing out and descending into the military low-level system, and aircraft receiving a Lower Airspace Radar Service (LARS) will be affected in the area of the proposed development.

Inverness Airport provides a vital and effective national and international flight network to both the local community and wider Highlands area. The Inverness PSR is used to support the provision of ATS to aircraft operating to/from the Airport and to aircraft requesting a service within radar and radio coverage. The introduction of wind turbines at Clash Gour has the potential to cause unacceptable interference to the Inverness Airport PSR thus impacting the safe provision of an ATS.

2.3 Proposed Mitigation

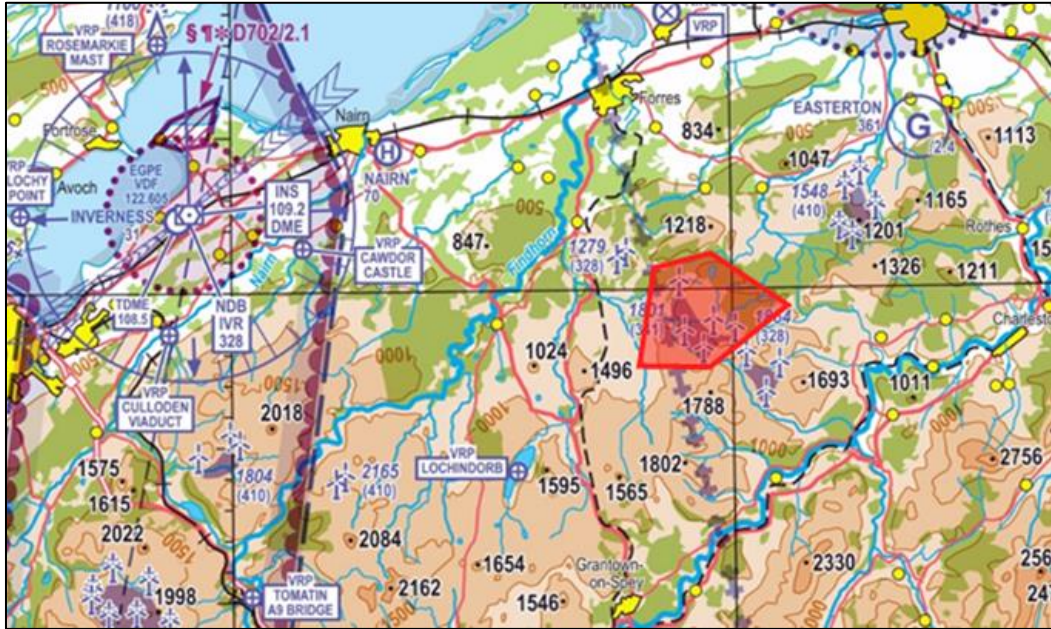
The ACP had originally been initiated to manage the development of both airspace and radar related mitigation options. It is the aspiration of the developers that the ACP will seek to strike the right balance between being proportionate whilst looking for opportunities to release as much wind farm development potential as is considered reasonable. During the 'design' phase a range of airspace options were also considered, but this has now been refined down to this final option, which was identified because of the Stage 3 consultation process.

The airspace change option being taken forward is:

- **Transponder Mandatory Zone (TMZ):** A TMZ can be established for overriding safety reasons in accordance with the Airspace Change Process (Note the airspace remains Class G). Provisions should be made for non-compliant aircraft to gain access to a TMZ where a legitimate requirement exists. The TMZ regulations require the carriage of a form of conspicuity, e.g., a pressure altitude reporting transponder or other electronic conspicuity data, such as ADS-B.). A pilot wishing to operate in a TMZ without such conspicuity equipment may be granted access subject to specific arrangements agreed with the TMZ Controlling Authority (RAF Lossiemouth).

The area of the proposed airspace change is shown as the red polygon in Figure 1. An airspace change of this nature, established over this area, must be combined with associated PSR blanking, thus removing clutter from the radar display screen whilst retaining the area as a 'known traffic environment' for the Air Traffic Control Officer (ATCO). The proposed airspace solution (TMZ) only needs to be operational at the point where turbines are being erected and are being brought into testing and operation. It is currently anticipated that turbines will be delivered to site and begin being erected in approximately Q3 2026, so the TMZ only needs to start operation from that point.

Initially the selected option had a variant which included a 2NM lateral geographic buffer zone. In accordance with the findings recorded in the Walney Transponder Mandatory Zone Post Implementation Review [Ref. 05] it was decided that applying a buffer zone in this case would be similarly inappropriate.



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Figure 1: Area of Proposed Airspace Change (TMZ)

3 Hazard Identification

3.1 Overview

A Hazard Identification (HazID) meeting was held on 16th February 2022 via Microsoft Teams. The following Sections provide a summary.

