Sheringham Shoal and Dudgeon Offshore Wind Farm Extension Projects

Environmental Statement

Volume 1

Chapter 15 - Aviation and Radar

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Glossary of Acronyms

ACC	Area Control Centre
ADR	Air Defence Radar
AIA	Aviation Impact Assessment
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
ATA	Aerial Tactics Area
ATC	Air Traffic Control
ATCO	Air Traffic Control Officer
ATCSMAC	Air Traffic Control Surveillance Minimum Altitude Chart
ATDI	Advanced Topographic Development and Imaging
ATS	Air Traffic Service
BEIS	Department For Business, Energy & Industrial Strategy
CAA	Civil Aviation Authority
CAP	Civil Aviation Publication
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
DGC	Defence Geographic Centre
DML	Deemed Marine Licence
EEA	European Economic Area
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EPP	Evidence Plan Process
FIR	Flight Information Region
FL	Flight Level

ft	feet
HAT	Highest Astronomical Tide
HMRI	Helicopter Main Route Indicators
HTZ	Helicopter Transit Zone
IAIP	Integrated Aeronautical Information Package
IFP	Instrument Flight Procedures
IFR	Instrument Flight Rules
IMC	Instrument Meteorological Conditions
IPMP	In-Principle Monitoring Plan
JTF	Joint Task Force
km	kilometre
LARS	Lower Airspace Radar Service
LAT	Lowest Astronomical Tide
LOS	Line of Sight
m	metre
MCA	Maritime and Coastguard Agency
MGN	Marine Guidance Note
Mil	Military
MOD	Ministry of Defence
MSA	Minimum Safe Altitude
NERL	NATS En-Route Ltd
NHV	Noordzee Helikopters Vlaanderen Group
NM	Nautical Mile
NNDC	North Norfolk District Council
NPS	National Policy Statement
NSIP	Nationally Significant Infrastructure Project
OREI	Offshore Renewable Energy Installations
OSP	Offshore Sub-station Platform
OWF	Offshore Wind Farm
OWIC	Offshore Wind Industry Council
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
RMS	Radar Mitigation System
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
UHF	Ultra High Frequency
UK	United Kingdom
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions
VHF	Very High Frequency
WAM	Wide Area Multilateration

Glossary of Terms

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.
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 Project (DEP)	The Dudgeon Offshore Wind Farm Extension onshore and offshore sites including all onshore and offshore infrastructure.
DEP offshore site	The Dudgeon Offshore Wind Farm Extension consisting of the DEP wind farm site, interlink cable corridors and offshore export cable corridor (up to mean high water springs).
DEP onshore site	The Dudgeon Offshore Wind Farm Extension onshore area consisting of the DEP onshore substation site, onshore cable corridor, construction compounds, temporary working areas and onshore landfall area.
DEP North array area	The wind farm site area of the DEP offshore site located to the north of the existing Dudgeon Offshore Wind Farm
DEP South array area	The wind farm site area of the DEP offshore site located to the south of the existing Dudgeon Offshore Wind Farm
DEP wind farm site	The offshore area of DEP within which wind turbines, infield cables and offshore substation platform/s will be located and the adjacent Offshore Temporary Works Area. This is also the collective term for the DEP North and South array areas.
Flight Level	A standard nominal altitude of an aircraft, in hundreds of feet, based upon a standardised air pressure at sea-level.
Grid Option	Mechanism by which SEP and DEP will connect to the existing electricity network. This may either be an integrated grid option providing transmission infrastructure which serves both of the wind farms, or a separated grid option, which allows SEP and DEP to transmit electricity entirely separately.
Helicopter Main Route Indicators (HMRI)	Helicopter Main Routes Indicators 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. HMRI promulgation does not predicate the flow of helicopter traffic. Whilst HMRIs 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.

Infield Cables	Cables which link the wind turbines to the offshore substation platform(s).
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.
Interlink Cables	Cables linking two separate project areas. This can be cables linking: DEP South array area and DEP North array area SEP and DEP South array area SEP and DEP North array area 1 is relevant if DEP is constructed in isolation or first in a phased development. 2 and 3 are relevant where SEP and DEP are both built.
Interlink cable corridor	This is the area which will contain the interlink cables between offshore substation platform/s and the adjacent Offshore Temporary Works Area.
Integrated Grid Option	Transmission infrastructure which serves both extension projects.
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.
Offshore cable corridors	This is the area which will contain the offshore export cables or interlink cables, including the adjacent Offshore Temporary Works Area.
Offshore export cable corridor	This is the area which will contain the offshore export cables between offshore substation platform/s and landfall, including the adjacent Offshore Temporary Works Area.
Offshore export cables	The cables which would bring electricity from the offshore substation platform(s) to the landfall. 220 – 230kV.
Offshore scoping area	An area presented at Scoping stage that encompassed all planned offshore infrastructure, including landfall options at both Weybourne and Bacton, allowing sufficient room for receptor identification and environmental surveys. This has been refined following further site selection and consultation for the PEIR and ES.

Offshore substation platform (OSP)	A fixed structure located within the wind farm area, containing electrical equipment to aggregate the power from the wind turbines and convert it into a more suitable form for export to shore.
Offshore Temporary Works Area	An Offshore Temporary Works Area within the DCO Order Limits in which vessels are permitted to carry out activities during construction, operation and decommissioning encompassing a 200m buffer around the wind farm sites and a 750m buffer around the offshore cable corridors. No permanent infrastructure would be installed within the Offshore Temporary Works Area.
Separated Grid Option	Transmission infrastructure which allows each project to transmit electricity entirely separately.
Sheringham Shoal Offshore Wind Farm Extension Project (SEP)	The Sheringham Shoal Offshore Wind Farm Extension onshore and offshore sites including all onshore and offshore infrastructure.
SEP offshore site	Sheringham Shoal Offshore Wind Farm Extension consisting of the SEP wind farm site and offshore export cable corridor (up to mean high water springs).
SEP onshore site	The Sheringham Shoal Wind Farm Extension onshore area consisting of the SEP onshore substation site, onshore cable corridor, construction compounds, temporary working areas and onshore landfall area.
SEP wind farm site	The offshore area of SEP within which wind turbines, infield cables and offshore substation platform/s will be located and the adjacent Offshore Temporary Works Area.
Study area	Area where potential impacts from the project could occur, as defined for each individual Environmental Impact Assessment (EIA) topic.
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 aircrews 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.
The Applicant	Equinor New Energy Limited

15 AVIATION AND RADAR

15.1 Introduction

1. This chapter of the Environmental Statement (ES) considers the potential impacts of the proposed Sheringham Shoal Offshore Wind Farm Extension Project (SEP) and Dudgeon Offshore Wind Farm Extension Project (DEP) 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 SEP and DEP.
2. This chapter has been written by Royal HaskoningDHV, based upon a technical assessment provided by Osprey Consulting Services Ltd (Osprey) (**Appendix 15.1**), with the assessment undertaken with specific reference to the relevant legislation and guidance, of which the primary source are National Policy Statements (NPS). Details of these and the methodology used for the Environmental Impact Assessment (EIA) and Cumulative Impact Assessment (CIA) are presented in **Chapter 5 EIA Methodology** (document reference 6.1.5) and **Section 15.4**.
3. The assessment should be read in conjunction with following linked chapters:
   - **Chapter 16 Petroleum Industry and Other Marine Users**; and
   - **Chapter 13 Shipping and Navigation.**
4. Additional information to support the Aviation and Radar assessment includes:
   - **Appendix 15.1 Aviation Impact Assessment (AIA)**
   - **Appendix 15.2 Surveillance Minimum Altitude Chart Analysis**

15.2 Consultation

5. Consultation with regard to Aviation and Radar has been undertaken in line with the general process described in **Chapter 5 EIA Methodology** and the **Consultation Report** (document reference 5.1). The key elements to date have included scoping, the ongoing Evidence Plan Process (EPP), the Preliminary Environmental Information Report (PEIR) and focused consultation with aviation and radar stakeholders undertaken by Osprey on behalf of the Applicant.
6. The feedback received throughout this process has been considered in preparing the ES. The chapter has been updated following consultation in order to produce the final assessment submitted within the Development Consent Order (DCO) application. **Table 15-1** provides a summary of the consultation responses received to date relevant to this topic, details of how the Project team has had regard to the comment and how these have been addressed within this chapter.
7. The consultation process is described further within **Chapter 5 EIA Methodology** (document refence 6.1.5). Full details of the consultation process is presented in the **Consultation Report** (document reference 5.1) which has been submitted as part of the DCO application.

Table 15-1: Consultation responses.

Consultee	Date/ Document	Comment	Project Response
Scoping Responses			
The Planning Inspectorate	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 SEP and DEP 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).	Impacts to aviation and radar, in addition to impacts on flight safety, where necessary, have been assessed within **Section 15.6**. Impacts associated with surveillance minimum altitude are assessed in **Appendix 15.2** and in **Section 15.6.2.4**.
The Planning Inspectorate	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. 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 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. 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

Consultee	Date/ Document	Comment	Project Response
			radar systems is provided in **Section 15.6.2.2**.
The Planning Inspectorate	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	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 15.6** identifies the impact significance of each potential impact in line with the EIA Regulations.
The Planning Inspectorate	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 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.	Subsequent MOD assessment concluded that there will be no operational impact to RAF Coningsby and, therefore, the MOD has no concerns for this radar and mitigation is not required. 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)	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.	Layout approval will be undertaken in consultation with MCA following consent.
Ministry of Defence (MOD)	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	**Section 15.6** identifies the impact significance of each potential impact in line with the EIA

Consultee	Date/ Document	Comment	Project Response
		as a relevant receptor. Both extension areas will be detectable to RRH Trimingham and will impact upon the operation of the air defence radar system. The impact on the ADR will need to be mitigated and it will be for the application to provide appropriate technical mitigation(s).	Regulations, including impacts to RRH Trimingham.
MOD	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.	Subsequent MOD assessment concludes that there will be no operational impact to RAF Coningsby and, therefore, the MOD no longer have concerns for this radar and mitigation is not required.
MOD	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 Sheringham Shoal and Dudgeon extension areas should be fitted with MOD accredited aviation safety lighting in accordance with the Air Navigation Order (ANO) 2022. The MOD would need to confirm the specification of the lighting to be used.	Lighting will be in accordance with the Air Navigation Order (ANO) and MOD requirements. Consideration of the fitment of aviation lighting is provided in **Table 15-3**.
MOD	01/11/19	Part of the cable 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 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 15.6.1.1**.
NATS	01/11/19	NATS state that their operations in the Southern North Sea (SNS) should be considered. NATS noted that both the existing Sheringham Shoal and Dudgeon 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 15.5.2.2**.

