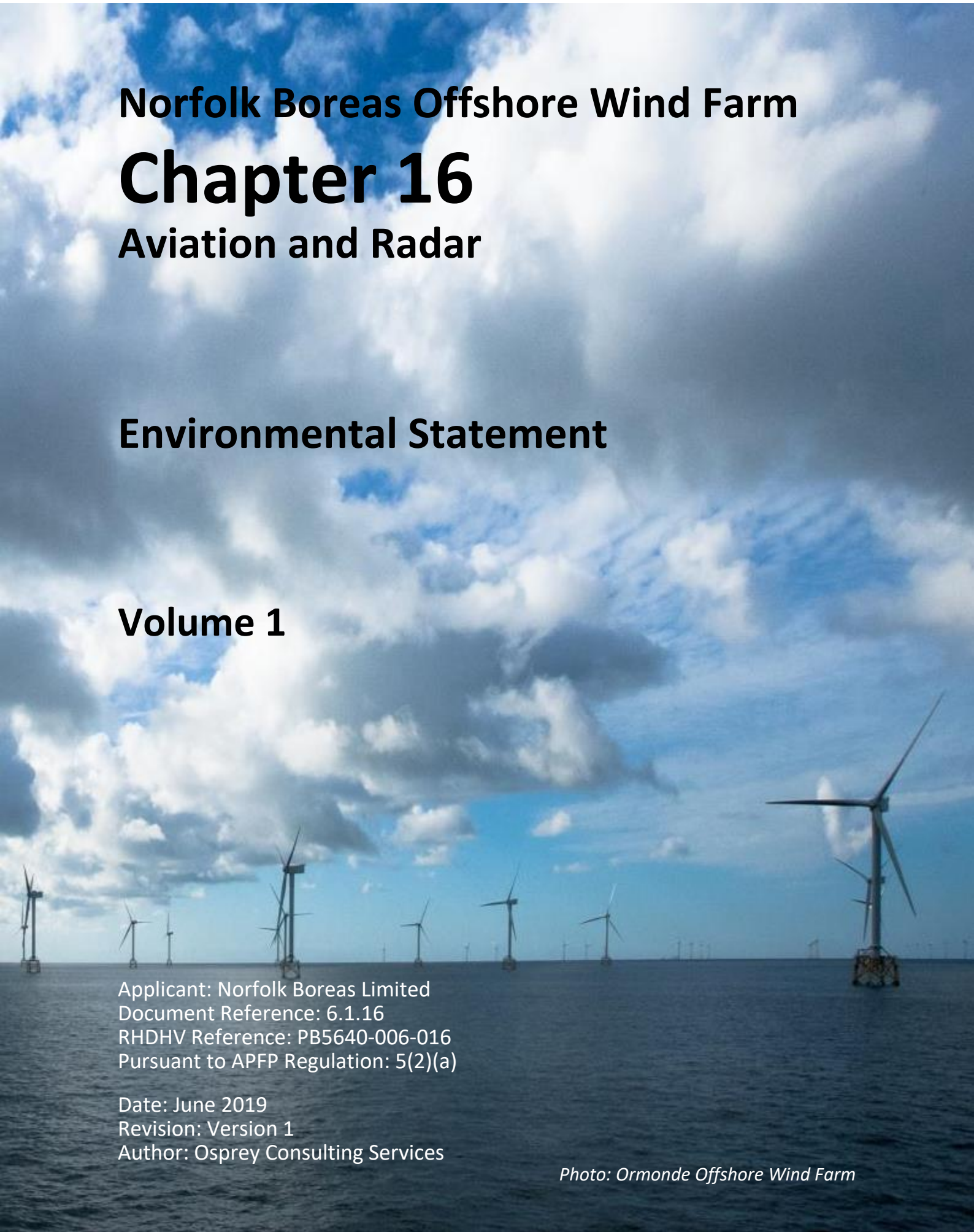
Norfolk Boreas Offshore Wind Farm

Chapter 16

Aviation and Radar

Environmental Statement

Volume 1



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Glossary of Acronyms

AARA	Air to Air Refuelling Area
ACC	Area Control Centre
ACP	Airspace Change Proposal
ADR	Air Defence Radar
agl	above ground level
AIP	Aeronautical Information Package
amsl	above mean sea level
AOC	Aircraft Operator Certificate
ARA	Airborne Radar Approach
ASACS	Air Surveillance and Control System
ATC	Air Traffic Control
ATS	Air Traffic Services
CAA	Civil Aviation Authority
CAP	Civil Aviation Publication
CAS	Controlled Airspace
CAT	Commercial Air Traffic
CGOC	Coast Guard Operations Centre
CNS	Communication Navigation Surveillance
CTV	Crew Transfer Vessel
DCO	Development Consent Order
DECC	Department for Energy and Climate Change
DGC	Defence Geographic Centre
DIO	Defence Infrastructure Organisation
ERCoP	Emergency Response Cooperation Plan
FIR	Flight Information Region
FL	Flight Level
ft	Feet
GAAC	General Aviation Awareness Council
GPS	Global Positioning System
HAT	Highest Astronomical Tide
HMR	Helicopter Main Route
IAIP	Integrated Aeronautical Information Package
IFR	Instrument Flight Rules
kt	Knot
ILT	Inspectie Leefomgeving en Transport
IMC	Instrument Meteorological Conditions
km	Kilometre
LARS	Lower Airspace Radar Service
LAT	Lowest Astronomical Tide
LOS	Line of Sight
LVNL	Luchtverkeersleiding Nederland
m	Metre
MAA	Military Aviation Authority
MAP	Missed Approach Procedure

MCA	Maritime and Coastguard Agency
MGN	Maritime Guidance Notes
Mil AIP	Military Aeronautical Information Publication
MoD	Ministry of Defence
m/s	Metres per Second
MRCC	Maritime Rescue Coordination Centre
MSA	Minimum Safe Altitude
NAIZ	Non-Automatic Initiation Zone
NATMAC	National Air Traffic Management Advisory Committee
NERL	NATS En Route Limited
NM	Nautical Mile
NOTAM	Notice to Airmen
NPS	National Policy Statement
OREI	Offshore Renewable Energy Installation
OWF	Offshore Wind Farm
PAR	Precision Approach Radar
PD	Probability of Detection
PEXA	Practice and Exercise Area
PINS	Planning Inspectorate
PSR	Primary Surveillance Radar
RAF	Royal Air Force
RAP	Recognised Air Picture
RCS	Radar Cross Section
RDDS	Radar Data Display System
RDP	Radar Data Processor
REZ	Renewables Energy Zone
rpm	Rotations per Minute
RRH	Remote Radar Head
SAR	Search and Rescue
SARG	Safety and Airspace Regulation Group
SMS	Safety Management System
SOV	Service Offshore Vessel
SSR	Secondary Surveillance Radar
TCE	The Crown Estate
UK	United Kingdom
UKHO	UK Hydrographic Office
UKLFS	UK Low Flying System
VFR	Visual Flight Rules
VMC	Visual Meteorological Conditions

Glossary of Terminology

0° isotherm	The altitude in which the temperature is at 0°C (the freezing point of water) in a free atmosphere.
Airborne Radar Approach (ARA)	A procedure used by helicopters for low-visibility approaches to offshore platforms which relies upon an aircraft's on-board weather radar for guidance and as a means of detecting obstacles in the approach path.
Air to Air Refuelling Areas (AARA)	A defined piece of airspace activated for the purpose of transferring aviation fuel from one aircraft to another.
Controlled Airspace (CAS)	Airspace in which Air Traffic Control exercises authority. In the UK, Class A, C, D and E airspace is controlled.
Flight Level (FL)	A standard nominal altitude of an aircraft, in hundreds of feet, based upon a standardised air pressure at sea-level.
Helicopter Main Route (HMR)	Routes which are established to facilitate safe helicopter flights in Instrument Flight Rules (IFR) conditions (i.e. when flight cannot be completed in visual conditions).
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.
Minimum Safe Altitude (MSA)	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.
Missed Approach Procedure (MAP)	The actions for the crew of an aircraft to take when an instrument approach procedure is not successful e.g. the crew are unable to see the runway, approach lights or helideck.
Norfolk Boreas site	The Norfolk Boreas wind farm boundary. Located offshore, this will contain all the wind farm array.
Norfolk Vanguard	Norfolk Vanguard offshore wind farm, sister project of Norfolk Boreas.
Offshore service platform	A platform to house workers offshore and/or provide helicopter refuelling facilities. An accommodation vessel may be used as an alternative for housing workers.
Offshore cable corridor	The corridor of seabed from the Norfolk Boreas site to the landfall site within which the offshore export cables will be located.
Offshore electrical platform	A fixed structure located within the Norfolk Boreas site, containing electrical equipment to aggregate the power from the wind turbines and convert it into a suitable form for export to shore.
Offshore export cables	The cables which transmit power from the offshore electrical platform to the landfall.
Offshore project area	The area including the Norfolk Boreas site, project interconnector search area and offshore cable corridor.
Onshore cable route	The up to 35m working width within a 45m wide corridor which will contain the buried export cables as well as the temporary running track, topsoil storage and excavated material during construction.
Onshore cables	The cables which take power and communications from landfall to the onshore project substation.
Onshore infrastructure	The combined name for all onshore infrastructure associated with the project from landfall to grid connection.
Project interconnector cable	Offshore cables which would link either turbines or an offshore electrical platform in the Norfolk Boreas site with an offshore electrical platform in one of the Norfolk Vanguard sites.

Project interconnector search area	The area within which the project interconnector cables would be installed.
Precision Approach Radar (PAR)	A military instrument approach system which provides both horizontal and vertical guidance for landing from 10 or 20 nautical miles (NM) from the airfield.
The Applicant	Norfolk Boreas Limited
The project	Norfolk Boreas Wind Farm including the onshore and offshore infrastructure.
Uncontrolled Airspace	Airspace in which Air Traffic Control does not exercise any executive authority, but may provide basic information services to aircraft in radio contact. In the UK, Class G airspace is uncontrolled.
Visual Flight Rules (VFR)	The rules governing flight conducted visually i.e. with the crew maintaining separation from obstacles, terrain and other aircraft visually.

16 AVIATION AND RADAR

16.1 Introduction

1. This chapter of the Environmental Statement (ES) describes the existing environment with regard to aviation within and around the proposed project, through the evaluation of existing data source and desk studies, and consultation with key stakeholders.

2. This chapter has been prepared by Osprey Consulting Services Limited (Osprey) and provides a summary description of key aspects relating to aviation and radar systems operating in the vicinity of the Norfolk Boreas site. This is followed by an assessment of the magnitude and significance of the effects upon the baseline conditions resulting from the construction, operation and decommissioning of the proposed Norfolk Boreas site, as well as those effects resulting from cumulative interactions with other existing or planned projects. The assessment of potential effects on aviation has been undertaken with specific reference to the relevant National Policy Statements (NPS). The following documents provide relevant guidance and legislation to the proposed project:

   - Department of Energy and Climate Change[1] (DECC, 2011) Overarching National Policy Statement for Energy (EN-1); and
   - Department of Energy and Climate Change National Policy Statement for Renewable Energy Infrastructure (EN-3) (DECC, 2011a).