An integral part of this Stage 4 review was to review and revalidate the output of the initial Hazard meeting. Other than some refinements associated with the removal of the 2NM buffer zone as part of the mitigation narrative, all remaining aspects of the hazard identification summary and the stated mitigation strategies were deemed to still be valid.

As shown below in para 3.3, assumptions A9 and A10 highlight that the original operational context was of the hazard considered the TMZ (and PSR blanking) to be the most likely solution and thus steered the assessment in that direction.

3.2 HazID Methodology

The aims of the HazID were as follows:

- Identify the major hazards associated with the proposed airspace change over and containing the Clash Gour Wind Farm.
- Identify potential consequences (incidents/accidents) which may arise from the identified hazards.
- Investigate potential mitigations/controls to prevent the identified hazards occurring, or at least limit the consequences from occurrence.
- Investigate the causes of the identified hazards.

The HazID comprised a structured sequence of “Sessions”, as follows.

- Session 1: Hazards Implicit in Baseline Service Capability.
- Session 2: Hazards Due to Clash Gour Wind Turbines.
- Session 3: Hazards Implicit in Airspace Design Concept.
- Session 4: Airspace Design Concept Implementation Functional Hazards.

For the original HazID sessions it employed a structured, systematic, ‘brainstorm’ and drew upon the knowledge and experience of a team of subject matter experts (who are listed in [Ref. 03]), to identify potential hazards.

Although not overtly recognised at the time of the conduct of this HazID, inspection of the results shows that consideration of the specific Controlling Authority scenarios outlined in section 6.2 of the RMZ/TMZ policy [Ref. 6] was undertaken.

3.3 HazID Assumptions

The HazID meeting was conducted with the following assumptions:

- A1. Current operations at RAF Lossiemouth maintain a tolerable level of safety.
- A2. Provision of an ATS at RAF Lossiemouth is by competent, trained personnel.
- A3. RAF Lossiemouth Surveillance System is fit for purpose.

- A4. RAF Lossiemouth Surveillance System is maintained by competent, trained personnel in accordance with manufacturer's instructions and the Unit's Maintenance instructions.
- A5. Current operations at Inverness Airport maintain a tolerable level of safety.
- A6. Provision of an ATS at Inverness Airport is by competent, trained personnel.
- A7. Inverness Airport Surveillance System is fit for purpose.
- A8. Inverness Airport Surveillance System is maintained by competent, trained personnel in accordance with manufacturer's instructions and the Unit's Maintenance instructions.

The following additional assumptions were identified during the initial HazID workshop, and they were still considered applicable to the Stage 4 revalidation of the conduct of that workshop and its output.

- A9. For the purposes of the HazID, it was assumed that the establishment of a TMZ (with associated PSR blanking) would be the most likely airspace solution for mitigating the adverse effects of the Clash Gour Wind Farm on the Inverness and RAF Lossiemouth PSRs.
- A10. For the purposes of the HazID, it was assumed that a controlling authority for the TMZ would be established, prior to the TMZ becoming operational.

Although not an assumption, the following was recorded as a limitation on the HazID results:

- The surveillance systems at both RAF Lossiemouth and Inverness Airport are being upgraded, however the in-service date of the assured surveillance coverage provided by the new systems is not yet known. Therefore, all HazID results are based upon the operation of:
 - Watchman Radar at RAF Lossiemouth, and associated Cobham RDS1600 Radar Display System (RDS).
 - Thales STAR 2000 PSR at Inverness Airport, and associated Thales RDS.

3.4 HazID Results Summary

The detailed results of the original HazID are recorded in the HazID Record [Ref. 03]. A consolidated list of the identified hazards is presented in Table 1.

During the Stage 4 revalidation of the original HazID output it was determined that the operational context and intent of each hazard remained the same. Any change merely reflected the removal of the 2NM lateral buffer zone, which had been a consideration during the first HazID workshop sessions.

