Dudgeon and Sheringham Shoal Offshore Wind Farm Extensions

Preliminary Environmental Information Report

Volume 1

Chapter 17 - Aviation and Radar

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Table of Contents

List of Tables

List of Plates

Volume 2

Volume 3

Glossary of Acronyms

ACC	Area Control Centre
ADR	Air Defence Radar
AIP	Aeronautical Information Publication
AIS	Aeronautical Information Service
amsl	Above Mean Sea Level
ANO	Air Navigation Order
ANS	Air Navigation Service
ANSP	Air Navigation Service Provider
ARA	Airborne Radar Approach
ATA	Aerial Tactics Area
ATC	Air Traffic Control
ATCO	Air Traffic Control Officer
ATDI	Advanced Topographic Development and Imaging
ATS	Air Traffic Service
C	Centigrade
CAA	Civil Aviation Authority
CAS	Controlled Air Space
CIA	Cumulative Impact Assessment
CNS	Communication Navigation and Surveillance
DCO	Development Consent Order
DECC	Department for Energy and Climate Change
DEP	Dudgeon Extension Project
EEA	European Economic Area
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
FIR	Flight Information Region
FL	Flight Level
ft	feet
HAT	Highest Astronomical Tide
HMR	Helicopter Main Route
HTZ	Helicopter Transit Zone
IAIP	Integrated Aeronautical Information Package

IFP	Instrument Flight Procedures
IMC	Instrument Meteorological Conditions
IPMP	In-Principle Monitoring Plan
km	kilometre
LARS	Lower Airspace Radar Service
LAT	Lowest Astronomical Tide
LOS	Line of Sight
m	metre
MCA	Maritime and Coastguard Agency
MDS	Maximum Design Scenario
Mil	Military
MOD	Ministry of Defence
MSA	Minimum Safe Altitude
NATS	National Air Traffic System
NERL	NATS En-Route Ltd
NHV	Noordzee Helikopters Vlaanderen Group
NM	Nautical Mile
NPS	National Policy Statement
NSIP	Nationally Significant Infrastructure Project
OREI	Offshore Renewable Energy Installations
OWF	Offshore Wind Farm
PEIR	Preliminary Environmental Information Report
PEXA	Practice and Exercise Areas
PSR	Primary Surveillance Radar
RAF	Royal Air Force
RAP	Recognised Air Picture
RCS	Radar Cross Section
RDDS	Radar Data Display Screen
RDP	Radar Data Processor
RRH	Remote Radar Head
SAR	Search and Rescue
SEP	Sheringham Shoal Extension Project
SMAC	Surveillance Minimum Altitude Chart

SNS	Southern North Sea
SSR	Secondary Surveillance Radar
TMZ	Transponder Mandatory Zone
UK	United Kingdom
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions

Glossary of Terms

The Applicant	Equinor New Energy Limited
Controlled Airspace	Airspace in which Air Traffic Control exercises authority. In the UK, Class A, C, D and E airspace is controlled and may consist of Controlled Areas (CTA) and Controlled Zones (CTR).
Dudgeon Offshore Wind Farm Extension site	The Dudgeon Offshore Wind Farm Extension offshore wind farm boundary.
The Dudgeon Offshore Wind Farm Extension Project (DEP)	The Dudgeon Offshore Wind Farm Extension site as well as all onshore and offshore infrastructure.
Azimuth	The direction of a celestial object from the observer, expressed as the angular distance from the north or south point of the horizon to the point at which a vertical circle passing through the object intersects the horizon.
Flight Level	A standard nominal altitude of an aircraft, in hundreds of feet, based upon a standardized air pressure at sea-level.
Helicopter Main Route (HMR)	Helicopter Main Routes are routes typically and routinely flown by helicopters operating to and from offshore destinations and are promulgated for the purpose of signposting concentrations of helicopter traffic to other airspace users. HMR promulgation does not predicate the flow of helicopter traffic. Whilst HMRs have no airspace status and assume the background airspace classification within which they lie (in the case of the Southern North Sea, Class G), they are used by the air navigation service provider and helicopter operators for flight planning and management purposes.
Instrument Flight Rules (IFR)	The rules governing procedures for flights conducted with the crew making reference to aircraft cockpit instruments for situation awareness and navigation.
Instrument Meteorological Conditions (IMC)	Weather conditions which would preclude flight by the Visual Flight Rules, i.e. conditions where the aircraft is in, or close to cloud or flying in visibility less than a specified minimum.
Landfall	The point at the coastline at which the offshore export cables are brought onshore, connecting to the onshore cables at the transition joint bay above mean high water

Minimum Safe Altitude	Under aviation flight rules, the altitude below which it is unsafe to fly in IMC owing to presence of terrain or obstacles within a specified area.
Mitigation	A term used interchangeably with Commitment(s) by Hornsea Four. Mitigation measures (Commitments) are embedded within the assessment at the relevant point in the EIA (e.g. at Scoping, PEIR, or ES).
Offshore substation platform (OSP)	A fixed structure located within the wind farm area, containing electrical equipment to aggregate the power from the wind turbine generators and convert it into a more suitable form for export to shore.
PEIR boundary	The area subject to survey and preliminary impact assessment to inform the PEIR, including all permanent and temporary works for DEP and SEP. The PEIR boundary will be refined down to the final DCO boundary ahead of the application for development consent.
Study area	Area where potential impacts from the project could occur, as defined for each individual EIA topic.
Sheringham Shoal Offshore Wind Farm Extension site	Sheringham Shoal Offshore Wind Farm Extension offshore wind farm boundary.
The Sheringham Shoal Offshore Wind Farm Extension Project (SEP)	The Sheringham Shoal Offshore Wind Farm Extension site as well as all onshore and offshore infrastructure.
Uncontrolled Airspace	Airspace in which Air Traffic Control does not exercise any executive authority but may provide flight information services to aircraft in radio contact. In the UK, Class G airspace is uncontrolled.
Visual Flight Rules (VFR)	The rules governing flight conducted visually i.e. with the crew maintaining separation from obstacles, terrain and other aircraft visually.
Visual Metrological Conditions (VMC)	A flight category which allows flight to be conducted under VFR defined by in flight visibility and clearance from cloud.

17 AVIATION AND RADAR

17.1 Introduction

1. This chapter of the Preliminary Environmental Information Report (PEIR) considers the potential impacts of the proposed Dudgeon Extension Offshore Wind Farm Project (DEP) and Sheringham Shoal Extension Offshore Wind Farm Project (SEP) on Aviation and Radar. The chapter provides an overview of the existing environment for the proposed offshore development area, followed by an assessment of the potential impacts and associated mitigation for the construction, operation, and decommissioning phases of the projects.
2. This chapter has been written by Royal HaskoningDHV, based upon a technical assessment provided by Osprey Consulting Services Ltd (Osprey), with the assessment undertaken with specific reference to the relevant legislation and guidance. Details of these and the methodology used for the Environmental Impact Assessment (EIA) and Cumulative Impact Assessment (CIA) are presented in **Section 17.4**.
3. The assessment should be read in conjunction with following linked chapters:
   - **Chapter 19 Petroleum Industry and Other Marine Users**; and
   - **Chapter 15 Shipping and Navigation.**
4. Additional information to support the Aviation and Radar assessment includes:
   - **Appendix 17.1 Radar Line of Sight Images**

17.2 Consultation

5. Consultation with regard to Aviation and Radar has been undertaken in line with the general process described in **Chapter 6 EIA Methodology**. The key elements to date have included scoping and focused consultation with aviation and radar stakeholders undertaken by Osprey on behalf of the Applicant. The feedback received has been considered in preparing the PEIR. **Table 17-1** provides a summary of how the consultation responses received to date have influenced the approach that has been taken.
6. This chapter will be updated following the consultation on the PEIR in order to produce the final assessment that will be submitted with the Development Consent Order (DCO) application. Full details of the consultation process will also be presented in the Consultation Report alongside the DCO application.

Table 17-1: Consultation responses.

Consultee	Date/ Document	Comment	Project Response
The Planning Inspectorate	Scoping Opinion, 19/11/19	"The Scoping Report explains that Royal HaskoningDHV (2013) assessed that the distance to the nearest airfield to the Dudgeon Offshore Wind Farm was too great for an unacceptable hazard to flight to occur. It concluded that although the extension projects weren't assessed and are located closer to the airfield, it is reasonable to conclude that the same applies to the DEP and SEP sites. It explains that, aircraft taking-off and landing will be at an altitude significantly greater than the tallest infrastructure related to any phase of the Proposed Development. The Inspectorate agrees that significant effects to flight safety are unlikely and that this matter can be scoped out of the Environmental Statement (ES)."	The Planning Inspectorate agreed that impacts on flight safety can be scoped out of the assessment and are therefore not considered further.
The Planning Inspectorate	Scoping Opinion, 19/11/19	"The Inspectorate agrees that effects on military training areas in the region are only likely to be significant during the operational phase since they occur as a result of impacts to radar and therefore can be scoped out of the assessment for construction and decommissioning.	The Planning Inspectorate agreed that impacts on military training areas can be scoped out of the assessment for the construction and decommissioning phase and are therefore not considered further.

Consultee	Date/ Document	Comment	Project Response
		With regards to the operational phase, paragraph 509 of the Scoping Report explains that potential effects are related to radar rather than physical obstruction as the training area flight level is between 5,000 feet (ft) and 17,000ft which is well above the proposed turbine height. The Inspectorate is content with this approach."	The assessment of impacts on military training areas during operation has focused on the impact to radar in line with the Scoping Report and the Inspectorate's comments. An assessment of theoretical radar detectability of wind turbines and how detectability will impact NATS radar systems is provided in **Section 17.6.2.2**.
The Planning Inspectorate	Scoping Opinion, 19/11/19	"The Inspectorate agrees that given the distance of the Proposed Development from international boundaries, transboundary effects are unlikely to be significant and this matter can be scoped out of the ES."	Transboundary impacts have been scoped out of the assessment in line with the Scoping Report and the Inspectorate's comments.
The Planning Inspectorate	Scoping Opinion, 19/11/19	"The Applicant is reminded of the need within the EIA Regulations 2017 to consider the significance of effects. The ES should therefore clearly identify whether or not an effect is considered to be significant."	**Section 17.6** identifies the impact significance of each potential impact in line with the EIA Regulations.

Consultee	Date/ Document	Comment	Project Response
The Planning Inspectorate	Scoping Opinion, 19/11/19	"The ES should assess any significant effects associated with impacts to known Ministry of Defence (MOD) receptor locations. The MOD consultation response highlights that the turbines on the western edge of the SEP would be detectable to the Primary Surveillance Radar at Royal Air Force (RAF) Coningsby. It also notes that part of the cable route corridor at the Weybourne landfall site occupies the eastern extent of the statutory safeguarding zone surrounding the RAF Weybourne transmitter site; and that the Bacton landfall site occupies the statutory safeguarding zone encompassing the Air Defence Radar (ADR) at Remote Radar Head (RRH) Trimingham."	**Section 17.6** identifies the significance of each potential impact in line with the EIA Regulations including effects on RAF Coningsby, and RAF Weybourne. Following site selection work carried out since scoping, the Bacton landfall is no longer in the project design envelope. Therefore, impacts relating to a Bacton landfall are not considered further.
Marine and Coastguard Agency (MCA)	Scoping Response, 01/11/19	"The turbine layout design will require MCA approval prior to construction to minimise the risks to surface vessels, including rescue boats, and Search and Rescue (SAR) aircraft operating within the site."	Noted that layout approval will be undertaken following consent.
Maritime and Coastguard Agency	18/11/20 Consultation Response	The MCA stated that they "will engage with the Applicant from a SAR and navigation safety point of view. "	An assessment of low flying aircraft and the potential creation of an obstruction is presented in **Sections 17.6.1.1** and **17.6.2.1**.

Consultee	Date/ Document	Comment	Project Response
MOD	Scoping Response, 01/11/19	"The applicant has recognised the potential need for mitigation to address the impacts on air defence systems and states they will engage with the MOD on this. The ADR at RRH Trimingham has been identified as a relevant receptor. Both extension areas will be detectable to RRH Trimingham and will impact upon the operation of the air defence system. The impact on the ADR will need to be mitigated and it will be for the application to provide appropriate technical mitigation(s)."	**Section 17.6** identifies the impact significance of each potential impact in line with the EIA Regulations, including effects on RRH Trimingham.
MOD	Scoping Response, 01/11/19	"Another consideration not covered in the Scoping Report is the impact of the turbines on the Primary Surveillance Radar (PSR) at RAF Coningsby. Turbines on the western edge of the Sheringham Shoal extension area will be detectable to the PSR at RAF Coningsby. This will need to be addressed and an appropriate technical mitigation will need to be provided by the applicant."	An assessment of theoretical radar detectability of wind turbines and how detectability will impact radar systems is provided in **Table 17-11**. Mitigation specifically for the RAF Coningsby PSR is provided in **Section 17.6.2.2.3**.

Consultee	Date/ Document	Comment	Project Response
MOD	Scoping Response, 01/11/19	"The Scoping Report makes reference to the lighting of the Dudgeon Offshore Wind Farm and the MOD's Lighting Guidance is listed as a data source. In the interest of air safety, the Dudgeon and Sheringham Shoal extension areas should be fitted with MOD accredited aviation safety lighting in accordance with the Air Navigation Order (ANO) 2016. The MOD would need to confirm the specification of the lighting to be used."	Lighting will be in accordance with the ANO and MOD requirements. Consideration of the fitment of aviation lighting is provided in **Table 17-3: Embedded Mitigation Measures**.
MOD	Scoping Response, 01/11/19	"Part of the cable route corridor at the Weybourne landfall site occupies the eastern extent of the statutory technical safeguarding zone surrounding the RAF Weybourne transmitter site; in particular the any development height zone. Any development within these zones will need to be compatible with technical safeguarding requirements."	An assessment of the Weybourne transmitter site is provided in **Section 17.6.1.2.**
NATS	Scoping Response, 01/11/19	NATS state that their operations in the Southern North Sea (SNS) should be considered. NATS noted that both the existing Dudgeon and Sheringham Shoal wind farms lie within the Greater Wash Transponder Mandatory Zone (TMZ), and the entirety of the proposed extensions do not.	An assessment of theoretical radar detectability of wind turbines and how detectability will impact NATS radar systems is provided in **Section 17.5.2.2**.