3. The effects of wind turbines on aviation interests have been widely publicised but the primary concern is one of safety. There are innumerable subtleties in the actual effects but there are two dominant scenarios that lead to objection from aviation stakeholders:

   - Physical obstruction. Wind turbines can present a physical obstruction to aircraft; and
   - Impacts on radar and the provision of a radar based Air Traffic Service (ATS). Wind turbine derived radar clutter[2] appearing on radar displays can affect the provision of an ATS to pilots. Radar clutter or false radar returns can confuse the air traffic controller in being unable to differentiate between aircraft and those radar returns resulting from the detection of wind turbines. Furthermore, the appearance of multiple false targets in close proximity can generate false aircraft tracks and seduce those returns from real aircraft away from the true aircraft position.

[1] DECC was superseded by the Department for Business, Energy and Industrial Strategy (BEIS) during 2016.
[2] The term clutter refers to unwanted radar returns.

4. The potential effects on aviation have been assessed conservatively using worst case scenarios for the proposed project. A detailed description of the project is contained in Chapter 5 Project Description.

5. As the entire offshore cable corridor and project interconnector cable is below sea level, they will not have an impact on aviation interests and therefore they are not assessed in this chapter.

16.2 Legislation, Guidance and Policy

6. The relevant guidance from NPS EN-1 and EN-3 which Norfolk Boreas Limited will give due consideration is outlined in Table 16.1 below.

Table 16.1 NPS Assessment Requirements

NPS Requirement	NPS Reference	Section Reference
Paragraphs 5.4.10 to 5.4.13 of EN-1 informs that if the proposed development could have an effect on civil and military aviation then the assessment should: • Consult the Ministry of Defence (MoD), the Civil Aviation Authority (CAA) and NATS and any aerodrome – licensed or otherwise – likely to be affected by the proposed development in preparing an assessment of the proposal on aviation or other defence interests. • Any assessment of aviation or other defence interests should include potential impacts of the project upon the operation of Communication, Navigation, Surveillance (CNS) infrastructure, flight patterns (both civil and military), other defence assets and aerodrome operational procedures. • Assess the cumulative effects of the project with other relevant projects in relation to aviation and defence.	NPS EN-1 Paragraph 5.4.10 to 5.4.13	Section 16.2
If there are conflicts between the Government's energy and transport policies and military interests in relation to the application, the decision maker should expect the relevant parties to have made appropriate efforts to work together to identify realistic and pragmatic solutions to the conflicts. In so doing, the parties should seek to protect the aims and interests of the other parties as far as possible.	NPS EN-1 Paragraph 5.4.15	Section 16.2 paras 8 to 15
There are statutory requirements concerning lighting to tall structures where lighting is requested on structures that go beyond statutory requirements by any of the relevant aviation and defence consultees, the decision maker should satisfy itself of the necessity of such lighting taking into account the case put forward by the consultees. The effect of such lighting on the landscape and ecology may be a relevant consideration.	NPS EN-1 Paragraph 5.4.16	Section 16.6.2
Where after reasonable mitigation, operational changes, obligations and requirements have been proposed, the decision maker considers that:	NPS EN-1 Paragraph 5.4.17	Section 16.2 Paras 10, 11 and 14

NPS Requirement	NPS Reference	Section Reference
• A development would prevent a licensed aerodrome from maintaining its licence; • The benefits of the proposed development are outweighed by the harm to aerodromes serving business, training or emergency service needs, taking into account the relevant importance and needs for such aviation infrastructure; or • The development would significantly impede or compromise the safe and effective use of defence assets or significantly limit military training; and • The development would have an impact on the safe and efficient provision of en route air traffic control services for civil aviation, in particular through an adverse effect on the infrastructure required to support communications, navigation or surveillance systems, consent should not be granted.		
Detailed discussions between the applicant for the offshore wind farm and the relevant consultees should have progressed as far as reasonably possible prior to the submission of an application to the decision maker. As such, appropriate mitigation should be included in any application to the decision maker, and ideally agreed between relevant parties.	NPS EN-3 Paragraph 2.6.187	Section 7 and Table 16.1
Aviation and navigation lighting should be minimised to avoid attracting birds, taking into account impacts on safety.	NPS EN-3 Paragraph 2.6.107	Section 16.6.2

7. A variety of aviation publications contain information and guidance relating to the potential effects of an offshore wind development on aviation stakeholders. The following documents informed the desk based study of potential impacts of the proposed project.

- Civil Aviation Policy (CAP) 168: Licensing of Aerodromes 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, 2019).
- CAP 393: The Air Navigation Order 2016 and Regulations sets out the provisions of the Air Navigation Order 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 Civil Aviation Authority (CAA). CAP 393 also includes application of aviation obstruction lighting to wind turbines in UK territorial waters. (CAA, 2018).
- CAP 437: Standards for Offshore Helicopter Landing Areas 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, 2018a).

- CAP 764: Policy and Guidelines on Wind Turbines 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, 2016).
- CAP 670: Air Traffic Services Safety Requirements sets out the safety regulatory framework and requirements associated with the provision of an air traffic service. (CAA, 2014).

8. Other data sources and guidance considered under the desktop review of the baseline environment definition include the following:

- CAA Visual Flight Rules Chart (CAA, 2018);
- Military Aeronautical Information Publication (Mil AIP) (MoD, 2019);
- MoD UK Low Flying System Priority Area Maps (MoD, 2011);
- CAP 032 UK Integrated Aeronautical Information Package (UK IAIP). The UK IAIP is the main resource for information and flight procedures at all licensed UK airports as well as airspace, en-route procedures, charts and other air navigation information (NATS, 2019); and
- Maritime and Coastguard Agency (MCA) MGN 543: Safety of Navigation Offshore Renewable Energy Installations (OREIs) – Guidance on UK Navigational Practice, Safety and Emergency Response (MCA, 2016) contains information for operators and developers in formulating their emergency response plans and site safety management.

16.3 Consultation

9. Consultation is a key part of the Development Consent Order (DCO) application process and therefore consultation with potentially affected stakeholders has been ongoing throughout the development of the former East Anglia Zone and its individual projects.

10. Following the offshore tender round in 2009, The Crown Estate awarded East Anglia Offshore Wind (EAOW) the rights to develop Zone 5 (the former East Anglia Zone). Chapter 4 Site Selection provides an explanation of the Zonal Appraisal and Planning process which involved consultation with aviation stakeholders.

11. During Q2 and Q3 of 2014, Section 42 consultation was undertaken in relation to the East Anglia THREE offshore Wind farm (which formed part of the East Anglia Zone) with NATS, the Ministry of Defence (MoD) the National Air Traffic Management Advisory Committee (NATMAC), transboundary stakeholders, offshore helicopter operators supporting the oil, gas and renewable energy industries and airborne Search and Rescue (SAR) operations.

12. Consultation responses received for the former East Anglia Zone of relevance to Norfolk Boreas can be summarised as follows:

- The MoD: Objection based on concerns with East Anglia Zone wind turbines being detectable by the Trimingham Air Defence Radar (ADR) system.
- NATS: Following modelling of wind turbines of a blade tip height of 225 metres[3] (m), NATS indicated that there would be no effect to the Cromer Primary Surveillance Radar (PSR) from the eastern part of the development which includes Norfolk Boreas.
- CAA: Outlined requirements for the lighting and charting of wind turbines.
- Ministerie van Defensie (Netherlands MoD): Confirmation of no radar issues from the East Anglia THREE.
- Inspectie Leefomgeving en Transport (ILT) (Netherlands CAA): Recommendation, for consistency of obstruction lighting, that those wind turbines that are within the Amsterdam Flight Information Region (FIR) are lit in accordance with United Kingdom (UK) requirements.
- Luchtverkeersleiding Nederland (LVNL) (Netherlands equivalent of UK NATS): No effect to infrastructure.

13. Whilst it is considered that the consultation response provided for the former East Anglia Zone is relevant to Norfolk Boreas, specific consultation has also been undertaken for the project. Furthermore, information submitted as part of the Norfolk Vanguard examination, has also been incorporated. However, in order that the programmed submission of the Norfolk Boreas DCO has not been impacted it has been necessary to use a cut-off point of the 20th March 2019 (which coincided with Norfolk Vanguard Examination Deadline 5). After this date information provided at the Norfolk Vanguard examination as well as any wider information has not been included in this assessment unless it could be done without impacting the programme for submission.

14. The Planning Inspectorate Scoping Opinion for Norfolk Boreas (Planning Inspectorate, 2017) assessed a maximum blade tip height of 325m. The Scoping Response from NATS (NATS, 2017) noted that the development had been examined from a technical safeguarding aspect and did not conflict with NATS safeguarding criteria[4]. However, the worst case scenario of blade tip height of 350m HAT will theoretically lead to a portion of the Norfolk Boreas site wind turbines being within radar line of sight (LOS) to the Cromer PSR system and therefore impact NATS operations. During September 2017, NATS and Norfolk Boreas Limited signed a radar mitigation scheme contract; the scheme, which is subject to regulatory

[3] Wort case scenario proposed wind turbine blade tip heights have since increased to 350 m HAT
[4] The worst case scenario wind turbine blade tip height is now 350 m above Highest Astronomical Tide (HAT) which will bring a portion of Norfolk Boreas into radar Line of Sight to the Cromer PSR.

approval by the CAA, would mitigate any impact to the Cromer PSR. The Planning Inspectorate welcomed the fact that Norfolk Boreas Limited is working with NATS to develop mitigation measures.

15. The Scoping Opinion also welcomed the proposed consultation with offshore helicopter aviation operators. Section 42 consultation was completed with those helicopter operators likely to operate in the location of the Norfolk Boreas site; of the eight helicopter organisations contacted only two responded both of which stated that the development would not impact operations.

16. Wind turbines within a nine nautical mile (NM) radius of an offshore helicopter installation can, through the introduction of an obstacle, impact the ability to safely conduct instrument flight procedures to the installation in inclement weather conditions. The CAA, within CAP 764 (CAA, 2016) states that a nine NM radius consultation zone exists around offshore installations, this 'consultation zone' is not a prohibition of development rather 'a trigger for consultation with offshore helicopter operators, the operators of existing installations and exploration and development locations to determine a solution that maintains safe offshore helicopter operations alongside the proposed development'. The Norfolk Boreas site is located within the consultation zone of seven Oil and Gas platforms; consultation has taken place with the three platform operators of the seven platforms, with only one operator responding stating that the helicopter platform for the Corvette Field had been decommissioned.

17. Consultation with the MoD to better understand its aviation and air defence activities, including ADR, Practice and Exercise Areas (PEXAs), low flying and air-to-air refuelling activities, started in 2015.

18. The nearest ADR to Norfolk Boreas is the TPS77 type radar located at Roya Air Force (RAF) Trimingham, North Norfolk. A Serco Report (Serco, 2015), using representative Norfolk Boreas wind turbine positions and tip heights (225m), concluded that the western half of the Norfolk Boreas site would be detectable by this ADR. The worst case scenario of a maximum wind turbine blade tip height of 350m above HAT is likely to increase radar detectability of wind turbines by the Trimingham ADR, however the number of wind turbines has been greatly reduced than that considered in the Serco Report (Serco, 2015).