Hazard No.	Hazard and Description
Haz01	Wind Turbine Clutter not Suppressed: False Returns/Alarms (Turbine Clutter) displayed on Radar Display.
Haz02	Increased ATC Workload: Introduction of the TMZ results in ATCO monitoring the TMZ region for potential unauthorised access. In addition, unsuppressed wind turbine clutter on display may cause ATCO distraction.
Haz03	Funnelling /Choke points: Introduction of the TMZ leads to “choke points” in the Class G airspace on the periphery of the TMZ: TMZ will cause non-transponding aircraft to route around the TMZ and come into conflict with Inverness Airport and RAF Lossiemouth operations.
Haz04	Unauthorised entry of TMZ by non-transponding aircraft: A non-transponding aircraft flies into the area of the TMZ without permission to do so from the controlling authority.
Haz05	Loss of TMZ display on ATCO display: Display of TMZ boundary on radar display is lost; ATCO no longer aware of TMZ position.
Haz06	Corruption of TMZ display on ATCO display: Display of TMZ boundary on radar display is incorrect; ATCO no longer aware of TMZs true position.
Haz07	Loss of PSR: ATCO will not detect any potential TMZ incursions by non-transponding aircraft.
Haz08	Corruption of PSR: The area of clutter suppression could be incorrect. Any potential TMZ incursions by non-transponding aircraft may not be detected by ATCO.
Haz09	Loss of SSR: TMZ becomes a “black hole” in the surveillance coverage.
Haz10	Corruption of SSR: Inverness or Lossiemouth ATC unaware of the aircraft’s true position within the TMZ. (Positional error or SSR data delayed)
Haz11	Loss of a single co-operative data plot/track: ATC unaware of the aircraft’s position within the TMZ.

Table 1: Consolidated List of Hazards

4 Safety Objectives and Requirements

4.1 Safety Objective Derivation

It is not practical to derive numerical Safety Objectives for the design of the TMZ due to the many unpredictable and unquantifiable factors in the operational environment, not least the inherent nature of Class G airspace and the use of that airspace.

Successful use of the TMZ will be reliant upon the serviceability of the cooperative surveillance system of the TMZ controlling authority – RAF Lossiemouth.

4.2 Safety Requirement Derivation

4.2.1 Overview

The assessment activities that contribute to the derivation of Safety Requirements in this Safety Case are qualitative, i.e. founded upon professional judgement, experience and common sense and conducted by Suitably Qualified and Experience Personnel (SQEP).

The qualitative assessment activities focus on managing the risks presented by the hazards to an acceptable level. In the context of this project, an acceptable level means a Risk Classification in accordance with CAP 760 (Guidance on the Conduct of Hazard Identification, Risk Assessment, and the Production of Safety Cases) [Ref. 04], that is either ACCEPTABLE or REVIEW (Risk Tolerability Criteria replicated in Appendix A2).

Identification of mitigations that manage the risks presented by the hazards to an acceptable level, allows the derivation of Safety Requirements for the Clash Gour ACP.

4.2.2 Risk Assessment

Risk Assessments for each hazard, are presented in Appendix A1.

4.2.3 Safety Requirement Summary

A consolidated list of Safety Requirements is presented below in Table 3.

4.3 Airspace and Infrastructure Requirements

A key element of the ACP is the need to demonstrate that the proposed changes comply with the Airspace and Infrastructure requirements as set out in Appendix F of CAP 1616 [Ref 01]. In addition, compliance must be shown with the CAA 'Policy for Radio Mandatory Zones and Transponder Mandatory Zones' [Ref. 6] published 13 January 2022.

These requirements are derived from the Single European Sky (SES) Regulations, ICAO Standards and Recommended Practises (SARPs) and European Civil Aviation Conference (ECAC)/EUROCONTROL requirements; the list also includes additional requirements to satisfy UK policy.

No.	Safety Requirement	Related Hazard/s
SR01	Consideration shall be given to other windfarms and potential solutions that can be worked collaboratively with other wind farm developers.	Haz01
SR02	Clutter shall be treated as unknown traffic; ATCO will take immediate avoiding action dependent on the radar service being provided.	Haz01
SR03	There shall be Cooperative surveillance coverage over the location of the TMZ.	Haz01
SR04	ATC shall have procedures to address turbine clutter on the radar display.	Haz01
SR05	Sympathetic design of the TMZ should not result in “choke points” in the surrounding Class G airspace.	Haz03
SR06	The TMZ shall be promulgated in the UK IAIP.	Haz03, Haz04
SR07	ATC shall have procedures to address unauthorised access of the TMZ (if detected).	Haz03, Haz04
SR08	TMZ size shall be kept to a minimum (Proposed TMZ is sized to cover the turbines within the development area).	Haz03, Haz11
SR09	There shall be an ability for a non-transponder to request access of the TMZ from the controlling authority.	Haz03
SR10	ATC shall have the tactical ability to draw a TMZ overlay on the radar display.	Haz05
SR11	ATCO shall receive familiarisation and/or training on the TMZ implementation and associated procedures.	Haz05
SR12	There should be alternative ‘support systems’ that display the location of TMZ.	Haz05
SR13	ATC shall have procedures to address the loss of TMZ demarcation on the radar display.	Haz05
SR14	Radar display maps shall be thoroughly checked before being used.	Haz06
SR15	Primary Echoes shall be used to indicate validity of PSR data.	Haz06
SR16	Inverness Airport ATC shall cease all radar services if the PSR is lost.	Haz07, Haz08
SR17	If PSR is lost, RAF Lossiemouth shall downgrade radar service to SSR alone.	Haz07, Haz08