Consultee	Date/ Document	Comment	Project Response
Norwich Airport	21/10/20 Consultation Response	Impact to the Norwich Airport Surveillance Minimum Altitude Chart (SMAC) due to the height above means sea level (amsl) may be apparent and will require assessment. Furthermore, the Norwich Airport and Cromer PSR may be impacted by the radar detection of the Project wind turbines.	An assessment of the Norwich Airport SMAC will be completed to inform the EIA. The conclusions of theoretical radar detectability of wind turbines and how detectability will impact NATS and the Norwich Airport radar systems is provided in **Section 17.6.2.2**.
Noordzee Helikopters Vlaanderen (NHV) Group	13/10/20 Consultation Response	The wind farm sites and the obstruction that they may present are located to the south and west of normal NHV operations. Overflight of the wind farm sites may be required during poor weather conditions where the wind turbines cannot be visually acquired by the pilot. Overflight will be at a height which may on occasion force the aircraft into icing conditions therefore to permit flight at a lower altitude where icing conditions are not a factor, obstacle free transit corridors may be required through the array areas.	Consultation with NHV Helicopters will continue in order to define the operational impact to their operations conducted in the vicinity of the wind farm sites. **Section 17.5** provides details of the offshore helicopter operations.

Consultee	Date/ Document	Comment	Project Response
Anglia Radar	13/10/20 Consultation Response	Impact to NATS radar systems are expected, as are current Air Traffic Control (ATC) operations. The use of Helicopter Main Routes [1](HMR) and Minimum Safe Altitudes (MSA) in the vicinity of the wind farm sites will require an assessment of the potential obstruction created by the wind turbines. Consultation with helicopter operators operating in the area of the wind farms is recommended.	An assessment of theoretical radar detectability of wind turbines and how detectability will impact NATS radar systems is provided in **Section 17.6.2.2**. Impact to HMR and MSA is provided in **Section 17.6.2.3.** Consultation with offshore helicopter operators will continue in order to define the operational impact to their operations conducted in the vicinity of DEP and SEP.
Independent Oil and Gas	TBC	Consultation has commenced and responses will be reported in the final ES.	N/A

[1] HMR will shortly be renamed Helicopter Main Route Indicators (HMRI).

Consultee	Date/ Document	Comment	Project Response
Perenco	01/02/2021 Meeting minutes	Perenco confirmed that DEP interactions with the Waveney gas platform and its associated activities are of potential concern. A helicopter visits Waveney approximately once per month and Perenco requested information about turbine dimensions and locations in order to understand possible implications for helicopter approach to the platform.	The Applicant will continue consultation with Perenco and provide necessary project information. An independent assessment of potential helicopter and marine vessel access impacts has been commissioned; however, conclusions will not be available until after PEIR submission (see **Chapter 18**).

17.3 Scope

17.3.1 Study Area

7. Whilst not definitive, Civil Aviation Authority's (CAA) CAP 764 Policy and Guidelines on Wind Turbines (CAA, 2016a) provide criteria for assessing whether any wind turbine development might have an impact on civil aerodrome related operations. Consideration of the potential for DEP or SEP to impact on aviation receptors has been undertaken in accordance with the standard consultation distances stated in CAP 764. The study area is therefore defined in line with the CAP 764 consultation zones or criteria which considers the following:

- Within 30 kilometres (km) of an aerodrome with surveillance radar – although it is acknowledged that the distance quoted in CAP 764 can be greater than 30km dependent on a number of factors at individual aerodromes, including type and coverage of radar utilised; this has been considered in the assessment of radar effect.
- Airspace coincident with published Instrument Flight Procedures (IFP) to take into account an aerodrome's requirement to protect its IFPs; however there is no such airspace within the vicinity of the DEP and SEP wind farm sites.
- Within 17km of a non-radar equipped licensed aerodrome with a runway of 1,100 metres (m) or more; there are no such aerodromes within 17km of the DEP and SEP wind farm sites.

8. The study area therefore encapsulates the airspace between the wind farm sites, the UK mainland from Norwich Airport and military radar equipped aerodromes which are capable of detecting DEP and SEP including RAF Marham to the south, the Brizlee Wood ADR to the north and RAF Coningsby and NATS Claxby PSRs located to the west and northwest onshore. Error! Reference source not found. provides an illustration of the aviation and radar study area, which encompasses the offshore wind farm sites and offshore cable corridors (PEIR boundary).

9. Specifically, the study area covers:

- Military ADR and aerodrome PSR systems on the eastern coast of England within operating range of the DEP and SEP wind farm sites with the potential to detect operational wind turbines at a maximum blade tip height of 330m amsl (which is within tolerance of the worst-case scenario of 330m to Highest Astronomical Tide (HAT);
- Civil Airports operating PSR within operating range of the offshore arrays;
- NATS En-route PSR systems;
- HMR located in the proximity of the offshore array areas;
- Offshore oil and gas platforms fitted with a helideck that have a 9 Nautical Mile (NM) 'consultation buffer' that overlap with the offshore wind farm array areas; and
- Littoral MOD assets within Statutory Technical Safeguarding range of any landfall elements of the onshore cable route.

10. The study area remains the same for undertaking the assessment of cumulative effects, except for the assessment of radar cumulative effects which includes other offshore wind farms in the SNS that could have potential cumulative effects on identified radar receptors.

11. The Study Area may be reviewed and amended following consultation responses, or as a result of any amendments to the array areas, and in accordance with any identification of additional constraints (environmental, technical and/or engineering).

17.3.2 Realistic Worst-Case Scenario

17.3.2.1 General Approach

12. The final design of DEP and SEP will be confirmed through detailed engineering design studies that will be undertaken post-consent to enable the commencement of construction. In order to provide a precautionary but robust impact assessment at this stage of the development process, realistic worst-case scenarios have been defined in terms of the potential effects that may arise. This approach to EIA, referred to as the Rochdale Envelope, is common practice for developments of this nature, as set out in Planning Inspectorate Advice Note Nine (2018). The Rochdale Envelope for a project outlines the realistic worst-case scenario for each individual impact, so that it can be safely assumed that all lesser options will have less impact. Further details are provided in **Chapter 6 EIA Methodology**.

13. The realistic worst-case scenarios for the Aviation and Radar assessment are summarised in **Table 17-2**. These are based on the project parameters described in **Chapter 5 Project Description**, which provides further details regarding specific activities and their durations.

14. In addition to the design parameters set out in **Table 17-2**, consideration is also given to how the DEP and SEP will be built out as described in **Section 17.3.2.2** to **Section 17.3.2.4** below. This accounts for the fact that whilst DEP and SEP are the subject of one DCO application, it is possible that either one or both DEP and SEP will be developed, and if both are developed, that construction may be undertaken either concurrently or sequentially.

Table 17-2: Realistic Worst Case Scenarios.

Impact	DEP in Isolation	SEP in Isolation	DEP & SEP Together	Notes and Rationale
Construction				
Impact 1: Creation of an obstacle to fixed wing and rotary aircraft operating offshore.	**Wind farm sites:** Two wind farm sites totaling **103.5km²** Installation of up to **32 turbines** (between 17 and 32 ranging from 14MW to 26MW) and **1 Offshore Substation Platform** (OSP) in DEP North Maximum turbine blade tip height: **330m** (relative to HAT) **Maximum temporal footprint** • Duration of offshore construction: **2 years**	**Wind farm site:** One wind farm site totaling **92.6km²** Installation of up to **24 turbines** (between 13 and 24 ranging from 14MW to 26MW) and **1 OSP** comprising in the SEP wind farm site Maximum turbine blade tip height: **330m** (relative to HAT) **Maximum temporal footprint** • Duration of offshore construction: **2 years**	**Wind farm sites:** Three farm sites totaling **196.1km²** (DEP North, DEP South and SEP). Installation of up to **56 turbines** (between 30 and 56 ranging from 14MW to 26MW) and 2 OSPs in DEP North and SEP wind farm sites (if projects are built in a separated grid option) Maximum turbine blade tip height: **330m** (relative to HAT) **Maximum temporal footprint** • Duration of offshore construction: **4 years** if built sequentially with a maximum gap of 1 year	Maximum number of wind turbines in the wind farm sites. Maximum physical obstruction to aviation operations due to size and number of above sea level infrastructure within the wind farm sites. Impact starting from a point of no infrastructure present to full presence over the construction period.

Impact	DEP in Isolation	SEP in Isolation	DEP & SEP Together	Notes and Rationale
Impact 2: Interference to the RAF Weybourne Transmitter.	Weybourne Transmitter site location is approximately 346m from the onshore cable corridor at its closest point (within safeguarded area).			Construction infrastructure can interrupt the radio signal transmitted.
Operation				
Impact 1: Creation of an obstacle to fixed wing and rotary aircraft operating offshore.	As for construction impact 1 **Maximum temporal footprint: 35 year operational period**	As for construction impact 1 **Maximum temporal footprint: 35 year operational period**	As for construction impact 1 **Maximum temporal footprint: 35 year operational period**	Maximum physical obstruction to aviation operations due to size and number of structures above sea level within the wind farm sites.
Impact 2: Wind turbines causing permanent interference on civil and military radar systems.	As for operation impact 1	As for operation impact 1	As for operation impact 1	ATC and Air Defence controllers may be unable to provide an effective surveillance service due to interference on radar displays.
Impact 3: Wind turbines creating an impact to offshore helicopter operations to oil and gas platforms equipped with a helideck.	As for operation impact 1	As for operation impact 1	As for operation impact 1	DEP North is located within the Helicopter Traffic Zone (HTZ) for the Waveney Field. Wind turbines could create a physical obstruction to aviation operations.

Impact	DEP in Isolation	SEP in Isolation	DEP & SEP Together	Notes and Rationale
Impact 4: Disruption to aircraft using HMRs.	As for operation impact 1 HMR 5 crosses DEP North. HMR 4 crosses DEP South. HMR 3 passes within 1.5 NM of DEP South	As for operation impact 1	As for operation impact 1 HMR 5 crosses DEP North. HMR 4 crosses DEP South. HMR 3 passes within 1.5 NM of DEP South	Wind turbines could create a physical obstruction to aviation operations.
Decommissioning				
Impact 1: Creation of an obstacle to fixed wing and rotary aircraft operating offshore.	As for construction impact 1	As for construction impact 1	As for construction impact 1	Maximum number of wind turbines in the wind farm sites. Maximum physical obstruction to aviation operations due to size and number of above sea level infrastructure within the wind farm sites.

17.3.2.2 Construction Scenarios

15. The following principles set out the framework for how DEP and SEP may be constructed:
    - DEP and SEP may be constructed at the same time, or at different times;
    - If built at the same time both projects could be constructed in four years, with offshore construction being undertaken over two years (likely years three and four) of the overall construction period;
    - If built at different times, either project could be built first;
    - If built at different times the first project would require a four-year period of construction including a two year offshore construction period, the second project a three-year period of construction including a two year offshore construction period;
    - If built at different times, the duration of the gap between start of construction of the first project, and the start of construction of the second project may vary from two to four years;
        - If the gap between the projects is less than two years, the first project would wait for the second project in order to be constructed together;
    - Assuming maximum construction periods, and taking the above into account, the maximum period over which the construction of both projects could take place is seven years; and
    - The earliest construction start date is 2024 and the latest is 2028.
16. In order to determine which construction scenario presents the realistic worst case for each receptor and impact, the assessment considers both maximum duration effects and maximum peak effects, in addition to each project being developed in isolation, drawing out any differences between DEP and SEP.
17. The three construction scenarios considered by the Aviation and Radar assessment are therefore:
    - Build DEP or build SEP in isolation;
    - Build DEP and SEP concurrently – reflecting the maximum peak effects; and
    - Build one project followed by the other with a gap of up to four years between the start of construction on each (sequential) – reflecting the maximum duration of effects. This would result in a maximum gap in offshore construction of one year.
18. Any differences between DEP and SEP, or differences that could result from the manner in which the first and the second Projects are built (concurrent or sequential and the length of any gap) are identified and discussed where relevant in the impact assessment section of this chapter (**Section 17.6**). For each potential impact only the worst-case construction scenario for two projects is presented, i.e. either concurrent or sequential. The justification for what constitutes the worst case is provided, where necessary, in **Section 17.6**.

17.3.2.3 Operation Scenarios

19. The assessment considers the following three operation scenarios:
    - Only DEP in operation;
    - Only SEP in operation; and
    - The two projects operating at the same time, with a gap of up to three years between each project commencing operation.

20. The operational lifetime of each project is expected to be 35 years.

17.3.2.4 Decommissioning Scenarios

21. Decommissioning scenarios are described in detail in **Chapter 5 Project Description**. Decommissioning arrangements will be agreed through the submission of a Decommissioning Plan prior to construction, however for the purpose of this assessment it is assumed that decommissioning of DEP and SEP could be conducted separately, or at the same time.

17.3.3 Summary of Mitigation Embedded in the Design

22. This section outlines the embedded mitigation relevant to the Aviation and Radar assessment, which has been incorporated into the design of the projects (**Table 17-3**). Where other further mitigation measures are proposed, these are detailed in the impact assessment (**Section 17.6**).

Table 17-3: Embedded Mitigation Measures

Parameter	Mitigation Measures Embedded into the Project Design
General	
Layout and Regularity	The projects will ensure compliance with the MCA Marine Guidance Note Maritime Guidance Note (MGN) 543 Safety of Navigation Offshore Renewable Energy Installations (OREIs) - Guidance on UK Navigational Practice, Safety and Emergency Response where appropriate and CAPs 393, 764 and 437.
Lighting and Marking	Aids to navigation (marking and lighting) will be deployed in accordance with the latest relevant available standard industry guidance and as advised by Trinity House, MCA, CAA and the MOD as appropriate.
Other	
Notification	The Defence Geographic Organisation (DGC) will be informed of the locations, heights and lighting status of the wind turbines, including estimated and actual dates of construction and the maximum height of any construction equipment to be used, prior to the start of construction, to allow inclusion on Aviation Charts.

17.4 Impact Assessment Methodology

17.4.1 Policy, Legislation and Guidance

17.4.1.1 National Policy Statements

23. The assessment of potential impacts upon Aviation and Radar has been made with specific reference to the relevant National Policy Statements (NPS). These are the principal decision making documents for Nationally Significant Infrastructure Projects (NSIPs). Those relevant to DEP and SEP are:

- Overarching NPS for Energy (EN-1) (Department of Energy and Climate Change (DECC) 2011a);
- NPS for Renewable Energy Infrastructure (EN-3) (DECC 2011b); and
- NPS for Electricity Networks Infrastructure (EN-5) (DECC 2011c).

24. The specific assessment requirements for Aviation and Radar, as detailed in the NPS, are summarised in **Table 17-4** together with an indication of the section of the PEIR chapter where each is addressed.