19. Consultation with the MoD has confirmed the predicted radar detectability of Norfolk Boreas by the Trimingham ADR. Consultation is ongoing with the MoD to agree a technical mitigation solution and it is expected that this consultation will be an iterative process, allowing for any concerns that are raised to be considered in the wind turbine layout and optimisation process of wind farm design. It is likely that the MoD will need to consider the cumulative effects of multiple wind farms in the

region as there may be limitations on the signal processing capability of the TPS77 to implement a technical solution for all offshore wind farms within the former East Anglia Zone (consented and in development) detectable by the Trimingham ADR.

20. A mitigation proposal has been accepted by the MoD to mitigate impact created by the operation of Norfolk Vanguard to the Trimingham ADR. This radar mitigation solution will be considered as a joint solution by Vattenfall Wind Power Limited (VWPL) for both the Norfolk Vanguard and Norfolk Boreas projects.

Table 16.2 Consultation Responses

Consultee	Date /Document	Comment	Response / where addressed in the ES
MoD	September 2016	During a meeting between Norfolk Boreas Limited and the Ministry of Defence (MoD), the MoD explained that the Serco Report (Serco, 2015) is valid and the radar impact to the Trimingham Air Defence Radar (ADR) can be mitigated. However, due to the size of the development zone, the detectability of wind turbines and the consequential predicted effects of shadowing, reduction in Probability of Detection (PD) and the radar clutter that detectable wind turbines will present to the ADR, the MoD cannot accept the mitigation solution presented within the Serco Report. The MoD described the process that the Defence Infrastructure Organisation (DIO) had taken with other offshore wind farms in which a designed reducing of effect was achieved by the consideration of a range of wind turbine heights (the lowering of wind turbine tip heights to reduce radar detectability) and consideration of the layout required regarding spacing of wind turbines (reducing shadow effects). DIO offered assistance of modelling scenarios in order to find a more acceptable solution.	Section 16.7.5.2 and 16.7.6.1
	July 2017	Drawings, coordinates and shapefiles for an indicative layout to Norfolk Boreas and for the 'sister project' Norfolk Vanguard were provided to DIO during July 2017 at an assumed blade tip height of 250 metres (m) above mean sea level (amsl).	
	March 2018	MoD informed the applicant that they have completed detailed assessments of the layouts presented however before confirming their safeguarding requirements they are obtaining "further	

Consultee	Date /Document	Comment	Response / where addressed in the ES
		technical and operational advice on the need to account for potential variances in radar performance" which may affect the extent to which the development will be detectable and could be a significant factor in determining the most appropriate means of addressing the issue.	
	August 2018	The MoD released a statement to industry stating that "the MOD has recently conducted a trial looking at the real life impact of two offshore wind farms in the vicinity of the Humber Estuary on the TPS 77 radar that was situated at Remote Radar Head (RRH) Staxton Wold. The trial determined that the wind farms had a detrimental effect on radar operations, specifically probability of detection and the aviation specification performance. The detrimental effect was not expected and the MoD needs to consider the findings of the trial further. As a result, the MoD must pause the receipt and assessment of any technical mitigation reports/submissions e.g. Serco reports, relating to the TPS 77 radars and multi-turbine wind farms with immediate effect. Technical mitigation reports relating to single turbine developments will still be received and assessed by MOD".	
	September 2018	The MoD informed the applicant that the use of the hitherto acceptable mitigation solution of the use of a Non-Automatic Initiation Zone (NAIZ) will not be acceptable in relation to the wind farm. Furthermore, in reviewing the turbine heights proposed approximately 50% of the Norfolk Boreas site would be detectable by the Trimingham ADR at a blade tip height of 275m.	
	December 2018	In response to statutory consultation the MoD stated that when operational the Norfolk Boreas wind turbines will be detectable to and cause unacceptable interference to the radar. Furthermore, the wind turbines and associated offshore platforms will affect military low flying activities conducted in the area.	
		The MoD have accepted a proposed	

Consultee	Date /Document	Comment	Response / where addressed in the ES
	January 2019 February 2019 Offshore order limits change report	mitigation solution to mitigate the Norfolk Boreas 'sister project' Norfolk Vanguard impact to the Trimingham ADR, it is expected that this mitigation solution will also be applicable to Norfolk Boreas. Consultation with the MoD is ongoing to agree a suitable mitigation solution for effects on the Trimingham ADR system created by Norfolk Boreas. The MoD responded to the offshore order limits change report with the following comment. 'This information was passed to our Advisors for their assessment and I have been informed that they have No Concerns relating to this activity in the location specified. I hope this information is sufficient for your purposes and thanks again for your help in regard to this matter'.	No response required, further detail on the offshore order limits change consultation are provided in the consultation report (document reference 5.1)
Secretary of State	June 2017 Scoping Opinion	The Secretary of State notes that an unacceptable impact is predicted on the Cromer Primary Surveillance Radar (PSR) and welcomes that the Applicant is working with NATS to develop mitigation measures. The Secretary of State agrees that impacts on military training areas can be scoped out of the assessment on the basis that the RAF Lakenheath North Aerial Tactics Area has a base height above the wind turbine height and that any potential effects on radar will be assessed. Furthermore, the Secretary and of State notes potential impacts relating to Helicopter Main Routes (HMRs) and welcomes the proposed consultation with offshore helicopter operators.	Section 7
NATS	June 2017 Scoping Opinion July 2017	NATS technical safeguarding teams examined the proposal for Norfolk Boreas and provided a response included within the Scoping Report which concluded that NATS has no safeguarding objection to the proposal. The worst case scenario of a wind turbine blade tip height of 350 m above HAT will theoretically bring a portion of Norfolk Boreas into detectability to the Cromer PSR. VWPL and NATS agreed the terms of a	Section 16.7.5.2

Consultee	Date /Document	Comment	Response / where addressed in the ES
		contract in which NATS would provide a possible solution for the mitigation of the NATS Cromer PSR system through the submission of an Airspace Change Proposal (ACP) to the Safety and Airspace Regulation Group (SARG) of the CAA; the ACP would outline potential mitigation solutions to mitigate the impact upon the PSR created by Norfolk Boreas and Norfolk Vanguard. The ACP will follow a defined seven stage process detailed in the CAA Civil Aviation Publication (CAP 1616) Airspace Design: Guidance on the regulatory process for changing airspace design including community engagement requirements (CAA, 2018b). Stage 1A of the ACP process has been completed, the CAA have agreed that the issue could reasonably be resolved by a change to the existing airspace design and provided a provisional indication of the scaling level of the ACP as Level 1. A Level 1 ACP could take up to 110 weeks to complete with the conclusion being a regulatory decision on the ACP by the CAA. A formal proposal which will provide a full description of the proposed change will submitted to the CAA via the CAA's online portal, where it will simultaneously be published and any progress will be recorded. The CAA will then review and assess the ACP and may request supplementary information or clarifications to the proposal. The CAA, as the UK's independent aviation regulator has the responsibility for deciding if the proposed change to airspace is approved.	
Offshore Helicopter Operators	November 2018 February 2019 Offshore order limits change report	Of the 8 helicopter operators consulted only Unifly and Shell Helicopters responded stating that no impact would be created by the development of the Norfolk Boreas site. Bristow Helicopters responded to the offshore order limits change report with the following comment, 'we have received the Consultation Document for the Amendment to Offshore Order Limits dated 30 Jan 2019 and can confirm we have no objections or comments to add	Section 16.6.7 No response required, further detail on the offshore order limits change consultation are provided in the consultation report (document

Consultee	Date /Document	Comment	Response / where addressed in the ES
		from an offshore aviation point of view'.	reference 5.1)
Oil and Gas Platform Operators	November 2018	Only Shell, of the 3 platform operators consulted responded to the consultation request. Shell informed the applicant that the Corvette platform helideck is decommissioned and therefore Shell had no further comment to make.	Section 16.6.7.2
Dutch Military	November 2018	No further action	N/A
Dutch ATC	November 2018 February 2019	The Dutch CAA stated that they will complete an audit of the Dutch commercial aviation impact of the Norfolk Boreas site and will keep the applicant advised of any impact. The Dutch Ministry of Infrastructure and Water Management confirmed on behalf of the civil aviation authority that the Norfolk Boreas site would not affect operations.	N/A

21. A new area to be included within the offshore Order limits has been consulted upon. Full details of this consultation are provided in section 27 of the Consultation Report (document reference 5.1).

16.4 Assessment Methodology

16.4.1 Impact Assessment Methodology

22. The 'sister project' Norfolk Vanguard may undertake some enabling works for Norfolk Boreas, as explained in Chapter 5 Project Description, but these are not relevant to aviation. Potential aviation receptors were identified in accordance with CAP 764 (CAA, 2016). This assessment considers all radar systems within operational range of the proposed project, as well as military areas of operation. For each identified receptor, the physical obstruction and / or radar effect, and then subsequently the operational impacts were considered with any other potential impacts. The operational range of a radar system is dependent on the type of radar used and its operational requirement. CAP 764 provides a guide of 30 kilometres (km) for assessment of radar impact however; any impact is dependent on radar detectability of operational wind turbines, the radars operational range and the use of airspace in which the project sits. The operational impact considers the orientation of approach and departure flight paths, physical safeguarding of flight, airspace characteristics and flight procedures as published in the UK IAIP (NATS,

2019) and the Mil AIP (MoD, 2019). This assessment has been informed by the results of baseline studies and consultation, with reference to the existing evidence base regarding the effects of the offshore wind farm project.

23. In assessing the significance of the effects from the proposed project, it was necessary to identify whether or not there would be an impact on aviation operations. The aviation industry is highly regulated and subject to numerous mandatory standards, checks and safety requirements, many international in nature and requiring the issue of operating licences. In all cases, the sensitivity and magnitude of the impact on operations can only be identified by the appropriate aviation organisation conforming to the Risk Classification Scheme used to quantify and qualify the severity and likelihood of a hazard occurring. The Risk Classification Scheme is a fundamental element of an aviation organisation's Safety Management System (SMS), which must be acceptable to, and approved by, the UK CAA or the Military Aviation Authority (MAA), as appropriate. As such, for the purposes of this assessment, no detailed grading has been made of the magnitude of the impact or sensitivity of the receptor on the basis that any potential reduction in aviation safety cannot be tolerated. Instead, definitions of basic significance have been defined in Table 16.3. This represents a deviation from the standard methodology presented within Chapter 6, Environmental Impact Assessment Methodology.

Table 16.3 Impact Significance Definitions

Potential Significance	Definition
Major	Receptor unable to continue safe operations or safe provision of air navigation services (radar) or effective air defence surveillance in the presence of wind turbines. Technical or operational mitigation of the impact is required.
Moderate	Receptor able to continue safe operations but with some restrictions or non-standard mitigation measures in place.
Not Significant	The proposed project would have little impact on the aviation stakeholder or the level of impact would be acceptable to the aviation stakeholder.
No Change	The proposed development would have no impact on the aviation stakeholder and would be acceptable to the aviation stakeholder.