No.	Safety Requirement	Related Hazard/s
SR18	Inverness Airport ATC shall cease all radar services if the SSR is lost.	Haz09
SR19	ATC shall have Loss of SSR procedures.	Haz09, Haz10, Haz11
SR20	ANSPs shall co-ordinate to allow tactical control of aircraft in the TMZ to maintain separation.	Haz09, Haz11
SR21	Far Field Monitor shall be used to indicate validity of SSR data.	Haz10

Table 2: Consolidated List of Safety Requirements

5 Safety Programme Requirements

5.1 Programme Planning and Management

An SPP has been developed for the Clash Gour ACP [Ref. 02], with the aim of setting out the processes, activities, roles and responsibilities adopted by the Project to demonstrate the required scrutiny and Safety Assurance.

Specifically, the SPP describes:

- The required organisation for the ACP; how responsibility will be assigned and how the tasks will be managed to ensure that the Safety Requirements are met to the satisfaction of the ‘Controlling Authority’ and the Regulator.
- An outline Safety Argument, showing how the claim that *“the implementation of the proposed airspace structure will allow for a continued acceptably safe ATS to be provided from Inverness Airport and RAF Lossiemouth, throughout its in-service usage”* will be demonstrated and supported by suitable evidence.
- The analytical and practical safety activities necessary to demonstrate the Safety Objectives and Requirements have been met and the Safety Argument can be satisfied.
- How the Safety Programme activities will be integrated with the CAP 1616 [Ref. 01] ACP process.

5.2 Safety Case

The primary means by which it is intended to provide safety assurance evidence to support the Clash Gour ACP is a Safety Case.

The Safety Case will be developed in four parts and aligned to the CAP 1616 [Ref. 01] process.

In support of the requirement to submit increasingly detailed Safety Assessments during the CAP 1616 ACP process, the planned documentation submission is as follows:

- Stage 2B: Initial Options – Part 1 SCR.
- Stage 4A: Final Options – Part 1 SCR, Part 2 SCR, Part 3 SCR, and Part 4 SCR.

Further details are provided in the Clash Gour ACP SPP [Ref. 02].

5.3 Outline Safety Argument

5.3.1 Overview

The following sections provide a summary of the Safety Argument underpinning the Safety Case. The SPP [Ref. 02] contains a more detailed Safety Argument and the proposed approach for satisfying the Claims is set out in Appendix A1 of that document.

This version of the Safety Argument has evolved from the previous one stated in the SPP and earlier version of the Safety Case Part 1, which was solution agnostic. Whereas this revised version recognises that the solution being taken forward is in the form of the Clash Gour TMZ, and associated PSR blanking.

5.3.2 Top Level Safety Claim

The overarching, top-level Safety Claim (Claim 0) is that the implementation of the proposed Clash Gour TMZ shall permit the continued provision of an acceptably safe ATS to be provided from Inverness Airport and RAF Lossiemouth, throughout its in-service usage.

In the context of this project, an acceptable level means a Risk Classification in accordance with CAP760 [Ref. 04] that is either ACCEPTABLE or REVIEW.

Definitions of ACCEPTABLE and REVIEW are given in CAP760 as follows:

- **Acceptable** - the consequence is so unlikely or not severe enough to be of concern. The risk is tolerable, and the Safety Objective has been met. However, consideration should be given to reducing the risk further to As Low As Reasonably Practical (ALARP) to further minimise the risk of an accident or incident.
- **Review** - the consequence and/or likelihood is of concern; measures to mitigate the risk to ALARP should be sought. Where the risk still lies within the 'Review' region after ALARP risk reduction has been undertaken, then the risk may be accepted provided that the risk is understood and has the endorsement of the individual ultimately accountable for safety within the organisation.

To demonstrate Claim 0 is valid, it is necessary to support it with two subsidiary claims, namely:

- Claim 1: The provision of an ATS within the extant airspace is acceptably safe.
- Claim 2: The provision of an ATS within the revised airspace will be acceptably safe.

5.3.3 Claim 1 Context

Claim 1 represents the current operational structure of the airspace and establishes the baseline against which all further claims are substantiated. It demonstrates that the in-use Concept of Operations is acceptably safe and that any local issues are understood; importantly it makes no statement about assuring future safety.