Table 17-4: NPS Assessment Requirements.

NPS Requirement	NPS Reference	Section Reference
En-1 NPS for Energy (EN-1)		
If the proposed development could have an effect on civil and military aviation (and/or other defence assets) an assessment of potential effects should be set out in the ES.	Paragraph 5.4.10 of EN-1	Construction, operation and decommissioning phases of the Projects have been assessed within the impact assessment at **Section 17.6**.
Consultation with the MOD, the CAA and NATS and any aerodrome - licensed or otherwise – likely to be affected by the proposed development should be completed.	Paragraph 5.4.11 of EN-1	Consultation activity is provided in **Table 17-1**.
Any assessment of aviation or other defence interests should include potential impacts of the project upon the operation of Communication, Navigation or Surveillance (CNS) infrastructure, flight patterns (both civil and military), other defence assets and aerodrome operational procedures. It should also assess the cumulative effects of the project with other relevant projects in relation to aviation and defence.	Paragraph 5.4.12 of EN-1	The assessment of civil and military aviation flight patterns and infrastructure is provided in **Section 17.6;** and cumulative impacts within **Section 17.7**.

17.4.1.2 Other

25. In addition to the NPS, legislation, policy and guidance applicable to the assessment of Aviation and Radar includes:

- CAA Civil Aviation Publication (CAP) 168: Licensing of Aerodromes (CAA, 2019): Sets out the standards required at UK licensed aerodromes relating to its management systems, operational procedures, physical characteristics, assessment and treatment of obstacles, and visual aids.
- CAA CAP 393: The Air Navigation Order (ANO) 2016 and Regulations (CAA, 2019a): Sets out the provisions of the ANO as amended together with regulations made under the Order. It is prepared for those concerned with day to day matters relating to air navigation that require an up to date version of the air navigation regulations and is edited by the Legal Advisers Department of the CAA. CAP 393 also includes application of aviation obstruction lighting to wind turbines in UK territorial waters.
- CAA CAP 764 Policy and Guidelines on Wind Turbines (CAA, 2016): Provides assistance to aviation stakeholders to help understand and address wind energy related issues thereby ensuring greater consistency in the consideration of the potential impact of proposed wind farm developments.
- CAA CAP 437: Standards for Offshore Helicopter Landing Areas (CAA, 2018): Provides the criteria applied by the CAA in assessing helicopter landing areas for worldwide use by helicopters registered in the UK. It includes design of winching area arrangements located on wind turbine platforms to represent current best practice.
- CAA CAP 670: Air Traffic Services Safety Requirements (CAA, 2019b): Sets out the safety regulatory framework and requirements associated with the provision of an Air Traffic Service (ATS).
- CAP 1616: Airspace Design: Guidance on the regulatory process for changing airspace design including community engagement requirements (CAA, 2020): Sets out the regulatory framework for the conduct of an Airspace Change Project.
- Information regarding construction should be passed to DGC (at dvof@mod.gov.uk) at least 10 weeks in advance of the obstacle type(s) erection, position, height (tip of arc) and type of aviation lighting. Once reported, all will be included in the DGC Obstruction database and all that meet chart inclusion criteria will be published for broader awareness.
- Appropriate information about the site construction and any associated lighting (where applicable), for example the height and temporary location of construction cranes, should be provided to the UK Aeronautical Information Service (NATS Aeronautical Information Service (AIS)) for promulgation in applicable aviation publications including the UK Integrated Aeronautical Information Package (IAIP).

17.4.2 Data and Information Sources

26. The data used in this chapter are the most up to date publicly available information which can be obtained from the data sources as cited. Sources that have been used to inform the assessment are listed in **Table 17-5**.

Table 17-5: Other available data and information sources.

Data set	Spatial coverage	Year
CAA Visual Flight Rules Charts.	Offshore Study Area	2020
MOD Military Aeronautical Information Publication (Mil AIP).	Offshore Study Area	2020
CAA CAP 032: UK IAIP.	Offshore Study Area	2020
MCA MGN 543 Safety of Navigation Offshore Renewable Energy Installations (OREIs) - Guidance on UK Navigational Practice, Safety and Emergency Response.	Offshore Study Area	2016

17.4.3 Impact Assessment Methodology

27. **Chapter 6 EIA Methodology** provides a summary of the general impact assessment methodology applied to DEP and SEP. The following sections confirm the methodology used to assess the potential impacts on Aviation and Radar which is consistent with that presented in Section 1.6 of the Scoping Report (Equinor, 2019).

17.4.3.1 Definitions

28. For each effect, the assessment identifies receptors sensitive to that effect and implements a systematic approach to understanding the impact pathways and the level of impacts on given receptors. The definitions of sensitivity and magnitude for the purpose of the Aviation and Radar assessment are provided in **Table 17-6** and **Table 17-7**.

Table 17-6: Definition of sensitivity for an Aviation and Radar receptor

Sensitivity	Definition
High	Receptor provides a service which is of high value to the local, regional or national economy, and/or the receptor is generally vulnerable to impacts that may arise from the projects, and/or recoverability is slow and/or costly.
Medium	Receptor provides a service which is of moderate value to the local, regional or national economy, and/or the receptor is somewhat vulnerable to impacts that may arise from the projects, and/or has moderate to high levels of recoverability.
Low	Receptor provides a service which is of low value to the local, regional or national economy, and/or the receptor is not generally vulnerable to impacts that may arise from the projects, and/or has high recoverability.

Sensitivity	Definition
Negligible	Receptor provides a service which is of negligible value to the local, regional or national economy, and/or the receptor is not vulnerable to impacts that may arise from the projects, and/or has high recoverability.

Table 17-7: Definition of magnitude

Magnitude	Definition
High	Total loss of ability to carry on activities and/or impact is of extended physical extent and/or long term duration (i.e. total life of project and/or frequency of repetition is continuous and/or effect is not reversible for the projects).
Medium	Loss or alteration to significant portions of key components of current activity and/or physical extent of impact is moderate and/or medium term duration (i.e. operational period) and/or frequency of repetition is medium to continuous and/or effect is not reversible for the project phase.
Low	Minor shift away from baseline, leading to a reduction in level of activity that may be undertaken and/or physical extent of impact is low and/or short to medium term duration (i.e. construction period) and/or frequency of repetition is low to continuous and/or effect is not reversible for the projects phase.
Negligible	Very slight change from baseline condition and/or physical extent of impact is negligible and/or short- term duration (i.e. less than two years) and/or frequency of repetition is negligible to continuous and/or effect is reversible.

17.4.3.2 Impact Significance

29. In basic terms, the potential significance of an impact is a function of the sensitivity of the receptor and the magnitude of the effect (see **Chapter 6 EIA Methodology** for further details). The determination of significance is guided by the use of an impact significance matrix, as shown in **Table 17-8**. Definitions of each level of significance as they apply to aviation and radar receptors are provided in **Table 17-9**.

30. Potential impacts identified within the assessment as major or moderate are regarded as significant in terms of the EIA regulations. Where appropriate, the acceptability in regard to the provision of an ATS safety is also highlighted. Appropriate mitigation has been identified, where possible, in consultation with the regulatory authorities and relevant stakeholders. The aim of mitigation measures is to avoid or reduce the overall impact in order to determine a residual impact upon a given receptor.

Table 17-8: Impact significance matrix

		Adverse Magnitude				Beneficial Magnitude			
		High	Medium	Low	Negligible	Negligible	Low	Medium	High
Sensitivity	High	*Major*	*Major*	*Moderate*	*Minor*	*Minor*	*Moderate*	*Major*	*Major*
	Medium	*Major*	*Moderate*	*Minor*	*Minor*	*Minor*	*Minor*	*Moderate*	*Major*
	Low	*Moderate*	*Minor*	*Minor*	*Negligible*	*Negligible*	*Minor*	*Minor*	*Moderate*
	Negligible	*Minor*	*Negligible*	*Negligible*	*Negligible*	*Negligible*	*Negligible*	*Negligible*	*Minor*

Table 17-9: Definition of impact significance

Significance	Definition
Major	Very large or large change in receptor condition, both adverse or beneficial, which are likely to be important considerations at a regional or district level because they contribute to achieving national, regional or local objectives, or could result in exceedance of statutory objectives and / or breaches of legislation.
Moderate	Intermediate change in receptor condition, which are likely to be important considerations at a local level.
Minor	Small change in receptor condition, which may be raised as local issues but are unlikely to be important in the decision making process.
Negligible	No discernible change in receptor condition.
No change	No impact, therefore, no change in receptor condition.

17.4.4 Cumulative Impact Assessment Methodology

31. The Cumulative Impact Assessment (CIA) considers other plans, projects and activities that may impact cumulatively with DEP and SEP. As part of this process, the assessment considers which of the residual impacts assessed for DEP and/or SEP on their own have the potential to contribute to a cumulative impact, the data and information available to inform the cumulative assessment and the resulting confidence in any assessment that is undertaken. **Chapter 6 EIA Methodology** provides further details of the general framework and approach to the CIA.

32. For Aviation and Radar, these activities include impacts from the DEP and SEP considered alongside those from other developments. This includes all projects that are likely to result in comparable effects on aviation and radar receptors that are not intrinsically considered as part of the existing environmental baseline.

17.4.5 Transboundary Impact Assessment Methodology

33. The transboundary assessment considers the potential for transboundary effects to occur on Aviation and Radar receptors as a result of DEP and SEP; either those that might arise within the Exclusive Economic Zone (EEZ) of European Economic Area (EEA) states or arising on the interests of EEA states. **Chapter 6 EIA Methodology** provides further details of the general framework and approach to the assessment of transboundary effects.

34. As set out in **Table 17-1** above, the potential for transboundary effects an aviation and radar receptors has been scoped out due to the locations of DEP and SEP entirely within UK waters/airspace (The Planning Inspectorate, 2019).

17.4.6 Radar Line of Sight (LOS) Analysis

17.4.6.1 Process of the Radar Line of Sight (LOS) Analysis

35. The Advanced Topographic Development and Imaging (ATDI) ICS LT tool has been used by Osprey to model the terrain elevation profile between the radar systems identified in the study area and the DEP and SEP wind farm sites. Otherwise known as point-to-point LOS analysis, the result is a graphical representation of the intervening terrain and the direct signal LOS (taking into account earth curvature and radar signal properties). Osprey used a generic grid pattern distribution of wind turbines with a blade tip height of 330m amsl across the wind farm site areas to complete the analysis.

36. The LOS analysis is designed to give an indication of the likelihood of the wind turbines being detected such that the operational significance of the DEP and SEP wind farm sites relative to nearby aviation radar assets can be assessed. The radar LOS analysis is completed at a wind turbine height of 330m amsl. The project wind turbines are referred to in the worst-case scenario as measured above HAT. The difference between the measurements will not affect the results of the radar LOS analysis. The radar LOS images for assessed radar systems are provided in **Appendix 17.1.**

17.4.6.1.1 Qualitative Definitions of the Radar LOS Analysis

37. The qualitative definitions used in the LOS assessment are defined in **Table 17-10**.

Table 17-10: Qualitative Definitions of Radar LOS Results

Result	Definition
Highly Likely	The wind turbine is highly likely to be detected by the radar: Direct LOS exists between the radar and the turbine.
Likely	The wind turbine is likely to be detected by the radar at least intermittently.
Unlikely	The wind turbine is unlikely to be detected by the radar but cannot rule out occasional detection.
No	The wind turbine is unlikely to be detected by the radar as significant intervening terrain exists.

17.4.7 Assumptions and Limitations

38. The LOS analysis is a limited and theoretical desk-based study; in reality there are unpredictable levels of signal refraction, diffraction and attenuation within a given radar environment that can influence the probability of an operational wind turbine being detected.

17.5 Existing Environment

17.5.1 Radar

39. Radar operates by alternately transmitting a stream of high-power radio frequency pulses and 'listening' to echoes received back from reflective objects within its coverage. The amount of energy that an object reflects back is related to the object's Radar Cross Section (RCS) which is proportionate to the physical size of the object. Generally, radars employ a rotating antenna which provides 360° coverage subject to terrain and other blocking infringements. The target range is measured based on the overall time taken for the transmitted pulse to arrive back at the receiver. The azimuth of the target is derived from the position of the antenna against a north reference point and where the pulse under consideration is the strongest in signal amplitude.

40. All radars employ processing techniques to reduce or remove targets that are unwanted, for example echoes from birds or fixed structures. These echoes are commonly known as 'clutter'. One key technique is to identify whether a target is moving or not, this is done through Doppler processing where the phase of the pulse is assessed against the transmitted pulse. If the phases are different then the target is moving.

Air Traffic Service (ATS)

41. Typically, ATS systems employ a cosec2 antenna which produces two beams (low and high). The two beams give a capability to reduce fixed ground clutter in the immediate area of the radar. These systems provide target detection in range and azimuth only and are generally known as 2 dimensional (2D) radars.

Air Defence Radar (ADR)

42. ADR systems typically employ complex rotating phased array antennas. The antennas produce many smaller 'pencil' beams which are stacked in elevation, this allows the system to process the received targets signal strength in each of the pencil beams, which in turn gives the radar the ability to provide an indication of the coarse height of a target as well as its range and azimuth. These types of radar are generally referred to as 3 dimensional (3D) systems.

43. The rotation rate of a radars antenna directly impacts upon the range achievable, the target update rate and the ability to resolve targets that are close together.

Primary Surveillance Radar (PSR)

44. A PSR such as the type in use at aerodromes across the UK has no height finding capability and as such the Air Traffic Control Officer (ATCO) relies on Secondary Surveillance Radar (SSR) for this purpose. SSR is a collaborative radar system which means that the radar will 'interrogate' a transponder on the aircraft for useful information such as altitude and heading, which is then passed to the ATC display console. All military aircraft (and most civilian aircraft) carry transponders which respond to secondary radar interrogation.

17.5.1.1 Background to Wind Turbine Effects on Aviation Radar

45. Radar detectable wind turbines are a significant cause of radar false plots, or clutter, as the rotating blades can trigger the Doppler threshold (e.g. minimum shift in signal frequency) of the Radar Data Processor (RDP) and therefore may be interpreted as aircraft targets. Significant effects have been observed on radar sensitivity caused by the substantial size and RCS of the wind turbine structural components (blades, tower and nacelle) which can exceed that of a large aircraft. The effect 'blinds' the radar (or the operator) to required targets in the immediate vicinity of the wind turbine. False plots and reduced radar sensitivity may reduce the effectiveness of radar to an unacceptable level and compromise the provision of a safe radar service to participating aircraft and detection of aircraft targets.