24. Significance of aviation impacts are typically difficult to establish; they are not strictly based on the sensitivity of the receptor or magnitude of change but on whether the industry regulations for safe obstacle avoidance or radar separation (from radar clutter) can be maintained in the presence of wind turbines.

25. The determined effects have been informed by the results of the desktop assessment, additional receptor consultation and with reference to the existing evidence base regarding the effects of wind turbines on aviation receptors.

16.4.2 Cumulative Impact Assessment

26. The approach to the cumulative impacts assessment for Norfolk Boreas takes into account Chapter 6 EIA Methodology as the general method together with comments made in response to other renewable energy developments and the Planning Inspectorate Advice Note 9: Rochdale Envelope (The Planning Inspectorate, 2018). The proximity of Norfolk Vanguard, together with the consented and in development East Anglia Offshore Wind Farms, indicates there is the potential for cumulative radar impact created by detectable operational wind turbines.

16.4.3 Transboundary Impact Assessment

27. Similar to the cumulative impacts this section considers transboundary offshore wind farms with regards to physical obstruction, radar impact and future airspace management.

16.5 Scope

16.5.1 Study Area

28. Whilst not definitive, CAA, CAP 764 (CAA, 2016) provides criteria for assessing whether any wind turbine development might have an impact on civil aerodrome related operations. Consideration of the proposed development's potential to impact on aviation stakeholders and receptors has been undertaken in accordance with the standard consultation distances stated in CAP 764. A number of consultees and receptors were scoped out from the consultation process as they were out-with the CAP 764 consultation zones or criteria which include:

- Within 30km 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; there are no such operational aerodromes within 30km of the proposed development.
- Airspace coincident with published airfield Instrument Flight Procedures (IFP) to take into account the requirement for an aerodrome's requirement to protect its IFP's; there is no such airspace within the proposed development vicinity.
- Within 17km of a non-radar equipped licensed aerodrome with a runway of 1,100m or more; there are no such aerodromes within 17km of the project.

29. The study area encapsulates Norfolk Boreas, Norfolk Vanguard and the East Anglia projects and for the assessment of cumulative effects also includes other offshore wind farms in the southern North Sea that could have potential effects on identified military, aviation and radar stakeholders. Specifically, the study area covers:

- Radars (civil and military) on the eastern coast of England that could potentially detect 350m above Highest Astronomical Tide (HAT) (blade tip) wind turbines within the proposed project boundaries (the final wind turbine blade tip height is yet to be finalised but may include blade tip heights of up to 350m HAT);
- Helicopter Main Routes (HMR) situated within the proximity of Norfolk Boreas; and
- Offshore Helicopter Platforms that have nine NM consultation buffers overlapping with the Norfolk Boreas offshore site.

16.5.2 Data Sources

30. Aviation stakeholders considered throughout this chapter utilise several different radar systems. Relevant additional data sources used in this chapter are presented in Table 16.4.

Table 16.4 Data Sources

Data	Year	Confidence	Notes
Cromer ASR-10SS Solid State PSR (NATS)	Accessed online 2019	High	One of a number of radar systems utilised by NATS for the provision of En-route ATC services.
Trimingham Lockheed Martin TPS-77 ADR (MoD)	Accessed online 2019	Medium	Limited data available as ADR systems are covered by the International Traffic in Arms (ITAR) restrictions. In addition, due to the sensitive role of the system, some information is not available in the public domain.
Dutch IAIP	2019	High	Similar to the UK IAIP the Netherlands Airports and Airspace Information is the main resource for information and flight procedures at all licensed Netherlands airports as well as airspace, en-route procedures, charts and other air navigation information.

16.5.3 Assumptions and Limitations

31. For the purpose of undertaking the assessment and for ensuring that the assessment is robust, all assumptions have been made on a worst case basis. No significant technical difficulties arose and there have been no issues which have prevented the

assessment of potential impacts or the identification of mitigation measures. The MoD and NATS have completed their own radar LOS analysis in order to identify potential impact to their radar systems and infrastructure.

16.6 Existing Environment

16.6.1 Overview

32. Norfolk Boreas will be situated in an area of Class G uncontrolled airspace, which is established from the surface up to Flight Level (FL) 175 (approximately 17,500 feet (ft)). Class A and C Controlled Airspace (CAS) is established above FL175. Under these classifications of airspace, the following applies:

- Class G uncontrolled airspace, any aircraft can operate in this area of uncontrolled airspace without any mandatory requirement to be in communication with an ATC unit. Pilots of aircraft operating under Visual Flight Rules (VFR)[5] in Class G airspace are ultimately responsible for seeing and avoiding other aircraft and obstructions.
- Class A and C CAS, all aircraft operating in this airspace must be in receipt of an ATS.

33. In the area of Norfolk Boreas, the Class G uncontrolled airspace below FL175 is sub-divided into areas with the following aviation stakeholder responsibility:

- Anglia Radar, based at Aberdeen Airport and employing NATS PSR systems, has its area of responsibility established for the provision of ATC services to Commercial Air Traffic (CAT) helicopter operations that support the offshore Oil & Gas Industry, from the surface up to FL65 (approximately 6,500 ft);
- Military En-Route Area Control, military air traffic controllers located at the Swanwick Area Control Centre (ACC) utilise NATS radar for the provision of ATS to aircraft flying outside of CAS above FL100 within radar and radio coverage; and
- MoD Air Surveillance and Control System (ASACS), uses its ADR resources in support of operational flights within UK airspace and for training exercises.

16.6.2 NATS

34. NATS provide an ATS at some airports in the UK and provide ATS to traffic en-route (overflying or flying between airports) in UK airspace. NATS operate a number of long range PSR and Secondary Surveillance Radar (SSR) systems positioned to provide maximum coverage of UK airspace. Additionally, NATS has a licence

[5] 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.

obligation to provide radar data to other remote aviation stakeholders to a high quality and performance standard for the benefit of UK aviation as a whole. Any effect that Norfolk Boreas might have on NATS radar systems must be considered both in terms of effect on the civilian en-route services and in the context of its remote users.

35. In addition, Military ATC Units are based in NATS ACCs to facilitate the control of aircraft that require ATS outside CAS. NATS have a contracted responsibility to provide appropriate PSR coverage to support this task.

36. The CAA, through CAP 764 (CAA, 2016), advises that 10km should be used as the trigger point for further discussions with the appropriate service provider who can make a more detailed, accurate assessment of the likely effect on their SSR. The Norfolk Boreas site is well in excess of 10km from any SSR facility and therefore no impact is assessed on SSR.

16.6.3 En-Route Operations

37. In aviation and airspace terms the world is divided into FIRs for the responsibility of the provision of ATS to aircraft. The boundary between London FIR (under the regulation of the UK CAA) and Amsterdam FIR (under the regulation of the Netherlands ILT) is located to the east of the edge of Norfolk Boreas site.

38. NATS En Route Limited (NERL) use a number of PSR systems located within the UK to support its provision of ATS to aircraft operating within and between the UK and mainland Europe. The Claxby PSR which is located in North Lincolnshire and the Cromer PSR[6] located in Norfolk, provide radar coverage to those aircraft overflying the London FIR in the vicinity of Norfolk Boreas except where responsibility for ATS has been formally delegated to the service provider in the Netherlands, LVNL, the agency responsible for the provision of ATC services in the Netherlands. Figure 16.1 provides an illustration of this delegated airspace (FL175 (17,500ft) to FL245 (24,500ft)). The Norfolk Boreas site is located in the delegated section of airspace known as CTA III (MOLIX) in which LVNL is responsible for providing ATS.

39. Below and above the delegated airspace, NATS is responsible for providing ATS within radar and radio coverage. During 2017, NATS and Norfolk Boreas Limited entered into an agreement for NATS to conduct work to confirm a solution in order to mitigate impacts on the NATS Cromer PSR. NATS have submitted a Statement of Need to the Civil Aviation Authority in application for an Airspace Change Proposal (ACP) which together with radar blanking of the Cromer PSR will provide the mitigation solution.

[6] Anglia Radar utilise data provided by the Claxby and Cromer PSRs.

16.6.4 Military Low Flying Operations, PEXA and Air-to-Air Refuelling

40. The military UK Low Flying System (UKLFS) covers the open airspace of the whole UK land mass and surrounding sea areas out to 2NM from the UK coast, from the surface to 2,000ft above ground level (agl) or amsl; however, military low flying may be conducted beyond this area over the sea. Military Practice and Exercise Areas (PEXAs) are areas available for training use primarily by the UK armed force but also those of overseas nations. They can be over land or water, or both, and may involve the firing of live ammunition. Norfolk Boreas does not lie within any aviation military training areas, PEXAs or Air to Air Refuelling Areas (AARA), the MoD have confirmed during consultation that the Norfolk Boreas site will not adversely affect MoD offshore danger and exercise areas and therefore physical obstruction impacts to military operations within these areas are not considered further. The MoD has requested that offshore platforms are fitted with appropriate aviation lighting to maintain safety to military aviation.

16.6.5 MoD Air Defence Operations

41. The MoD through the ASACS Force is responsible for compiling a Recognised Air Picture (RAP) to monitor the airspace in and around the UK in order to launch a response to any potential airborne threat. This is achieved through the utilisation of a network of long-range ADR systems, some of which are located along the east coast of the UK. Any identified effect of wind turbines on the ASACS radar systems that serve the airspace above Norfolk Boreas would reduce the capability of the ASACS force.

42. The proposed project will be detectable by the TPS-77 ADR system located at Trimingham, North Norfolk. Consultation with the MoD continues with the aim of agreeing a suitable mitigation solution and the viability of any other identified mitigation regarding the detectability of the proposed wind turbines by the Trimingham ADR. Further details are contained in Table 16.2.

16.6.6 Norwich Airport

43. Norwich Airport provides radar services to pilots on request of a Lower Airspace Radar Service (LARS). The service is available to all aircraft flying outside CAS up to FL100, within the limits of radar and radio cover. The service is provided by Norwich Airport to a service radius of 30NM from the airport; the western boundary of Norfolk Boreas is located approximately 54NM from Norwich Airport and therefore will not impact LARS provision and is not considered further within the assessment.

16.6.7 Offshore Helicopter Operations

44. Offshore Oil and Gas platforms in the North Sea are supported by a number of helicopter operators who ferry crews and supplies to and from the mainland. The routes taken by helicopters on such flights may follow HMRs which form a network of corridors between offshore platforms and the main support bases at Norwich Airport and Humberside Airport. CAP 764 (CAA, 2016) states that a large number of wind turbines beneath an HMR might force a helicopter to fly higher (and thus risk entering cloud) to avoid compromising the minimum vertical separation height above the wind turbines. Figure 16.2 illustrates the HMRs that cross the offshore project area and Oil and Gas platforms within applicable consultation zone detailed in section 16.6.7.1.

45. HMR 445 crosses the north eastern part of the area from the Indefatigable Field to the UK/Dutch FIR boundary; HMR 446 crosses west to east in the northern half of the offshore development area from the Hewett Field to the UK/Dutch FIR boundary; whilst HMR 447 crosses the outer southwest extremities of the area from Hewett Field to the UK/Dutch FIR boundary.