5.3.4 Claim 2 Context

The introduction of the Clash Gour TMZ will require that any change in the current operational characteristics and aviation environment must be identified, as must the practises and procedures that manage any safety risk arising from this change. This includes any revised interaction required of the nominated controlling authority (RAF Lossiemouth), interactions with other interested parties, e.g. other airspace users, adjacent airports and ANSPs.

It is imperative that the transition into service of the Clash Gour TMZ is subject to a managed process that ensures all the safety claims, relating to the ATS, remain valid from the point of first use and throughout its operational use. This includes assurance that all external stakeholders are prepared for the revised operational environment.

Claim 2 is supported by four sub-claims:

- Claim 2.1: All hazards pertaining to the introduction of the Clash Gour TMZ have been identified and understood, including those associated with airspace users, adjacent airports and aviation organisations.
- Claim 2.2: The submitted design of the Clash Gour TMZ is deemed acceptably safe and agreed by the CAA.
- Claim 2.3: The Programme for transitioning the Clash Gour TMZ into operational use is planned and acceptably safe.
- Claim 2.4: The use of the Clash Gour TMZ will remain acceptably safe during its operational life.

6 References

Ref	Title	Origin
[Ref. 01]	CAP 1616 Airspace Design: Guidance on the regulatory process for changing airspace design including community engagement requirements. V4 Issued March 2021 ¹	CAA
[Ref. 02]	Safety Programme Plan Clash Gour Airspace Change Proposal 71609 013, Issue 1, 5 th January 2022	Osprey
[Ref. 03]	Hazard Identification Record Clash Gour Airspace Change Proposal 71609 015, Issue 3, 18 th March 2022	Osprey
[Ref. 04]	CAP 760: Guidance on the Conduct of Hazard Identification, Risk Assessment and the Production of Safety Cases: For Aerodrome Operators and Air Traffic Service Providers 1st Edition (inc. amendments 2010/01), 10 th December 2010	CAA
[Ref. 05]	Walney Transponder Mandatory Zone Post Implementation Review May 2019	CAA
[Ref. 06]	Policy for Radio Mandatory Zones and Transponder Mandatory Zones 13 January 2022	CAA

¹ Email from CAA 15 December 2023 confirmed that CAP1616 Version 4 shall apply to this ACP until it is concluded.

A1 Hazard Risk Assessment

Haz No.	Description & Cause	Consequence	Severity/ Likelihood	Pre-mitigation tolerability	Mitigating Factors and Safety Requirements	Severity/ Likelihood	Post-mitigation tolerability
Haz01	<p>Wind Turbine Clutter Not Suppressed: False Returns/Alarms (Turbine Clutter) displayed on Radar Display.</p> <p>Causes:</p> <ul style="list-style-type: none"> • Clutter from adjacent wind turbines not suppressed from display. • PSR fault/ Suppression Solution Failure. • Data Comms failure. • Power failure/ fluctuations. 	<p>Increased ATCO workload.</p> <p>In worst case, leading to the Potential for loss of horizontal and/or vertical separation between aircraft.</p>	Sig I / RP	Review	<p>Consideration needs to be given to other windfarms and potential solutions that can be worked collaboratively with other wind farm developers. (SR01)</p> <p>Clutter treated as unknown traffic; ATCO will take immediate avoiding action dependent on the radar service being provided. (SR02)</p> <p>TMZ in place means that air traffic over the Clash Gour Wind Farm will be transponding (SSR coverage). (SR03)</p> <p>ATCO downgrades ATS or warns of reduced traffic information associated with the ATS being provided; SSR alone. (SR04)</p>	Sig I / Rem	Acceptable
Haz02	<p>Increased ATC Workload: Introduction of the TMZ results in ATCO monitoring the TMZ region for potential unauthorised access. In addition, unsuppressed wind turbine clutter on display may cause ATCO distraction.</p>	<p><i>This hazard is in fact a consequence of other identified hazards. As such Haz02 will not be analysed further in its own right.</i></p>					