Consultee	Date/ Document	Comment	Project Response
Osprey AIA Consultation			
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.	**Section 15.5** details offshore helicopter operations. Air Traffic Control Surveillance Minimum Altitude Chart (ATCSMAC) analysis has been undertaken and is contained within **Appendix 15.2.**
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 15.6.2.2**. Impact to HMR and MSA is provided in **Section 15.6.2.3** and **15.6.2.4**. ATCSMAC analysis in vicinity of Norwich Airport has been undertaken and is located at **Appendix 15.2.**
Norwich Airport	21/10/20 Consultation Response	Impact to the Norwich Airport ATCSMAC 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 ATCSMAC is contained within **Appendix 15.2**. The conclusions of theoretical radar detectability of wind turbines and how detectability will impact NATS

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

Consultee	Date/ Document	Comment	Project Response
			and the Norwich Airport radar systems is provided in **Section 15.6.2.2**.
NATS	26/10/20 Consultation Response	The results of the radar Line of Sight (LOS) analysis were provided to NATS; analysis predicted an impact to the NATS operated Claxby and Cromer PSRs. NATS stated that they would investigate the level of impact to the two PSR and discuss the potential for a mitigation solution internally.	An assessment of theoretical radar detectability of wind turbines and how detectability will impact NATS radar systems is provided in **Section 15.5.2.2**.
UniFly Helicopters	18/11/20 Consultation Response	UniFly Helicopters have no comment to make on the Projects.	Noted.
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 83** and **15.6.2.1**.
MOD	02/07/21 Meeting	The MOD will object to the Projects on application based on affect to RRH Trimingham ADR.	The impact to RRH Trimingham ADR is assessed in **Section 15.6.2.2**
NATS	19/10/21 Consultation Response	NATS confirmed that on conclusion of internal discussions, blanking of the affected PSR together with an extension of the Greater Wash TMZ would mitigate the predicted affect to the Claxby and Cromer PSRs.	Impacts to the Claxby and Cromer PSRs are assessed in **Section 15.6.2.2.**Additional mitigations are detailed in **Section 15.6.2.3**
NATS	16/12/21	NATS is presently objecting based on the impacts to Cromer and Claxby. A two-step approach of radar blanking followed by extension to the TMZ, via the (Civil Aviation Publication (CAP 1616) process, was identified by NATS as the preferred mitigation solution. This approach to mitigation was agreed and it was expressed by NATS that the blanking of Claxby and Cromer would be relatively simple from NATS' side.	Impacts to the Claxby and Cromer PSRs are assessed in **Section 15.6.2.2** which also details additional mitigations.
Norwich Airport	04/02/22	Raising the MSA may lead to increased risk of icing in certain weather conditions. During good weather	Impacts associated with ATCSMAC are assessed within

Consultee	Date/ Document	Comment	Project Response
		conditions and in the absence of icing conditions, VFR flight at lower altitudes can be achieved and avoidance of obstacles can be completed by visual reference, During poor weather conditions when the 0° Degree isotherm is at a lowered altitude, aircraft will be forced to fly at a higher altitude to avoid obstacles by a required minima (1,000ft) which is likely to place the aircraft into unsafe icing conditions.	Section 15.6.2.4. Commercial discussions are continuing with helicopter operators to successfully mitigate any impact created and to limit extended journey times.
Norwich Airport	04/02/22	It was noted that stakeholder comments must be taken into account throughout the CAP 1616 engagement and consultation process, The Norwich Airport PSR filters out known wind farm areas at Scroby Sands and Sheringham Shoal and subject to assessment, radar modelling and any reconfiguration of the PSR may provide a mitigation solution to the Norwich Airport PSR system this may take the form of radar manipulation or the use of technical radar mitigation techniques such as the use of holographic radar. [Norwich Airport] would be happy to support an extension to the TMZ.	Noted. Stakeholders will continue to be consulted throughout the CAP 1616 process in line with requirements.
Norwich Airport	04/02/22	HMR's to the north do cross the proposed extension projects, however, they are not regulated airspace and many operators take a direct route rather than following the HMR.	Noted.
MOD	08/02/22	The project must first propose mitigation [for Trimingham] which the MOD will review. If mitigations are deemed acceptable, the objection would be withdrawn and a condition created.	Noted.
MOD	08/02/22	Within 750m [of the Weybourne transmitter] any large buildings, shrubs, trees, or soil engineering/soil piling should be avoided.	No permanent above ground structures would be placed within this zone, A temporary rig for horizontal drilling will be located outside of the zone and vehicles

Consultee	Date/ Document	Comment	Project Response
			will use the existing transport route.
MOD	08/02/22	There is a Wide Area Multilateration (WAM) surveillance network employing multiple remote sensors in vicinity of the onshore cable corridor. Impacts are unlikely if no surface structures are to be installed,	Noted. Information has been supplied to the MOD for evaluation. Discussions are ongoing with the MOD to establish implications to the WAM.
Norwich Helicopter Operators	28/04/22	As far as helicopter pilots are concerned the stated worst-case scenario of the tallest wind turbines is their 'best-case' scenario in terms of access/ avoidance [due to spacing].	Impacts associated with helicopter access to nearby infrastructure are assessed within **Chapter 16 Petroleum Industry and Other Marine Users.**
Norwich Helicopter Operators	28/04/22	Aircrews would effectively avoid the block of obstruction (the wind farm arrays) by climbing above the tallest height of the obstruction(s) and hence reducing the navigable airspace available.	Impacts on ATCSMAC are assessed within **Section 15.6.2.4**.
Norwich Helicopter Operators	28/04/22	A climb in altitude would be required in order to meet the required obstruction avoidance with the extensions in place and at a blade tip height of 330m, outbound transit flights across the arrays would be at an altitude of 2,100 and 3,100 ft inbound, which may, in certain weather conditions, require flight in IMC and subject the aircraft to icing conditions, which would be unacceptable.	Impacts on ATCSMAC are assessed within **Section 15.6.2.4**.
Norwich Helicopter Operators	28/04/22	A number of routes from Norwich Airport take the aircraft towards and to the north of the extension arrays in support of Oil and Gas/ operational wind farms.	Noted.
Norwich Helicopter Operators	28/04/22	DEP South array has a disproportionately large impact for the given small overlap with NE quadrant. Committing to not putting 330m turbines here would free up access to that whole quadrant and so many of the North Sea routes.	Impacts on ATCSMAC are assessed within **Section 15.6.2.4**.

Consultee	Date/ Document	Comment	Project Response
Norwich Helicopter Operators	28/04/22	A re-route of aircraft would increase the km flown per trip, leading to a reduced aircraft payload, increased fuel costs and would produce a 'bottleneck' for normal routings.	Noted. Impacts on ATCSMAC are assessed within **Section 15.6.2.4**.
Norwich Airport	12/07/22	A change to the Norwich Airport ATCSMAC will require an amendment to the extant Letter of Agreement between Norwich Airport, NATS (Anglia Radar) and Norwich based offshore helicopter operators (CHC, Bristow and NHV), specifically regarding Operational aspects and standard routing altitudes.	Noted.
Norwich Airport	12/07/22	Raising the ATCSMAC as discussed [within the segmented area] will not impact Norwich Airport ATC; the Airport would not object to the suggested amendment however, Norwich Airport could not speak for NATS (Anglia Radar) and the Norwich based helicopter operators.	Noted.
Section 42 Responses			
NATS	10/05/21	The operational Sheringham Shoal and Dudgeon Wind Farm array areas are located within the Greater Wash TMZ which was established to mitigate effect to aviation PSR.	An assessment of theoretical radar detectability of wind turbines and how detectability will impact NATS radar systems is provided in **Section 15.5.2.2**.
MOD	09/06/21	Both Projects will be detectable by the Trimingham ADR and will impact the operation of the air defence system. Mitigation will be required.	Impacts to the Trimingham ADR are assessed in **Section 15.6.2.2**.
MOD	09/06/21	The RAF Coningsby ATC PSR is also predicted to detect the operational wind turbines in both arrays however, the MOD assessment concludes that there will be no operational impact and, therefore, the MOD have no concerns for this radar and mitigation is not required. No impact will be created to military danger area or PEXA.	Noted.

Consultee	Date/ Document	Comment	Project Response
MOD	09/06/21	The MOD will require that the array areas should be fitted with MOD accredited aviation safety lighting in accordance with the ANO. The MOD would need to confirm the specification of the lighting to be used.	Lighting of the Projects will be in accordance with the ANO and MOD requirements. Consideration of the fitment of aviation lighting is provided in **Table 15-3**.
MOD	09/06/21	Construction activity in the location of the Weybourne transmitter site will need to be compatible with technical safeguarding requirements.	Impacts to the Weybourne Transmitter site are considered at **Section 15.6.1.1**.
MCA	10/06/21	The MCA response focused on shipping and navigation elements of the PEIR however, the MCA will continue to engage with the Applicant from a SAR and navigation safety point of view.	The layout and SAR requirements will be agreed with the MCA and MMO post consent via the Deemed Marine Licence (DML) which would form part of the DCO.
IOG	10/06/21	IOG as operator of the Blyth offshore platform highlighted that helicopter approaches to the Blyth platform helideck continue in varying weather conditions.	A Helicopter Access Study with a focus on access to nearby oil and gas assets has been undertaken. The results are detailed within **Chapter 16** and **Appendix 16.2**.
North Norfolk District Council (NNDC)	10/06/21	NNDC would defer to the advice of the MCA, MOD, NATS and other experts in respect of matters within this Chapter of the PEIR.	Noted.
Other Consultation			
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.	An assessment of helicopter access impacts has been undertaken in **Chapter 16 Petroleum Industry and Other Marine Users** and **Appendix 16.2**.

Consultee	Date/ Document	Comment	Project Response
MOD	10/08/2022 Email	Reassessment of the new location of the Trimingham ADR has been completed and the majority of both of the proposed Sheringham Shoal and Dudgeon wind farms will be line of sight to the ADR when located at Neatishead.	Noted. Impacts to the Trimingham ADR are assessed in **Section 15.6.2.2**.

8. The following helicopter operator that supports the offshore oil and gas industries was also consulted, however, no response was received:

- Babcock Mission Critical Services Offshore

15.3 Scope

15.3.1 Study Area

9. The study area for aviation and radar has been defined on the basis of CAP 764 consultation zones and criteria. Whilst not definitive, the Civil Aviation Authority's (CAA) CAP 764 Policy and Guidelines on Wind Turbines (CAA, 2016a) provides criteria for assessing whether any wind turbine development might have an impact on civil aerodrome related operations. Consideration of the potential for SEP or DEP 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:

10. 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;

11. 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 SEP and DEP wind farm sites; and,

12. 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 SEP and DEP wind farm sites.

