European Offshore Wind Deployment Centre

Environmental Statement

Appendix 15.1: Navigational Risk Assessment

A project part-funded by the European Union under the European Economic Plan for Recovery in the field of Energy

Navigation Risk Assessment

European Offshore Wind Deployment Centre

(Technical Note)

Prepared by:	Anatec Limited
Presented to:	Aberdeen Offshore Wind Farm Limited
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Anatec	**Aberdeen Office**	**Cambridge Office**
Address:	36 Upperkirkgate, Aberdeen, AB10 1BA, Scotland, UK	16 Ward Way, Witchford, Ely, Cambs, CB6 2JR, UK
Tel:	01224 633711	01353 661200
Fax:	0709 2367306	0709 2367306
Email:	aberdeen@anatec.com	cambs@anatec.com

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1. INTRODUCTION

1.1 Background

Anatec was commissioned by Aberdeen Offshore Wind Farm Limited (AOWFL) to perform a shipping and navigation assessment of the European Offshore Wind Deployment Centre (EOWDC), situated in Aberdeen Bay.

The report presents information on the proposed development relative to the baseline navigational activity and features for the area. Following this, an assessment of the impact of the proposed development on navigation is presented.

1.2 Scope of the Assessment and Methodology

The assessment methodology principally followed the Department of Energy and Climate Change (DECC) Risk Assessment Methodology (Ref. i) and the Maritime and Coastguard Agency's (MCA) Marine Guidance Notice 371 (MGN 371) (Ref. ii).

An overview of the general methodology applied in the assessment is presented in Figure 1.1. (More information on the regulations and guidance being addressed is presented in Section 2.)

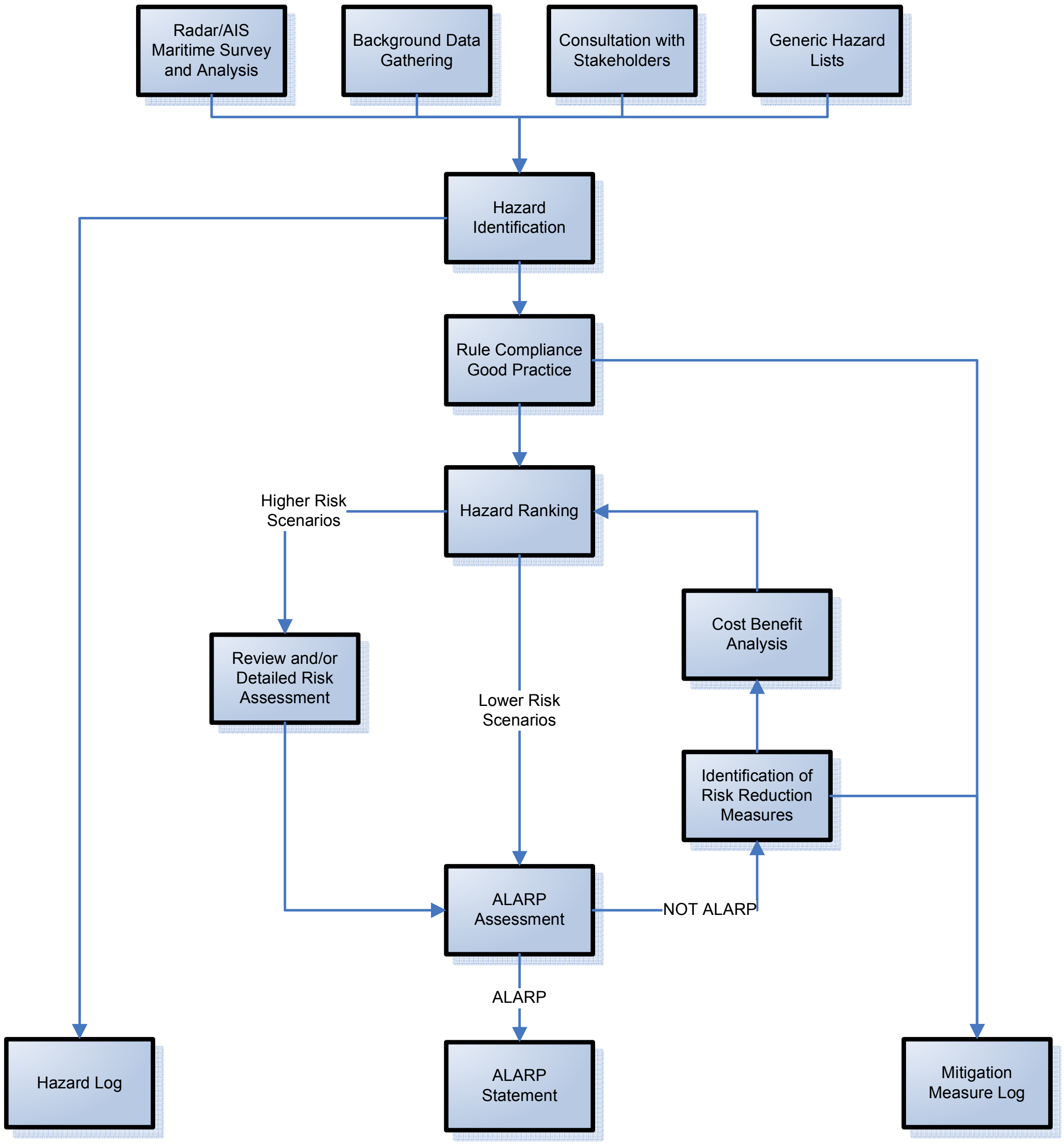


Figure 1.1 Overview of Methodology for Navigation Assessment

The main part of the assessment considers the impact of the surface structures associated with the operational phase of the proposed development on the following maritime activities:

- Commercial Shipping
- Fishing
- Recreational Sailing

In addition to these activities, consideration is given to the following:

- Impacts of Structures on Marine Radar

- Impact of Subsea cables
- Impacts associated with Construction / Decommissioning phases
- Cumulative Impacts with other nearby developments

The assessment is based on the turbine layout 039 which has evolved from various site iterations and extensive consultation. The number of turbines has subsequently been reduced from the initial plans to take on board comments received from navigational stakeholders, in particular Aberdeen Harbour Board and the Marine Safety Forum.

1.3 Abbreviations

The following abbreviations are used in this report:

AHB	-	Aberdeen Harbour Board
AIS	-	Automatic Identification System
ALARP	-	As Low as Reasonably Practicable
ALB	-	All-Weather Lifeboat
AOWFL	-	Aberdeen Offshore Wind Farm Limited
AREG	-	Aberdeen Renewable Energy Group
ARPA	-	Automatic Radar Plotting Aid
ARRC	-	Autonomous Rescue and Recovery Craft
AtoN	-	Aid to Navigation
BATNEC	-	Best Available Technology Not at Excessive Cost
BERR	-	Department for Business Enterprise & Regulatory Reform
BMAPA	-	British Marine Aggregate Producers Association
BWEA	-	British Wind Energy Association
CA	-	Cruising Association
CAA	-	Civil Aviation Authority
CBA	-	Cost Benefit Analysis
COLREGS	-	International Regulations for Preventing Collisions at Sea
CPA	-	Closest Point of Approach
DECC	-	Department of Energy and Climate Change
DEFRA	-	Department for Environment, Food and Rural Affairs
DfT	-	Department for Transport
DSC	-	Digital Selective Calling
DTI	-	Department of Trade and Industry
DW	-	Deep Water
DWT	-	Dead Weight Tonnes
DZ	-	Danger Zone
EIA	-	Environmental Impact Assessment
EOWDC	-	European Offshore Wind Deployment Centre
ERCoP	-	Emergency Response Cooperation Plan
ERRV	-	Emergency Response and Rescue Vessel
ES	-	Environmental Statement
ETV	-	Emergency Towing Vessel
FN	-	Frequency-Number

FSA	-	Formal Safety Assessment
GPS	-	Global Positioning System
GRP	-	Glass Reinforced Plastic
HAT	-	Highest Astronomical Tide
HF	-	High Frequency
HSC	-	High Speed Craft
HSE	-	Health and Safety Executive
HW	-	High Water
IALA	-	International Association of Marine Aids to Navigation and Lighthouses
ILB	-	Inshore Lifeboat
ICES	-	International Council for the Exploration of the Seas
ICST	-	The International Classification of Ships by Type
IMO	-	International Maritime Organisation
IPS	-	Intermediate Peripheral Structures
ITOPF	-	International Tanker Owners Pollution Federation Limited
km	-	Kilometre
LORAN	-	Long Range Navigation
MAIB	-	Marine Accident Investigation Branch
MBS	-	Maritime Buoyage System
MCA	-	Maritime and Coastguard Agency
MFA	-	Marine and Fisheries Agency
MGN	-	Marine Guidance Notice
MHWN	-	Mean High Water Neaps
MHWS	-	Mean High Water Springs
MLWN	-	Mean Low Water Neaps
MLWS	-	Mean Low Water Springs
MRCC	-	Maritime Rescue Co-ordination Centre
MRSC	-	Maritime Rescue Sub-Centre
MSL	-	Mean Sea Level
MW	-	Mega-Watt
nm	-	Nautical Miles
NUC	-	Not Under Command
OREI	-	Offshore Renewable Energy Installations
OWF	-	Offshore Wind Farm
PLA	-	Port of London Authority
PLL	-	Potential Loss of Life
PLN	-	Port Letter Number
PPE	-	Personal Protective Equipment
RAF	-	Royal Air Force
RCM	-	Risk Control Measure
RIB	-	Rigid Inflatable Boat
RNLI	-	Royal National Lifeboat Institution
Ro-Ro	-	Roll-on, Roll-off
RYA	-	Royal Yachting Association

SAR	-	Search and Rescue
SEA	-	Strategic Environmental Assessment
SFF	-	Scottish Fishermen's Federation
SPS	-	Significant Peripheral Structure
SRR	-	Search and Rescue Region
TSS	-	Traffic Separation Scheme
UHF	-	Ultra High Frequency
UKCS	-	United Kingdom Continental Shelf
UKHO	-	United Kingdom Hydrographic Office
VHF	-	Very High Frequency
VMS	-	Vessel Monitoring Service
VTS	-	Vessel Traffic Services

2. REGULATIONS AND GUIDANCE

2.1 Introduction

This section briefly summarises the key regulations and guidance relevant when considering the navigation safety issues associated with offshore wind farm developments in the UK.