46. Stationary objects do not cause an effect to radar systems as radar processing techniques remove stationary objects from the radar display; therefore, radar detectable wind turbines only create effect to radar once they are in operation and rotational.

47. Generally, the larger a wind turbine is, the larger its RCS will be to a radar. This results in more energy being reflected and an increased chance of it creating unwanted returns (clutter). This clutter will be processed by the radar and presented to the ATCO on their Radar Data Display Screens (RDDS). Additionally, the blades of wind turbines rotate which give an indication that the target is moving with respect to the radar and thus defeating Doppler processing techniques. This issue can be further compounded by a large number of wind turbines located together which cause a cumulative effect over a greater volume with higher densities of clutter produced.

48. The generalised effects wind turbines have on radar systems are as follows:

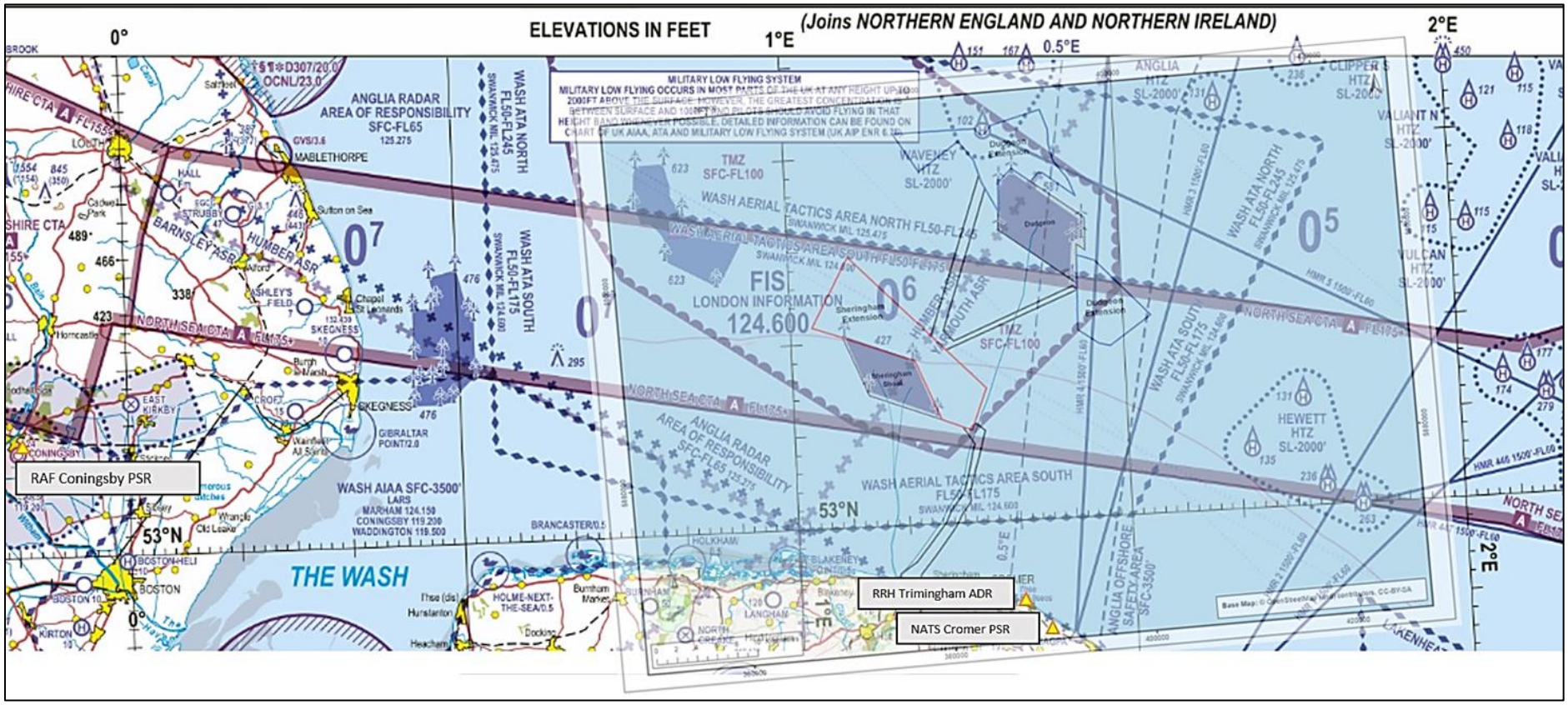
- Twinkling appearance/blade flash effect which can distract a controller;
- Masking of true aircraft targets by increased clutter on an RDDS;
- Increase in unwanted targets or false aircraft tracks;
- Receiver saturation;
- Target desensitisation causing loss of valid targets that are of a small RCS;
- Shadowing behind the wind turbines caused by physical obstruction (blocking of radar transmitted signal);
- Degradation of tracking capabilities including track seduction; and
- Degradation of target processing capability and processing overload.

49. Without specific wind turbine mitigation processing capabilities, radars cannot distinguish between returns from wind turbines (false returns, or 'clutter') and those from aircraft. ATCOs and Air Defence Controllers are required to assume that actual aircraft targets could be lost over the location of a wind farm; furthermore, identification of aircraft under control could be lost or interrupted. It is mainly for the above reasons that aviation radar system operators object to wind farm developments that are within LOS of their radar systems.

17.5.2 Airspace

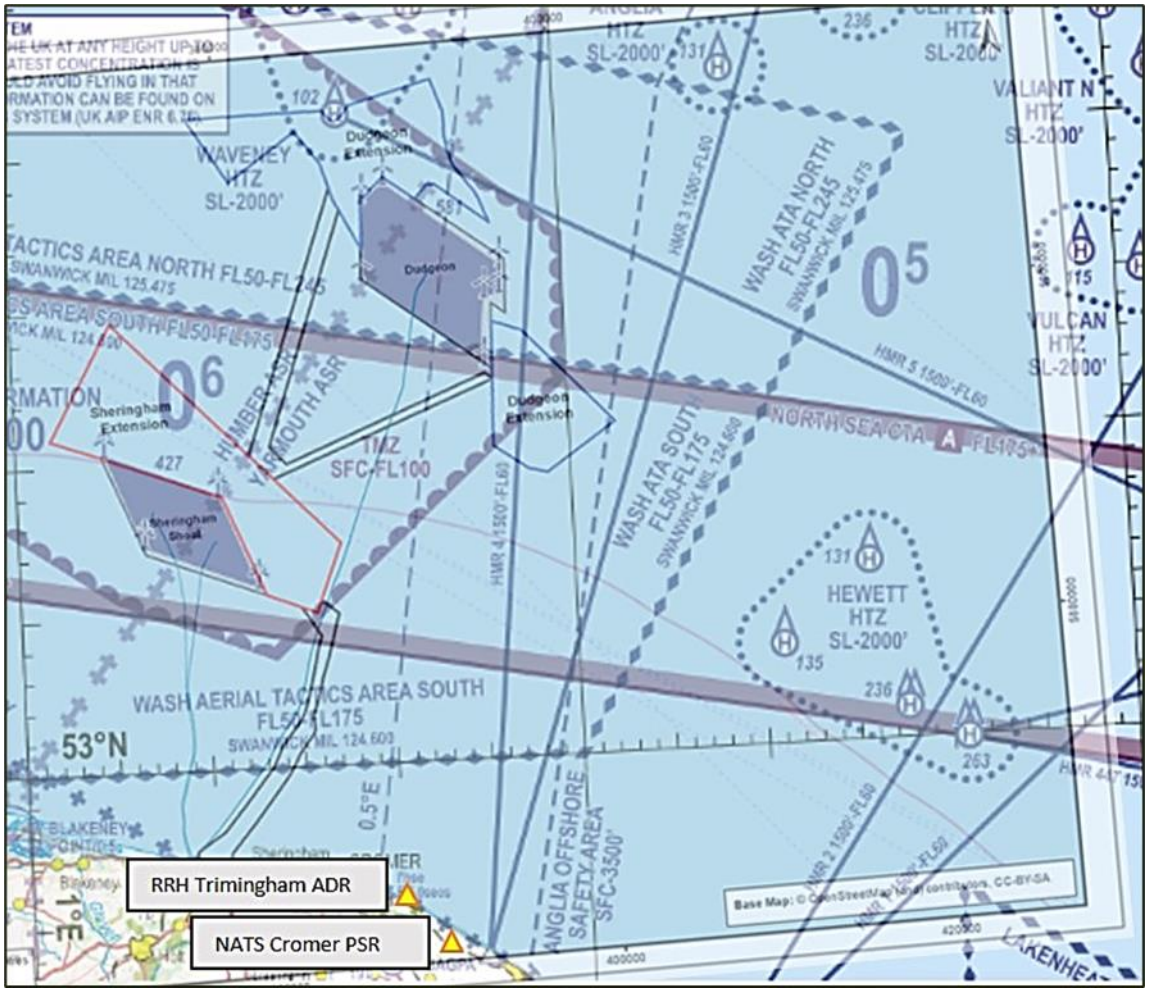
50. An enlarged illustration of the baseline environment including littoral areas for the Projects is provided in **Plate 17.1**

Plate 17-1: Airspace Baseline Environment



51. The DEP and SEP offshore wind farm sites will be located beneath complex airspace above the SNS characterised by military exercise areas, restrictive airspace, airways, and offshore helicopter platforms and transit routes as shown in a Visual Flight Rules[2] (VFR) aviation chart in **Plate 17-2.**

Plate 17-2: Airspace, HMRs and gas platforms with helipads



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52. The airspace within, above and surrounding the DEP and SEP wind farm sites is used by both military and civil registered aircraft which observe the airspace rules according to the classification of airspace they are operating in as follows:

- Glass G uncontrolled airspace: any aircraft can operate in an area of uncontrolled airspace without any mandatory requirement to be in communication with ATC. Pilots of aircraft operating under VFR in Class G airspace are ultimately responsible for seeing and avoiding other aircraft, terrain and obstructions.

[2] Visual Flight Rules - A set of regulations under which a pilot operates an aircraft in weather conditions clear enough to allow the pilot to see where the aircraft is going; the pilot must be able to operate the aircraft with visual reference to the ground, and by visually avoiding obstructions and other flying machines.

- Class A and C Controlled Airspace (CAS): all aircraft operating in this airspace must be in receipt of an ATS.

17.5.2.1 Military Operations within Practice and Exercise Area (PEXA)

53. The Wash ATA North and South (**Plate 17-2**:) is used intensively by military aircraft for tactical training above the SNS. Aircraft whilst in receipt of an Air Traffic Service will be under the control of air defence controllers utilising ADR, air traffic controllers utilising NATS radar systems at the Swanwick ACC or airborne assets. When the exercise areas are not required for specific military training or exercise use, the airspace is then available for use by civil and military en-route operations.

54. Airborne activity in PEXA may be affected by obstructions created by the physical presence of wind turbines. However, as the base level of the PEXA (FL50) is well above the height of the wind turbine blade tips there will be no direct obstruction created to airborne activities concluded in PEXAs. Effects on PEXA are confined to possible interference with radar due to detection of operational wind turbines.

17.5.2.2 National Air Traffic System (NATS)

55. Above 17,500ft (FL195) (and lower levels of en-route Controlled Air Space CAS), NATS En-route Limited (NERL) (which is a subsidiary of NATS) are the main ATS provider utilising a network of long-range radar systems (PSR and SSR) positioned to provide maximum coverage of UK airspace. Additionally, NATS has a licence obligation to provide radar data to other remote aviation stakeholders to a high quality and performance standard for the benefit of UK aviation. Any effect that DEP and SEP will have on NERL radar systems must be considered both in terms of effect on the civilian en-route services and in the context of its remote users such as Anglia Radar and the MOD.

17.5.2.3 Claxby and Cromer

56. Claxby and Cromer NATS are located within the study area and close enough for turbines to be detectable on primary surveillance radar.

17.5.2.4 Anglia Radar

57. Anglia Radar, based at Aberdeen Airport and employing NATS PSR systems, has its area of responsibility established for the provision of ATC services to helicopter operations that support the offshore oil and gas industry and other aircraft, from the surface up to approximately 6,500ft (FL 65).

17.5.2.1 RAF Coningsby

58. RAF Coningsby PSR in Lincolnshire is a Quick Reaction Alert Stations which protect UK airspace is located with the study area as is close enough for turbines to be detectable on primary surveillance radar.

17.5.2.2 Norwich Airport

59. Norwich Airport operates a PSR that provides radar coverage in the airspace above the DEP and SEP wind farm sites and an Air Traffic Service to the helicopter operations servicing oil and gas activities in the SNS (including the HMRs in the vicinity of the DEP and SEP wind farm sites). Further away from the airport this responsibility is transferred to Anglia Radar who utilise NATS radar systems. Norwich Airport also receives radar data from the NATS Cromer PSR system (**Plate 17.1**) and provides a Lower Airspace Radar Service (LARS) to those aircraft requesting it within radar and radio coverage.

17.5.2.3 Air Defence Radar (ADR)

60. The RAF is responsible for the UK's Air Surveillance and Control System which is part of the ADR network. The Trimingham ADR system on the North Norfolk coast (**Plate 17-1**: Airspace Baseline Environment

61.) is close enough to DEP and SEP that the turbines could be detectable on primary surveillance radar (Radar LOS analysis detailed in **Section 17.6.2.2**).

17.5.2.4 Met Office Radar

62. The safeguarded Met Office weather radar network currently consists of 16 sites. The Met Office employs wind turbine safeguarding guidelines that may result in an objection for any development within 20km of any affected weather radar.

63. There are no weather radar stations within 20km of the DEP and SEP wind farm sites and therefore Met Office radar is scoped out.

17.5.2.5 SEP Airspace Baseline Environment

64. The airspace immediately surrounding the SEP wind farm site is classified as a Greater Wash Transponder Mandatory Zone (TMZ) established to mitigate the impact of the existing Sheringham Shoal and Dudgeon Offshore Wind Farms on aviation radar systems. The TMZ extends from the sea surface up to Flight Level (FL) 100 (or 10,000 feet (ft)) amsl and adopts the classification of airspace in which it is located (Class G in this case) however, no aircraft may fly within the TMZ without operating a serviceable transponder.

65. Above the TMZ is airspace associated with military exercises; the Wash Aerial Tactics Area (ATA) South is Class G airspace which extends above the SEP wind farm site between FL50 (5,000ft) and FL175 (17,500ft) amsl. Crossing the site above FL175 (17,500ft) is an airway designated North Sea Control Area, Class A airspace. Air Navigation Services (ANS) in the area are provided by NATS and military controllers based at the Swanwick Area Control Centre (ACC).