13. The study area encapsulates the airspace between the wind farm sites, the United Kingdom (UK) mainland from Norwich Airport and military radar equipped aerodromes which are capable of detecting SEP and DEP including RAF Marham, the Cromer PSR, Trimingham ADR to the south, the Brizlee Wood ADR to the north and the NATS Claxby PSRs located to the west and northwest onshore. **Plate 15-1** provides an illustration of the aviation and radar study area, which encompasses the offshore wind farm sites and offshore cable corridors.

14. Specifically, the study area covers:

- Military ADR and aerodrome PSR systems on the eastern coast of England within operating range of the SEP and DEP with the potential to detect operational wind turbines at a maximum blade tip height of 330m above mean sea level (amsl));
- 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 (see also Chapter 16 Petroleum Industry and Other Marine Users; and
- Littoral MOD assets within Statutory Technical Safeguarding range of any landfall elements of the onshore cable corridor.

15. 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 Southern North Sea (SNS) that could have potential cumulative effects on identified radar receptors.

15.3.2 Realistic Worst-Case Scenario

15.3.2.1 General Approach

16. The final design of SEP and DEP 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: Rochdale Envelope (v3, 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 5 EIA Methodology** (document reference 6.1.5).

17. The realistic worst-case scenarios for the Aviation and Radar assessment are summarised in **Table 15-2**. These are based on the project parameters described in **Chapter 4 Project Description** (document reference 6.1.4), which provides further details regarding specific activities and their durations.

18. In addition to the design parameters set out in **Table 15-2**, consideration is also given to:

- How SEP and DEP will be built out as described in **Section 15.3.2.2** to **Section 15.3.2.4**. This accounts for the fact that whilst SEP and DEP are the subject of one DCO application, it is possible that only one project could be built out (i.e. build SEP or DEP in isolation) or that both projects could be developed. If both are developed, construction may be undertaken either concurrently or sequentially.
- A number of further development options which either depend on pre-investment or anticipatory investment, or that relate to the final design of the wind farms.
- Whether one OSP or two OSPs are required (relevant only to the offshore assessments).
- The design option of whether to use all of the DEP North and DEP South array areas, or whether to use the DEP North array area only (relevant only to the offshore assessments).

19. In order to ensure that a robust assessment has been undertaken, all development scenarios and options have been considered to ensure the realistic worst-case scenario for each topic has been assessed. Further details are provided in **Chapter 4 Project Description** (document reference 6.1.4).

15.3.2.2 Construction Scenarios

20. In the event that both SEP and DEP are built, the following principles set out the framework for how SEP and DEP may be constructed:
    - SEP and DEP may be constructed at the same time, or at different times;
    - If built at the same time both SEP and DEP could be constructed in four years;
    - If built at different times, either Project could be built first;
    - If built at different times, each Project would require a four year period of construction;
    - If built at different times, the offset between the start of construction of the first Project, and the start of construction of the second Project may vary from two to four years;
    - Taking the above into account, the total maximum period during which construction could take place is eight years for both Projects; and
        - The earliest construction start date is 2025.

21. The impact assessment for Aviation and Radar considers the following development scenarios in determining the worst-case scenario for each topic:
    - Build SEP or build DEP in isolation – one OSP only; and
    - Build SEP and DEP concurrently or sequentially – with either two OSPs, one for SEP and one for DEP, or with one OSP only to serve both SEP and DEP.

22. For each of these scenarios it has been considered whether the build out of the DEP North and DEP South array areas, or the build out of the DEP North array area only, represents the worst-case for that topic. Any differences between SEP and DEP, 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 15.6**). For each potential impact, where necessary, 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 15.6**.

23. In the case of Aviation and Radar, sequential construction is considered to represent the worst-case should both SEP and DEP be developed.

15.3.2.3 Operation Scenarios

24. Operation scenarios are described in detail in **Chapter 4 Project Description** (document reference 6.1.4). Where necessary, the assessment considers the following three scenarios:
    - Only SEP in operation;
    - Only DEP in operation; and

- The two Projects operating at the same time, with a gap of two to four years between each Project commencing operation.

25. The operational lifetime of each Project is expected to be 40 years.

15.3.2.4 Decommissioning Scenarios

26. Decommissioning scenarios are described in detail in **Chapter 4 Project Description** (document reference 6.1.4). Decommissioning arrangements will be agreed through the submission of a Decommissioning Programme prior to construction, however for the purpose of this assessment it is assumed that decommissioning of SEP and DEP could be conducted separately, or at the same time.

Table 15-2: Realistic Worst-Case Scenarios.

Impact	DEP in Isolation	SEP in Isolation	SEP and DEP	Notes and Rationale
Construction				
Impact 1: Creation of an obstacle to fixed wing and rotary aircraft operating offshore.	**Wind farm site (excluding offshore temporary works area):** One wind farm site (consisting of the DEP North and South array areas) totaling **103.5km²** Installation of up to **30 turbines** (between 17 and 30 ranging from 15MW 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: Min 3 years, max 4 years. • Duration of operation: 40 years	**Wind farm site (excluding offshore temporary works area):** One wind farm site totaling **92.6km²** Installation of up to **23 turbines** (between 13 and 23 ranging from 15MW 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: Min 3 years, max 4 years. • Duration of operation: 40 years	**Wind farm sites (excluding offshore temporary works area):** Two wind farm sites totaling **196.1km²**. Installation of up **to 53 turbines** (between 30 and 53 ranging from 15MW to 26MW) and up to **2 OSPs, one** in DEP North array area and one in SEP wind farm site (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: 8 years if built sequentially (**Section 15.3.2.2**) • Duration of operation: 40 years	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	SEP and DEP	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 14.1m above the maximum ground height can interrupt the radio signal transmitted.
Operation				
Impact 1: Creation of an obstacle to fixed wing and rotary aircraft operating offshore.	**Wind farm site:** As above Installation of up to **30 turbines** (between 17 and 30 ranging from 15MW to 26MW) and **1 Offshore Substation Platform (OSP)** in DEP North Maximum turbine blade tip height: **330m** (relative to HAT) Duration of operation: 40 years	**Wind farm site:** As above Installation of up to **23 turbines** (between 13 and 23 ranging from 15MW to 26MW) and **1 OSP** comprising in the SEP wind farm site Maximum turbine blade tip height: **330m** (relative to HAT) Duration of operation: 40 years	**Wind farm sites:** As above Installation of up **to 53 turbines** (between 30 and 53 ranging from 15MW to 26MW) and **2 OSPs, one** in DEP North array area and one in SEP wind farm site (if projects are built in a separated grid option) Maximum turbine blade tip height: **330m** (relative to HAT) Duration of operation: 40 years	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.	**Wind farm site:** As above Installation of up to **30 turbines** (between 17 and 30 ranging from 15MW to 26MW) and **1 Offshore Substation Platform (OSP)** in DEP North	**Wind farm site:** As above Installation of up to **23 turbines** (between 13 and 23 ranging from 15MW to 26MW) and **1 OSP** comprising in the SEP wind farm site	**Wind farm sites:** As above Installation of up **to 53 turbines** (between 30 and 53 ranging from 15MW to 26MW) and **2 OSPs, one** in DEP North array area and one in SEP wind farm site (if	ATC and Air Defence controllers may be unable to provide an effective surveillance service due to interference on radar displays.

Impact	DEP in Isolation	SEP in Isolation	SEP and DEP	Notes and Rationale
	Maximum turbine blade tip height: **330m** (relative to HAT) Duration of operation: 40 years	Maximum turbine blade tip height: **330m** (relative to HAT) Duration of operation: 40 years	projects are built in a separated grid option) Maximum turbine blade tip height: **330m** (relative to HAT) Duration of operation: 40 years	
Impact 3: Disruption to aircraft using HMRs.	**Wind farm sites:** As above Installation of up to **30 turbines** (between 17 and 30 ranging from 15MW 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 operation: 40 years	**Wind farm site:** As above Installation of up to **23 turbines** (between 13 and 23 ranging from 15MW 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 operation: 40 years	**Wind farm sites:** As above Installation of up **to 53 turbines** (between 30 and 53 ranging from 15MW to 26MW) and **2 OSPs, one** in DEP North array area and one in SEP wind farm site (if projects are built in a separated grid option) Maximum turbine blade tip height: **330m** (relative to HAT) **Maximum temporal footprint** Duration of operation: 40 years	Wind turbines could create a physical obstruction to aviation operations. HMR 5 crosses DEP North. HMR 4 crosses DEP South. HMR 3 passes within 1.5 NM of DEP South
Impact 4: Impact to Air Traffic Control	**Wind farm sites:** As above	**Wind farm site:** As above	**Wind farm sites:** As above	Maximum blade tip height will breach the Norwich Airport Air

Impact	DEP in Isolation	SEP in Isolation	SEP and DEP	Notes and Rationale
Surveillance Minimum Altitude Chart	Installation of up to **30 turbines** (between 17 and 30 ranging from 15MW to 26MW) and **1 Offshore Substation Platform (OSP)** in DEP North Maximum turbine blade tip height: **330m** (relative to HAT) Duration of operation: 40 years	Installation of up to **23 turbines** (between 13 and 23 ranging from 15MW to 26MW) and **1 OSP** comprising in the SEP wind farm site Maximum turbine blade tip height: **330m** (relative to HAT) Duration of operation: 40 years	Installation of up **to 53 turbines** (between 30 and 53 ranging from 15MW to 26MW) and **2 OSPs, one** in DEP North array area and one in SEP wind farm site (if projects are built in a separated grid option) Maximum turbine blade tip height: **330m** (relative to HAT) Duration of operation: 40 years	Traffic Control Surveillance Minimum Altitude Chart (ATCSMAC) MINIMA
Decommissioning				
Impact 1: Creation of an obstacle to fixed wing and rotary aircraft operating offshore.	The detail and scope of the decommissioning works will be determined by the relevant legislation and guidance at the time of decommissioning and will be agreed with the regulator. It is anticipated that for the purposes of a worst-case scenario, the impacts will be no greater than those identified for the construction phase.			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.

15.3.3 Summary of Mitigation Embedded in the Design

27. This section outlines the embedded mitigation relevant to the Aviation and Radar assessment, which has been incorporated into the design of SEP and DEP (**Table 15-3**). Where other further mitigation measures are proposed, these are detailed in the impact assessment (**Section 15.6**).