2.2 MCA Marine Guidance Notice 371

This guidance notice (Ref. ii) highlights issues that need to be taken into consideration when assessing the impact on navigational safety from offshore renewable energy developments, proposed for United Kingdom internal waters, territorial sea or Renewable Energy Zones.

There are 5 annexes containing recommendations (1-4) and regulatory extracts (5-6) as follows:

- Annex 1: Considerations on site position, structures and safety zones.
- Annex 2: Navigation, collision avoidance and communications.
- Annex 3: MCA shipping template, assessing wind farm boundary distances from shipping routes.
- Annex 4: Safety and mitigation measures recommended for OREI during construction, operation and decommissioning.
- Annex 5: Standards and procedures for generator shutdown and other operational requirements in the event of a search and rescue, counter pollution or salvage incident in or around an OREI.

A checklist referencing the sections in this report which address MCA requirements is presented in Appendix A.

2.3 MCA Wind Farm: "Shipping Route" Template

A trial performed by the Maritime & Coastguard Agency at the North Hoyle Offshore Wind Farm (Ref.iii) indicated that turbines provide erroneous returns to radar transceivers. Multiple side echoes may be generated that have the potential to mask real targets. This has been validated by more recent trials carried out by the industry on the Kentish Flats Offshore Wind Farm in the Thames estuary (Ref. iv). The onset range from the turbines of these returns is about 1.5nm, with a progressive deterioration in the radar picture as the turbines are closed to about 500 m. Adjustment of the radar controls can filter out some of these unwanted radar returns but comes at the cost of potentially losing small radar cross sectional targets such as buoys or small craft.

The MCA's Wind farm Shipping Route Template (Annex 3 of Ref. ii), reproduced in Figure 2.1, indicates that turbines within 0.5nm of a route will be Very High Risk. Close scrutiny and potentially mitigation will be needed between 0.5nm and 5nm to ensure risks are ALARP, particularly between 0.5nm and 2nm which is considered Medium to High Risk. Beyond 2nm is Low Risk although an adjacent wind farm or TSS introduces cumulative effects which have to be scrutinised.

Annex 3 of Ref. ii states that the template is not a prescriptive tool but needs intelligent application to explore where the distance should be measured from, e.g., route centre, 90% traffic level, nearest ship, etc. The potential boundaries are illustrated in Figure 2.2.

Marine traffic survey information collected for the proposed EOWDC site has been analysed in this study to inform such boundaries and investigate influencing factors such as route bias, vessel type, size, cargo, etc.

WIND FARM: "SHIPPING ROUTE" Template

Distance in miles (nm) of Turbine Boundary from Shipping Route	Factors	Risk	Tolerability
< 0.25nm (500m)	500m inter-turbine spacing = small craft only recommended	VERY HIGH	INTOLERABLE
0.25nm (500m)	X band radar interference	VERY HIGH	
0.45nm (800m)	Vessels may generate multiple echoes on shore based radars	VERY HIGH	
			TOLERABLE IF ALARP (As Low As Reasonably Practicable)* * Descriptions of ALARP can be found in a) Great Britain Health and Safety Executive (2001) Reducing risks protecting people b) IMO (2002) MSC Circ 1023 dated 5th April 2002 Formal Safety Assessment c) IMO (2007) MSC 83-21-INF2 Consolidated guidelines for Formal Safety Assessment
0.5nm (926m)	Mariners' high traffic density domain	HIGH	
0.8nm (1481m)	Mariners' ship domain	HIGH	
1 nm (1852m)	Minimum distance to parallel boundary of TSS	MEDIUM	
1.5nm (2778m)	S band radar interference ARPA affected	MEDIUM	
2 nm (3704m)	Compliance with COLREGS becomes less challenging	MEDIUM	
>2nm > (3704m)	But not near TSS	LOW	
3.5nm (6482m)	Minimum separation distance between turbines opposite sides of a route	LOW	
5nm (9260m)	Adjacent wind farm introduces cumulative effect Distance from TSS entry/exit	VERY LOW	BROADLY ACCEPTABLE
10nm (18520m)	No other wind farms	VERY LOW	

Figure 2.1 Wind Farm "Shipping Route" Template (Ref. ii)

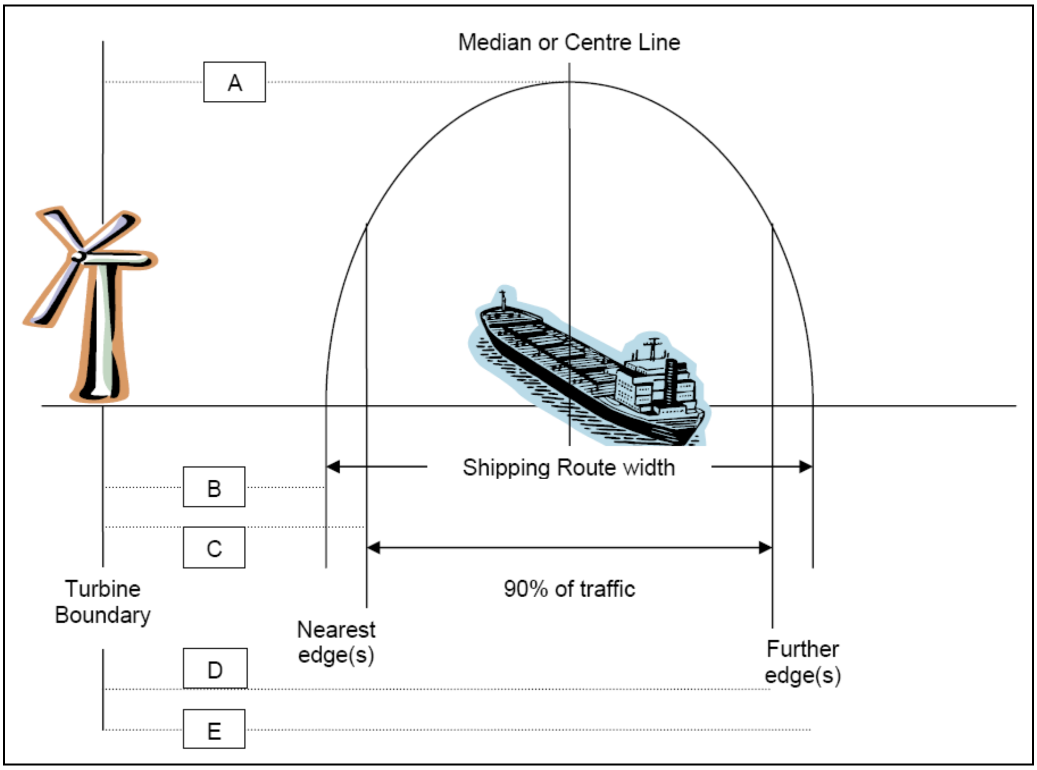


Figure 2.2 Interactive Boundaries (require Interpretative Flexibility), where:

A = Turbine boundary to the shipping route median or centre line
B = Turbine boundary to nearest shipping route edge
C = Turbine boundary to nearest shipping 90% traffic level*
D = Turbine boundary to further shipping 90% traffic level*
E = Turbine boundary to further shipping route edge
(* = or another % to be determined)

2.4 DECC Methodology

DECC (formerly BERR) produced a Methodology for Assessing the Marine Navigational Safety Risks of Offshore Wind Farms in association with the MCA and the DfT (Ref. i).

Its purpose is to be used as a template by Developers in preparing their NRAs, and for Government Departments to help in the assessment of these.

The Methodology is centred around risk controls and the feedback from risk controls into risk assessment. It requires a submission that shows that sufficient risk controls are, or will be, in place for the assessed risk to be judged as broadly acceptable or tolerable with further controls or actions.

The key features of the Marine Safety NRA Methodology are risk assessment (supported by appropriate techniques and tools), creating a hazard log, defining the risk controls (in a Risk Control Log) required to achieve a level of risk that is broadly acceptable (or tolerable with controls or actions), and preparing a submission that includes a claim, based on a reasoned argument, for a positive consent decision.

Table 2.1 Key Features of the DECC Methodology (Ref. i)

1	Define a scope and depth of the submission proportionate to the scale of the development and the magnitude of the risk
2	Estimate the “base case” level of risk
3	Estimate the “future case” level of risk
4	Create a hazard log
5	Define risk control and create a risk control log
6	Predict “base case with wind farm” level of risk
7	Predict “future case with wind farm” level of risk
8	Submission

2.5 Aids to Navigation

The proposed EOWDC would be marked in accordance with the requirements of The Northern Lighthouse Board (NLB) which is the statutory body advising on the marking of Renewable Energy Installations in Scottish waters. The requirements will be agreed for all phases of the development.

3. PROJECT DETAILS

3.1 Introduction

This section presents details on the proposed development in Aberdeen Bay. Improvements have been made to the site layout in order to minimise the risk of the proposed project.

3.2 Lease Boundary

The lease boundary for the proposed EOWDC site is located approximately 1nm east of Black Dog. The total area of the lease boundary is approximately 5.8nm^2 (20 km^2). The corner coordinates of this area are presented in Table 3.1.

Table 3.1 Co-ordinates of EOWDC Lease Boundary (WGS 84)

Corner	Latitude (dd)	Longitude (dd)
c1	57.2060° N	1.9780° W
c2	57.1974° N	2.0454° W
c3	57.2454° N	2.0152° W
c4	57.2540° N	1.9477° W

The proposed turbine layout has a perimeter (area formed by joining outer turbine locations) considerably smaller than the licensed area. The coordinates of the proposed eleven turbine locations are presented in Table 3.2.