46. A HMR is not a mandatory routing for helicopter operators offshore. Where ATC coverage is less comprehensive (as in the Northern North Sea, northeast of Aberdeen), flights are more likely to be conducted along HMRs. The region of the offshore site is served by radar coverage and provision of ATC services by Anglia Radar to aircraft operating offshore; where this is the case helicopter flights are likely to be provided a direct routing to their offshore destination and therefore HMRs are considered likely to be rarely used. Anglia Radar was consulted however; they did not provide a response. Anglia Radar did confirm during consultation regarding the Norfolk Vanguard Wind Farm that HMRs in the southern North Sea are not required to be strictly adhered to regularly; in respect to HMRs the development would not cause any issues to the Anglia radar operation once clutter had been removed from the Cromer PSR. Anglia Radar did state within their response that offshore installations could affect the routings and levels for offshore helicopter flights should they need to deviate around the area, and that Anglia Radar recommend that the helicopter companies are approached to determine if they have any objections. Details of consultation with helicopter operators can be found in Table 16.2. In addition, a 9 NM radius consultation zone around offshore installations is recommended to allow for the safe continuation of operation of helicopter instrument approaches to platforms in poor weather conditions. The individual consultation zones of a number of installations extend across the Norfolk Boreas site boundaries.

16.6.7.1 HMR Operational Impact

47. CAP 764 (CAA, 2016) states that HMRs have no defined lateral dimensions, although 2NM either side of the route centreline should ideally be kept obstacle free, it may be considered that wind turbine development within 2 NM of the route centreline could be manageable. HMRs 445, 446 and 447 cross through portions of the Norfolk Boreas site. These routes may be used for transit from both Norwich International Airport to the Indefatigable offshore installations to the north of the proposed project area, although helicopters are likely to be provided a direct route to their offshore location without the use of a HMR. Consultation on the proposed project has been completed with helicopter operators potentially using these HMRs, two of which responded with no objection whilst the other 6 operators provided no response.

48. When operating under Instrument Flight Rules (IFR), helicopters require a Minimum Safe Altitude (MSA) of 300m (984ft) height clearance from obstacles within 1NM of the aircraft, which would indicate that whilst operating above the physical obstruction of the Norfolk Boreas wind turbines, offshore helicopters would be required to fly at 2,200ft amsl (1,149ft (350m) plus 984ft rounded up to nearest 100ft). When operating under VFR and Visual Meteorological Conditions (VMC), helicopters require a minimum of 500ft separation from obstacles; however, whilst operating under IFR helicopters are likely to be under Anglia Radar ATS provision with no predicted impact to Anglia Radar operations.

49. Helicopters will normally plan to fly at the following en-route altitudes

- Outbound (land to sea) 2,000ft and 3,000ft;
- Inbound (sea to land) 1,500ft and 2,500ft.

50. This allows for 500ft vertical separation between helicopters travelling in opposite directions. A large number of wind turbines beneath an HMR might result in helicopters flying higher in order to maintain a safe vertical separation from wind turbines. However, this option is not available on days of low cloud base when the icing level might provide a risk of ice aggregation on the aircraft. The proliferation of wind turbines, whether close to an HMR or not (as some offshore installations are located away from the HMR system), could restrict the pilots freedom of manoeuvre when conditions are not ideal. Helicopter operators and ATC service providers have been consulted with regard to any potential impact on HMRs with limited response in return. Furthermore, Anglia Radar did not respond to a request for consultation but have previously indicated that the HMR structure in the southern North Sea is not required to be followed.

16.6.7.2 Offshore Oil and Gas Platforms

51. In order to help achieve a safe operating environment, a consultation zone of 9NM radius (CAP 764, 2016) exists around offshore helicopter installations. This consultation zone is not considered a prohibition on wind turbine development within a 9NM radius of offshore operations but a trigger for consultation between platform operators, the offshore helicopter operators, the operators of existing installations and wind developers to maintain a safe coexistence between wind turbines and offshore helicopter operations. The seven platforms considered requiring consultation are illustrated in Figure 16.2 and are listed in Table 16.5.

Table 16.5 Offshore platforms requiring consultation

Platform	Operator	Latitude (decimal degrees)	Longitude (decimal degrees)	Distance to Norfolk Boreas site boundary (km)
Thames A	Perenco	53.0844	2.5469	14.494
Thames AR	Perenco	53.0840	2.5482	14.534
Corvette	Shell	53.2320	2.6227	16.192
Sean PD	ONER	53.1897	2.8626	2.567
Sean PP	ONER	53.1892	2.8616	2.564
Sean RD	ONER	53.2262	2.8276	7.199
Davy A	Perenco	53.0052	2.8961	9.181

52. The basic requirement of the 9NM consultation zone is to provide airspace for the safe operation of helicopter instrument approaches to helicopter platforms in poor weather conditions where a low visibility approach profile is needed. In addition, the zone provides a safe area for helicopters to carry out a Missed Approach Procedure (MAP). The Norfolk Boreas offshore boundary would extend into 9NM consultation zones where established around the platforms listed in Table 16.5.

53. Wind turbines within the consultation zones are considered as physical obstructions, under IFR, requiring a minimum of 1,000ft vertical avoidance; furthermore, during the approach to an installation, all radar contacts (including radar contacts which are assumed to be wind turbines) have to be avoided laterally by at least 1NM. These combined avoidance requirements within a 9NM consultation zone of an offshore installation might impair the safety of helicopter operations to that installation and affect the installation operators' regulatory requirements with regard to safety of operation. The three platform operators listed in Table 16.5 have been consulted with only Shell responding to the request.

16.6.7.3 Helicopter airborne radar approach

54. Helicopters which operate to and from offshore platforms (installations) are fitted with weather radar which can be used to conduct an instrument approach in poor visibility. Airborne Radar Approaches (ARA) could be used as a low-visibility approach procedure to the platforms; pilots rely upon the on-board weather radar for obstacle detection and navigation. The radar is designed to display weather phenomena, such as rain, as well as obstacles such as the oil, gas platforms, or wind turbines. In Instrument Meteorological Conditions (IMC) combined with certain wind conditions, which dictate the area of approach to the platform, a standard ARA procedure might not be available due to the proximity of wind turbines, requiring 1,000ft vertical or 1NM lateral avoidance under IFR, to the approach track.

55. It can generally be assumed that offshore support helicopters will be able to fly an ARA from any direction if the wind speed is below 2.5m per second (m/s) (5 knots (kt)). Strong cross-wind components to an ARA procedure are unacceptable, and the ARA procedure must take place predominantly into wind. The platforms in Table 16.5 lie to the north and northwest of the Norfolk Boreas site, however, one platform (Davy A) operated by Perenco lies within the offshore site. The prevailing winds in the southern North Sea are south-westerly; however, it is possible in some wind conditions, other than the prevailing, that ARAs would be required to take place over the Norfolk Boreas developments. As outlined previously this might not be achievable due to the requirement to avoid wind turbine radar contacts by the required minimum.

56. From previous discussions with helicopter operators, it is understood that flying to offshore platforms is conducted 365 days per year, and that ARA, IFR procedures are conducted to each platform when weather conditions (limited inflight visibility) dictate. During other periods, it is assumed that approaches will be conducted under VFR which dictates a minimum in-flight visibility of 5km (approx. 3 NM).

57. Helicopter operator's ARA charts indicate that for a worst case scenario, when flying an ARA, helicopters could be within 8NM of the destination platform. Furthermore, during the approach to a platform, all radar contacts (including radar contacts that are assumed to be wind turbines) have to be avoided laterally by at least 1NM.

58. Helicopter operations using ARA will be restricted in accessing platforms under certain weather conditions (in poor visibility (IMC) coupled with strong winds), for a limited period of time during a year. The extent of this effect can be defined spatially; however, the temporary nature of the effect will vary on a case by case basis. This is due to the fact that both the length of time in which helicopters can operate VFR will vary due to different weather conditions and the fact there are inherent restrictions on other phases of flight in certain weather conditions not attributed to the presence of wind turbines near the destination platform. This

variation in weather conditions is something that currently has an effect on helicopter operations. A collaborative approach between Norfolk Boreas Limited and Offshore Helicopter Aviation Stakeholders will realise a suitable compromise that will allow development of wind turbines within the areas adjacent to offshore platforms however as noted previously, none of the helicopter operators consulted have formally objected to the development of the Norfolk Boreas site.

16.6.8 Airborne Search and Rescue (SAR) Operations

59. The SAR force provides 24hour aeronautical SAR cover in the UK which is provided from ten strategically located bases across the UK. The bases are positioned close to SAR hotspots so that aircraft can provide support as quickly and efficiently as possible. Bristow Helicopters were awarded the contract to provide SAR helicopter services for the UK in 2013.

60. The development of Norfolk Boreas will lead to a change of the operating environment should an airborne SAR operation be required within or close to the project. When on an operational mission, SAR aircraft are not constrained by the normal rules of the air, and operate in accordance with their (Bristow) Aircraft Operator Certificate (AOC). This allows SAR pilots total flexibility to manoeuvre using best judgement thus making them highly adaptable to the environment and conditions in which they are operating.

61. An Emergency Response Co-operation Plan (ERCoP) will be in place for the construction, operation and decommissioning phases of Norfolk Boreas. The ERCoP is completed initially in discussion between the developer and the MCA, SAR and Navigation Safety Branches. Detailed completion of the plan will then be in cooperation with the Maritime Rescue Coordination Centre (MRCC), responsible for maritime emergency response. The ERCoP must then be submitted to and approved by the MCA. The ERCoP will detail specific lighting of the wind turbines furthermore; the SAR helicopter bases will be supplied with an accurate chart of the Norfolk Boreas wind turbine Global Positioning System (GPS) positions. The requirements for the lighting of wind turbines are contained in Article 223 of CAP 393 (CAA, 2018).

16.6.9 Transboundary Considerations

62. Amsterdam Schiphol Airport is located approximately 70NM from the eastern boundary of Norfolk Boreas and therefore no direct impact on the airport is assessed as the development is outside of that considered for an airport with surveillance radar. Relevant Dutch aviation authorities for the project have all been consulted during the scoping stage of the East Anglia THREE this included ILT, LVNL and the Netherlands Ministerie van Defensie; these authorities all confirmed that there will be no impacts to aviation radar infrastructure and operations conducted by them.

Further consultation has been completed with the Netherlands agencies to confirm the results of the previous consultation apply to Norfolk Boreas. Details of the consultation and response can be found in Table 16.2.

63. A network of HMRs is established in the Netherlands to support the transport of personnel and material to offshore oil and gas installations. It is assumed that helicopters operating from the Netherlands could be required to fly within the region of the Norfolk Boreas site, these helicopters which may operate in the region may utilise Dutch HMRs to transit across the London / Amsterdam FIR boundary which then become part of existing HMRs in the London FIR in UK airspace which cross the Norfolk Boreas sites. As aviation operations are regulated by international criteria, there would be little difference in the impacts perceived by receptors in the Netherlands over those experienced in the UK. Consultation on the proposed project has been completed with helicopter operators in in the UK and the Netherlands with minimal response, further detail can be found in Table 16.2.