Table 15-3: 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 (MGN) 654 Safety of Navigation Offshore Renewable Energy Installations (OREI) - Guidance on UK Navigational Practice, Safety and Emergency Response, in addition to CAP 393 Air Navigation Order 2022, CAP 764 CAA Policy and Guidelines on Wind Turbines and CAP 437 Standards for Offshore Helicopter Landing Areas, where applicable.
Lighting and Marking	Marking and lighting will be deployed in accordance with the latest relevant available standard industry guidance and as advised by CAA, MOD, Trinity House and MCA, as appropriate.
Safeguarding requirements	Any temporary / permanent above-ground infrastructure to remain below the Weybourne safeguarding requirements.
Notification	The Defence Geographic Centre (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.

15.4 Impact Assessment Methodology

15.4.1 Policy, Legislation and Guidance

15.4.1.1 National Policy Statements

28. The assessment of potential impacts upon aviation and radar has been made with specific reference to the relevant NPS. These are the principal decision making documents for Nationally Significant Infrastructure Projects (NSIP). Those relevant to SEP and DEP 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).

29. The specific assessment requirements for Aviation and Radar, as detailed in the NPS, are summarised in **Table 15-4** together with an indication of the section of the ES chapter where each is addressed.

30. It is noted that the NPS for Energy (EN-1) and the NPS for Renewable Energy Infrastructure (EN-3) are in the process of being revised. Draft versions were published for consultation in September 2021 (Department for Business Energy and Industrial Strategy (BEIS), 2021). A review of the draft versions has been undertaken in the context of this ES chapter.

31. No relevant additional requirements are contained within the draft EN-3 or EN-1 documents.

Table 15-4: NPS Assessment Requirements.

NPS Requirement	NPS Reference	Section Reference
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 15.6**.
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 15-1**.
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 15.6**; and cumulative impacts within **Section 15.7**.

32. In addition to the NPS, there are a number of pieces of legislation, policy and guidance applicable to the assessment of Aviation and Radar.

15.4.1.2 Legislation

- CAA CAP 393: The Air Navigation Order (ANO) 2022 (CAA, 2022): 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.

15.4.1.3 Guidance

- CAA 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 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, 2021): 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; and
- 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).

33. Further detail where relevant is provided in **Chapter 2 Policy and Legislative Context** (document reference 6.1.2).

15.4.2 Data and Information Sources

34. The data and other available relevant information sources used in this chapter are the most up to date publicly available information which can be obtained. Sources that have been used to inform the assessment are listed in **Table 15-5**.

Table 15-5: Other available data and information sources.

Data set	Spatial coverage	Year
CAA Visual Flight Rules Charts.	Offshore Study Area	2022
MOD Military Aeronautical Information Publication (Mil AIP).	Offshore Study Area	2022
CAA CAP 032: UK IAIP.	Offshore Study Area	2022
MCA MGN654 Safety of Navigation Offshore Renewable Energy Installations (OREIs) - Guidance on UK Navigational Practice, Safety and Emergency Response.	Offshore Study Area	2021

15.4.3 Impact Assessment Methodology

35. **Chapter 5 EIA Methodology** (document reference 6.1.5) provides a summary of the general impact assessment methodology applied to SEP and DEP. The following sections confirm the methodology used to assess the potential impacts on aviation and radar.

15.4.3.1 Definitions

36. 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 15-6** and **Table 15-7**.

Table 15-6: 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.
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 15-7: 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.

15.4.3.2 Impact Significance

37. 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 5 EIA Methodology** (document reference 6.1.5) for further details). The determination of significance is guided by the use of an impact significance matrix, as shown in **Table 15-8**. Definitions of each level of significance as they apply to aviation and radar receptors are provided in **Table 15-9**.

38. 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 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 15-8: 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 15-9: 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.

15.4.3.3 Radar Line of Sight Analysis

39. 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 SEP and DEP. 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).

40. 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 SEP and DEP wind farm sites relative to nearby aviation radar assets can be assessed. Osprey used a generic grid pattern distribution of wind turbines and a blade tip 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 has not affected the results of the radar LOS analysis. The radar LOS images for assessed radar systems are provided in **Appendix 15.1.**

41. The qualitative definitions used in the LOS assessment are defined in **Table 15-10**. The LOS assessment has been utilised to inform the assessment of impact significance.

Table 15-10: 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.

15.4.4 Cumulative Impact Assessment Methodology

42. The Cumulative Impact Assessment (CIA) considers other plans, projects and activities that may impact cumulatively with SEP and DEP. As part of this process, the assessment considers which of the residual impacts assessed for SEP and/or DEP 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 5 EIA Methodology** (document reference 6.1.5) provides further details of the general framework and approach to the CIA.

43. For aviation and radar, these activities include impacts from SEP and DEP 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.

15.4.5 Transboundary Impact Assessment Methodology

44. The transboundary assessment considers the potential for transboundary effects to occur on aviation and radar receptors as a result of SEP and DEP; 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 5 EIA Methodology** (document reference 6.1.5) provides further details of the general framework and approach to the assessment of transboundary effects.

45. As set out in **Table 15-1** above, the potential for transboundary effects on aviation and radar receptors has been scoped out due to the locations of SEP and DEP entirely within UK waters/airspace (The Planning Inspectorate, 2019).

15.4.6 Assumptions and Limitations

46. 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.

15.5 Existing Environment

15.5.1 Radar

47. 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.

48. 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 Primary Surveillance Radar (PSR)

49. 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

50. 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.

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

Secondary Surveillance Radar

52. A SSR 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.

15.5.1.1 Background to Wind Turbine Effects on Aviation Radar

53. 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.

54. 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.

55. 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 gives 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.

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

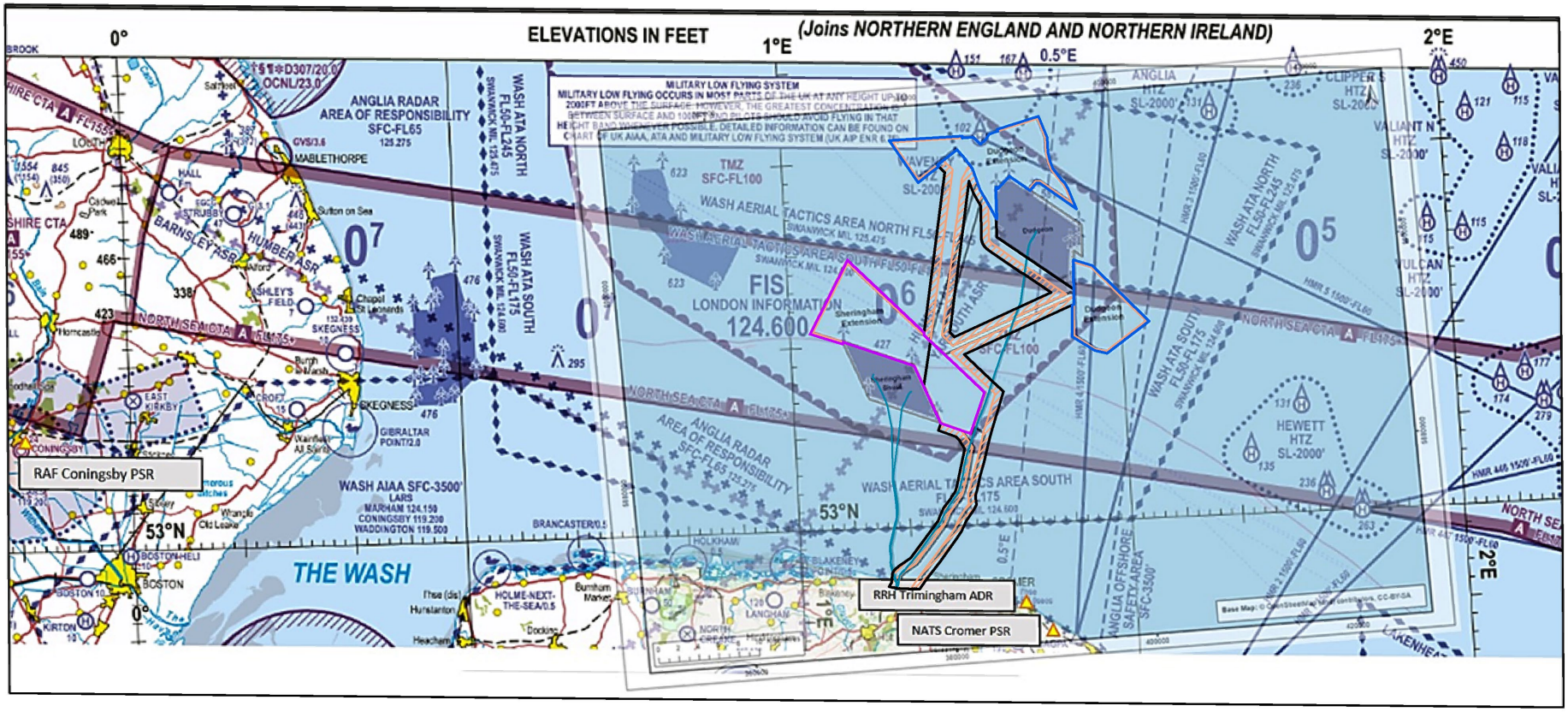
- Twinkling appearance/blade flash effect which can distract a controller;
- Masking of true aircraft targets by increased clutter on an RDDS;
- Increase in unwanted targets or false aircraft tracks;
- Receiver saturation;
- Target desensitisation causing loss of valid targets that are of a small RCS;
- 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.

57. 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.