Table 3.2 Co-ordinates of Proposed EOWDC Turbines (WGS 84)

Turbine Number	Latitude (dsm)	Longitude (dsm)
1	57° 12' 28.570" N	002° 00' 35.007” W
2	57° 12' 56.899" N	002° 00' 40.259” W
3	57° 13' 25.226" N	002° 00' 45.453” W
4	57° 12' 42.251" N	001° 59' 55.259” W
5	57° 13' 12.197" N	002° 00' 0.801” W
6	57° 13' 42.142" N	002° 00' 6.286” W
7	57° 12' 57.642" N	001° 59' 10.554” W
8	57° 13' 29.399" N	001° 59' 16.385” W
9	57° 14' 01.188" N	001° 59' 22.218” W
10	57° 13' 48.536" N	001° 58' 27.007” W
11	57° 14' 22.331" N	001° 58' 33.185” W

Charts of the lease boundary and proposed turbine locations are presented in Figure 3.1 and Figure 3.2, respectively. Adjacent turbines are located approximately 800-1,110m apart.

Water depths (below chart datum) at the turbine locations range from approximately 20m to 30m.

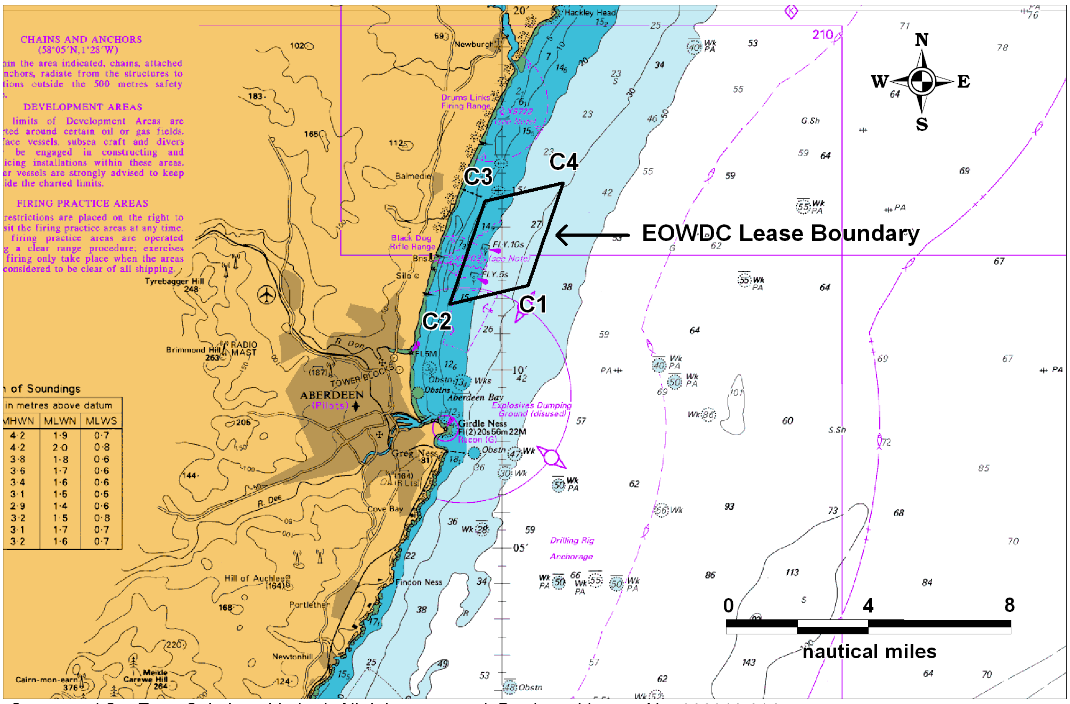


Figure 3.1 Chart Overview of EOWDC Lease Boundary

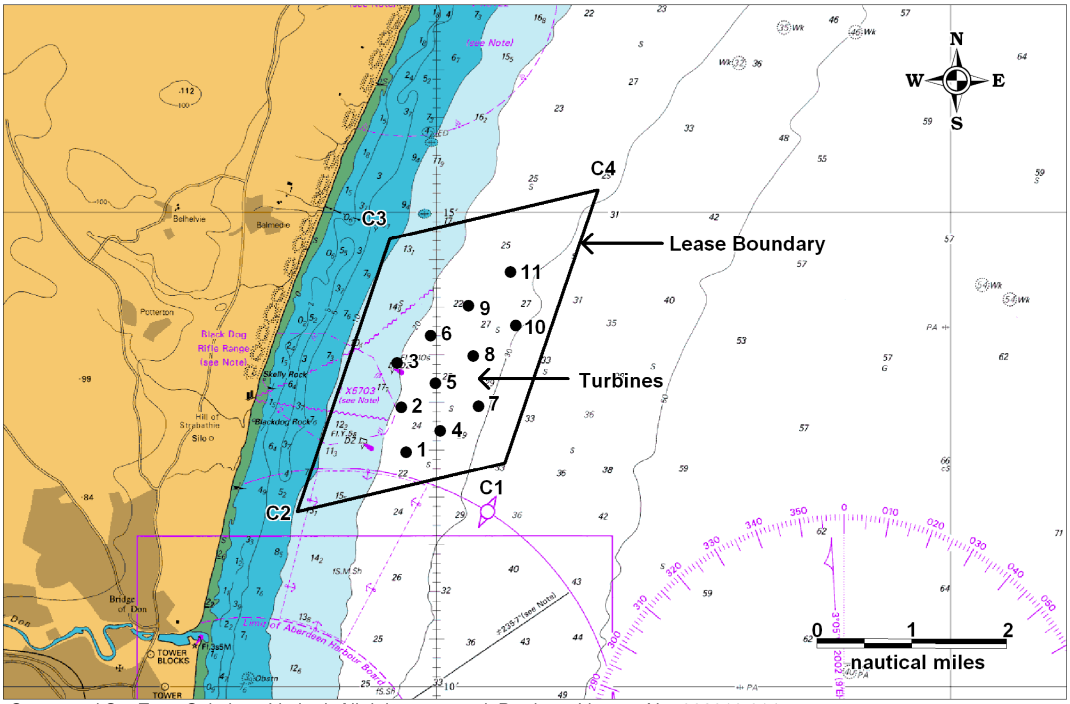


Figure 3.2 Detailed Chart Overview of proposed EOWDC site and Lease boundary

3.3 Site Revision

Figure 3.3 shows the current turbine layout versus a previous layout from 2006. It can be seen that there are now fewer turbines and that the overall 'turbine footprint' area is much smaller. The site has also been moved further north away from Aberdeen port to reduce the impact on ships navigating and anchoring in the vicinity. These changes were agreed with maritime stakeholders, such as the Aberdeen Harbour Board, during consultation on the proposed development.

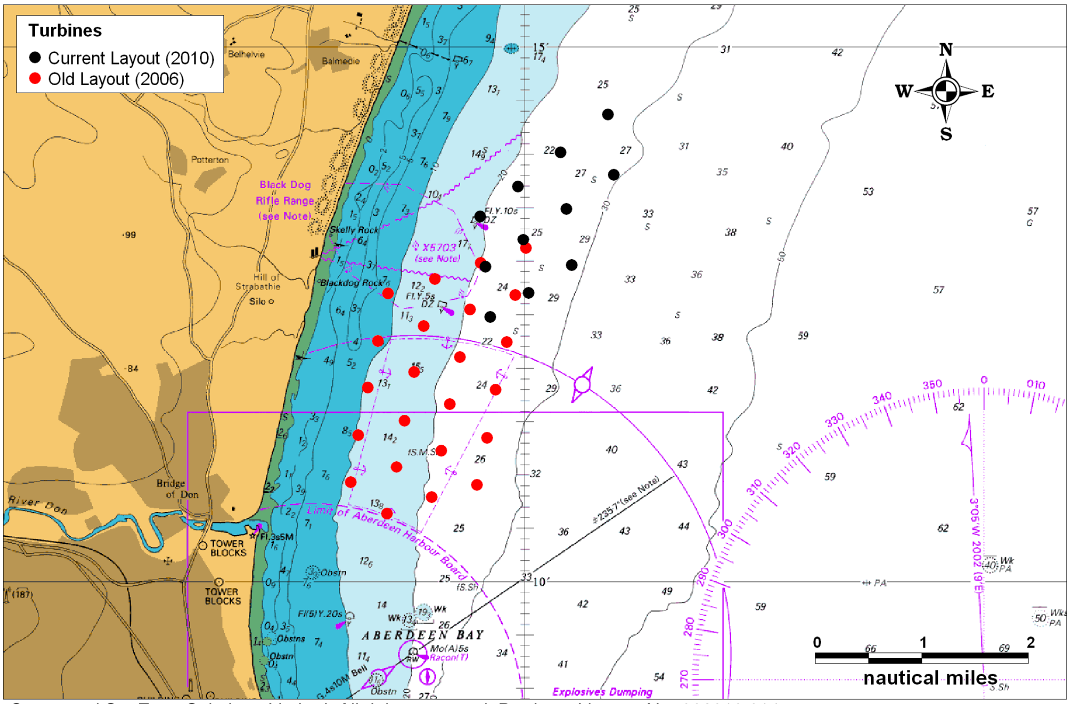


Figure 3.3 Current Layout (2010) versus Old Layout (2006)

3.4 Structure Details

Several layout options have been considered for the proposed EOWDC. The finalised turbine arrangement (layout 39) consists of 11 wind turbines on jacket substructures. It is expected that the turbines installed will vary in size and power. The table below summarises the dimensions of the possible machines ranging from 4 MW to 10 MW.

Table 3.3 Dimensions for Minimum and Maximum Size Machines

Wind Turbine Size	Max Hub Height above LAT (m)	Max Rotor Diameter (m)	Maximum Tip Height above LAT (m)
4MW	100	120	160
10MW	120	150	195

Conservatively, the worst case jacket substructure dimensions of 21m by 21m have been assumed within this collision risk assessment, as a worst case out of all potential foundations being considered for the site as defined by the project.

A typical design of the wind turbine and the jacket sub-structure is represented in Figure 3.4 and Figure 3.5. There will be a minimum 22m rotor blade tip clearance (air draught) over MHWS in accordance with MCA and RYA recommendations.