16.7 Potential Impacts

64. The receptors for each impact are described within the text for each assessment and have been identified in section 16.6. Those receptors which are not considered to have any potential to be impacted by the proposed project have not been presented within the baseline.

16.7.1 Specific Mitigation

65. It is good practice to notify aviation stakeholders of the location and dimension of any wind energy development and the associated construction activities. Information regarding construction should be passed to the Defence Geographic Centre (DGC) and the General Aviation Awareness Council (GAAC) at least ten weeks in advance of the erection of the first wind turbine and to follow up on the day with a confirmation that the activity has taken place. The data would include:

- Location, height (of all structures over 150ft (45.7m), date of erection, date of removal and lighting type (none, infra-red or lighting brightness); and
- Local aerodromes identified during consultation should be notified, particularly any police helicopter or air ambulance unit.

66. Information would be circulated to relevant aviation stakeholders including NATS, MoD, and RenewableUK. Information on potential aviation obstructions would be promulgated within the UK IAIP (NATS, 2019) and notified to DGC for marking on appropriate aeronautical related charts and documentation.

16.7.2 Embedded Mitigation

67. A range of embedded mitigation measures to minimise effects have been applied to the development of Norfolk Boreas and will be designed into the development. These mitigation measures would comply with current guidelines and be agreed with the appropriate stakeholders, as follows:

- CAP 393 Article 223 (CAA, 2018) sets out the mandatory requirements for lighting of offshore wind turbines.
    - Legislation requires the fitting of obstacle lighting on offshore wind turbines with a height of 60m or more above the level of the sea at the HAT;
    - Where four or more wind turbines are located together in the same group, with the permission of the CAA, only those on the periphery of the group need to be fitted with at least one medium intensity steady red light positioned as close as reasonably practicable to the top of the fixed structure; and
    - The obstruction light or lights must be fitted to show when displayed in all directions without interruption. The requirements of the angle of the plane of the beam and peak intensity levels and other specifications are defined within CAP 393 (CAA, 2018).
- CAP 437 (CAA, 2018) sets out a procedure to indicate to a helicopter operator that the wind turbine blades and nacelle are safely secured in position prior to helicopter hoist operations commencing.
    - CAP 437 states that this is best achieved through the provision of a helihoist status light located on the nacelle of the wind turbine within the pilot's field of view, which is capable of being operated remotely and from the platform itself or from within the nacelle.
    - A steady green light is displayed to indicate to the pilot that the wind turbine blades and nacelle are secure and it is safe to operate. A flashing green light is displayed to indicate that the wind turbine is in a state of preparation to accept hoist operations or, when displayed during hoist operations, that parameters are moving out of limits. When the light is extinguished this indicates to the operator that it is not safe to conduct helicopter hoist operations.
    - Obstruction lighting in the vicinity of the winching area that has a potential to cause glare or dazzle to the pilot or to a helicopter hoist operations crew member should be switched off prior to, and during, helicopter hoist operations.

68. The ERCoP would be completed initially in discussion between the developer and the MCA SAR Navigation Safety Branch. Detailed completion of the plan would then be in cooperation with the Coastguard Operations Centre (CGOC) responsible for maritime emergency response in the area of Norfolk Boreas. The ERCoP would then be submitted to and approved by the MCA (MCA, 2016).

69. The ERCoP would detail specific marking and lighting of the wind turbines. The SAR helicopter bases would be supplied with an accurate chart of Norfolk Boreas wind turbine GPS locations and would provide any required SAR access lanes, helicopter access positions and spacing between wind turbines. Furthermore, the arrangements of liaison between the wind farm developer and HM Coastguard in the event of an emergency response would be detailed together with an explanation of procedures and processes carried out at the Norfolk Boreas control centre to shut down the wind turbines and the procedures for the CGOC to request a wind turbine shut down.

16.7.3 Worst Case

70. The potential development parameters and scenarios are defined as a design envelope presented in Chapter 5 Project Description. The assessment of potential impacts on civil and military aviation is based on the worst case scenario as identified from this design envelope, and is specific to the potential impacts identified in this chapter. The key parameters for the worst case scenario include consideration of the maximum number of wind turbines across the largest area and the maximum blade tip height of 350m above HAT.

71. During construction and prior to commissioning wind turbine blades will not be rotational. As a result, the infrastructure will not be processed and presented onto aviation control displays by the radar; therefore, there will be no impacts on aviation radar during these phases. The worst case scenario for impacts on aviation radar services assumes that the entirety of the Norfolk Boreas site will be populated with wind turbines at the maximum blade tip height of 350m above HAT. This is because the largest area of the highest wind turbines will create the largest impact from an obstruction perspective, leading to a greater effect on aviation services. Any aspects of the infrastructure that are lower in height than the wind turbines and less than the extent of the Norfolk Boreas site boundary will not create an incremental effect on aviation interests.

72. Table 16.6 presents the worst-case scenarios for each assessed impact.

Table 16.6 Worst Case Assumptions

Impact	Key Design parameters forming realistic worst case scenario	Rationale
Construction		
Creation of aviation obstacle.	Ninety wind turbines with a maximum blade tip height of 350m above HAT. Two offshore electrical platforms at 100m (including crane) above HAT. One Offshore service platform to house workers offshore and / or provide helicopter refuelling facilities. One met mast at maximum hub height of the wind turbine.	Wind turbines with the maximum possible blade tip height creating a physical obstruction to aviation operations due to size of above sea level infrastructure within the Norfolk Boreas site. Impact starting from a point of zero infrastructure present to full presence over a 3 year indicative construction programme (section 5.4.15 Chapter 5 Project Description).
Wind turbines causing permanent interference on civil and military radar.	Wind turbines: 90 turbines with a tip height of 350m above HAT.	Maximum number of radar detectable wind turbines in the Norfolk Boreas site. During construction, and prior to commissioning wind turbine blades would not be rotational. As a result, the infrastructure would not be processed and presented onto Radar Data Display Screens (RDDS) by the radar. Therefore, there would be no impact to radar systems during the construction phase.
Increased air traffic in the area related to wind farm activities.	Fourteen return helicopter trips per week.	Maximum number of helicopter trips as a result of being engaged on works for Norfolk Boreas causing a slight increased possibility of aircraft to aircraft collision.
Operation		
Creation of aviation obstacle environment.	Ninety wind turbines with a maximum blade tip height of 350m above HAT. Two offshore electrical platforms at 100m (including crane) above HAT. One Offshore service platform to house workers offshore and / or provide helicopter refuelling facilities. One met mast at maximum hub height of the wind turbine.	Wind turbines with the maximum possible blade tip height creating a physical obstruction to aviation operations due to size of above sea level infrastructure within the Norfolk Boreas site. Impact duration present during operational period.
Wind turbines causing permanent interference on civil and military radars.	Wind turbines: 90 turbines with a tip height of 350m above HAT.	Maximum number of radar detectable wind turbines in the Norfolk Boreas site. UK ADR detection capability and therefore national security could be

Impact	Key Design parameters forming realistic worst case scenario	Rationale
		compromised. ATC may be unable to provide an effective surveillance service due to interference on radar displays. Impact duration present during operational period.
Increased air traffic in the area related to wind farm activities.	Fourteen return helicopter trips per week.	Maximum number of helicopter trips as a result of being engaged on works for Norfolk Boreas causing increased possibility of aircraft to aircraft collision.
Decommissioning		
Creation of aviation obstacle environment	Ninety wind turbines with a maximum blade tip height of 350m above HAT Two offshore electrical platforms at 100m (including crane) above HAT One Offshore service platform to house workers offshore and / or provide helicopter refuelling One met mast at maximum hub height of the wind turbine	Wind turbines with the maximum possible blade tip height creating a physical obstruction to aviation operations due to size of above sea level infrastructure within the Norfolk Boreas site. Impact starting from a point of full presence infrastructure to zero presence over a decommissioning period of approximately 1 year.
Wind turbines causing permanent interference on civil and military radar.	Wind turbines: 90 turbines with a tip height of 350m above HAT.	Maximum number of radar detectable wind turbines in the Norfolk Boreas site. Any agreed mitigation would be maintained until the last wind turbine is non-operational in the decommissioning phase, or as agreed with the aviation stakeholder. Once all wind turbines are stationary the decommissioning infrastructure is not predicted to affect the radar system, or be processed and presented as clutter on the RDDS by the radar.
Increased air traffic in the area related to wind farm activities.	Fourteen return helicopter trips per week.	Maximum number of helicopter trips as a result of being engaged on works for Norfolk Boreas causing increased possibility of aircraft to aircraft collision.

16.7.4 Notes on Radar Operation

73. Radar operates by alternately transmitting a stream of high power radio frequency pulses and 'listening' to echoes received back from targets within its LOS. Generally, air surveillance (aviation) radars employ a rotating antenna that provides 360° coverage in azimuth; the typical scan rate is 15 rotations per minute (rpm) thus illuminating a given target every four seconds.

74. PSR can distinguish between moving and static targets; for targets that are moving towards or away from the radar, the frequency of the reflected signal from a moving target changes between each pulse (transmit and receive) which is known as the Doppler shift. This can be most practically explained by considering the change in frequency of the engine sound heard by a pedestrian when a car passes by on the road – the sound as the car approaches is higher than the sound heard by the pedestrian as it travels away. The Doppler shift has the effect of making the sound waves appear to bunch up in front of the vehicle (giving a higher frequency) and spread out behind it (lower frequency). The true frequency of the engine is only heard when the car is immediately next to the pedestrian. The aviation radar receiver is 'listening' to the radio waves reflected from the moving object and working out whether the returned signal is of a higher or lower frequency (moving object) or if the returned frequency is the same as the transmitted signal (a stationary object.

16.7.4.1 Notes on wind turbines effects on radar

75. Wind turbines are a significant cause of PSR false plots or clutter, as the rotating blades can trigger the Doppler threshold (minimum shift in signal frequency) of the Radar Data Processor (RDP) and therefore may be interpreted as aircraft movements. Significant effects have been observed on radar sensitivity caused by the substantial Radar Cross Section (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 wanted targets in the immediate vicinity of the wind turbine. False plots and reduced radar sensitivity may reduce the effectiveness of the radar system itself to an unacceptable level and compromise the provision of a safe radar service to participating aircraft.

16.7.5 Potential Impacts during Construction

16.7.5.1 Creation of an aviation obstacle

76. Wind turbine construction infrastructure above HAT could pose a physical obstruction to flight operations in the vicinity of the Norfolk Boreas site. 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 aircraft flight operations.

77. The CAA, helicopter operators and ATC service providers have been consulted with regard to establishing if a perceived impact would be created to helicopters operating on HMRs in the region of Norfolk Boreas. No potential effects of operating on HMRs were notified from either of the helicopter operators. Anglia Radar (the ATS provider) did not respond to consultation.