15.5.2 Airspace

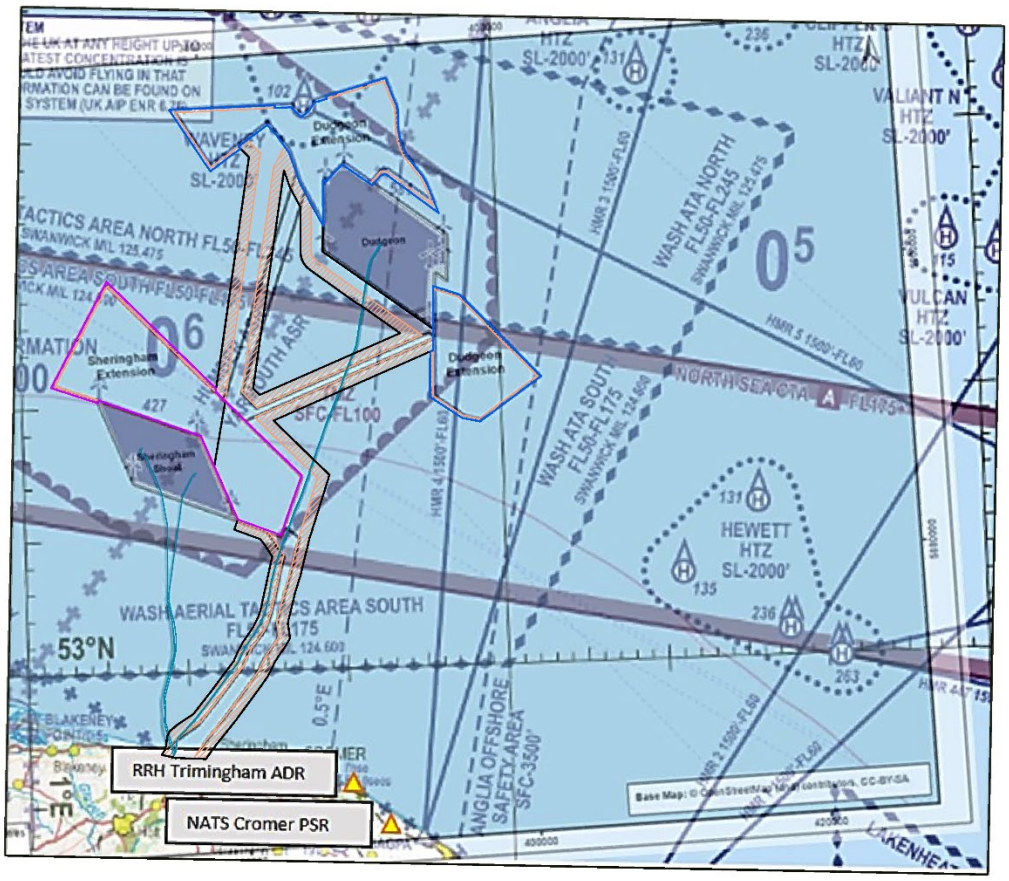
58. An illustration of the baseline environment including littoral areas for the Projects is provided in **Plate 15-1**.

Plate 15-1: Airspace Baseline Environment



59. The SEP and DEP 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 15-2.**

Plate 15-2: Airspace, HMRs and gas platforms with helipads



60. The airspace within, above and surrounding SEP and DEP 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.

15.5.2.1 Military Operations within Practice and Exercise Area

61. The Wash ATA North and South (**Plate 15-2**:) 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.

62. Airborne activity in Practice and Exercise Area (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. Impacts to PEXA are scoped out as the base level is well above the height of the wind turbines.

15.5.2.2 NATS

63. Above 17,500ft (Flight Level (FL)195) (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 SEP and DEP 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.

Claxby and Cromer

64. The NATS operated Claxby and Cromer PSRs are located within the study area and close enough for turbines to be detectable on these PSR systems.

Anglia Radar

65. 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).

66. NATS Anglia Radar uses the Claxby and Cromer PSRs to support its provision of an Offshore ATS to helicopters supporting the offshore Oil and Gas industry platforms and installations in the vicinity of the SEP and DEP.

15.5.2.3 RAF Coningsby

67. RAF Coningsby in Lincolnshire is a Quick Reaction Alert Station which protects UK airspace. RAF Coningsby PSR is close enough for turbines to be detectable on this PSR however, the MOD assessment concludes that there will be no operational impact and, therefore, has no concerns for this radar. RAF Coningsby will therefore not be considered further.

15.5.2.4 Norwich Airport

68. Norwich Airport operates a PSR that provides radar coverage in the airspace above the SEP and DEP 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 SEP and DEP wind farm sites). Further away from the airport this responsibility is transferred to Anglia Radar who utilise NATS radar systems. As well as its own PSR, Norwich Airport also receives radar data from the NATS Cromer PSR system (**Plate 15-1**) and provides a Lower Airspace Radar Service (LARS) to those aircraft requesting it within radar and radio coverage.

15.5.2.5 Air Defence Radar

69. The RAF is responsible for the UK's Air Surveillance and Control System which is part of the Air Defence Radar (ADR) network. The Trimingham ADR system on the North Norfolk coast (**Plate 15-1**) is close enough to SEP and DEP that the turbines could be detectable by this ADR (Radar LOS analysis detailed in **Section 15.6.2.2**). It was noted in consultation with the MOD that the Trimingahm ADR is to be relocated to Neatishead. Assessment of the new location has been completed by MOD and the majority of both of the proposed Sheringham Shoal and Dudgeon wind farms will be line of sight to the AD radar when located at Neatishead.

15.5.2.6 Meteorological Office Radar

70. The safeguarded Meteorological (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.

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

15.5.2.7 SEP Airspace Baseline Environment

72. The airspace immediately surrounding the SEP wind farm site consists of the Greater Wash TMZ established to mitigate the impact of wind farms including the Sheringham Shoal and Dudgeon Offshore Wind Farms (OWF) on aviation radar systems. The TMZ extends from the sea surface up to 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.

73. 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 of controlled airspace are provided by NATS and military controllers based at the Swanwick Area Control Centre (ACC).

74. The southern edge of the SEP wind farm site is located approximately 6.5 Nautical Miles (NM) 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 15-2** and **Chapter 16 Petroleum Industry and Other Marine Users** (document number 6.1.16))).

15.5.2.8 DEP Airspace Baseline Environment

75. The airspace immediately surrounding the DEP North array area and DEP South array area is also in the TMZ established to mitigate the impact of the existing Sheringham Shoal and Dudgeon OWF. 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.

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

- The DEP North array area 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 15-2**).
- The DEP South array area 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.

77. The DEP North array area 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 array area is located south of the consented Independent Oil and Gas normally unmanned production platform, Blythe, and Elgood, (to be tied back to Blythe)) and located between the DEP North array area and the Dudgeon OWF. 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 15-2**). Impacts associated with access to oil and gas infrastructure in vicinity of SEP and DEP are assessed within **Chapter 16 Petroleum Industry and Other Marine Users** (document 6.1.16).

78. HMR 5 crosses the DEP North array between the southernmost platform in the Waveney field (532109N 0011811E) to the Leman field (530313N 0021358E) (**Plate 15-2**).

79. 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 15-2**).

[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.

80. 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 15-2**).

15.6 Potential Impacts

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

- Radar and communications:

  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 and ATCSMAC;

  En-route PSR operated by NATS at Cromer (Norfolk Coast) and Claxby (Lincolnshire);

  Helicopter Main Routes;

Military low flying operations[4].

82. Impacts to offshore helicopter operations in support of the oil and gas industry were also identified for assessment. An independent assessment has been undertaken the results of which are contained within **Appendix 16.2** with impacts assessed within **Chapter 16 Petroleum Industry and Other Marine Users** (document reference 6.1.16).

15.6.1 Potential Impacts during Construction

83. The impacts of the offshore construction of SEP and DEP and the landfall location of the onshore cable corridor search area have been assessed for aviation and radar. Impact 1: Creation of an obstacle to low flying fixed wing and rotary aircraft operating offshore.

SEP or DEP in Isolation

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

85. The construction of either SEP or DEP 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, SEP and DEP should be fitted with MOD accredited aviation safety lighting in accordance with the ANO 2022. The specification of the lighting to be used would be confirmed alongside requirements for the CAA, MCA, MOD and Trinity House in consideration of effects to low flying aircraft.

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

86. 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 would comply with current guidelines and be agreed with the appropriate stakeholders. Embedded mitigation measures are outlined in **Table 15-3**.

87. 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 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) in the vicinity of the construction area, pilots will be flying above the MSA and 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 and the magnitude of effect is therefore considered to be low.

88. Receptors will be notified of construction activity and therefore the ability of aviation receptors to continue to operate safely in the vicinity of 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.

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

SEP and DEP

90. In the event that the SEP and DEP 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 considered to be little difference between the scenarios; however, on balance sequential construction, if not separated by a large timeframe, would be a worst-case for aviation.

91. As for the construction of SEP or DEP 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.

92. 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.

Mitigation

93. No additional mitigation above that embedded is proposed.

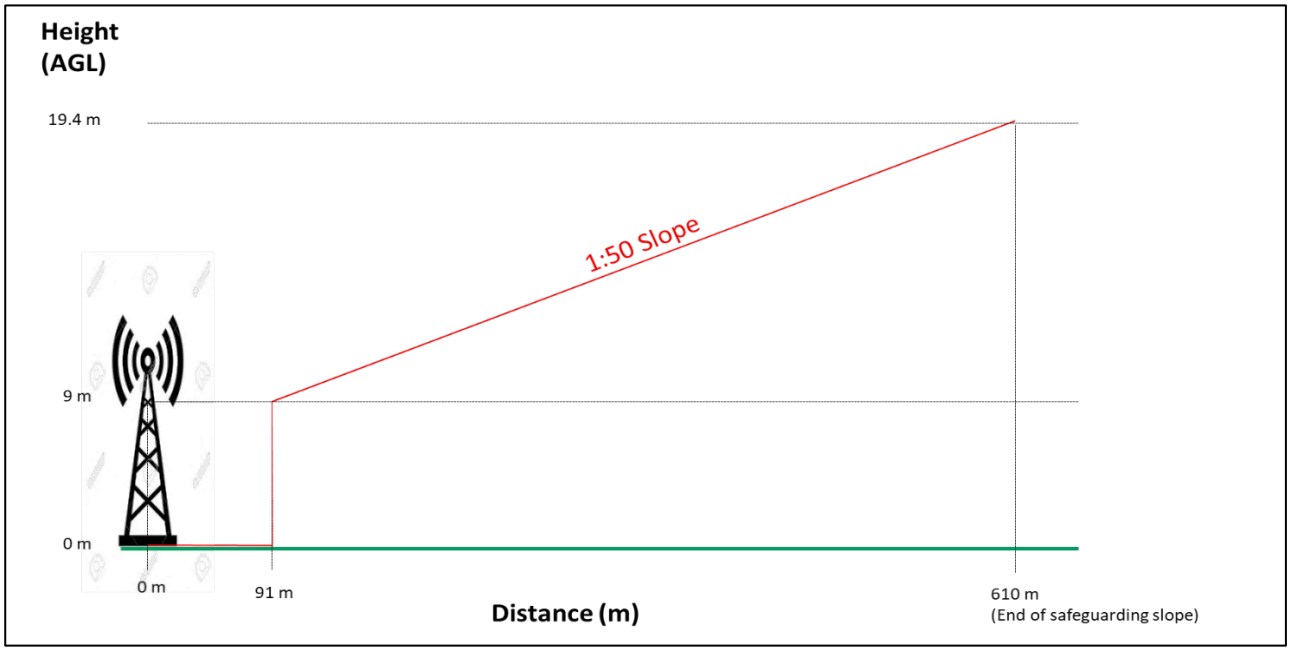
15.6.1.1 Impact 2: Interference to the RAF Weybourne Transmitter

SEP or DEP in Isolation

94. This section considers the onshore cable corridor and therefore the potential effect applies to construction of both scenarios and is the same for both SEP and DEP. 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 Very High Frequency (VHF) / Ultra High Frequency (UHF) Transmitters.