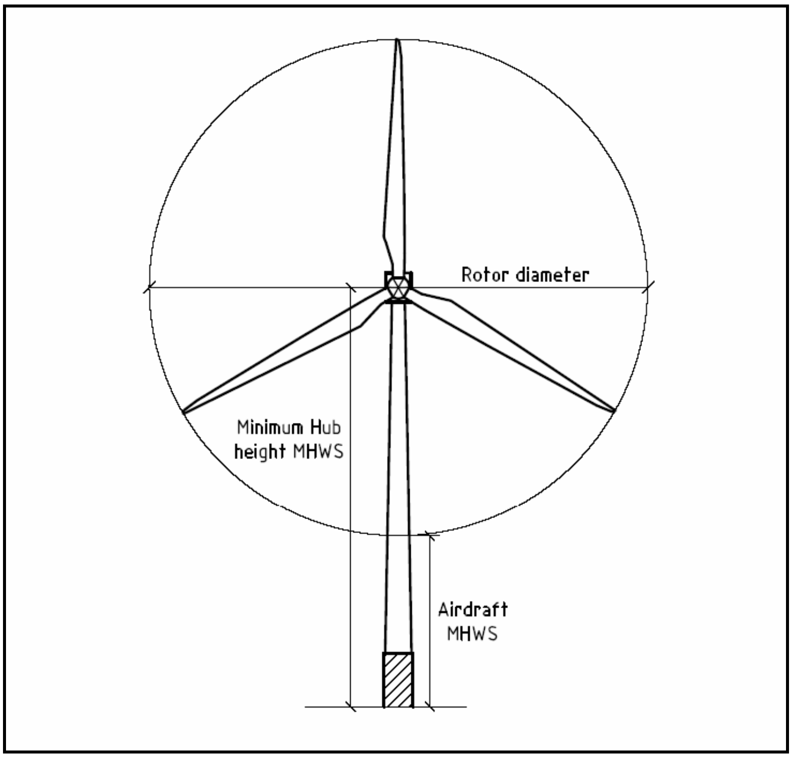


Figure 3.4 Outline of Typical Turbine Structure

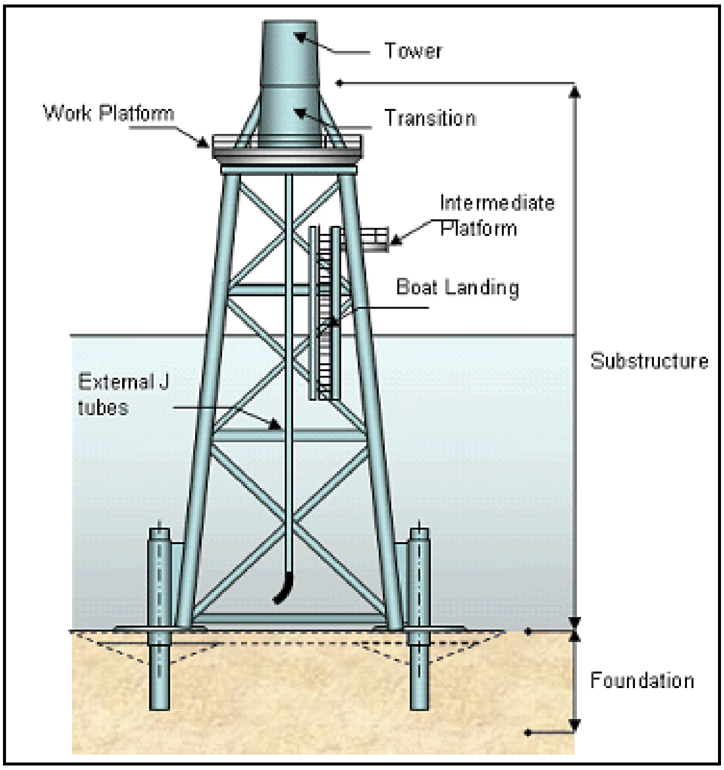


Figure 3.5 Outline of Typical Jacket Substructure

3.5 Offshore Cable Routes

An overview of the cable corridor is presented in the following figure:

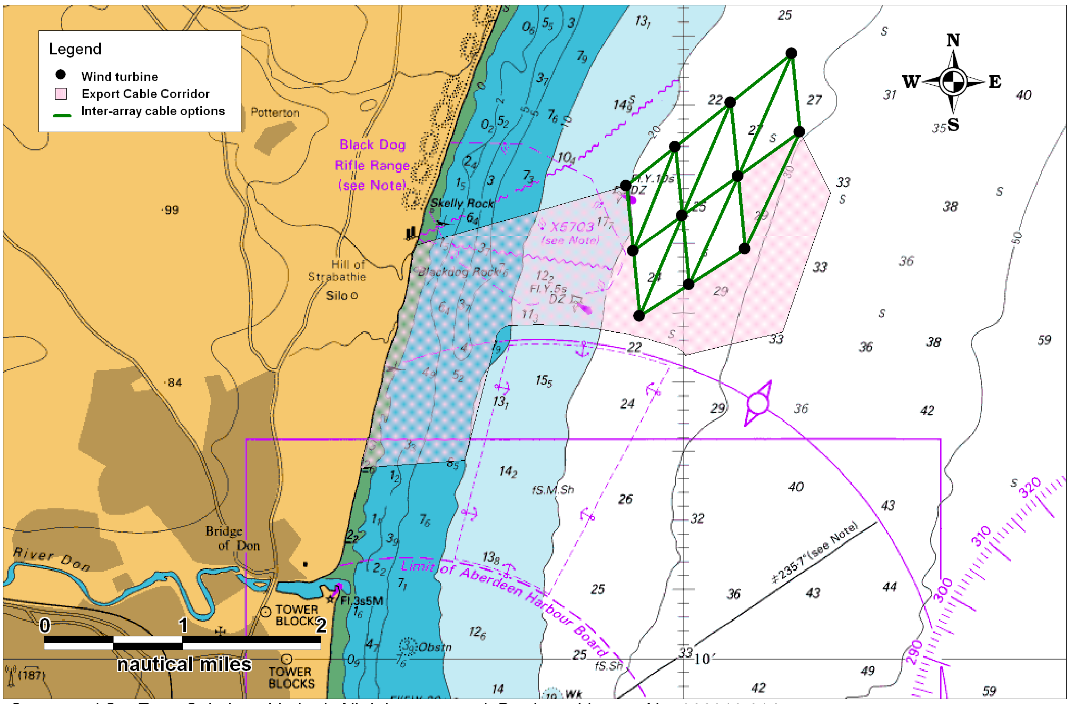


Figure 3.6 Cables associated with Wind Farm

The Rochdale envelope for the project states that the export and inter-array cables will be buried to a minimum depth of 0.6 and to a maximum depth of 3m.

4. MARINE NAVIGATIONAL MARKINGS

4.1 Introduction

Throughout the project marine navigational marking will be provided in accordance with the Northern Lighthouse Board requirements, which will comply with IALA Recommendation 0-139 on the Marking of Offshore Wind Farms and the additional requirements of MCA MGN 371(Ref. ii). It is also noted that there is a requirement to mark selected structures with lights for aviation as per Civil Aviation Authority (CAA) requirements.

NLB have advised that final marking and lighting recommendations will be made in a formal response through the Coast Protection Act 1949: Section 34 consultation process. This will now be implemented through the Marine Licence. All navigational marking and lighting of the site or its associated marine infrastructure will require the Statutory Sanction of the Northern Lighthouse Board prior to deployment.

4.2 Construction/Decommissioning

During the construction / decommissioning of the project, working areas will be established and marked in accordance with the IALA Maritime Buoyage System (MBS). In addition to this, where advised by NLB, additional temporary marking will be applied.

Notices to Mariners, Radio Navigational Warnings-NAVTEX and/or broadcast warnings as well as Notices to Airmen will be promulgated in advance of and during construction / decommissioning of any individual structure/project.

4.3 Marking of Individual Structures

The tower of every wind turbine will be painted yellow all around from the level of Highest Astronomical Tide (HAT) to 12m above HAT or the height of the Aid to Navigation, if fitted, whichever is greater.

As per the MCA requirements, each of the structures will be marked with clearly visible unique identification characteristics at a location that is easily and readily serviceable. The identification characteristics will each be illuminated by a low-intensity light, so that the sign is visible from a vessel thus enabling the structure to be detected at a suitable distance to avoid a collision with it. This will be such that under normal conditions of visibility and all known tidal conditions, they are clearly readable by an observer (with naked eye), stationed 3m above sea level, and at a distance of at least 150 m from the turbine. The light will be either hooded or baffled so as to avoid unnecessary light pollution or confusion with navigation marks.

4.4 Proposed Markings

The markings for the proposed EOWDC will be agreed in consultation with NLB. As per IALA guidelines it is likely that once fully developed:

- All corner towers will be marked as Significant Peripheral Structures (SPSs) and where necessary, depending on spacing, intermediate towers on each of the north, east and south facing boundaries will be marked as Intermediate Peripheral Structures (IPSs).

- In all the layouts, towers designated as SPSs are to exhibit Flashing Yellow 5 second (Fl Y 5s) lights of 5nm nominal range and omnidirectional fog signals with a character of 1 blast of 2 seconds duration every 30 seconds and an IALA usual range of 2nm. Towers designated as IPSs are to exhibit Fl Y 2.5s lights of 2nm nominal range.

- All the lights are to be visible to shipping through 360 degrees and if more than 1 lantern is required on a tower to meet the all round visibility requirement, then all the lanterns on that tower should be synchronised.

- All the lights are to be exhibited at the same height at least 12m above Highest Astronomical Tide (HAT) and below the arc of the lowest turbine blades.

- All the lights are to be exhibited at least at night and when the visibility is reduced to 2nm or less. Fog signals are to be sounded at least when the visibility is 2nm or less.

- All the structures in the boundary of the turbine towers are to be coloured yellow from at least HAT to the height of the lights (the equivalent height on the unlighted structures).

- Any lighting required for aeronautical purposes is to be shielded / arranged such that it is not visible to shipping. If this cannot be achieved, then the requirement will be considered as having been met if the aviation light is reduced to 10% of its peak intensity when the visibility is more than 5km.