78. A range of mitigation measures for the project, as detailed in section 16.7.2, 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 proposed project and will reduce impact to low flying aircraft operating in the vicinity of the wind farm. These will comply with current guidelines and be agreed with the appropriate stakeholders and are outlined in section 16.7.1 and in section 16.7.2. 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. Under VFR conditions, pilots are ultimately responsible for seeing and avoiding obstructions such as wind turbines and will be aware of their presence through the notification procedures of the project. Embedded mitigation and notification of construction, operation and decommissioning of the wind farm and the lighting and promulgation on aviation charts will reduce any physical obstruction effect to aviation activities in the region of Norfolk Boreas. Appropriate liaison will be completed to ensure information on the construction and decommissioning of the wind farm is circulated in a Notice to Airmen (NOTAM) and other appropriate media. The impact to offshore helicopter operations utilising HMRs and military low flying operations is assessed as **not significant.**

79. Norfolk Boreas Limited has completed consultation with all relevant Oil and Gas operators, during which no specific concerns were raised and it is expected that users could co-exist. This will be managed through coexistence agreements where necessary. Impacts on other marine users are discussed further in Chapter 18 Infrastructure and Other Users.

16.7.5.2 Wind Turbines causing permanent interference on civil and military radar

80. During construction, and prior to commissioning wind turbine blades will not be rotational. As a result the infrastructure will not be processed and presented onto an RDDS by the radar. Therefore there will be no impacts on radar systems during the construction phase. As a result of non-detection by radar during construction the impacts is considered to be of **no change.**

16.7.5.3 Increased air traffic in the area related to wind farm activities

81. There will be a maximum number of 14 helicopter return trips per week as a result of being engaged on works for Norfolk Boreas. Helicopters, if required, would operate from a local base. Use of helicopters will provide a small increase in helicopters routinely operating in the area; however, the slight increase could impact on existing air traffic operating in the area.

82. As detailed in section 16.7.2, a range of mitigation measures (notification, lighting and marking) to minimise environmental effects would apply to the development of the proposed project. These will comply with current guidelines and be agreed with the appropriate stakeholders and are outlined in section 16.7.1 and in section 16.7.2. The airspace surrounding the Norfolk coast and the proposed project is well served by ATC radar in support of ATS provision. When helicopters are operating under VFR rules and VMC, aircraft can be in receipt of an ATS and may be provided with traffic information on other aircraft, but ultimately pilots are responsible for their own separation from other aircraft, obstacles and terrain. Due to the low number of helicopter movements predicted to be caused by the construction of the proposed project, the procedures existing for ATC radar provision and the availability of existing ATS, the impact to aircraft operators in the vicinity of Norfolk Boreas, is considered to be **not significant**.

16.7.6 Potential Impacts during Operation

16.7.6.1 Creation of an aviation obstacle

83. During the operation of the proposed project, wind turbines could pose a physical obstruction to flight to aircraft in the vicinity. The CAA, helicopter operators and ATC service providers have been consulted to establish if a perceived impact would be created to helicopters operating in the region of the Norfolk Boreas site. No potential effects of operating on HMRs were notified from either of the helicopter operators. Anglia Radar (the ATS provider) did not respond to consultation.

84. A range of specific and embedded mitigation measures (notification, lighting and marking) to minimise environmental effects would apply to the development of the proposed project. These will comply with current guidelines and be agreed with the appropriate stakeholders and are outlined in section 16.7.1 and section 16.7.2.

85. 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. Pilots are ultimately responsible for seeing and avoiding obstructions such as wind turbines and will be aware of the proposed project through notification procedures. The impact to offshore helicopter operations utilising HMRs and military low flying operations is assessed as **not significant**.

86. Norfolk Boreas Limited have undertaken consultation with all relevant helicopter and Oil and Gas platform operators, during which no specific concerns were raised and it is expected that users could co-exist. This will be managed through coexistence agreements where necessary. Impacts on other marine users are discussed further in Chapter 18 Infrastructure and Other Users.

16.7.6.2 Wind turbines causing permanent interference on civil and military radar

87. The proposed project would be theoretically detectable by the NATS Cromer PSR and the MoD ADR located at Trimingham. Wind turbines detectable by a PSR or ADR system might degrade the system by creating false targets, reduce system sensitivity, create radar shadowing behind the wind turbines and saturate the radar receiver leading to clutter potentially concealing real aircraft targets.

88. Mitigation of the Cromer PSR has been identified and agreed with NATS and will be implemented prior to construction of the proposed project, subject to acceptance of the airspace change proposal by the UK regulator, the CAA. With mitigation in place the impact will reduce to **not significant.**

89. The MoD Trimingham TPS77 ADR has an inherent resilience, utilising hardware and software, to wind turbine induced clutter through the use of pulse Doppler processing; however, where the inherent radar performance is not considered to be satisfactory for ADR purposes, the TPS77 has an enhanced signal processing capability which enables the implementation of a Non-Automatic Initiation Zone (NAIZ).

90. A NAIZ prevents the radar from automatically creating tracks from any returns that originate within the NAIZ. In creating an NAIZ around a wind farm, none of the wind turbine returns will be processed, thereby significantly reducing the possibility of unwanted tracks. Tracks which have been formed from returns originating outside the NAIZ (an aircraft transiting through the NAIZ) will still be tracked. The MoD informed Norfolk Boreas Limited that the use of the hitherto acceptable mitigation solution of the use of a NAIZ will not be acceptable in relation to the wind farm. Furthermore, in reviewing the turbine heights proposed approximately 50% of the Norfolk Boreas site would be detectable by the Trimingham ADR at a blade tip height of 275m, increasing the blade tip height to 350m above HAT will increase the detectability of the wind turbines to the ADR. Mitigation has been accepted by the MoD to mitigate impact created by the operation of Norfolk Vanguard to the Trimingham ADR and is expected to be applicable to Norfolk Boreas. It is expected that a technical solution / mitigation will be agreed with the MoD prior to construction.

91. It is anticipated that the potential risk posed to civil and military radar systems will be wholly and successfully mitigated through the application of individual technical

solutions to the two radar systems. Mitigation of the Cromer PSR has been agreed (subject to acceptance of the ACP by the CAA), the mitigation solution will remove impact to the PSR. Until mitigation is in place; the impact to both radar systems is of **major significance**. However, mitigation of the radar systems will be agreed with NATS and the MoD prior to offshore construction works which will remove the impact created by Norfolk Boreas and reduce the impact to **not significant**.

16.7.6.3 Increased air traffic in the area related to wind farm activities

92. The operational phase may see increased helicopter air traffic over the proposed project in support of operational and maintenance missions. The effect of this is to create a slight increase in the potential risk of a mid-air collision between aircraft engaged in such operations and / or aircraft in transit across the Norfolk Boreas site. A range of embedded mitigation measures (notification, lighting and marking) to minimise environmental effects would apply to the development of the proposed project. These will comply with current guidelines and be agreed with the appropriate stakeholders and are outlined in section 16.7.1 and section 16.7.2. The safety of aircraft operating in the uncontrolled airspace immediately above the proposed project ultimately resides with aircrew, who may request the provision of an ATS that would be provided in accordance with national procedures. The infrastructure and provision of an appropriate level of ATS, as well as SAR services in times of emergency are already in place to support the existing offshore oil and gas industries and the see and avoid principle is considered to reduce potential impacts to **not significant**.

16.7.7 Potential Impacts during Decommissioning

16.7.7.1 Creation of an Aviation Obstacle

93. During the decommissioning phase, the presence and movement of decommissioning infrastructure may present a potential collision risk to aircraft in the vicinity.

94. A range of mitigation measures (notification, lighting and marking) to minimise environmental effects would apply to the decommissioning of the proposed project. These will comply with current guidelines and be agreed with the appropriate stakeholders and are outlined in section 16.7.1. 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. Pilots are ultimately responsible for seeing and avoiding obstructions such as wind turbines and decommissioning infrastructure and will be aware of the proposed project through notification procedures. The impact to offshore helicopter operations and military low flying operations is assessed as **not significant.**

95. Norfolk Boreas Limited has undertaken consultation with all relevant Offshore Platform Operators, during which no specific concerns were raised and it is expected that users could co-exist. This will be managed through coexistence agreements where necessary.

96. Any mitigation implemented will remain in place until the last wind turbine has been removed.

16.7.7.2 Wind turbines causing permanent interference on civil and military radar

97. During the gradual decommissioning of above sea level infrastructure at the Norfolk Boreas site, the impact on radar would be incrementally removed. Firstly, as wind turbines are decommissioned and the blades cease rotation, before being removed from the site. In addition, any agreed mitigation will be maintained until the last wind turbine is non-operational and unable to rotate in the decommissioning phase. The impact on radar during decommissioning is therefore expected to be no change, as the site is returned to pre-development conditions.

16.7.7.3 Increased air traffic in the area related to wind farm activities

98. The use of helicopters during the decommissioning phase of the proposed project could impact on aircraft operations in the vicinity of Norfolk Boreas. Due to the low number of movements predicted during the decommissioning period of the proposed project, the existing mitigation inherent for operating in uncontrolled airspace and the availability of existing ATS and by complying with embedded mitigation outlined in sections 16.7.1 and 16.7.2, the impact to aircraft operators in the vicinity of the proposed project is expected to be **not significant**.

16.8 Cumulative Impacts

99. Cumulative impacts refer to impacts upon receptors arising from the proposed project when considered alongside other proposed developments and activities and any other reasonably foreseeable project(s) proposals. In this context the term projects is considered to refer to any project with comparable effects and is not limited to offshore wind projects.

100. In assessing the potential cumulative impact(s) for Norfolk Boreas, it is important to bear in mind that for some projects, predominantly those ‘proposed’ or identified in development plans etc. may or may not actually be taken forward. Therefore, there is a need to build in some consideration of certainty (or uncertainty) with respect to the potential impacts which might arise from such proposals. For example, relevant projects / plans that are already under construction are likely to contribute to cumulative impacts with Norfolk Boreas whereas projects / plans not yet approved or not yet submitted are less certain to contribute to such an impact, as some may not achieve approval or may not ultimately be built due to other factors.

101. By virtue of its distance from centres of aviation activity, the proposed project produces fewer direct adverse effects on aviation operations than an equivalent onshore development. In the case of Norfolk Boreas, aviation impacts are confined to the introduction of a remote obstacle environment, the effect of wind turbine detection by the Cromer PSR and the Trimingham ADR systems, and the increase of air traffic in the vicinity of the proposed project. The potential for cumulative impact created by the radar detection of the Norfolk Boreas site exists to the Cromer PSR and Trimingham ADR radar systems that will also detect the wind farm developments listed in Table 16.8 below.