66. The southern edge of the SEP wind farm site is located approximately 6.5NM west of HMR 4, sufficiently far that the HMR will not be impacted by SEP. There are no offshore platforms with helidecks located within 9NM of the SEP wind farm site (within the CAA recommended[3] 9NM consultation zone) (**Plate 17-2**:).

[3] CAP 764 CAA Policy and Guidelines on Wind Turbines (CAA, 2016) provides guidance to developers to include installation operators, helicopter operators and other interested parties in the consultation process.

17.5.2.6 DEP Airspace Baseline Environment

67. The airspace immediately surrounding DEP North and DEP South is also in the TMZ established to mitigate the impact of the existing Sheringham Shoal and Dudgeon OWFs. However, DEP North and DEP South are not located entirely within the TMZ boundary. The Class G airspace TMZ extends from the surface up to FL100 (or 10,000ft). No aircraft may fly within this area without operating a serviceable transponder.

68. Above the TMZ is airspace associated with military exercises as follows:

- DEP North is located beneath the Wash ATA North which extends between FL50 (5,000ft) and FL245 (24,500ft). DEP South straddles the Wash ATA North and South, which also extends between FL50 (5,000ft) and FL245 (24,500ft), segments (**Plate 17-2**:).
- DEP South is partially beneath the airway designated North Sea Control Area Class A airspace above FL175 (17,500ft). ANS in the area are provided by NATS and military controllers based at the Swanwick ACC.

69. DEP North is located within the Helicopter Traffic Zone (HTZ) for the Waveney Field and the northern boundary of DEP North is approximately 500m from the normally unmanned, Perenco operated Waveney platform. DEP South is located south of the consented Independent Oil and Gas normally unmanned production platform, Blythe, and an additional well, Elgood, to be tied back to Blythe (Independent Oil and Gas, 2019) and located between DEP North and the Dudgeon OWF. Helicopter access is likely to be required from construction and operation of Blythe Hub infrastructure, and consultation will be undertaken as necessary. HTZs are established as notifications of helicopters engaged in platform approaches, departures and extensive uncoordinated inter-platform transit flying. The HTZ is formed of lines of maximum 5NM joining circles of radius 1.5NM around each platform (**Plate 17-2**:).

70. HMR 5 crosses the DEP North array between the southernmost platform in the Waveney field (532109N 0011811E) to the Leman field (530313N 0021358E) (**Plate 17-2**:).

71. HMR 4, which is operated between 1,500ft to FL60 (6,000ft), crosses DEP South. This route is between waypoint BAGPA (525338N 012421E) on the North Norfolk coast and platforms in the Trent Field. The maximum cruise level for helicopters on this route is FL40 (4,000ft) unless cleared by Anglia Radar (NATS) **Plate 17-2**:).

72. HMR 3 passes within 1.5NM of DEP South. This route is between waypoint BAGPA on the North Norfolk coast to platforms in the Munro field (**Plate 17-2**:).

17.5.3 Climate Change and Natural Trends

73. There are no implications related to climate and natural trends on Aviation and Radar.

17.6 Potential Impacts

74. In accordance with the Scoping Opinion (Planning Inspectorate, 2019), the following impacts are scoped out of the assessment:

- Impacts on flight safety for aircraft landing and departing aerodromes due to the distance of DEP and SEP from aerodromes located in the east of England.

- Impacts on airborne activity within PEXA because the PEXA base level is well above the height of the wind turbines.
- Impacts on Meteorological Office weather radar because the DEP and SEP wind farm sites are located outside of the 20km safeguarding area within which there may be an objection to development.

75. Potential impacts on the following receptors are scoped into the assessment:

- Radar and communications
  - RAF Coningsby PSR
  - RRH Trimingham ADR
  - RAF Weybourne transmitter site (a proportion of the onshore cable corridor near landfall falls within the statutory technical safeguarding area, specifically the 'any development height zone')
  - Norwich Airport PSR
  - En-route PSR operated by NATS at Cromer (Norfolk Coast) and Claxby (Lincolnshire)
- Offshore helicopter operations in support of the oil and gas industry including potential impact to HMR
- Airborne low flying SAR flight operations
- Military low flying operations[4].

17.6.1 Potential Impacts during Construction

76. The impacts of the offshore construction of DEP and SEP (as well as the onshore PEIR boundary close to landfall) on aviation and radar have been assessed.

17.6.1.1 Impact 1: Creation of an obstacle to low flying fixed wing and rotary aircraft operating offshore.

17.6.1.1.1 DEP or SEP in Isolation

77. Aviation receptors that are likely to operate in the vicinity of DEP and SEP (helicopter operators, the MOD and ATC service providers) have been consulted with regard to the offshore area defined by the PEIR boundary and the potential for the creation of an obstruction to low flying aircraft operating in the vicinity of construction infrastructure.

[4] Military aircraft are deemed to be low flying at or below 2,000ft above the surface.

78. The construction of either DEP or SEP will create a physical obstruction to flight operations in the vicinity of the projects. Construction infrastructure such as vessels, offshore substation platforms and erected wind turbines can be difficult to see from the air, particularly in poor meteorological conditions, leading to potential increased obstacle collision risk. Furthermore, during the construction phase, the presence and movement of construction infrastructure may present a potential obstacle collision risk to low flying aircraft operations. The MOD commented that in the interest of air safety, DEP and SEP should be fitted with MOD accredited aviation safety lighting in accordance with the Air Navigation Order 2016. The specification of the lighting to be used would be confirmed alongside requirements for NATS (Anglia Radar) and effects to helicopters, MSAs and the HMRs.

79. A range of embedded mitigation measures, in the form of appropriate notification to aviation stakeholders, lighting and marking to minimise effects to aviation flight operations would apply to the development of the projects. These measures will comply with current guidelines and be agreed with the appropriate stakeholders; mitigation measures are outlined in **Table 17-3**.

80. Pilots are obliged to plan their flying activities in advance and to be familiar with any en-route obstacles they may encounter; however, during flight, weather conditions or operational requirements may necessitate route adjustments. In Visual Meteorological Conditions (VMC), pilots are ultimately responsible for seeing and avoiding obstructions such as wind turbines and will be aware through notification of construction activities. Furthermore, when flying in Instrumental Meteorological Conditions (IMC) flying in the construction area pilots will utilise on board radar which detects obstructions and will be under the control of ATC with an appropriate level of radar service. The impact is predicted to be of short-term duration and intermittent. It is predicted that the impact will affect receptors directly, the magnitude of effect is considered to be low.

81. Receptors will be notified of construction activity and therefore the ability of aviation receptors to continue to operate safely in the project construction areas is unaffected. However, as aviation receptors may be required to alter routes to avoid construction areas the sensitivity of the receptors is considered to be medium.

82. The magnitude of effect is deemed to be low; the sensitivity of the receptors is considered to be medium. Therefore, the impact on fixed wing and rotary aircraft operating this the construction area is considered to be of **minor** adverse significance, which is not significant in EIA terms.

17.6.1.1.2 DEP and SEP Together

83. In the event that the DEP and SEP are both constructed the magnitude of effects would be greater and would provide the worst-case scenario, however because there could be more construction activity over a larger area in a concurrent scenario, or effects would last longer if the projects are built sequentially there is no difference between the DEP and SEP together scenarios.

84. As for the construction of DEP or SEP in isolation, pilots would be notified of the extent of the construction area, the period of activity, the lighting and marking of construction infrastructure together with the maximum height of obstruction. Concurrent construction could reduce the low-level airspace that can be operated in and may lead to a funnelling effect of aircraft operating in the same area. Pilots are required to visually acquire and avoid obstructions however, when operating in weather conditions that do not allow visual acquisition, pilots will operate their aircraft above a height that will maintain the required separation from obstacles below them.

85. The magnitude of effect is deemed to be low; the sensitivity of the receptors is considered to be medium. Therefore, the impact will be of **minor** adverse significance, which is not significant in EIA terms.

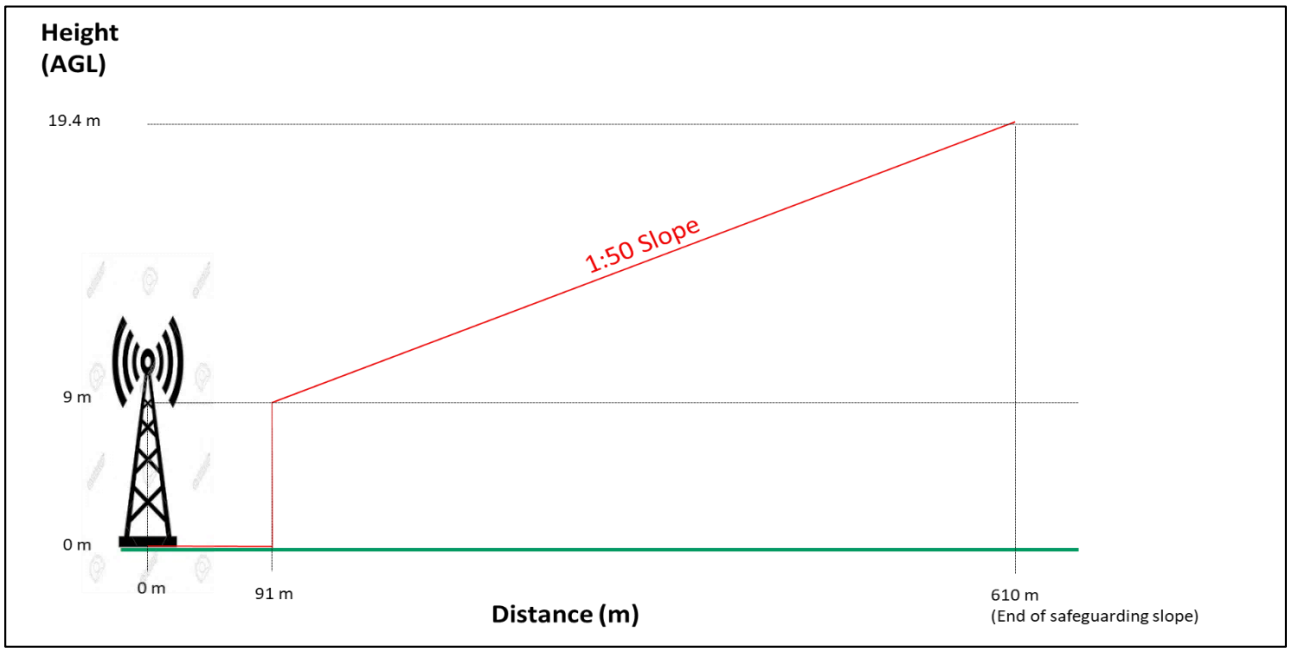
17.6.1.2 Impact 2: Interference to the RAF Weybourne Transmitter

17.6.1.2.1 DEP or SEP in Isolation

86. This section considers the onshore cable corridor and therefore the potential effect applies to construction of both scenarios and is the same for both DEP and SEP. Air-Ground (A/G) communications equipment enables ATC to communicate with aircraft operating in the surrounding area. Communications are critical to flight safety due to ATC reliance upon voice communication for giving instructions and verifying the flight crew confirmation responses. Therefore, technical safeguarding requirements exist to protect communications equipment such as VHF / UHF Transmitters.

87. In the absence of specific manufacturer requirements CAP 670 GEN 02 defines the following technical safeguarding requirement for VHF / UHF Transmitters and Receivers: 'Ground level safeguarding of circle radius 91 m centred on the base of the main aerial tower (or equivalent structure). Additionally, from an elevation of 9 m on this circle a 2% (1:50) slope out to a radius of 610 m'. The A/G communications equipment technical safeguarding area is provided in **Plate 17.3** below.

Plate 17-3: A/G Technical Safeguarded Area



88. The inner safeguarding perimeters are defined by a 91m radius circle (identified in red in **Plate 17.4**) centred on the transmitter mast locations (HF TX 1 and HF TX 2). The outer safeguarding perimeter is defined by a 610m radius circle centred on the masts, identified in orange in **Plate 17.4**.

Plate 17-4: Onshore Cable Search Area (blue line) and Transmitter Safeguarded Areas

89. The area within the red circles illustrated above is safeguarded to ground level so any proposed development within the area of the red safeguarding circles is likely to raise an objection. The orange circles indicate the extent of the outer conical safeguarded areas for each transmitter location based on a 1:50 slope which extends to a radius of 610m from each transmitter. Any construction activity which breaches the height of the slope is likely to raise additional objection.

90. The extent of the onshore cable route search area closest to the transmitter locations is defined by the blue line which stretches along the coastline and extends inland. The shortest distance between TX 1 and the onshore cable route search area is 346m. The shortest distance between TX 2 and the onshore cable route search area is 443m. The western most search area lies underneath the TX 1 and TX 2 safeguarded conical slopes as depicted in **Plate 17.3** and **Plate 17.4** above.

91. **Plate 17.5 and Plate 17.6** below provide illustrations of the safeguarded 1:50 slopes for each transmitter.