Over the period of the site being developed the above may vary but all markings will be agreed with NLB in advance.

4.5 Superintendence and Management

Aberdeen Offshore Wind Farm Limited (AOWFL) will ensure that they have a reliable maintenance and casualty response regime in place such that the required availability targets are met.

5. CONSULTATION

5.1 Introduction

Extensive consultation on navigational issues has been carried out with stakeholders during the evolution of the proposed development. This section briefly summarises the key consultations.

5.2 Aberdeen Harbour

Several meetings have been held with Aberdeen Harbour, including the Harbour Master, over the past five years.

This has led to the changes in the site layout as identified in Section 3.3. Aberdeen Harbour officials also participated in the Hazard Review Workshop discussed below.

5.3 Marine Stakeholders Meetings

A number of consultation meetings have been held with maritime stakeholders during the course of the project, including presentations to the Marine Safety Forum.

More recently, a marine stakeholders meeting was held in Aberdeen on 18th March 2010. The meeting was attended by representatives of various marine stakeholders including Aberdeen Harbour, Craig Group, Gulf Offshore, Trico and Shell Marine.

Within this meeting, the main navigational concerns (associated with the previous layout) were highlighted as loss of anchorage, increased congestion and potential impact on navigational aids.

Further meetings were held on the 26th March and 12th April 2010 involving members of the project team, and aviation and marine stakeholders. From these meetings two optimal layouts were derived (Layouts 038 and 039).

Following this, a consultation document was circulated by the Marine Safety Forum on 10th May with both proposed layouts presented to gather their input (Ref. v). The response to this is quoted below as received on 17th May 2010.

> *"Following feedback we are able to give you our (MSF Steering Group) acceptance of either layout 38 or 39 as the footprint layout for the test facility. Please note we will be attending the risk assessment with a positive attitude to the windfarm on this basis. Should the layout revert to the previous more southerly positions we would then be forced to withdraw our agreement."*

Details on the workshop are provided in Section 12.

NorthLink Ferries operate passenger ferry services between Aberdeen and the Northern Isles (Kirkwall in Orkney and Lerwick in Shetland).

An initial meeting between AREG and NorthLink Ferries was held in Aberdeen on 15 January 2009. The purpose of the meeting was to discuss maritime safety issues associated with the proposed EOWDC.

NorthLink advised that they had two main safety concerns (based on the earlier 23 turbine layout (date)):

- Radar interference
- A navigational hazard, due to the pinching effect of loss of approach width. This would be particularly serious when traveling south with a northerly wind behind.

It was pointed out that radar interference was now a well understood issue which had been dealt with at many sites. On navigation it was agreed that routing issues would be discussed at a follow-up meeting during the risk assessment work.

Two further meetings were held onboard the NorthLink ferries *Hjaltland* and *Hrossey* in Aberdeen on 1 and 2 June 2010 following revision of the turbine layout. The Ferry Masters indicated the new layout was a vast improvement by moving to the north, away from the harbour entrance and anchorage area. The ferries normal passage plan keeps to the east of the current turbine layout, although it can vary in different wind conditions. If necessary the passage plan could be adjusted a few miles to the east without a major problem.

Radar interference was not considered to be a major issue based on past experience at other sites.

5.4 Scottish Fishermen's Federation (SFF)

Meetings have been held in Aberdeen with SFF to discuss the potential impact of the proposed EOWDC site on fishing vessels. No significant navigational issues were identified.

Further consultation on fisheries has been carried out as part of the Commercial Fisheries study (Chapter 7.7).

5.5 Hazard Review Workshop – Aberdeen

A hazard review workshop was held in Aberdeen on the 25 August 2010, hosted by Aberdeen Harbour. The purpose of the workshop was to identify and review the potential navigational hazards associated with the proposed development of the EOWDC.

More details on the workshop are provided in Section 12.

5.6 Other Consultation

Various consultation exercises have been carried out by the project over a number of years including several public events which allowed all stakeholders to contribute opinions on the proposals. This and other feedback was used in developing the current layout.

6. BASELINE ENVIRONMENT

6.1 Introduction

This section presents the following baseline information relating to navigation in the Aberdeen area:

- Ports
- Navigational Aids
- Sailing Directions
- Oil & Gas Infrastructure
- Military Exercise Areas
- Metocean data

6.2 Aberdeen Harbour

Aberdeen Harbour is the principal commercial port serving the northeast of Scotland with approximately 16,000 ship movements in 2009 handling approximately 4.5 million tonnes of imports and exports. The Port is the main marine support centre for the North Sea oil and gas industry. In addition to the oil and gas support services there are regular shipping services to Orkney, Shetland and Scandinavia via Ro-Ro services for passengers and cargo, with 142,468 passengers passing through the port in 2009 (Ref vi).

The Port also has a large modern fish market and although there are no commercial fisheries within the area of jurisdiction of Aberdeen Harbour or proximity, deep-sea fishing vessels and a number of locally registered potters land their catches at the Aberdeen fish market located at Palmerston Quay.

The nearest proposed turbine within the EOWDC site would be located over 2 nautical miles (nm) from the northern limits of Aberdeen Harbour.

A chart of the Aberdeen Harbour limit and main features is presented in Figure 6.1. There is a designated anchorage area just to the north of the Aberdeen Port boundary, which was established in the first half of 2010.

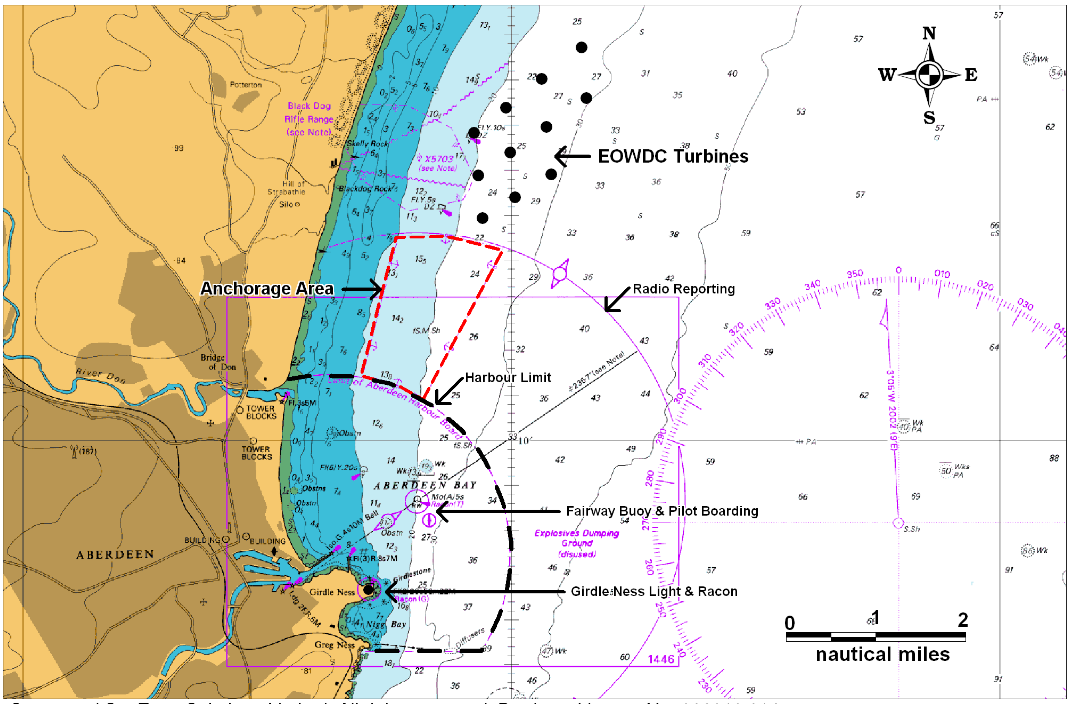


Figure 6.1 Overview of Aberdeen Harbour Limit

6.3 Port Facilities/Services

Aberdeen Harbour is a modern port with a state-of-the-art Marine Operations Centre.

Figure 6.2 Marine Operations Centre at Aberdeen Harbour Entrance

Facilities and services that assist in the safe navigation of shipping within the harbour include:

- Controlling depths & maximum vessel size
- Radar based vessel traffic services
- Pilotage
- Anchorage
- Navigational aids

More details are provided below.

6.3.1 Controlling Depths & Maximum Vessel Size

The maximum dimensions and size for vessels entering Aberdeen are quoted as:

- Length: 165m
- Beam: 26m
- Draught: 8.5m
- Largest Vessel (Tonnage): 18,500 GT

However, it is noted that there are a number of deep-water berths available within the harbour which are restricted by water depth based on mean low water springs (MLWS) and mean high water springs (MHWS) levels. The deep-water berths are given below:

- Atlantic Wharf is 137 m long with depth of 9.3m at MLWS and 13.0m at MHWS.
- Pacific Wharf is 205m long with 9.9m of water at MLWS and 13.6m at MHWS.
- Waterloo Quay West is 172m long with 9.9m of water at MLWS and 13.6m at MHWS.
- Regent Quay East is 255m long with 9.9m of water MLWS and 13.6m at MHWS.
- Telford Dock has 520m of berthing with 9.6m of water at MLWS and 13.3m at MHWS.
- Matthews Quay is 236 m long with 9.6m of water at MLWS and 13.3m at MHWS.

Berthing is also available in six areas within the harbour; the details of each are given in Table 6.1.

Table 6.1 Details of Berthing Locations in Aberdeen Harbour

Location	Area (ha)	Length of Quays (m)	Max depth of berths MLWS / MHWS (m)
Tidal Harbour	14.5	1,574	9.6/13.3
Albert Basin	8.5	1,525	8.4/13.6
River Dee (navigable area)	4.1	928	8.4/10.8

Location	Area (ha)	Length of Quays (m)	Max depth of berths MLWS / MHWS (m)
Dock	1.5	410	9.6/13.3
Upper Dock	2.0	429	6.6/10.3
Victoria Dock	8.5	1,500	9.9/13.6

6.3.2 Vessel Traffic Service (VTS)

All shipping movements in Aberdeen Harbour are controlled and monitored from the state-of-the-art Navigation Control Centre situated at the inner end of the North Pier.