Haz No.	Description & Cause	Consequence	Severity/Likelihood	Pre-mitigation tolerability	Mitigating Factors and Safety Requirements	Severity/Likelihood	Post-mitigation tolerability
Haz03	<p>Funnelling /Choke points: Introduction of the TMZ leads to “choke points” in the class G airspace on the periphery of the TMZ:</p> <p>TMZ will cause non-transponding aircraft to route around the TMZ and come into conflict with Inverness Airport and RAF Lossiemouth operations.</p> <ul style="list-style-type: none"> • TMZ design dictated by the location of the windfarm. • GA aircraft may not be equipped with conspicuity device and may be required to avoid the TMZ 	<p>Infringement of the TMZ.</p> <p>Potential for loss of horizontal and/or vertical separation between aircraft and/or terrain.</p>	MI / RP	Unacceptable	<p>Sympathetic design of TMZ should not result in “choke points” in the surrounding Class G airspace. (SR05)</p> <p>Clear designation and promulgation of the TMZ in UK IAIP. (SR06)</p> <p>RAF Lossiemouth and Inverness Airport have good PSR and SSR coverage in area. Aircraft without conspicuity MAY be seen by ATCO on PSR (outside TMZ); An aircraft receiving a Radar Service from either Inverness or RAF Lossiemouth, would be provided with Traffic Information regarding the ‘unknown’ traffic along with vectors to avoid. (SR07)</p> <p>TMZ size: TMZ size shall be kept to a minimum (Proposed TMZ is sized to cover the turbines within the development area). (SR08)</p> <p>There will be an ability for a non-transponder to request access of the TMZ from the controlling authority. (SR09)</p> <p>Class G Airspace - pilots are ultimately responsible for self-briefing for potential hazards along their planned route of flight, collision avoidance and maintaining the rules of the air.</p>	MI / Rem	Review

Haz No.	Description & Cause	Consequence	Severity/ Likelihood	Pre-mitigation tolerability	Mitigating Factors and Safety Requirements	Severity/ Likelihood	Post-mitigation tolerability
Haz04	<p>Unauthorised entry of TMZ by non-transponding aircraft: A non-transponding aircraft flies into the area of the TMZ without permission to do so from the controlling authority.</p> <ul style="list-style-type: none"> Flight crew unaware of the TMZ. Flight Crew navigational error 	Potential for Loss of horizontal and/or vertical separation between aircraft.	MI / Rem	Review	<p>Clear designation and promulgation of the TMZ in UK IAIP. (SR06)</p> <p>RAF Lossiemouth and Inverness Airport have good PSR and SSR coverage in area. Aircraft without conspicuity MAY be seen by ATCO on PSR (outside TMZ); An aircraft receiving a Radar Service from either Inverness or RAF Lossiemouth, would be provided with Traffic Information regarding the 'unknown' traffic along with vectors to avoid. (SR07)</p> <p>Class G Airspace - pilots are ultimately responsible for self-briefing for potential hazards along their planned route of flight, collision avoidance and maintaining the rules of the air.</p>	MI / Ex Rem	Acceptable
Haz05	<p>Loss of TMZ display on ATCO display: Display of TMZ boundary on radar display is lost; ATCO no longer aware of TMZ position.</p> <ul style="list-style-type: none"> Radar system/display failure. Human error. 	<p>Increased ATCO workload.</p> <p>In worst case, leading to the Potential for loss of horizontal and/or vertical separation between aircraft.</p>	Sig I / Rem	Acceptable	<p>ATCO will have the tactical ability to draw an overlay (SR10).</p> <p>ATCO experience and training (SR11), and other support systems displaying location of TMZ (SR12).</p> <p>Inverness have no 'backup' system and therefore would vector aircraft to provide a wide berth of the location of the TMZ area. (SR13)</p>	Sig I / Ex Rem	Acceptable

Haz No.	Description & Cause	Consequence	Severity/ Likelihood	Pre-mitigation tolerability	Mitigating Factors and Safety Requirements	Severity/ Likelihood	Post-mitigation tolerability
Haz06	<p>Corruption of TMZ display on ATCO display: Display of TMZ boundary on radar display is incorrect; ATCO no longer aware of TMZs true position.</p> <ul style="list-style-type: none"> Radar system/display failure. Human error. 	<p>Increased ATCO workload.</p> <p>In worst case, leading to the Potential for loss of horizontal and/or vertical separation between aircraft.</p>	Sig I / Rem	Acceptable	<p>Unlikely failure mode: maps thoroughly checked before being used. (SR14)</p> <p>Primary Echoes used to indicate validity of PSR data. (SR15)</p> <p>Undetected corruption thought to be extremely unlikely.</p>	Sig I / Ex Rem	Acceptable
Haz07	<p>Loss of PSR: ATCO will not detect any potential TMZ incursions by non-transponding aircraft.</p> <ul style="list-style-type: none"> PSR failure. Data Comms failure. Power failure/ fluctuations. 	<p>Increased ATCO workload.</p> <p>In worst case, leading to the Potential for loss of horizontal and/or vertical separation between aircraft.</p>	Sig I / Rem	Acceptable	<p>Inverness Airport will stop all radar services if the PSR is lost. (SR16)</p> <p>RAF Lossiemouth will downgrade radar service to SSR alone and accept the higher risk – TMZ airspace was known environment immediately prior to PSR loss. (SR17)</p> <p>Class G Airspace - pilots are ultimately responsible for collision avoidance.</p>	Sig I / Ex Rem	Acceptable