Plate 17-5: Profile View of TX 1 Safeguarded Areas

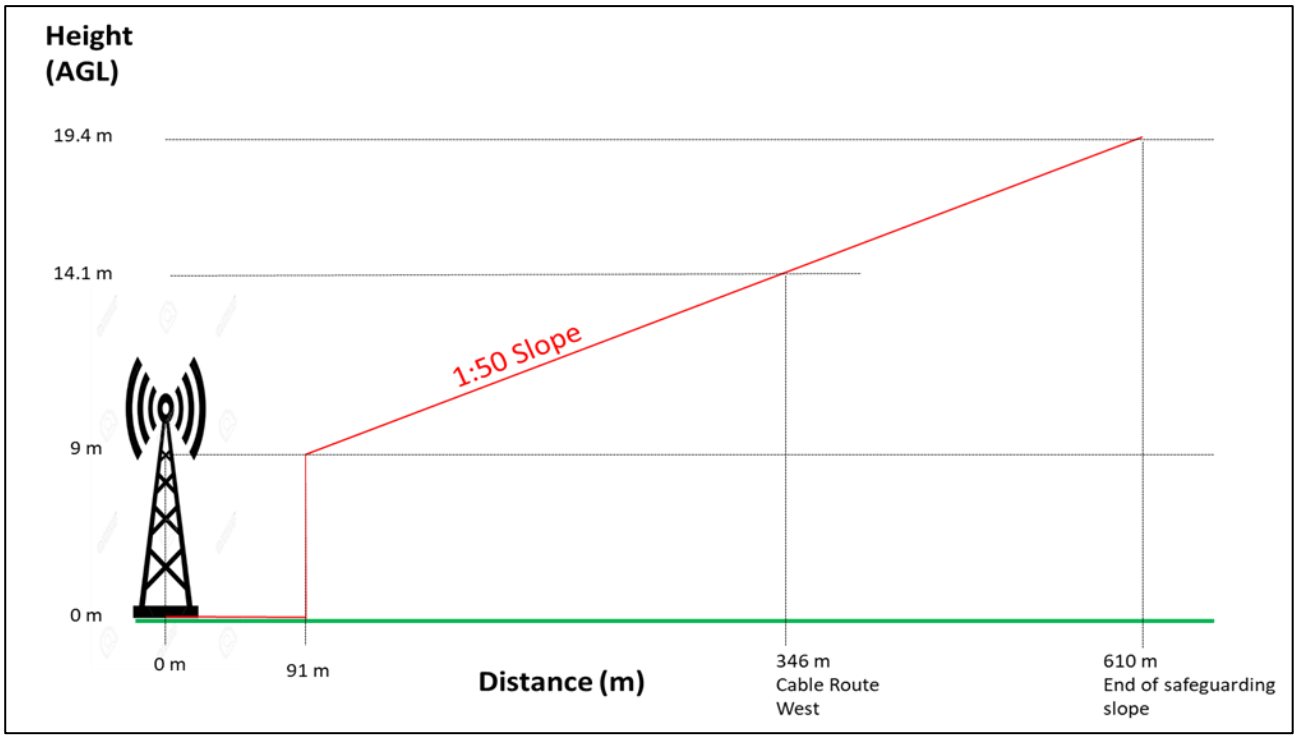
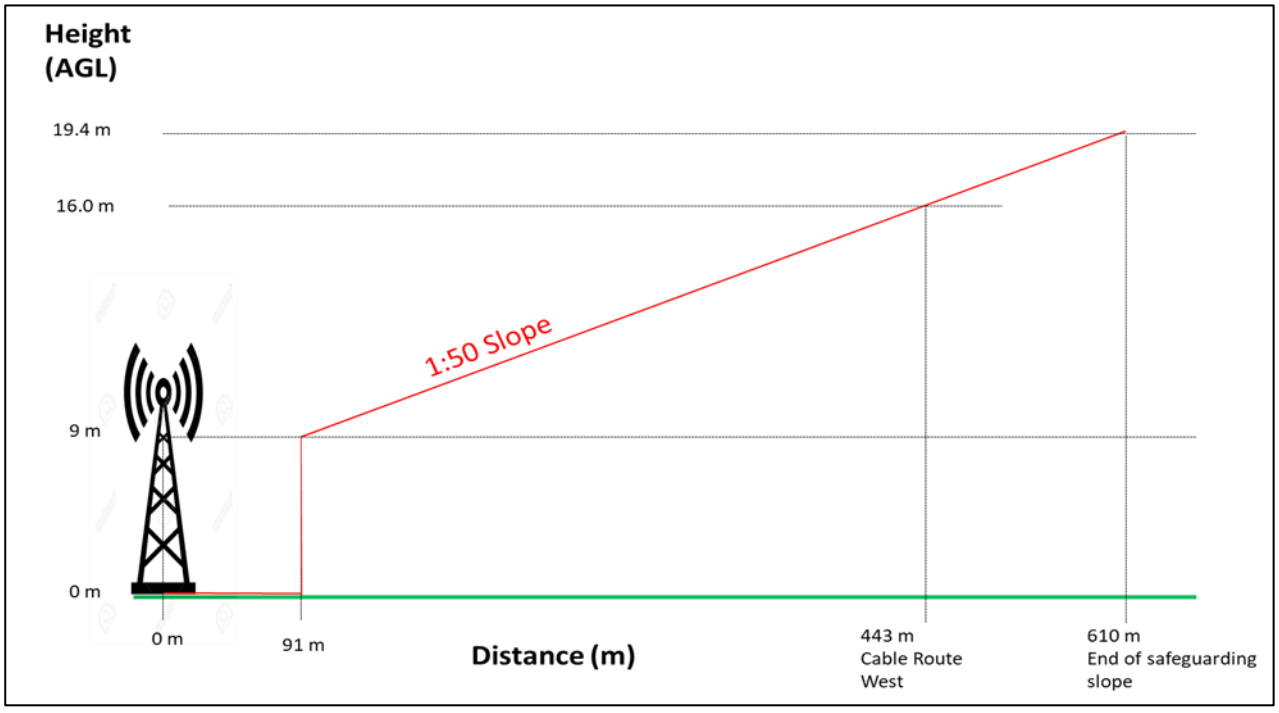


Plate 17-6: Profile View of TX 2 Safeguarded Areas



92. The safeguarding slope for TX 1 is the most onerous in terms of development restrictions. Satisfying the TX 1 safeguarding requirements would also satisfy the requirements for TX 2. Assessment conclusions indicate that the maximum height of any development within the orange safeguarded circle for TX 1 is 14.1m above the transmitter base datum height, rising in line with the 1:50 safeguarding slope moving eastwards until the slope ends 610m from the TX 1 transmitter base. The magnitude of effect is considered to be negligible for both scenarios so long as construction and any permanent above-ground infrastructure remain below the safeguarding requirements.

93. The sensitivity of ATC and aviation receptors is considered to be medium and has moderate to high levels of recoverability. Receptors will be notified of construction activity and the maximum height of construction equipment.

94. The magnitude of effect is deemed to be negligible; the sensitivity of the receptors is considered to be medium. The impact will therefore be of **minor** adverse significance which is not significant in EIA terms.

17.6.1.2.2 DEP and SEP Together

95. Should DEP and SEP both be constructed, either concurrently or sequentially, two onshore cables will be installation in parallel inside the onshore export cable corridor using the same construction methods. The assessed magnitude of effect would be the same as for the projects in isolation and would remain negligible. The sensitivity of the receptors remains medium. The impact will therefore be of **minor** adverse significance, which is not significant in EIA terms.

17.6.2 Potential Impacts during Operation

17.6.2.1 Impact 1: Creation of an obstacle to low flying fixed wing and rotary aircraft operating offshore.

17.6.2.1.1 DEP or SEP in Isolation

96. The operation of either DEP or SEP in isolation will create a physical obstruction to flight operations in the vicinity of the project and therefore the assessment of the creation of an obstacle is the same for both projects. During the operational phase of either project, wind turbines and the offshore substation platform could pose a physical obstruction to the flight of aircraft operating in the wind farm sites, specifically to offshore helicopters and low flying aircraft. Helicopter operators, the MOD and ATC service providers have been consulted with regard to the potential for the projects to create an obstruction to aviation activities conducted in the vicinity of the wind turbines and the offshore substation platform.

97. A range of embedded mitigation measures, in the form of appropriate notification to aviation stakeholders, lighting and marking to minimise effects to aviation flight operations would apply to the development of the projects, as included in **Table 17-3**.

98. As described in **Section 17.6.1.1**, pilots are obliged to plan their flying activities in advance and to be familiar with any en-route obstacles they may encounter; however, during flight, weather conditions or operational requirements may necessitate route adjustments. In VMC, pilots would be expected to see and avoid obstructions. In low visibility and when operating in IMC, pilots use on board radar to detect obstructions and be under the control of ATC with an appropriate level of radar service. The effect will be a reduction in the level of military activity at very low-level and long-term, but not offshore support helicopters or other airborne surveillance platforms, and the frequency of repetition is continuous and not reversible. It is predicted that the impact will affect the receptor directly however, the magnitude is considered to be low for both projects given the minimal change from baseline expected.

99. A range of embedded mitigation measures, in the form of appropriate notification to aviation stakeholders of the extent of the operational area, the maximum height of obstructions, the operational period and timings of any maintenance activity, together with the lighting and marking of infrastructure (in accordance with CAA CAP 393) will minimise effects to aviation flight operations. Receptors will be notified of construction activity. The ability of aviation receptors to continue to operate safely remains as the obstacles are marked, lit and notified; however, in poor weather conditions and at night, some aircraft, dependent upon onboard systems and operator role, will be required to alter tracks and operation to avoid the area, the sensitivity of the receptors is therefore considered to be medium.

100. The magnitude of effect is deemed to be low; the sensitivity of the receptors is considered to be medium. Therefore, the impact on fixed wing and rotary aircraft during the operational phase is considered to be of **minor** adverse significance for both projects, which is not significant in EIA terms.

17.6.2.1.2 DEP and SEP Together

101. In the event that DEP and SEP are both developed, as for DEP or SEP in isolation, pilots would be notified of infrastructure and any maintenance activities, and lighting and marking of the operational wind turbines and offshore substation platforms will be in accordance with required guidance. However, the larger operational area of DEP and SEP combined would reduce the low-level airspace that can be operated in and may lead to a funnelling effect of aircraft operating in the same area. Pilots are required to visually acquire and avoid obstructions however, when operating in weather conditions that do not allow visual acquisition, pilots will operate their aircraft above a height that will maintain the required separation from obstacles below them.

102. The magnitude of effect is deemed to be low; the sensitivity of the receptors is considered to be medium. The impact will therefore be of **minor** adverse significance, which is not significant in EIA terms.

17.6.2.2 Impact 2: Wind turbines causing interference on civil and military radar systems

17.6.2.2.1 DEP or SEP in Isolation

103. Radar LOS analysis has provided the results of theoretical radar detection of the operational wind turbines for both SEP and DEP. Results of predicted radar detectability between DEP and SEP differ and are provided in **Table 17-11** below. The theoretical distribution of detectable turbines within the wind farm sites is illustrated in **Appendix 17.1**. Receptors within the study area such as RAF Marham and Brizlee Wood ADR outside of detection are scoped out.

Table 17-11: Results of the radar LOS analysis

Radar	Summary of Results
NATS Claxby PSR	SEP – Highly Likely, whole array detectable
	DEP North and South – Highly Likely, whole array detectable
NATS Cromer PSR	SEP – Highly Likely, whole array detectable
	DEP North and South – Highly Likely, whole array detectable
RAF Coningsby PSR	SEP – Highly Likely, whole array detectable
	DEP North – The western edge of the array area is likely to be detectable DEP South– The whole array area is unlikely to be detectable
MOD Trimingham ADR	SEP – Highly Likely, whole array detectable
	DEP North and South – Highly Likely, whole array detectable
Norwich Airport PSR	SEP – Highly Likely, whole array detectable
	DEP North – The western edge of the array area is likely to be detectable DEP South – The whole array area is likely to be detectable

104. Theoretically DEP and SEP operational wind turbines would all be highly likely to be detectable by the NATS Claxby and Cromer PSRs, and the MOD ADR located at Trimingham. The operation of the projects in isolation or together will have a detrimental effect to these radar systems.

105. The RAF Coningsby and Norwich Airport PSRs will theoretically detect turbines within the DEP and SEP arrays to varying degrees, with SEP having the greatest effect to radar systems due to its location closer to onshore radar systems. The operation of the projects in isolation or together will also have a detrimental effect to these radar systems.

106. Wind turbines detectable by a PSR or ADR system will degrade the system by creating false targets, reducing system sensitivity, creating radar shadowing behind the wind turbines and saturating the radar receiver. This 'clutter' would have potential to conceal real aircraft targets leading to a loss of situational awareness by controllers.

107. The impact created by the detection of operational wind turbines is predicted to be repetitious, long-term and continuous but is reversible owing to the current, TMZ construct. It is predicted that the impact will affect the receptor directly and the magnitude of effect is considered to be medium for all receptors.

108. The ability of NATS, the MOD (Coningsby and Trimingham) and Norwich Airport to accurately use their respective radar systems for the provision of an ATS, and in the case of the MOD to compile a Recognised Air Picture (RAP) to monitor the airspace in and around the UK in order to launch a response to any potential airborne threat, could be impacted in the presence of wind turbine interference and the production of radar clutter on radar displays.

109. All radar receptors aim to ensure 'clutter free' radar to continue to deliver a safe and effective ATS and to monitor UK airspace. The radar stakeholders are considered to be of high vulnerability, low recoverability and high value. The sensitivity of these receptors is therefore considered to be high.

110. The magnitude of effect is deemed to be medium; the sensitivity of the receptors is considered to be high. Without further mitigation, the impact will therefore be of **major** adverse significance for both DEP and SEP, which is significant in EIA terms.

17.6.2.2.2 DEP and SEP Together

111. In the event that DEP and SEP are both developed, the impact on radar receptors will be greater due to the greater number of operational wind turbines detected by the radar systems. The impact manifests as an increased level of degradation of the affected radar systems therefore, the operation of DEP and SEP together is the worst-case scenario.

112. The magnitude of effect is deemed to be medium; the sensitivity of the receptors is considered to be high. Without further mitigation, the impact will therefore be of **major** adverse significance, which is significant in EIA terms.

17.6.2.2.3 Mitigation and Residual Impacts

113. In addition to the embedded mitigation outlined in **Table 17-3**, further mitigation and assessments are made below for all radar receptors.

Claxby and Cromer PSRs

114. NATS have previously suggested a preferred mitigation solution for other offshore developments in the SNS which will be applicable for DEP and SEP. If applied this mitigation will remove impacts from DEP and SEP on the Claxby and Cromer PSRs. The mitigation will require two stages – blanking of the affected radar systems; and an application to the UK regulator (the CAA) under an airspace change proposal detailed in CAP 1616 (CAA, 2020) to establish a TMZ. With this mitigation in place, the magnitude of effect would be reduced to negligible and therefore the residual impact on the NATS Claxby and Cromer PSR would reduce to **minor** adverse for both DEP and SEP in isolation and together, which is not significant in EIA terms.

Norwich Airport PSR

115. Norwich Airport also utilises data from the Cromer PSR and therefore any mitigation applicable to that radar system will also benefit the end user at Norwich Airport. The Norwich PSR and to a certain extent the Indra RDP, filter out known wind farms at Scroby Sands & Sheringham Shoal. Further wind farm development will require modelling and if necessary, re-configuration of the Norwich Airport PSR by the radar manufacturer. Consultation with the airport safeguarding team has commenced and will continue to reach agreement on the best mitigation solution to remove the impact created by the projects. With mitigation in place the impact will be reduced to **minor** adverse significance for both DEP and SEP in isolation and together, which is not significant in EIA terms.