The Centre operates continuously for 24 Hrs and is fitted with radar and VHF Radio (Channels 12 and 16). Masters and boat crews have to obtain permission from the Harbour Master before launching a vessel into the harbour waters, by contacting VTS on VHF Channel 12.

There are reporting procedures as well as reporting points for vessels as listed below:

Vessels Inward Bound:

(1) All vessels (except fishing and recreational craft) should send Aberdeen VTS 24hr prior to arrival (or give as much advance notice as possible) stating:

- Vessels name
- IMO number
- Length overall (LOA)
- Maximum draught
- Last port/location
- ETA
- Pilotage requirements
- Gross tonnage (GT)
- List of defects
- Cargo
- Agent

(2) All vessels (including fishing and recreational craft) must call Aberdeen VTS when 1hr from the Fairway light buoy, and confirm ETA and draught.

(3) All vessels (including fishing and recreational craft) must call Aberdeen VTS when 3nm from the Fairway light buoy to obtain permission to enter the Aberdeen VTS area. Fishing vessels and recreational craft should provide the information listed at (1) if required to do so.

(4) All vessels must maintain a continuous listening watch on VHF channel 12 when navigating within the Aberdeen VTS area.

(5) All vessels must report to Aberdeen VTS when in close vicinity to the Fairway light buoy in order to obtain authorization to enter the navigation channel.

(6) *Vessels within the area:*
(a) All vessels must maintain a continuous listening watch on channel 12.
(b) All vessels must report on anchoring or berthing
(c) All vessels must obtain authorisation from Aberdeen VTS before getting underway from anchor or leaving a berth.
(d) All vessels must report on leaving anchorage or berth

(7) Vessels Outward-Bound and Shifting Berth:
(a) All vessels must send ETD to Aberdeen VTS when known, message should also include:
(i) Draught
(ii) Where bound (next Port/Location/Berth)
(iii) All vessels must obtain authorisation from Aberdeen VTS prior to leaving berth.

All vessels must report to Aberdeen VTS when passing the reporting points I and B. All vessels, when required by VTS to do so, must report when passing Reporting Points A, C and D.

Table 6.2 VTS Reporting Points for Aberdeen Harbour (Note [1])

Reporting Point	Position	Remarks
I	3 nm from Fairway light buoy	Inward and Outward-Bound
B	Close vicinity to Fairway Lt buoy	Inward and Outward-Bound
A	57° 08.52’ N, 002° 04.77’ W	Entrance to Albert Basin
C	57° 08.63’N, 002° 04.85’ W	Entrance to Victoria Dock (the Cut)
D	57° 08.42’ N 02° 04.52’ W	Entrance to Dee River

Note [1]: Vessels (in particular Offshore Support and Fishing Vessels) may be required to hold at these points.

For entry into the port, there are light signals that have the following meanings:

- A **GREEN** light - No entry into the Navigation Channel for vessels proceeding towards the Harbour.
- A **RED** light - No entry into the Navigation Channel for vessels proceeding to sea.
- A **GREEN** and **RED** light - No entry into the Navigation Channel for any vessel.

The traffic regulations as laid out in Ref. vii state:

The master of a vessel waiting within the limits of the port and harbour to enter the harbour shall so manoeuvre such vessel as to be at all times clear of the ordinary course of ships entering or leaving the harbour.

The master or owner of a vessel which is to enter the harbour shall, on the arrival of such vessel in Aberdeen Bay and before it approaches the harbour entrance, notify the harbour master of the intended entry of the vessel, giving the name of the vessel, the name of the master, the port or place from which the vessel has arrived and the draught of water of the vessel.

The master of a vessel shall not cause or permit such vessel to enter the navigation channel abreast of any other vessel or to overtake any other vessel in said channel, and every master shall keep his vessel at a distance of not less than 70m behind any other vessel proceeding in the same direction ahead of his vessel in the said channel except when towing or being towed.

The master of a vessel shall not cause or permit such vessel to proceed in any part of the harbour at a speed in excess of 5 knots over the ground.

6.3.3 Pilotage & Tugs

All vessel movements within Aberdeen Harbour are well managed by Port Control with set pilotage procedures. Aberdeen has compulsory pilotage for vessels of 60 m and over in length. However, for vessels with an operational bow thruster this limit is increased to 75 m.

The majority of vessels entering Aberdeen Harbour have bow and stern thrusters and are highly manoeuvrable. When pilotage is required the Pilot will normally board vessels in the vicinity of the Fairway Buoy. There are two pilot vessels in operation at Aberdeen, the *Sea Haven* and *Sea Shepherd*, which are show in Figure 6.3 and Figure 6.4.

Figure 6.3 Pilot Vessel *Sea Haven*

Figure 6.4 Pilot Vessel *Sea Shepherd*

It is noted that two tugs are available within Aberdeen Harbour for towing vessels into and out of the port.

6.3.4 Anchorage

Aberdeen Bay is free of danger and has a regular sandy bottom, therefore can be used as a long term temporary anchorage.

A designated anchorage area to the north of Aberdeen Bay was established in 2010.

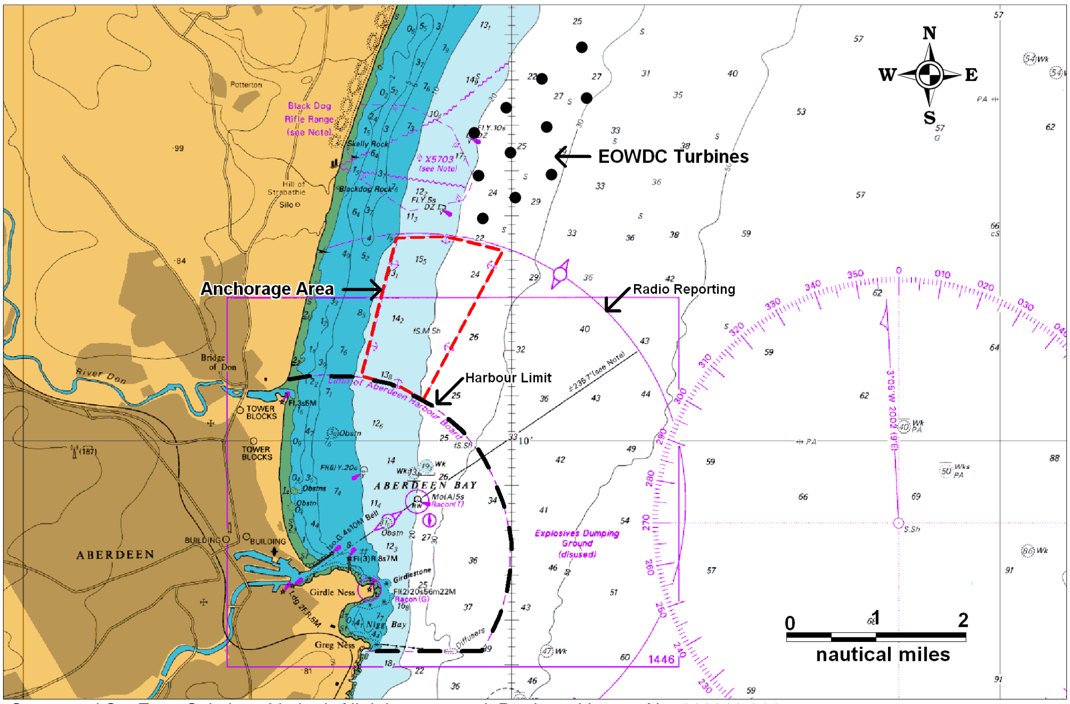


Figure 6.5 Official Anchorage Area to the North of Aberdeen Bay

A detailed analysis of anchoring within Aberdeen Bay is presented in Section 8.6.

6.4 Navigational Aids

A plot of the principal navigational aids within 15nm of Aberdeen Bay is presented in Figure 6.6, with a detailed plot of Aberdeen Bay presented in Figure 6.7.

The principal landmarks are those listed in Admiralty Sailing Directions for the area (Ref. vii). The buoy positions are taken from Admiralty Charts of the area.

The Fairway Buoy (Racon) is the main navigational aid approximately 1 mile from Aberdeen Harbour's South Breakwater.

Other buoys in the vicinity of the Aberdeen Bay are generally located along the coastline. The closest buoys are approximately 4nm and 5nm, respectively, to the north of Aberdeen Bay, marking the limits of a military practice firing range at Blackdog. Other main aids to navigation are located at Stonehaven Harbour approximately 14nm south and at The Skares off Cruden Bay approximately 15nm north.