102. The establishment of the Norfolk Boreas site in the southern North Sea provides for adequate airspace above and around the development in which aircraft can be operated to enable the prescribed separation standards to be achieved without incurring adverse impacts from other developments, either onshore or offshore and therefore the affect to civil and military operations is assessed as **no change.**

103. Without mitigation for radar a wind farm in operational range and detectable of the radar system will likely create cumulative effects of **major significance** in terms of the area affected by radar clutter and the distances between areas of clutter on the RDDS. Following implementation of mitigation, it can be expected that the stand-alone and cumulative effects of the proposed project in terms of the Cromer PSR and Trimingham ADR, for which mitigation is being sought are also reduced in proportion to this reduced level of local impact and are therefore assessed as **not significant.**

104. All phases may see increased helicopter air traffic over the proposed project in support of logistics missions. The effect of this is to create a slightly increased potential risk of a mid-air collision between aircraft engaged in such operations and / or aircraft in transit across the Norfolk Boreas site. A range of embedded mitigation measures (notification, lighting and marking) to minimise environmental effects would apply to the development of the proposed project. These will comply with current guidelines and be agreed with the appropriate stakeholders and are outlined in sections 16.7.1 and section 16.7.2. The safety of aircraft operating in the uncontrolled airspace immediately above, and around, the proposed project ultimately resides with aircrew, who may request the provision of an ATS that would be provided in accordance with national procedures. The infrastructure and provision of an appropriate level of ATS, as well as SAR services in times of an emergency are already in place to support the existing offshore oil and gas industries. In light of the measures to be adopted, potential cumulative impacts are considered **not significant**. Table 16.8

Table 16.7 Potential Cumulative Impacts

Impact	Potential for cumulative impact	Data confidence	Rationale
Creation of an aviation obstacle.	No	High	Aircraft captains have the responsibility for the safety of their aircraft and are required to avoid any obstacle by legislated minimum distances. There would be no cumulative effects from the establishment of the proposed project.
Wind turbines causing permanent interference on civil and military radar.	Yes, until mitigation is in place.	High	The proposed project is approximately 1km (Norfolk Vanguard East) to 51km (East Anglia ONE North), from proposed offshore wind farm developments that will be located in the southern North Sea. Other developments are at a sufficient distance in ATS terms that they would not create cumulative impacts on aviation operations in the area of Norfolk Boreas. With respect to onshore wind farm sites, these would all be of a sufficient distance from the proposed project that there would be no cumulative effects on aviation operations that arise from any combined adverse impacts. Adjacent offshore wind farms have the potential to create a cumulative effect on radar systems similarly impacted by the development of Norfolk Boreas. Norfolk Vanguard is being developed by the same applicant as Norfolk Boreas and it is assumed that mitigation for Norfolk Boreas will be equally suitable for the effects Norfolk Vanguard will create to identified radar systems. Similarly, it is assumed that operational wind farms and those proposed are mitigated against effect to aviation radar; therefore, any potential for a cumulative effect will be removed once mitigation is in place for current and future wind farms.
Increased air traffic in the area related to wind farm activities.	No	High	The area in the vicinity of the proposed project is likely to see increased helicopter air traffic over the current baseline levels due to the use of helicopters in the provision of operational support. The implementation of embedded mitigation outlined in section 16.7.1, the reliance of pilots to comply with the rules of the air and the distances between other wind farms included in the cumulative assessment is expected to nullify any possibility of cumulative impact.

Table 16.8 Summary of projects considered for the CIA in relation to aviation

Project	Status	[7]Distance from Norfolk Boreas Offshore Project Area(km)	Project definition	Included in CIA	Rationale
Norfolk Vanguard East	Application Submitted	1	Planning information available	Yes	Proximity to proposed project
Norfolk Vanguard West	Application Submitted	13	Planning information available	Yes	Proximity to proposed project
East Anglia ONE	Under Construction	62	Consented information available	Yes	Proximity to proposed project.
Dudgeon Offshore Wind Farm	Under Construction	90	Consented information available	Yes	Proximity to proposed project
Race Bank	Under Construction	113	Consented information available	Yes	Proximity to proposed project
Triton Knoll	Under Construction	120	Consented information available	Yes	Proximity to proposed project
Hornsea Project 1	Under Construction	53	Consented information available	Yes	Proximity to proposed project
Hornsea Project 2	Under Construction	125	Consented information available	Yes	Proximity to proposed project
Hornsea Project 3	Planning	87	Planning information available	Yes	Proximity to proposed project
East Anglia THREE	Consented	13	Consented information available	Yes	Proximity to proposed project
East Anglia TWO	Planning	73	Scoping Completed	Yes	Proximity to proposed project
East Anglia ONE North	Planning	51	Scoping Completed	Yes	Proximity to proposed project

[7] Shortest distance between the considered project and Norfolk Boreas – unless specified otherwise.

105. Table 16.8 above provides a summary of projects considered for the CIA in relation to aviation. There may be an element of uncertainty associated with the design envelope of proposed projects; therefore, a judgement is made on the confidence associated with the latest available design envelope.

106. Radar LOS modelling has not been completed for those projects listed above. Currently, for radar systems for which impacts are not mitigated against it is assumed that any effects are considered acceptable; however, the addition of further unmitigated clutter created by the Norfolk Boreas site could create a cumulative effect where existing detectable wind turbines are currently considered manageable. Those developments which are detectable by the Cromer PSR and Trimingham ADR are likely to create a cumulative effect until they are mitigated.

16.9 Transboundary Impacts

107. Other EU member states that could be impacted by the proposed project are detailed in Table 16.9.

Table 16.9 List of Other EU Member States Retained in the Transboundary Impact Assessment in Relation to the Topic

EU member state	Commentary
Netherlands	Norfolk Boreas would be located adjacent to the London / Amsterdam FIR. Consultation with Dutch civil and military aviation stakeholders has been completed for Norfolk Boreas with confirmation that there will be no impact to operations conducted by Dutch aviation authorities. Dutch HMRs located in the Amsterdam FIR continue into the UK and vice-versa however from the consultation response received from helicopter operators no impact is predicted.

108. The strategies applied to mitigate any impact to offshore helicopter operations and the provision of ATS should be equally effective in the Netherlands as aviation operations are regulated by international criteria. Consultation with helicopter operators based in the UK, Netherlands and Belgium has been undertaken with limited response from the operators and therefore based on the outcome of consultation transboundary impacts are assessed as **not significant**.

16.10 Inter-relationships

109. This chapter has an inter-relationship with Chapter 15 Shipping and Navigation. Aviation lighting to offshore wind turbines could cause confusion to maritime activities as the specification for lighting to be displayed below the horizontal plane of the light fitment itself could cause mariners some confusion. To resolve concerns from the maritime community, work to develop an aviation warning light standard which is clearly distinguishable from maritime lighting has been undertaken. Within CAP 764 (CAA, 2016) the CAA state that where it is evident that the default aviation

warning lighting standard for offshore obstacles may generate issues for the maritime community, a developer can make a case, that is likely to receive CAA approval, for the use of a flashing red Morse Code Letter 'W' instead. There is, however, no intent to change the lighting intensity specifications set out for offshore obstacles; indeed those specifications remain the default aviation warning lighting requirement. Provision is made within CAP 393 that requires the reduction in lighting intensity at or below the horizontal and allows for a further reduction in lighting intensity when the visibility in all directions from every wind turbine is more than 5 km. Table 16.10 provides chapter topic relationship.

Table 16.10 Chapter topic inter-relationships

Topic and description	Related Chapter	Where addressed in this Chapter
Aviation obstruction lighting	Chapter 15 Shipping and Navigation	Section 16.10

16.11 Summary

110. Table 16.11 presents a summary of the impact assessment undertaken with respect to the proposed project in relation to Aviation and Radar, which is discussed in section 16.6.

Table 16.11 Potential Impacts Identified for aviation

Potential Impact	Receptor	Significance	Mitigation	Residual Impact
Construction				
Creation of an aviation obstacle.	Aircraft undertaking low flying operations Oil and Gas platform operators and the use of specific helicopter operations to / from offshore oil and gas platforms.	**Not significant**	Norfolk Boreas Limited has undertaken consultation with all relevant Offshore Platform and helicopter Operators, during which no specific concerns were raised and it is expected that users could co-exist. This will be managed through coexistence agreements where necessary.	**Not Significant**
Wind turbines causing permanent interference to civil and military radar.	NATS Cromer PSR MoD Trimingham ADR	**No change**	N/A	**N/A**
Increased air traffic in the area related	Aircraft undertaking low	**Not significant**	N/A	**N/A**

Potential Impact	Receptor	Significance	Mitigation	Residual Impact
to wind farm activities.	flying operations. Helicopters operating offshore.			
Operation				
Creation of an aviation obstacle.	Aircraft undertaking low flying operations. Oil and Gas platform operators and the use of specific helicopter operations to / from offshore oil and gas platforms.	**Not significant**	Norfolk Boreas Limited has undertaken consultation with all relevant Offshore Platform and helicopter Operators, during which no specific concerns were raised and it is expected that users could co-exist. This will be managed through coexistence agreements where necessary.	**Not significant**
Wind turbines causing permanent interference to civil and military radar.	NATS Cromer PSR MoD Trimingham ADR	**Major Significance**	A mitigation agreement between Norfolk Boreas Limited and NATS has been entered into. NATS are considering all options for mitigation and have submitted a request for an Airspace Change Proposal to the UK regulator (the CAA) which will be subject to regulatory approval. Mitigation of the Trimingham ADR will be agreed with the MoD which will remove the impact created by Norfolk Boreas.	**Not Significant**
Increased air traffic in the area related to wind farm activities.	Helicopters operating in support of Norfolk Boreas.	**Not significant**	N/A	**N/A**
Decommissioning				
Creation of an aviation obstacle	Aircraft undertaking low flying operations. Oil and Gas platform operators and the use of specific helicopter operations to / from offshore oil and gas platforms.	**Not Significant**	Norfolk Boreas Limited has undertaken consultation with all relevant Offshore Platform and helicopter Operators, during which no specific concerns were raised and it is expected that users could co-exist. This will be managed through coexistence agreements where necessary.	**Not significant**

Potential Impact	Receptor	Significance	Mitigation	Residual Impact
Wind turbines causing permanent interference to civil and military radar.	NATS Cromer PSR MoD Trimingham ADR	**No change**	N/A	**N/A**
Increased air traffic in the area related to wind farm activities.	Helicopters operating in support of Norfolk Boreas.	**Not significant**	N/A	**N/A**
Cumulative				
Norfolk Vanguard, East Anglia Three Wind Farm – Creation of an aviation obstacle.	Aircraft undertaking low flying operations. Helicopters operating offshore. IFR ARA helicopter operations to offshore oil and gas platforms and the continuation of emergency evacuation procedures.	**Not significant**	Norfolk Boreas Limited has undertaken consultation with all relevant Offshore Platform and helicopter Operators, during which no specific concerns were raised and it is expected that users could co-exist. This will be managed through coexistence agreements where necessary.	**N/A**
Norfolk Vanguard, East Anglia ONE and Three, Scroby Sands, Greater Gabbard, Galloper Wind Farm, Dudgeon, Race Bank, Triton Knoll, Hornsea 1, 2, 3 – Wind turbines causing interference to civil and military radar	NATS Cromer PSR MoD Trimingham ADR	**Major Significance**	Individual mitigation of the two radar systems will remove any cumulative impact of the proposed development.	**Not Significant**

Potential Impact	Receptor	Significance	Mitigation	Residual Impact
Norfolk Vanguard, East Anglia Three Wind Farm – increased air traffic in the area related to wind farm activities	Helicopters operating in support of Norfolk Boreas.	**Not significant**	N/A	**N/A**
Transboundary				
Impacts to aircraft operators between the London and Amsterdam FIRs.	Helicopters operating offshore using HMR which transit the proposed project.	**Not Significant**	N/A	**N/A**
Impacts on Dutch PSR.	LVNL Ministerie Van Defensie	**Not significant**	N/A	**N/A**

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