Haz No.	Description & Cause	Consequence	Severity/ Likelihood	Pre-mitigation tolerability	Mitigating Factors and Safety Requirements	Severity/ Likelihood	Post-mitigation tolerability
Haz08	<p>Corruption of PSR: The area of clutter suppression could be incorrect. Any potential TMZ incursions by non-transponding aircraft may not be detected by ATCO.</p> <ul style="list-style-type: none"> PSR fault. Human error (when applying clutter suppression technique). Data Comms failure. 	<p>Increased ATCO workload.</p> <p>In worst case, leading to the Potential for loss of horizontal and/or vertical separation between aircraft.</p>	Sig I / Rem	Acceptable	<p>Primary Echoes (PEs) used to indicate validity of PSR data.</p> <p>Inverness Airport will stop all radar services if the PSR is lost. (SR16)</p> <p>RAF Lossiemouth will downgrade radar service to SSR alone and accept the higher risk – TMZ airspace was known environment immediately prior to PSR loss. (SR17)</p> <p>Class G Airspace - pilots are ultimately responsible for collision avoidance.</p>	Sig I / Ex Rem	Acceptable

Haz No.	Description & Cause	Consequence	Severity/ Likelihood	Pre-mitigation tolerability	Mitigating Factors and Safety Requirements	Severity/ Likelihood	Post-mitigation tolerability
Haz09	<p>Loss of SSR: TMZ becomes a “black hole” in the surveillance coverage.</p> <ul style="list-style-type: none"> SSR / Co-operative surveillance failure. Data Comms failure. Power failure/ fluctuations. 	<p>Increased ATCO workload.</p> <p>In worst case, leading to the Potential for loss of horizontal and/or vertical separation between aircraft.</p>	Sig I / Rem	Acceptable	<p>Inverness Airport will stop all radar services if the SSR is lost. (SR18)</p> <p>ATC will attempt to establish voice comms with the aircraft (if not already done so) and will downgrade the ATS or warns of reduced traffic information associated with the ATS being provided (Loss of SSR procedures.) (SR19)</p> <p>It is possible that aircraft has established comms with another ANSP (i.e., Inverness or Lossiemouth). Co-ordination between ANSPs will allow tactical control of aircraft in the TMZ to maintain separation. (SR20)</p> <p>Once outside the TMZ the aircraft would be re-identified on PSR.</p> <p>Class G Airspace - pilots are ultimately responsible for collision avoidance.</p>	Sig I / Ex Rem	Acceptable

Haz No.	Description & Cause	Consequence	Severity/ Likelihood	Pre-mitigation tolerability	Mitigating Factors and Safety Requirements	Severity/ Likelihood	Post-mitigation tolerability
Haz10	<p>Corruption of SSR: Inverness or Lossiemouth ATC unaware of the aircraft's true position within the TMZ. (Positional error or SSR data delayed)</p> <ul style="list-style-type: none"> SSR / Co-operative surveillance fault 	<p>Increased ATCO workload.</p> <p>In worst case, leading to the Potential for loss of horizontal and/or vertical separation between aircraft.</p>	Sig I / Rem	Acceptable	<p>Far Field Monitor used to indicate validity of SSR data. (SR21)</p> <p>ATC will attempt to establish voice comms with the aircraft (if not already done so) and will downgrade the ATS or warns of reduced traffic information associated with the ATS being provided (Loss of SSR procedures.) (SR19)</p> <p>Once outside the TMZ the aircraft would be re-identified on PSR.</p> <p>Class G Airspace - pilots are ultimately responsible for collision avoidance.</p>	Sig I / Ex Rem	Acceptable



Haz No.	Description & Cause	Consequence	Severity/ Likelihood	Pre-mitigation tolerability	Mitigating Factors and Safety Requirements	Severity/ Likelihood	Post-mitigation tolerability
Haz11	<p>Loss of a single co-operative data plot/track: ATC unaware of the aircraft's position within the TMZ.</p> <ul style="list-style-type: none"> Aircraft transponder failure. Human error. 	<p>Increased ATCO workload.</p> <p>In worst case, leading to the Potential for loss of horizontal and/or vertical separation between aircraft.</p>	Sig I / Rem	Acceptable	<p>ATC will attempt to establish voice comms with the aircraft (if not already done so) and will downgrade the ATS or warns of reduced traffic information associated with the ATS being provided (Loss of SSR procedures.) (SR19)</p> <p>It is possible that aircraft has established comms with another ANSP (i.e., Inverness or Lossiemouth). Co-ordination between ANSPs will allow tactical control of aircraft in the TMZ to maintain separation. (SR20)</p> <p>Once outside the TMZ the aircraft would be re-identified on PSR.</p> <p>TMZ size: TMZ size shall be kept to a minimum (Proposed TMZ is sized to cover the turbines within the development area). (SR08)</p> <p>Class G Airspace - pilots are ultimately responsible for collision avoidance.</p>	Sig I / Ex Rem	Acceptable

A2 Risk Tolerability Criteria

The Risk Tolerability Criteria presented in the following tables, is taken from CAP760 [Ref. 04].