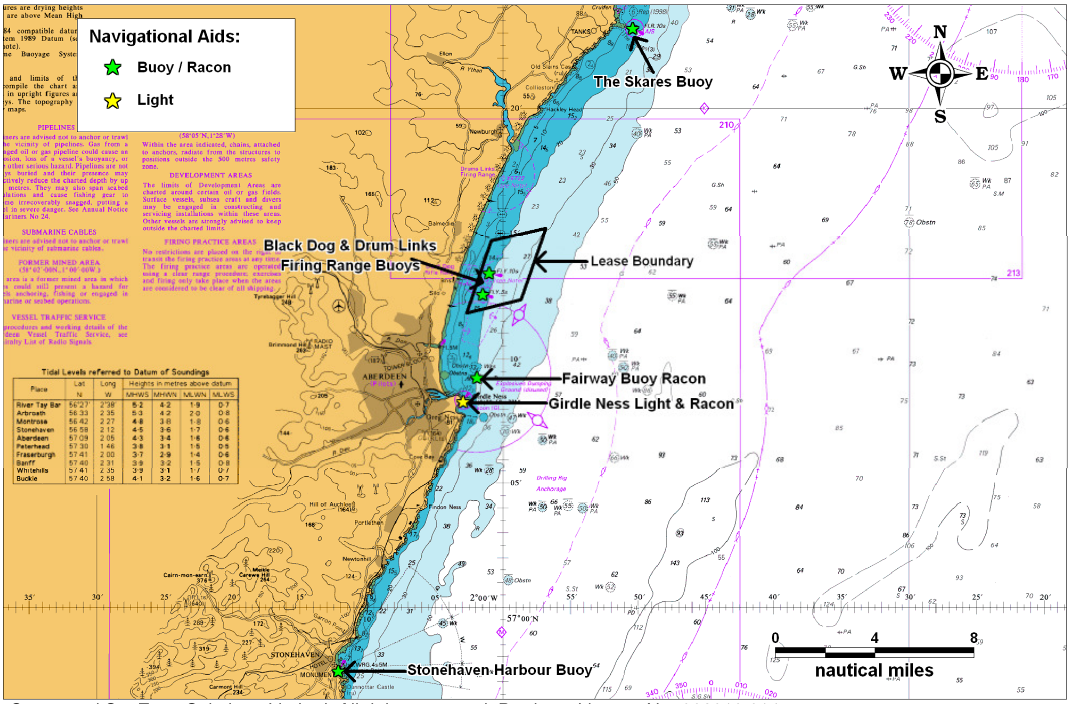
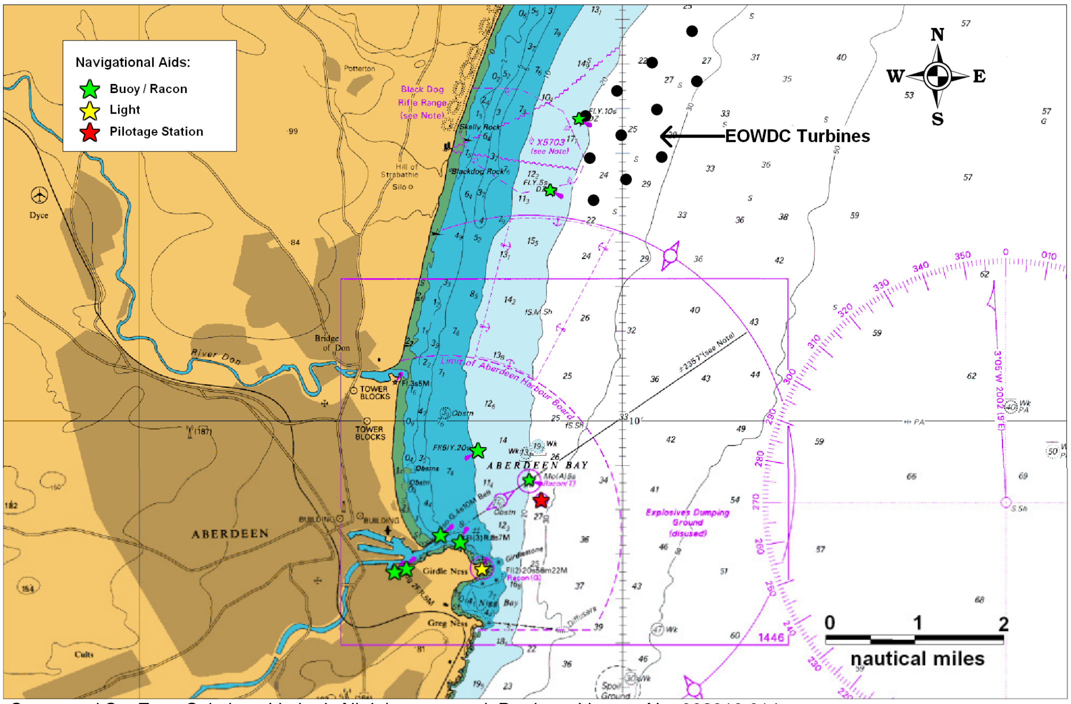


Figure 6.6 Navigational Aids along the North East Coast relative to Aberdeen



NOT TO BE USED FOR NAVIGATION

Figure 6.7 Navigational Aids in the vicinity of Aberdeen Bay

6.5 Sailing Directions

Sailing directions for the area are presented in the North Sea (West) Pilot (Ref. vii). A plot of the routes for vessels bound from Rattray Head to Isle of May is presented in Figure 6.8.

The arrows are not accurate if superimposed on a chart but they illustrate the general passages used by ships. A description of the two routes passing the site is given below.

- (3.43) From a position E of Buchan Ness (57° 28' N, 1° 46' W) the route leads SSW for a distance of 22 miles to the Fairway Light-buoy 1 mile NE of the entrance to Aberdeen Harbour.
- (3.86) From a position E of Girdle Ness (57° 08' N, 2° 03' W) the coastal route leads SSW to a position E of Stonehaven.

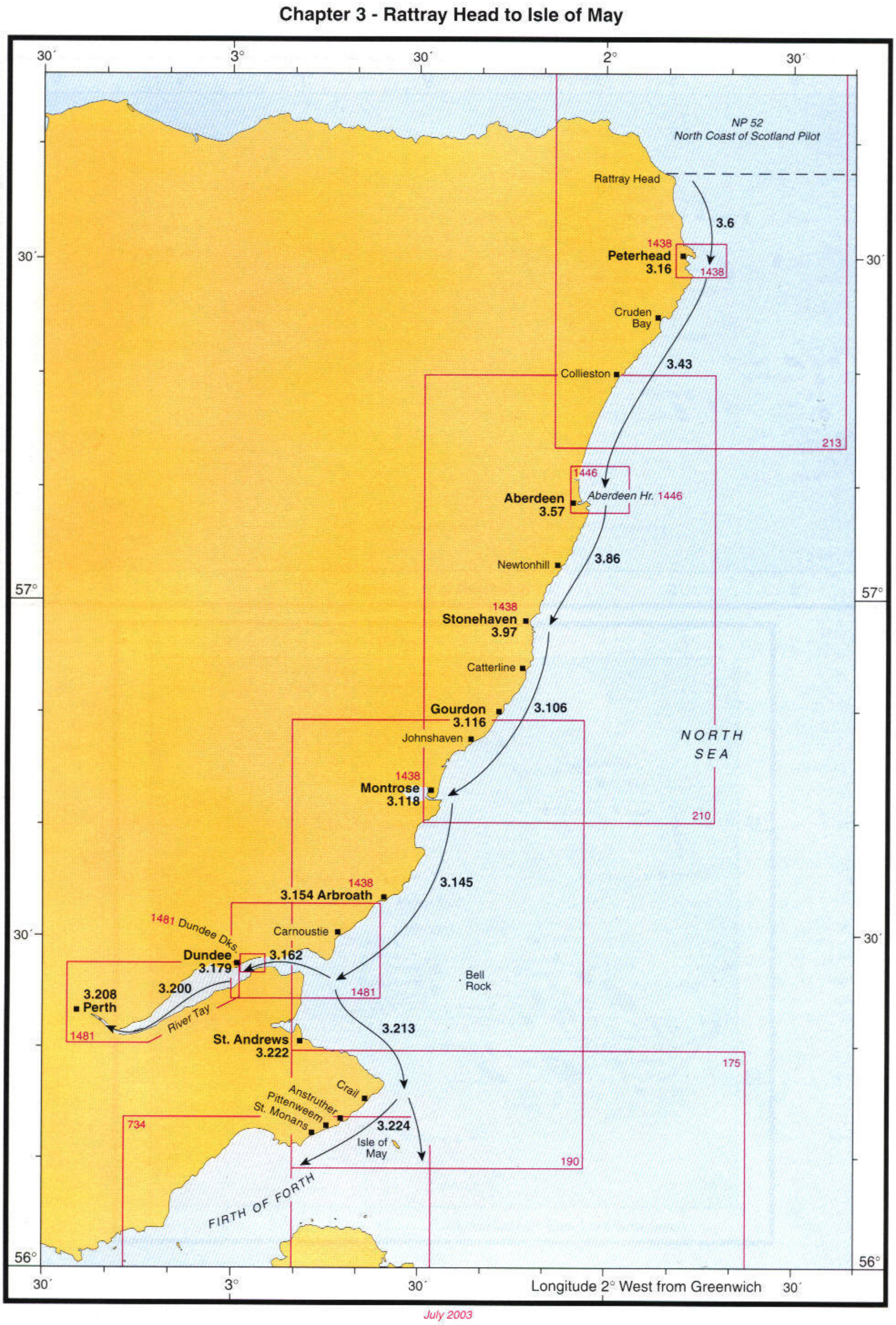


Figure 6.8 Routes from Rattray Head to Isle of May (Ref. vii)

6.6 Wrecks

An assessment of the offshore archaeology has been carried out as part of this ES to identify wrecks and archaeological sites of interest in the area. This identified a single wreck with a height of 0.7m within the area. Further details can be found in the Offshore Assessment Archaeology Section of the ES.

6.7 Oil & Gas Infrastructure

The licence blocks in the area of the proposed EOWDC are presented in Figure 6.9.