95. 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 15-3**.

Plate 15-3: A/G Technical Safeguarded Area



96. The inner safeguarding perimeters are defined by a 91m radius circle 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.

Plate 15-4: Onshore Cable Search Area (Blue Line) and Transmitter Safeguarded Areas

97. The area within the red circles illustrated in **Plate 15-4** 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.

98. The extent of the onshore cable corridor 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 corridor search area is 346m. The shortest distance between TX 2 and the onshore cable corridor search area is 443m. The western most search area lies underneath the TX 1 and TX 2 safeguarded conical slopes as depicted in **Plate 15-3** and **Plate 15-4**. **Plate 15-5** and **Plate 15-6** provide illustrations of the safeguarded 1:50 slopes for each transmitter.

Plate 15-5: Profile View of TX 1 Safeguarded Areas

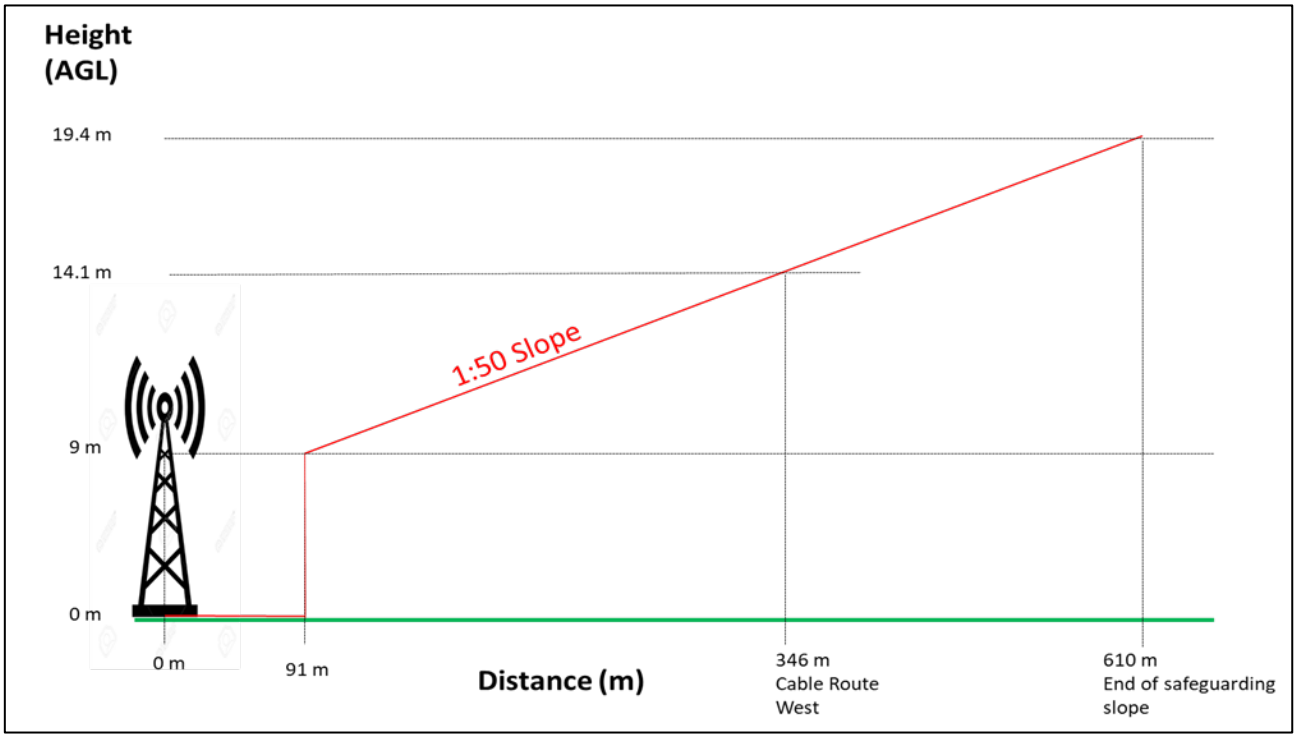
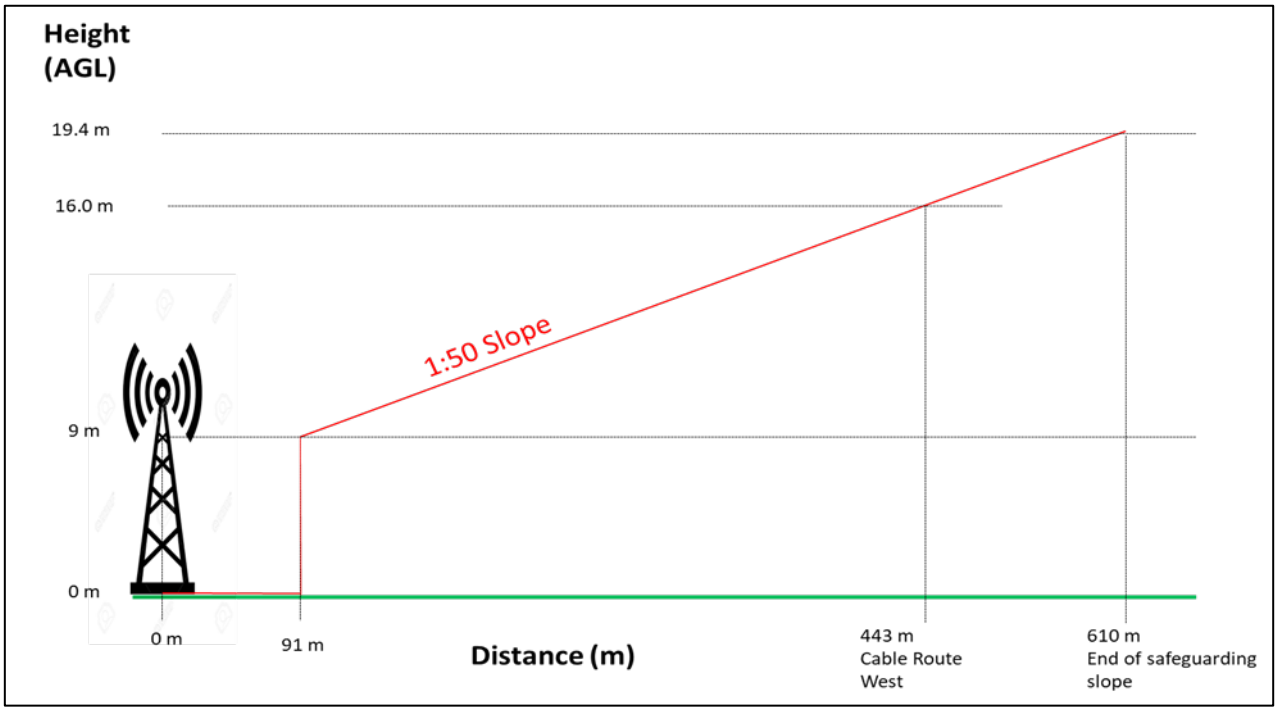


Plate 15-6: Profile View of TX 2 Safeguarded Areas



99. 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 (**Table 15-3**).

100. Only a small portion of the onshore cable search area lies within the confines of the outer safeguarded area of the transmitters. 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.

101. 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.

0 SEP and DEP

102. Should SEP and DEP both be constructed, either concurrently or sequentially, 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.

Mitigation

103. No additional mitigation above that embedded is proposed.

15.6.2 Potential Impacts during Operation

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

SEP or DEP in Isolation

104. The operation of either SEP or DEP 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.

105. 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 15-3**.

106. As described in **Section 15.6.1.1**, 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 will be flying above the MSA, use on board radar to detect obstructions and be under the control of ATC with an appropriate level of radar service. 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 (**Appendix 15.1**).

107. 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, may be required to alter tracks to avoid the area, the sensitivity of the receptors is therefore considered to be medium.

108. 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.

SEP and DEP

109. In the event that SEP and DEP are both developed, as for SEP or DEP 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 SEP and DEP 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.

110. 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.

Mitigation

111. No additional mitigation above that embedded is proposed.

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

SEP or DEP in Isolation

112. Radar LOS analysis has provided the results of theoretical radar detection of the operational wind turbines for both SEP and DEP (**Appendix 15.1**). Results of predicted radar detectability between SEP and DEP differ and are provided in **Table 15-11**. The theoretical distribution of detectable turbines within the wind farm sites is illustrated in **Appendix 15.1**. Receptors within the study area such as RAF Marham PSR and the Brizlee Wood ADR which are outside of theoretical detectability of SEP and DEP operational wind turbines, are scoped out.

Table 15-11: 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
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

**because of the coastal location and lack of blocking terrain impacts are not expected to change once relocated to Neatishead.*

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

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

115. 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.

116. Without mitigation, the impact created by the detection of operational wind turbines is predicted to be repetitious, long-term and continuous. It is predicted that the impact will affect the receptor directly and the magnitude of effect is considered to be medium for all receptors.

117. The ability of NATS, the MOD 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 to launch a response to any potential airborne threat, could be impacted by the presence of wind turbine interference and the production of radar clutter on radar displays.

118. 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.

119. 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 SEP and DEP, which is significant in EIA terms.

SEP and DEP

120. In the event that SEP and DEP 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 both SEP and DEP is the worst-case scenario.

121. 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.

Mitigation

122. In addition to the embedded mitigation outlined in **Table 15-3**, further mitigation and assessments are made below for all radar receptors.

Claxby and Cromer PSRs

123. NATS shas previously suggested a preferred mitigation solution for other offshore developments in the SNS which will be applicable for SEP and DEP. If applied this mitigation will remove impacts from SEP and DEP 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. NATS Anglia Radar uses the Claxby and Cromer PSRs to support its provision of an Offshore ATS to helicopters supporting the offshore Oil and Gas industry platforms and installations in the vicinity of the SEP and DEP. Mitigation of the NATS PSR assets impacted by SEP and DEP will also mitigate the radar impact to its end users of the data including Anglia Radar.

Norwich Airport PSR

124. 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 is ongoing to reach agreement on the best mitigation solution to remove the impact created by the projects.

Trimingham ADR

125. 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 (as operated at RRH Trimingham) 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".

126. 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].