RAF Coningsby PSR

116. The MOD regulations for radar mitigation solutions (contained in Def Stan 00-972 Issue 1, MOD 2018, 2019) align with those for mitigation of civilian radar systems contained in CAP 670 (CAA, 2019b). Def Stan 00-972 states: '*This Def Stan is primarily a Military Delta to Civil Aviation Publication (CAP) 670 ATS Safety Requirements. CAP 670 shall be used as a baseline in establishing appropriate design and air safety requirements taking account of the procurement strategy to be adopted, unless otherwise stated within this Def Stan*.'

117. ATC radar mitigation solutions are in place at civilian airfields such as Newcastle, Liverpool and Glasgow which successfully mitigate the impact created by radar detectable wind farms therefore it is feasible that these solutions in place at civilian aerodromes may meet military requirements. Equinor will continue engagement with the MOD on which mitigation solutions (which are in place and operational at civilian aerodromes) will be applicable and acceptable for MOD ATC PSR systems and specifically to the RAF Coningsby PSR. The assumption that suitable mitigation will be agreed with the MOD removes the impacts created by DEP and SEP; with mitigation in place the residual impact on the RAF Coningsby PSR system is considered to be **minor** adverse for both DEP and SEP in isolation and together, which is not significant in EIA terms.

Trimingham ADR

118. On the 24 August 2018, the MOD released information regarding ADR mitigation (MOD, 2018) in which it stated that the receipt and assessment of any technical mitigation reports/submissions reports, relating to the TPS-77 ADRs and multi-turbine wind farms will be paused with immediate effect. An update to this statement was provided on the 12 June 2019 (MOD, 2019) in which the MOD stated that it continues to work collaboratively with Government and wind farm developers to "fully understand and mitigate all risks to our current and future military air surveillance capabilities".

119. The MOD confirmed that they will "…continue to work with industry to resolve the current issues and will, on a case by case basis, consider certain developments where impacts on operational capability is deemed to be acceptable". The UK Defence and Security Accelerator has launched a competition seeking proposals that can provide future offshore wind farm mitigation for the UK ADR[5].

120. The Applicant has and will continue to engage with the MOD prior to and during the application process and will continue this engagement and seek to identify agreed mitigation for the ADR system. The assumption that suitable mitigation will be agreed with the MOD reduces the impact (magnitude of effect) created by the projects; with mitigation in place the residual impact to the MOD Trimingham ADR system is considered to be **minor** adverse for both DEP and SEP in isolation and together, which is not significant in EIA terms.

17.6.2.3 Impact 3: Disruption to aircraft using HMRs

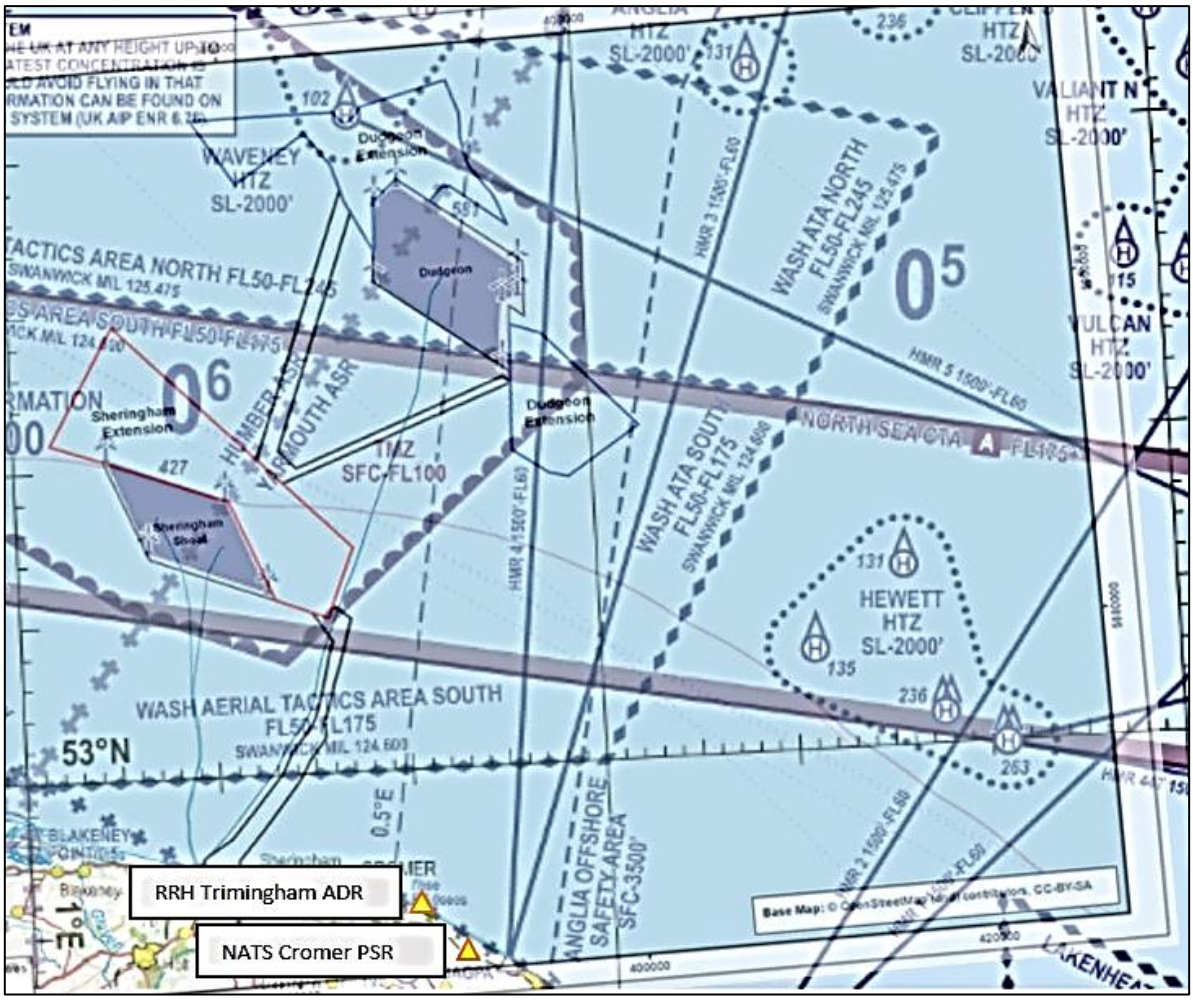
17.6.2.3.1 DEP or SEP in Isolation

121. Helicopter Main Routes (HMRs) are routes that may be flown by helicopters operating to and from offshore destinations. HMRs are promulgated for the purpose of signposting concentrations of helicopter traffic to other airspace users, however, their use is not mandatory. Whilst HMRs have no airspace status and assume the background airspace classification within which they are located (in the case of the SNS, Class G), they are used by the Air Navigation Service Provider (ANSP) (Anglia Radar) and helicopter operators for flight planning and management purposes. CAP 764 (CAA, 2016) recommends HMRs should ideally be free of obstacles 2NM either side of their centre line, and where development is planned inside this area it should be consulted upon with the helicopter operators and the ANSP. Previously, consultation with helicopter operators has advised that the HMR network is not widely used in the SNS and that helicopter operators choose to route directly to their destination.

122. A network of HMRs is established in the vicinity of DEP to support the transport of personnel and material to offshore oil and gas installations. There are no HMRs located in the immediate vicinity of SEP therefore no impact from SEP is applicable. **Plate 17.7** provides an illustration of the HMRs surrounding and crossing DEP North and DEP South.

[5] https://www.gov.uk/government/news/dasa-seeks-innovative-ideas-to-mitigate-radar-risk-of-windfarms

Plate 17-7: HMR Structure



123. Three HMRs are located in close proximity or within the DEP wind farm sites, all of which are operated between 1,500ft to FL60 (6,000ft):

- HMR 5 crosses DEP North between the Waveney platform and the Leman Field.
- HMR 4 crosses DEP South. This route is between waypoint BAGPA on the North Norfolk coast and platforms in the Trent Field. The maximum cruise level for helicopters on this route is FL40 (4,000ft) unless cleared by Anglia Radar.
- HMR 3 passes within 1.5NM of DEP South, however, at this distance it is not considered that the HMR would to be impacted by the operation of DEP South.

124. The presence of the wind turbines below HMR 4 and 5 would preclude the use of these routes when the weather requires flight at a lower altitude because there would not be the required obstacle clearance for low visibility IMC of 1,000ft. In cold weather helicopters may also require to fly at lower altitude to remain below the icing level (the level at which the air temperature reaches freezing). As the helicopters are Instrument Flight Rules (IFR) equipped, the only weather factor which could preclude use of the HMR is an icing level below 2000ft. The effect is predicted to be at low frequency when low flying is necessary over DEP and SEP in the operational period, therefore the magnitude is considered to be low.

125. The sensitivity of the receptors relates to its value and its vulnerability to the effect. Helicopters provide an important service to a high value industry (oil and gas) and are also an important component of offshore SAR capability. Offshore helicopter flights would only be vulnerable in low visibility conditions (IMC) when the icing level is <2,000ft. UK SAR helicopters have a full icing clearance (icing protection capability) and therefore an icing level <2,000ft. Helicopters servicing the oil and gas industry may also have a certain level of icing protection. There are alternative routes that can be flown to avoid DEP North and DEP South, although with the consequence of increased journey times and fuel burn. Although helicopter operations are of high value, due to their ability to avoid the altitude restrictions in the vicinity of DEP North and DEP South, their vulnerability is considered low and therefore the sensitivity of the receptor is considered to be low.

126. Overall, the sensitivity of the receptor is considered to be low, and the magnitude of effect is assessed as low. The impact will therefore be of **minor** adverse significance for DEP in isolation (i.e. not significant in EIA terms) and **no impact** associated with the operation of SEP in isolation.

17.6.2.3.2 DEP and SEP Together

127. There are no HMRs that have the potential to be impacted by SEP. Potential impact to HMR operations is restricted to DEP. The impact from the operation of DEP and SEP together will therefore be the same as for DEP in isolation, of **minor** adverse significance, which is not significant in EIA terms.

17.6.3 Potential Impacts during Decommissioning

17.6.3.1 Impact 1: Creation of an obstacle to fixed wing and rotary aircraft operating offshore

17.6.3.1.1 DEP or SEP in Isolation

128. The decommissioning of either DEP or SEP will create a physical obstruction to flight operations in the vicinity of the projects. Project infrastructure including offshore substation platforms and erected wind turbines can be difficult to see from the air, although as these structures are removed through the decommissioning phase the potential impact will reduce. Decommissioning infrastructure such as vessels can be difficult to see from the air, particularly in poor meteorological conditions leading to potential increased obstacle collision risk to low flying aircraft operations. The sensitivity and magnitude of effects would be comparable to those identified for the construction phase (**Section 17.6.1.1**).

129. As for the construction phase, a range of embedded mitigation measures in the form of appropriate notification to aviation stakeholders, lighting and marking to minimise effects to aviation flight operations would apply to the decommissioning of DEP and SEP. These will comply with current guidelines and be agreed with the appropriate stakeholders and are outlined in **Table 17-1**. Mitigation implemented will remain in place until the last wind turbine has been removed. The impact is predicted to be of short-term duration and intermittent. It is predicted that the impact will affect receptors directly, the magnitude is considered to be low.

130. Aviation receptors would be expected to continue to operate safely in the vicinity of the project decommissioning areas and the sensitivity of the receptors is therefore considered to be medium.

131. The magnitude of effect is deemed to be low; the sensitivity of the receptors is considered to be medium. The impact will therefore be of **minor** adverse significance for DEP or SEP in isolation, which is not significant in EIA terms.

17.6.3.1.2 DEP and SEP Together

132. Physical obstruction to flight operations during decommissioning of DEP and SEP, either concurrently or sequentially, would result in the same worst case potential impacts to fixed wing and rotary aircraft (**minor** adverse) as for the construction phase, which is not significant in EIA terms.

17.7 Cumulative Impacts

17.7.1 Identification of Potential Cumulative Impacts

133. The first step in the cumulative assessment is the identification of which residual impacts assessed for DEP and/or SEP on their own have the potential for a cumulative impact with other plans, projects and activities (described as 'impact screening'). This information is set out in **Table 17-12** below, together with a consideration of the confidence in the data that is available to inform a detailed assessment and the associated rationale. Only potential impacts assessed in **Section 17.6** as negligible or above are included in the CIA (i.e. those assessed as 'no impact' are not taken forward as there is no potential for them to contribute to a cumulative impact).

134. **Table 17-12** provides those cumulative impacts included in the CIA.

Table 17-12: Potential Cumulative Impacts (impact screening)

Impact	Potential for Cumulative Impact	Data Confidence	Rationale
Construction			
Impact 1: Creation of an obstacle to fixed wing and rotary aircraft operating offshore	Yes	High	Multiple wind turbines located closely together will restrict the area for aircraft operation.

Impact	Potential for Cumulative Impact	Data Confidence	Rationale
Impact 2: Interference to the RAF Weybourne Transmitter	No	High	Any impact from export cable activities would be highly localised.
Operation			
Impact 1: Creation of an obstacle to fixed wing and rotary aircraft operating offshore	Yes	High	Multiple wind turbines located closely together will restrict the area for aircraft operation.
Impact 2: Wind turbines causing permanent interference on civil and military radar systems	Yes	High	Unmitigated multiple radar detectable wind farm development will overload a radar system.
Impact 3: Disruption to aircraft using HMRs	No	High	Any impacts would be highly localised. Potential impacts from DEP only.
Decommissioning			
Impact 1: Creation of an obstacle to fixed wing and rotary aircraft operating offshore	Yes	High	Multiple wind turbines located closely together will restrict the area for aircraft operation.

17.7.2 Other Plans, Projects and Activities

135. The second step in the cumulative assessment is the identification of the other plans, projects and activities that may result in cumulative impacts for inclusion in the CIA (described as ‘project screening’). This information is set out in **Table 17-13** below, together with a consideration of the relevant details of each, including current status (e.g. under construction), planned construction period, closest distance to DEP and SEP, status of available data and rationale for including or excluding from the assessment.

136. The project screening has been informed by the development of a CIA Project List which forms an exhaustive list of plans, projects and activities in a very large study area relevant to DEP and SEP. The list has been appraised, based on the confidence in being able to undertake an assessment from the information and data available, enabling individual plans, projects and activities to be screened in or out. Other projects within 100km (the maximum range where radar cumulative effect may occur) of DEP and SEP are considered for the effect of wind turbines causing interference on radar systems; in regard to the creation of an obstacle to fixed wing and rotary aircraft operating offshore. Other projects within 40km of DEP and SEP are considered for the effect of creating an obstacle to fixed and rotary wing aircraft operating offshore.