A2.1 Severity Classification Scheme

Accidents	Accident - as defined in Council directive 94/56/EC for air traffic services. Also includes loss of or substantial damage to major aerodrome facilities. Serious injury or death of multiple staff/ members of public at the aerodrome.
Serious Incidents	Serious Incident - as defined in Council directive 94/56/EC for air traffic services. For the aerodrome, an event where an accident nearly occurs. No safety barriers remaining. The outcome is not under control and could very likely lead to an accident. Damage to major aerodrome facilities. Serious injury to staff/members of public at the aerodrome.
Major Incidents	A major incident associated with the operation of an aircraft, in which safety of aircraft may have been compromised, having led to a near collision between aircraft, with ground or obstacles. A large reduction in safety margins. The outcome is controllable by use of existing emergency or non-normal procedures and/or emergency equipment. The safety barriers are very few approaching none. Minor injury to occupants of the aircraft or staff/members of public at the aerodrome. Minor damage to aircraft or major aerodrome facilities may occur.
Significant Incidents	Significant incident involving circumstances indicating that an accident, a serious or major incident could have occurred, if the risk had not been managed within safety margins, or if another aircraft had been in the vicinity. A significant reduction in safety margins but several safety barriers remain to prevent an accident. Reduced ability of the flight crew or air traffic control to cope with the increase in workload as a result of the conditions impairing their efficiency. Only on rare occasions can the occurrence develop into an accident. Nuisance to occupants of the aircraft or staff/members of public at the aerodrome.
No Effect Immediately	No immediate effect on safety No direct or low safety impact. Existing safety barriers come into play to avoid the event turning into a significant incident or accident.

A2.2 Probability/Likelihood Classification

	Probability of Occurrence Definitions				
	Extremely improbable	Extremely remote	Remote	Reasonably probable	Frequent
Qualitative definition	Should virtually never occur	Very unlikely to occur	Unlikely to occur during the total operational life of the system	May occur once during total operational life of the system	May occur several times during operational life
Quantitative numerical definition	< 10 ⁻⁹ per hour	10 ⁻⁷ to 10 ⁻⁹ per hour	10 ⁻⁵ to 10 ⁻⁷ per hour	10 ⁻³ to 10 ⁻⁵ per hour	1 to 10 ⁻³ per hour
Quantitative annual/daily equivalent (approximate)	Never	Once in 1000 years to once in 100,000 years	Once in 10 years to once in 1000 years	Once per 40 days to once in 10 years	Once per hour to once in 40 days

A2.3 Risk Classification/Tolerability Matrix

		Probability of Occurrence (Likelihood)				
		Extremely Improbable	Extremely Remote	Remote	Reasonably Probable	Frequent
		<10 ⁻⁹ per hour	10 ⁻⁷ to 10 ⁻⁹ per hour	10 ⁻⁵ to 10 ⁻⁷ per hour	10 ⁻³ to 10 ⁻⁵ per hour	1 to 10 ⁻³ per hour
ESARR 4 Severity	Accidents	Review	Unacceptable	Unacceptable	Unacceptable	Unacceptable
	Serious Incidents	Acceptable	Review	Unacceptable	Unacceptable	Unacceptable
	Major Incidents	Acceptable	Acceptable	Review	Unacceptable	Unacceptable
	Significant Incidents	Acceptable	Acceptable	Acceptable	Review	Unacceptable
	No Effect Immediately	Acceptable	Acceptable	Acceptable	Acceptable	Review

A2.4 Risk Toleration Description

Acceptable	The consequence is so unlikely or not severe enough to be of concern. The risk is tolerable, and the Safety Objective has been met. However, consideration should be given to reducing the risk further to As Low As Reasonably Practical (ALARP) in order to further minimise the risk of an accident or incident.
Review	The consequence and/or likelihood is of concern; measures to mitigate the risk to ALARP should be sought. Where the risk still lies within the 'Review' region after ALARP risk reduction has been undertaken, then the risk may be accepted provided that the risk is understood and has the endorsement of the individual ultimately accountable for safety within the organisation.
Unacceptable	The likelihood and/or severity of the consequence is intolerable. Major mitigation or redesign of the system may be necessary to reduce the likelihood or severity of the consequences associated with the hazard.