127. The MOD, BEIS, the Crown Estate and the Offshore Wind Industry Council (OWIC) formed a Joint Task Force (JTF) in 2019 with the aim of enabling the co-existence of air defence and offshore wind in the UK. The Applicant is a participating member of the OWIC ATF and is actively engaged in the workstreams being progressed through that forum. In September 2021, the task force published a strategy document entitled Air Defence and Offshore Wind, Working Together Towards Net Zero[1] (JTF, 2021) which sets out the process of the development of future technical radar mitigation schemes to mitigate ADR from the impact created by the radar detectability of operational wind turbines. Potential technical radar mitigation solutions have been identified through concept demonstrations, and these systems have demonstrated that they could potentially support wind farm development, the JTF are working towards the joint procurement of an ADR technical mitigation solution in partnership with other participating developers.

128. The Applicant has also sought to engage with the MOD directly throughout the pre-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

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

Residual Impacts - SEP or DEP in Isolation

129. The residual impact to all civil and military radar systems would be **minor adverse** with mitigation which is not significant in EIA terms.

Residual Impacts - SEP and DEP

130. Should both SEP and DEP be constructed the residual impact to all civil and military radar systems is considered to be the same as in isolation (**minor adverse**) with mitigation in place which is not significant in EIA terms.

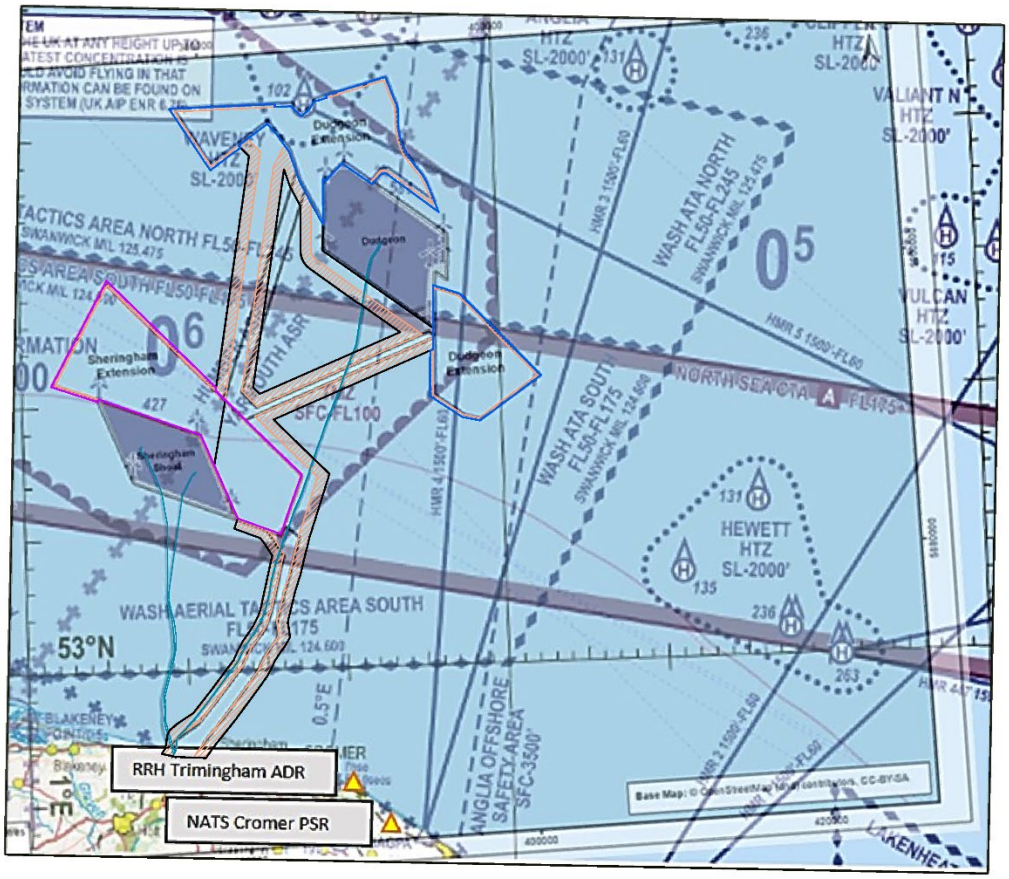
15.6.2.3 Impact 3: Disruption to aircraft using Helicopter Main Routes

SEP or DEP in Isolation

131. HMRIs 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. Consultation with helicopter operators has advised that the HMR network is not widely used in the SNS with helicopter operators choosing instead to route directly to their destination.

132. 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 15-7** provides an illustration of the HMRs surrounding and crossing DEP North array area and DEP South array area.

Plate 15-7: HMRI Structure



Data included in this product reproduced under licence from NATS (Services) Ltd © Copyright 2022 NATS (Services) Ltd. All rights reserved. Temporary Works Area shown in orange.

133. 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 array area between the Waveney platform and the Leman field.
- HMR 4 crosses DEP South array area. 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 array area, however, at this distance it is not considered that the HMR would to be impacted by the operation of DEP South.

134. HMRI are not religiously flown by crews in the SNS however, the presence of the wind turbines below HMRI 4 and 5 is likely to limit the use of these routes when the prevailing weather conditions in which visual avoidance of turbines is not possible requires a higher transit flight altitude to avoid the wind turbines. This higher altitude may place the aircraft into icing conditions which would be unacceptable for those aircraft not equipped with an anti-icing capability. In inclement cold weather conditions, helicopters without anti-icing may also require to fly at a lower altitude to remain below the icing level (the level at which the air temperature reaches freezing).. Due to the infrequent use of HMRI, the effect is predicted to be at low frequency when low flying is necessary over SEP and DEP however non anti-icing equipped helicopters would be restricted in overflight of SEP and DEP in conditions which preclude higher altitude of flight above the wind farms therefore the magnitude is considered to be medium.

135. 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) at 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 array area and DEP South array area, 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 array area and DEP South array area, their vulnerability is considered low and therefore the sensitivity of the receptor is considered to be low.

136. Overall, the sensitivity of the receptor is considered to be low, and the magnitude of effect is assessed as medium. 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.

0 SEP and DEP 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 both SEP and DEP will therefore be the same as for DEP in isolation, of **minor adverse** *significance, which is not significant in EIA terms.*

Mitigation

137. No additional mitigation above that embedded is proposed.

15.6.2.4 Impact 4 Impact on Air Traffic Control Surveillance Minimum Safe Altitude

SEP or DEP in Isolation

138. Norwich Airport raised concerns with regard to the worst-case height of the wind turbines and the possibility of a requirement to raise the Norwich Airport ATCSMAC. An Osprey CAA approved IFP designer completed an analysis of the ATCSMAC (**Appendix 15.2**) which has confirmed, with the maximum blade tip height in place and a requirement for at least 300m minimum obstacle clearance, the ATCSMAC minima would be breached resulting in a requirement for the ATCSMAC minima to be raised.

139. It was noted in consultation with the Norwich based helicopter operators that the DEP South array area has a disproportionately large impact given the small overlap with the NE quadrant (**Appendix 15.2**).

140. The northeast quadrant is intersected by the DEP South array area and northwest quadrant by the SEP wind farm site. Should either project be constructed in isolation, the ATCSMAC in either quadrant would be required to be raised to 2,100ft.

141. A number of routes from Norwich Airport take the aircraft towards and to the north of the extension arrays in support of the Oil and Gas and offshore windfarms. Helicopters operating out of Norwich Airport to oil and gas infrastructure offshore provide a service that is of high value to the national economy and as such the receptor is vulnerable to changes to the ATCSMAC. The sensitivity is therefore determined to be high for both SEP or DEP.

142. Without mitigation, helicopter operations would be impacted in certain weather conditions above SEP or the DEP South array, which may result in alterations to existing routes. The impact would be continuous and irreversible for the operational phase. The magnitude of impact is therefore medium for both SEP or DEP. The impact will therefore be of **major adverse** significance without mitigation which is significant in EIA terms.

SEP and DEP

143. In the event that SEP and DEP are both developed, the impact on radar receptors will be greater as the ATCSMAC minima will need to be raised across both of the northern quadrants. A number of routes from Norwich Airport take the aircraft towards and to the north of the extension arrays in support of the Oil and Gas and offshore windfarms which provide a service that is of high value to the national economy The sensitivity is therefore determined to be high for SEP or DEP.

144. 139. Without mitigation, helicopter operations would be impacted in certain weather conditions above SEP or the DEP South array area which may result in alteration to existing routes. The impact would be continuous and irreversible for the operational phase. The magnitude of impact is therefore medium for both SEP and DEP. The impact will therefore be of **major adverse** significance without mitigation which is significant in EIA terms.

Mitigation

145. Consultation with Norwich Airport and helicopter operators is progressing to reach a mutually applicable solution.

146. The following mitigations are proposed:

- Increase in height of the ATCSMAC minima in the sectors effected by the projects. Consultation with the airport and helicopter operators is ongoing for an agreement by the airport to increase the level of the ATCSMAC minima. It is expected that agreement will be made with the airport to mitigate the effect to the ATCSMAC;
- Further sectorisation of the existing northern ATCSMAC quadrants (segmented to align with the outer limits of SEP and DEP) to minimise impacts, such as increased journey times, to helicopter operations; and

- Commercial agreements with oil and gas operators where necessary. Concern was raised in consultation with the helicopter operators that in order to meet the required obstruction avoidance (2,100 ft for the extension areas), in certain weather conditions, flight in IMC may be required and subject the aircraft to icing conditions, which would be unacceptable. Where significant diversions are required markedly increasing flight times and fuel burn, commercial agreements will be sought where necessary. Assessment is ongoing to quantify the level of impact of diversions in IMC.

Residual Impacts - SEP or DEP in Isolation

147. The residual impact to Air Traffic Control Minimum Safe Altitude would be **minor adverse** with mitigation which is not significant in EIA terms.

Residual Impacts - SEP and DEP

148. Should both SEP and DEP be constructed the residual impact to air traffic control surveillance minimum safe altitude is considered to be the same as in isolation (**minor adverse**) with mitigation in place which is not significant in EIA terms.

15.6.3 Potential Impacts during Decommissioning

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

SEP or DEP in Isolation

149. The decommissioning of either SEP or DEP 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 15.6.1.1**).

150. 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 SEP and DEP. These will comply with current guidelines and be agreed with the appropriate stakeholders and are outlined in **Table 15-1**. 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.

151. The ability of aviation receptors to continue to operate safely in the vicinity of the project decommissioning areas will be unaffected and the sensitivity of the receptors is therefore considered to be low.

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

SEP and DEP

153. Physical obstruction to flight operations during decommissioning of SEP and DEP, 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.