Table 17-13: Summary of projects considered for the CIA in relation to Aviation and Radar (project screening)

Project	Status	Construction Period	Closest Distance from the Project (km)*	Confidence in data	Included in the CIA (Y/N)	Rationale
Dudgeon Offshore Wind Farm	Operational	N/A	0	High	Y	Impact to available airspace for low flying aircraft and radar cumulative effect
Sheringham Shoal Offshore Wind Farm	Operational	N/A	0	High	Y	Impact to available airspace for low flying aircraft and radar cumulative effect
Hornsea Project Three Offshore Wind Farm	Consented	2024 to 2028	83	Medium	N	No radar effect as the consented wind farm will not be built without a technical Radar Mitigation System (RMS) in place
Race Bank Offshore Wind Farm	Operational	N/A	10	High	Y	Potential cumulative effect on radar
Triton Knoll Offshore Wind Farm	Operational	N/A	13	High	Y	Potential cumulative effect on radar
Lincs Offshore Wind farm	Operational	N/A	34	High	Y	Potential cumulative effect on radar
Lynn and Inner Dowsing Offshore Wind Farm	Operational	N/A	37	High	Y	Potential cumulative effect on radar

Project	Status	Construction Period	Closest Distance from the Project (km)*	Confidence in data	Included in the CIA (Y/N)	Rationale
Scroby Sands Offshore Wind Farm	Operational	N/A	58	High	Y	Potential cumulative effect on radar
Hornsea Project Four Offshore Wind Farm	Application expected	2024 to 2029	52	Medium	N	No radar effect as the consented wind farm will not be built without a technical Radar Mitigation System (RMS) in place
Hornsea Project Two Offshore Wind Farm	In Construction	2020 to 2022	66	High	N	No radar effect as the consented wind farm will not be built without a technical Radar Mitigation System (RMS) in place
Hornsea Project One Offshore Wind Farm	Operational	2019	66	Medium	N	No radar effect as technical Radar Mitigation System (RMS) is in place
Humber Gateway Offshore Wind Farm	Operational	N/A	64	High	Y	Potential cumulative effect on radar

*Measured to the nearest DEP or SEP wind farm site

17.7.3 Assessment of Cumulative Impacts

137. Having established the residual impacts from DEP and/or SEP with the potential for a cumulative impact, along with the other relevant plans, projects and activities, the following sections provide an assessment of the level of impact that may arise.

17.7.3.1 Creation of an obstacle to low flying fixed wing and rotary aircraft operating offshore

17.7.3.1.1 DEP or SEP in isolation

138. There is potential for cumulative effects on fixed wing and rotary aircraft as a result of obstacles created by construction, operation and decommissioning activities associated with DEP and SEP and other wind farms. For the purposes of this assessment, this possible cumulative effect has been assessed for projects within 40km from DEP and SEP, which is considered to be the maximum range where the creation of an aviation obstacle to fixed wing and rotary aircraft operating offshore may occur.

139. As for obstacles associated with DEP and SEP, at times of sufficient visibility (VMC) pilots are ultimately responsible for seeing and avoiding obstructions such as wind turbines and other infrastructure and will be aware through notification procedures of the projects. When flying in low visibility (IMC) pilots will be utilising on board radar which detects obstructions and be under the control of ATC with an appropriate level of radar service.

140. Aviation operations in the UK are highly regulated. The DEP and SEP study area is located in airspace where the provision of an Air Traffic Service (ATS) is routine. The same rules of the air which maintain a safe operating environment in the current baseline will apply in the other projects in the SNS. Pilots of military low flying aircraft and other low flying operations such as in the support of the oil and gas industry are obliged to plan their flying activities in advance and to be familiar with any en-route obstacles they may encounter, and will be notified of all project phases through notification procedures outlined in **Table 17-3**.

141. The impact is predicted to be of long- term duration, not reversable and continuous for the operational lifetime of the projects. It is predicted that the impact will affect the aviation receptors operating in the airspace directly. Receptors will be notified of construction activity. The ability of aviation receptors to continue to operate safely in the vicinity of the wind farm sites remains as the obstacles are marked, lit and notified; however, in poor weather conditions and at night, some aircraft, dependent upon onboard systems and operator role, will alter tracks and operation to avoid the area. The sensitivity of the receptors is considered to be medium and the magnitude low, as while a larger area will be affected, in the context of the airspace available there is not a substantial increase of effects from the projects in isolation.

142. Overall, the sensitivity of the receptors is considered to be medium and the magnitude of cumulative effects is deemed to be low. The effect will, therefore, be of **minor** adverse significance for all scenarios, which is not significant in EIA terms.

17.7.3.2 Wind turbines causing permanent interference on civil and military radar systems

143. The potential for cumulative impact created by the radar detection of DEP and SEP either in isolation or together exists to those radar systems that will also detect the wind farm developments listed in **Table 17-13**. Cumulative radar effect is only possible in the operational phase of the projects. For the purposes of this assessment, this additive impact has been assessed within 100km from the projects, which is considered to be the maximum range where radar cumulative effect may occur. The projects identified within this search area with the potential to have cumulative impacts with DEP and SEP are listed in **Table 17-13**.

144. Theoretical radar LOS analysis indicates that wind turbines with a tip height of 326m LAT within both SEP and DEP wind farm sites would be theoretically detectable (by varying degrees) by the Claxby, Cromer, Norwich Airport and RAF Coningsby PSR systems and the Trimingham ADR radar systems. The potential cumulative impact will be increased radar clutter and possibly an increase in the individual signal processing demands effected radar systems. The worst-case magnitude of potential cumulative effects is deemed to be medium. However, on the basis that no wind farm will be permitted to operate without the necessary radar mitigation in place in agreement with key aviation stakeholders, it is considered that with radar mitigation in place the projects will not contribute to adverse cumulative impacts on aviation radar. With mitigation in place the magnitude is considered to be low.

145. All radar stakeholders will ensure ‘clutter free’ radar to continue to deliver a safe and effective ATS to their customers and to monitor UK airspace in a safety critical environment. As described previously, the sensitivity of radar stakeholders is considered to be high.

146. The sensitivity of the receptors considered is high and the worst-case magnitude of potential cumulative effects is deemed to be medium without mitigation. The impact for all of the receptors considered would therefore, in the absence of mitigation, have to potential to have major adverse cumulative impacts on radar receptors. However, as mitigation will be required for those radar systems which are affected by other projects, no radar cumulative effect will be apparent and therefore with mitigation in place the effect will be **minor** adverse for all scenarios due to the requirement for a technical solution to mitigate radar effect.

17.8 Transboundary Impacts

147. DEP and SEP are contained wholly in the UK Flight Information Region (FIR) and UK waters and therefore there are no transboundary considerations. Transboundary impacts are therefore scoped out of this assessment, in accordance with the Scoping Opinion (Planning Inspectorate, 2019), as confirmed in **Table 17-1**.

17.9 Inter-relationships

148. Inter relationships with other chapters are identified in **Table 17-14**.

Table 17-14 :Chapter Topic interactions

Topic and description	Related chapter	Where addressed in this chapter	Rationale
Operation			
Aviation lighting	Chapter 15: Shipping and Navigation	**Section 17.6.2.1**	Any lighting requirements for maritime and aviation navigation will be balanced with aviation lighting requirements defined through consultation.

17.10 Interactions

149. The potential for impacts identified and assessed in this chapter to interact with each other to affect the same receptor, and increase the level of impact upon that receptor, has been assessed for all project phases. No such interactions have been identified for Aviation and Radar that are not covered by the assessments provided above.

17.11 Potential Monitoring Requirements

150. Monitoring requirements will be described in the 'In-Principle Monitoring Plan' (IPMP) submitted alongside the DCO application and further developed and agreed with stakeholders prior to construction based on the IPMP and taking account of the final detailed design of the projects.

151. If an airspace change is seen to be the most suitable form of mitigation for NATS radar systems, the airspace change process requires a post implementation review of any airspace solution.

17.12 Assessment Summary

152. This chapter provides a characterisation of the existing environment for Aviation and Radar based on existing information, which has established the potential for some adverse residual impacts, as summarised in **Table 17-15**.

153. DEP and SEP are assessed against their potential interactions with the following aviation receptors:

- Radar and communications
  - NATS En-route PSRs including Anglia Radar
  - The MOD including the RAF Coningsby PSR and the Trimingham ADR
  - Norwich Airport
- Offshore helicopter operations

17.12.1 Radar and Communications

17.12.1.1 NATS

154. DEP and SEP will be theoretically detectable by the NATS Cromer and Claxby PSRs, which without mitigation, is likely to produce unacceptable effect to a safe level of service due to clutter on radar displays, and a major adverse effect in EIA terms. The projects are located beneath the busy airspace of the SNS where aircraft are transferred between ATC agencies and where accurate aircraft identification is paramount to maintaining safe operations. Consultation with NATS will continue to ascertain the full extent of the potential impact on NATS operations.

155. NATS preferred mitigation solution has previously comprised of blanking of the affected radar systems, together with a proposal to change airspace (through an airspace change proposal) above the array area. It may be that an extension to the existing TMZ to cover the full extent of the DEP and SEP wind farm sites may be the most cost-efficient mitigation solution.

17.12.1.2 The MOD

156. DEP and SEP are predicted to present an unacceptable effect to a safe level of service, and a major impact in EIA terms, on the Trimingham ADR without additional mitigation. The RAF Coningsby PSR will theoretically detect all of the SEP wind turbines at a blade tip height of 330m above mean sea level; with a lesser effect created by DEP where intermittent and occasional detection cannot be ruled out. Creation of an obstruction is likely to effect military low flying, however, military low flying operations continue safely in the presence of the operational Sheringham Shoal and Dudgeon OWFs through the use of notification and lighting of these developments which will be applied to DEP and SEP.

157. ATC radar mitigation solutions are in place at civilian airfields which successfully mitigate the impact created by radar detectable wind farms. Therefore it is feasible that these solutions in place at civilian aerodromes may meet military requirements for the mitigation of ATC radar systems.

158. The MOD are working with industry to seek proposals that can provide future offshore wind farm mitigation for the UK ADR. The Applicant will continue to engage with the MOD prior to and during the application process and will continue this engagement to identify agreed mitigation for the ADR system.

159. The assessment of the Weybourne Transmitter defines the safeguarded areas of each transmitter aerial; avoidance of these areas either laterally (or where required) vertically will remove any potential for impact.

17.12.1.3 Norwich Airport

160. The SEP wind farm site and DEP South are theoretically highly likely to be detectable by the Norwich Airport PSR, and intermittent detection of turbines in the western area of DEP North cannot be ruled out. The location of the wind turbines would result in clutter close to the routes used by aircraft en-route to support offshore operations and is likely to lead to a reduction in radar sensitivity. Consultation with Norwich Airport will continue to establish the operational impact the projects will have on continued safe radar operations.

161. Technical manipulation of the Norwich Airport PSR may be possible to remove the impacts expected on the radar system by the operation of DEP and SEP. Norwich Airport will continue to be consulted to agree mitigation to remove impacts to the radar system.

17.12.2 Offshore Helicopter Operations

162. Offshore helicopter operations are completed in VFR (weather conditions where pilots can see and avoid obstructions) or IMC conditions (where the icing level permits it). Two HMRs cross the DEP wind farm sites and a third is in close proximity to DEP South. When operating on HMRs, should weather conditions exist whereby transits cannot be continued above the DEP wind farm sites, helicopters may choose to reroute or climb to avoid the array areas. An obstacle free route is available as a deviation around the DEP wind farm sites if required and therefore the ability of the helicopter operator to safely undertake the intended journey is not affected. Potential increased workload, fuel burn and flight times are assessed as minor adverse for DEP only, with no impact for SEP.

Table 17-15: Summary of potential impacts on Aviation and Radar

Potential impact	Receptor	Sensitivity	Magnitude	Pre-mitigation impact	Mitigation measures proposed	Residual impact
Construction						
Impact 1: Creation of an obstacle to fixed wing and rotary aircraft operating offshore.	Military low flying and offshore helicopter operators	Medium	Low	Minor Adverse for all scenarios	As listed in **17.6.1.1**	Minor Adverse for all scenarios
Impact 2: Interference to the RAF Weybourne Transmitter	Agencies utilising the transmitter	Medium	Negligible	Minor Adverse for all scenarios	As provided in **17.6.1.2.**	Minor Adverse for all scenarios
Operation						
Impact 1: Creation of an obstacle to fixed wing and rotary aircraft operating offshore	Military low flying and offshore helicopter operators	Medium	Low	Minor Adverse for all scenarios	As listed in **17.6.2.1**	Minor Adverse for all scenarios

Potential impact	Receptor	Sensitivity	Magnitude	Pre-mitigation impact	Mitigation measures proposed	Residual impact
Impact 2: Wind turbines causing permanent interference on civil and military radar systems	MOD, NATS and Norwich Airport	High	Medium	Major Adverse for all scenarios	Mitigation of ADR and ATC PSR with agreed mitigation in place impact will be reduced.	Minor Adverse for all scenarios
Impact 3: Disruption to aircraft using HMRs	Offshore Helicopter operators	Low	Low	Minor Adverse for DEP only (no impact for SEP)	As listed in **17.6.2.3**	Minor Adverse for DEP only (no impact for SEP)
Decommissioning						
Impact 1: Creation of an obstacle to fixed wing and rotary aircraft operating offshore	Military low flying and offshore helicopter operators	Medium	Low	Minor Adverse for all scenarios	As listed in **17.6.3.1**	Minor Adverse for all scenarios

17.13 References

CAA (2016). CAP 764 Policy and Guidelines on Wind Turbines.
CAA (2018). CAP 437 Standards for Offshore Helicopter Landing Areas
CAA (2019). CAP 168 Licensing of Aerodromes
CAA (2019a). CAP 393 The Air Navigation Order and Regulations
CAA (2019b). CAP 670 Air Traffic Services Safety Requirements
CAA (2020). CAP 1616 Airspace change: Guidance on the Regulatory Process for Changing the Notified Airspace Design and Planned and Permanent Redistribution of Air Traffic, and on Providing Airspace Information
MOD (2018). Air Defence Radar Mitigation Def Stan 00-972
MOD (2019). Air Defence Radar Mitigation Update Def Stan 00-972 (Amendment)
PINS (2019). Scoping Opinion: Proposed Dudgeon and Sheringham Shoal Offshore Wind Farm Extensions. Planning Inspectorate Reference EN010109. Available at:https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010109/EN010109-000006-EQNR_Scoping%20Opinion%202017%20EIA%20Regs.pdf
PINS (2018). Planning Inspectorate Advice Note Nine: Rochdale Envelope