15.7 Cumulative Impacts

15.7.1 Identification of Potential Cumulative Impacts

154. The first step in the cumulative assessment is the identification of which residual impacts assessed for SEP and/or DEP 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 15-12**, 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 15.6** 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).

155. **Table 15-12** provides those cumulative impacts included in the CIA.

Table 15-12: 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 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.
Impact 4: Impact on Air Traffic Control Surveillance Minimum Safe Altitude	Yes	High	The ATCSMAC will be breached by the worst-case turbine height increasing the required minimum safe altitude.

Impact	Potential for Cumulative Impact	Data Confidence	Rationale
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.

15.7.2 Other Plans, Projects and Activities

156. 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 15-13** together with a consideration of the relevant details of each, including current status (e.g. under construction), planned construction period, closest distance to SEP and DEP, status of available data and rationale for including or excluding from the assessment.

157. 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 SEP and DEP. 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. It is noted that existing operational projects are considered within the existing environment and not cumulatively.

158. Other projects within 100km (the maximum range where radar cumulative effect may occur) of SEP and DEP are considered for the effect of wind turbines causing interference on radar systems.. Other projects within 40km of SEP and DEP are considered for the effect of creating an obstacle to fixed and rotary wing aircraft operating offshore.

Table 15-13: Summary of Planned 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
Outer Dowsing	Pre-Scoping	Unknown	13 (array area) 16 (cable corridor)	High	Y	There is the potential for overlap in the operational phases of the OWF and SEP and DEP.
Hornsea Project Three Offshore Wind Farm	Consented	2023-2031 (offshore export cable construction 2026-2027, possibly also 2030-2031)	0 (cable corridor) 83 (array area)	High	Y	There is the potential for overlap in the construction and/or operational phases of the OWF and SEP and DEP.
Hornsea Project Four Offshore Wind Farm	Application submitted	2024 to 2029	52 (array area) 70 (cable corridor)	Medium	Y	There is the potential for overlap in the construction and/or operational phases of the OWF and SEP and DEP.
Hornsea Project Two Offshore Wind Farm	In Construction	2020 to 2022 (offshore construction)	66.434 (cable corridor) 52 (array area)	High	Y	There is the potential for overlap in the construction and/or operational phases of the OWF and SEP and DEP.
Norfolk Vanguard Offshore Wind Farm	Consented	2025 – 2027 (offshore construction)	28 (cable corridor) 58 (array area)	High	Y	There is the potential for overlap in the construction and/or operational phases of the OWF and SEP and DEP.
Five Estuaries	Pre-PEIR	Late 2020's	127 (cable corridor)	Low	Y	There is the potential for overlap in the construction and/or operational phases of the OWF and SEP and DEP.

Project	Status	Construction Period	Closest Distance from the Project (km)*	Confidence in data	Included in the CIA (Y/N)	Rationale
			135 (array area)			
North Falls	Pre-PEIR	Late 2020's	120 (cable corridor) 128 (array area)	Low	Y	There is the potential for overlap in the construction and/or operational phases of the OWF and SEP and DEP.
Norfolk Boreas	Consented	2025 -2029	22 (cable corridor) 82 (array area)	High	Y	There is the potential for overlap in the construction and/or operational phases of the OWF and SEP and DEP.
East Anglia THREE Offshore Wind Farm	Consented	2023 - 2026	94 (cable corridor) 95 (array area)	High	Y	There is the potential for overlap in the construction and/or operational phases of the OWF and SEP and DEP.
East Anglia ONE North Offshore Wind Farm	Under determination	2023-2026	97 (cable corridor) 98 (array area)	High	Y	There is the potential for overlap in the construction and/or operational phases of the OWF and SEP and DEP.

**Measured to the nearest SEP or DEP wind farm site element.*

15.7.3 Assessment of Cumulative Impacts

159. Having established the residual impacts from SEP and/or DEP 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.

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

SEP or DEP in isolation

160. 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 SEP and DEP and other wind farms. For the purposes of this assessment, this possible cumulative effect has been assessed for projects within 40km from SEP and DEP, 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.

161. As for obstacles associated with SEP and DEP, 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.

162. Aviation operations in the UK are highly regulated. The SEP and DEP study area is located in airspace where the provision of an ATS is routine. The same rules of the air which maintain a safe operating environment in the current baseline will apply for the other projects in the SNS which themselves and where required will not be operated without a technical Radar Mitigation System (RMS) in place. 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 15-3**.

163. 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.

164. In the context of the airspace available and given that the cumulative projects will not be operated without an RMS in place, there is not a substantial increase of effects. 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.

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

165. The potential impact created by the radar detection of SEP and DEP also exists to radar systems from the developments listed in **Table 15-13**. Cumulative radar effect is only possible in the operational phase of the projects. For the purposes of this assessment, this 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 SEP and DEP are listed in **Table 15-13**.

166. Theoretical radar LOS analysis indicates that wind turbines with a tip height of 330m HAT within SEP and DEP would be theoretically detectable (by varying degrees) by the Claxby, Cromer and Norwich Airport 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 of the 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 the projects will not contribute to adverse cumulative impacts on aviation radar, and the magnitude is considered to be low.

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

168. The sensitivity of the receptors considered is high and the worst-case magnitude of potential cumulative effects is deemed to be low given that the cumulative projects will not be operated without an RMS in place. The effect is **minor adverse** for all scenarios given that a technical radar mitigation solution exists across each cumulative project to mitigate its radar effect.

15.8 Transboundary Impacts

169. SEP and DEP 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 15-1**.

15.9 Inter-relationships

170. Inter relationships with other chapters are identified in **Table 15-14**.

Table 15-14 :Chapter Topic interactions

Topic and description	Related chapter	Where addressed in this chapter	Rationale
Operation			
Aviation lighting	**Chapter 15: Shipping and Navigation**	**Section 15.6.2.1**	Any lighting requirements for maritime and aviation navigation will be balanced with aviation lighting

Topic and description	Related chapter	Where addressed in this chapter	Rationale
			requirements defined through consultation.
Helicopter Access	Chapter 16 Petroleum Industry and Other Marine Users	Section 15.6.2.3 and Section 15.6.2.4	Deviations may be necessary in certain conditions which may impact access to offshore platforms.

15.10 Interactions

171. 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.

15.11 Potential Monitoring Requirements

172. Monitoring requirements will be described in the **'In-Principle Monitoring Plan'** (IPMP) (document reference 9.6) 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.

173. 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.

15.12 Assessment Summary

174. This chapter has provided 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 15-15**.

175. SEP and DEP 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 Trimingham ADR and low flying operations.

  Norwich Airport ATCSMAC and PSR.
- Offshore helicopter operations

15.12.1 Radar and Communications

15.12.1.1 NATS

176. SEP and DEP will be theoretically detectable by the NATS Cromer and Claxby PSRs, which without mitigation, is likely to produce an 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.

177. NATS has provided an agreed mitigation solution comprising of blanking of the affected radar systems, together with a suggestion of an application to change airspace (through an airspace change proposal) above the array area. The extension to the existing TMZ to cover the full extent of the Project array areas will be the most cost-efficient mitigation solution.

15.12.1.2 The MOD

178. SEP and DEP are predicted to present an unacceptable (major) impact on the Trimingham ADR without additional mitigation. 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 SEP and DEP.

179. The MOD, BEIS, the Crown Estate and OWIC through the JTF is working with industry to seek proposals that can provide future offshore wind farm mitigation for the UK ADR. Potential technical radar mitigation solutions have been identified and the JTF is working towards the procurement of an ADR technical mitigation solution which once deployed will provide an enduring solution. The Applicant will continue to engage with the MOD to identify agreed mitigation for the Trimingham ADR system.

180. 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.

15.12.1.3 Norwich Airport

181. SEP and DEP South array area will theoretically be highly likely to be detectable by the Norwich Airport PSR, and intermittent detection of turbines in the western area of DEP North array area 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. Technical manipulation of the Norwich Airport PSR may be possible to remove the impacts expected on the radar system by manipulation of the radar system or through the use of a technical radar mitigation techniques such as the use of holographic radar. Further sectorisation of the existing ATCSMAC northern quadrants and raising of the ATCSMAC within the central quadrant would limit impacts to helicopter operations. Consultation with Norwich Airport, Norwich based helicopter operators and platform operators is ongoing. .

15.12.2 Offshore Helicopter Operations

182. 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 would be experienced if a reroute of aircraft is required when overflight of SEP and DEP are not possible due to the possibility of placing the aircraft in icing conditions. Further assessment of impacts to helicopter access to nearby oil and gas platforms is contained within **Chapter 16 Petroleum Industry and Other Marine Users** (document number 6.1.16).

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

Potential impact	Receptor	Sensitivity	Magnitude	Pre-additional mitigation impact	Additional 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	N/A	Minor adverse for all scenarios
Impact 2: Interference to the RAF Weybourne Transmitter	Agencies utilising the transmitter	Medium	Negligible	Minor adverse for all scenarios	N/A	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	N/A	Minor adverse for all scenarios
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. Blanking of affected PSR's	Minor adverse for all scenarios
Impact 3: Disruption to aircraft using HMRs	Offshore Helicopter operators	Low	Medium	Minor adverse for DEP only (no impact for SEP)	N/A	Minor adverse for DEP only (no impact for SEP)

Potential impact	Receptor	Sensitivity	Magnitude	Pre-additional mitigation impact	Additional Mitigation measures proposed	Residual impact
Impact 4:Impact on Air Traffic Control Surveillance Minimum Safe Altitude	Norwich Airport, offshore helicopter operators.	High	Medium	Major adverse	Raise ATCSMAC, Sectorisation of ATCSMAC, Commercial agreement where required.	Minor adverse
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	N/A	Minor adverse for all scenarios
Cumulative						
Impact 1: Creation of an obstacle to low flying fixed wing and rotary aircraft operating offshore	Military low flying and offshore helicopter operators	Low	Medium	Minor adverse for all scenarios	N/A	Minor adverse for all scenarios
Impact 2: Wind turbines causing interference on civil and military radar systems	MOD, NATS and Norwich Airport	High	Low	Minor adverse for all scenarios	Mitigation of ADR and ATC PSR. With agreed mitigation in place impact will be reduced.	Minor adverse for all scenarios

15.13 References

CAA (2016). CAP 764 Policy and Guidelines on Wind Turbines.
CAA (2021). CAP 437 Standards for Offshore Helicopter Landing Areas
CAA (2019). CAP 168 Licensing of Aerodromes
CAA (2022). CAP 393 The Air Navigation Order and Regulations
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