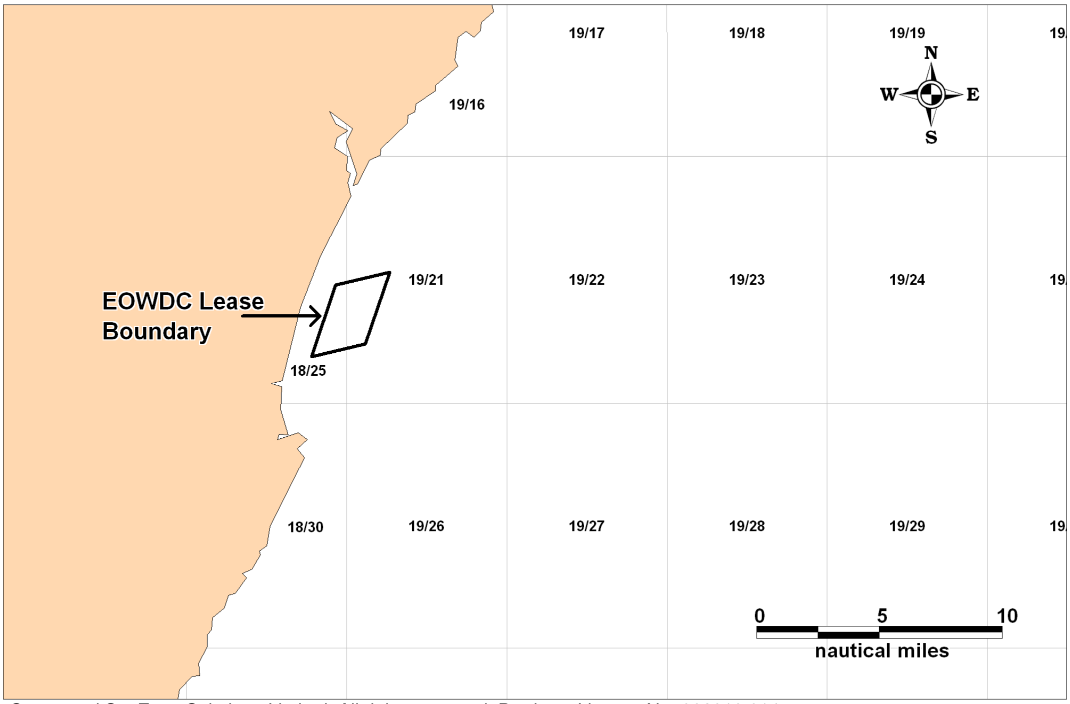


Figure 6.9 Oil & Gas UKCS Blocks, Installations and Licence Areas near Aberdeen

The proposed site is mostly within UKCS Block 19/21 which was on offer as part of the 26th round of UKCS licensing. This block has never previously been licensed and at the moment there is no operator for this block. Block 18/25 which contains part of the EOWDC site was not available due to the MOD military practice area at Blackdog and Drums Links.

The nearest existing offshore surface installation is at the Buzzard Field which is approximately 47nm to the northeast of the site which is remote from the site, beyond the extents of the Figure 6.9.

6.8 Exercise Areas

There is a rifle firing range at Blackdog which borders the western edge of the proposed EOWDC site, and is marked with Danger Zone (DZ) Buoys, as shown in Figure 6.10.

No restrictions are placed on the right to transit the Blackdog firing practice area at any time and they operate a clear range procedure with exercises only taking place when the areas are clear of shipping. Red flags or red lights are displayed to indicate that the area is in use.

The Drums Links military firing range is located approximately 1.7nm to the north of the proposed EOWDC site; this area uses the same procedures as Blackdog, whereby firing will only take place when the area is clear of shipping, as firing takes place seaward. There is also the central Managed Danger Area (MDA), which is a military practice zone for high altitude RAF training exercises and is located approximately 6.7nm to the east of the proposed EOWDC site.

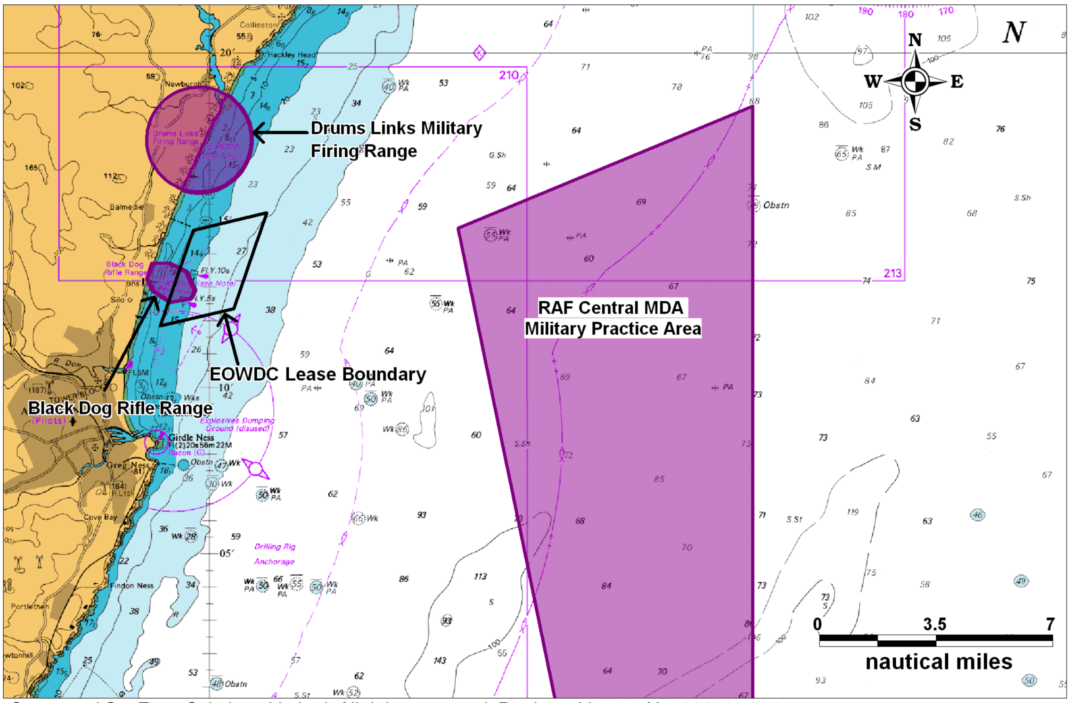


Figure 6.10 Military Practice Areas relative to Site

6.9 Metocean Data

6.9.1 Introduction

This section presents Metocean statistics for the area of the proposed EOWDC site which have been used as input to the risk assessment.

According to the Admiralty Sailing Directions (Ref. vii), the west North Sea region enjoys a generally mild climate.

Rainfall is not considerable, and there is little variation throughout the year. It is frequently cloudy throughout the year; however, the winter months are more susceptible to overcast skies.

Fog (or haar) occasionally affects the east cost of the UK, particularly in the north.

6.9.2 Wind

The wind data presented here has been taken from recordings made at Dyce, Aberdeen (Ref.vii).

The wind direction distribution is presented in Figure 6.11 based on 20 to 30 years observations between 1960 and 2002. It can be seen that the predominant wind direction is from the south.

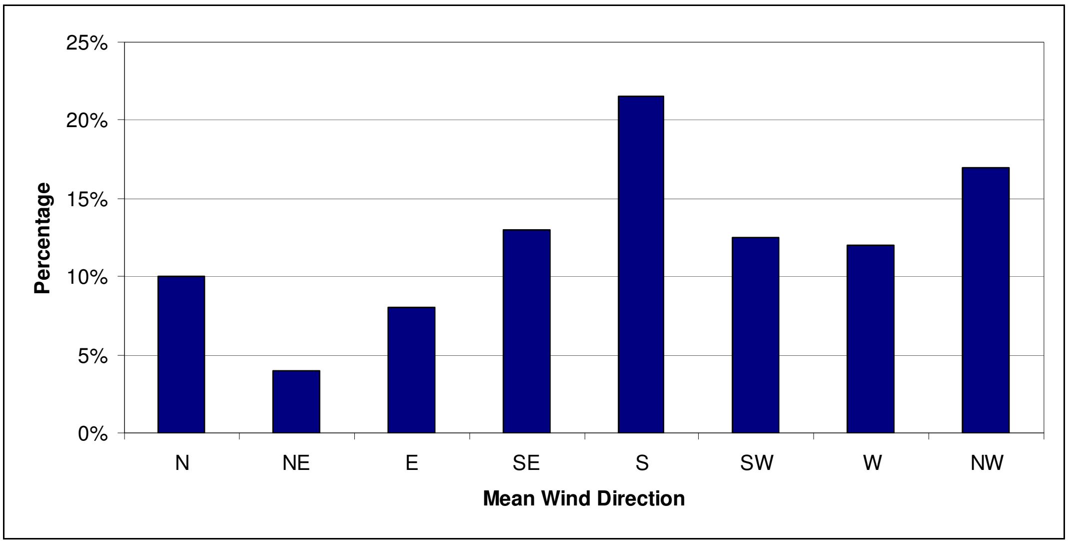


Figure 6.11 Average Annual Wind Direction Distribution

Gales are more common in the winter months, although they still may occur during the summer with the average wind speed recorded over a twenty year period between 10 and 11 knots (height above mean sea level of 65m).

6.9.3 Visibility

Historically, visibility has been shown to have a major influence on the risk of ship collision.

Visibility data was obtained from Dyce, Aberdeen. The number of days with fog per month over 20 years of data is presented in Figure 6.12.

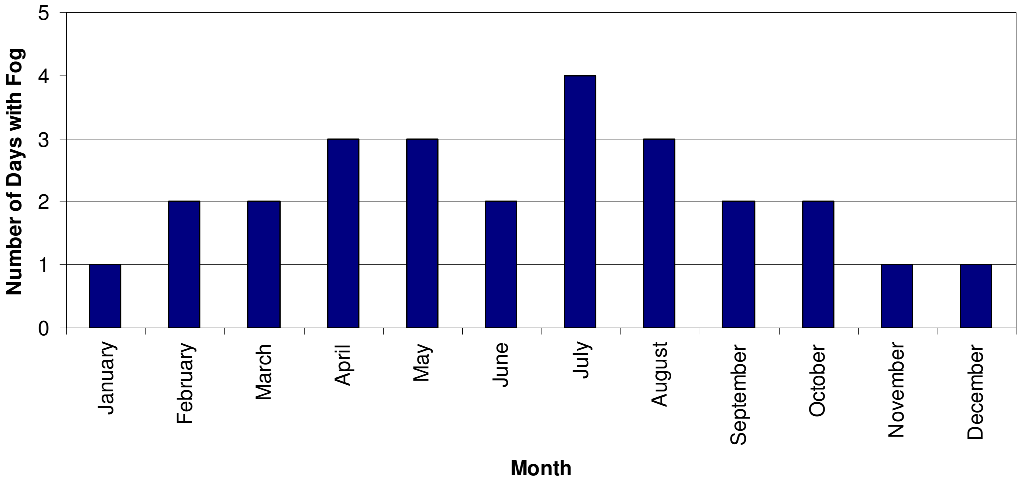


Figure 6.12 Monthly Distribution of Days with Fog (1983-2002)

It can be seen from the above figure that fog is more common between April and August and occurs less frequently from November to January.

6.9.4 Tide

A description of the tidal streams in the general area is provided below (Ref. vii):

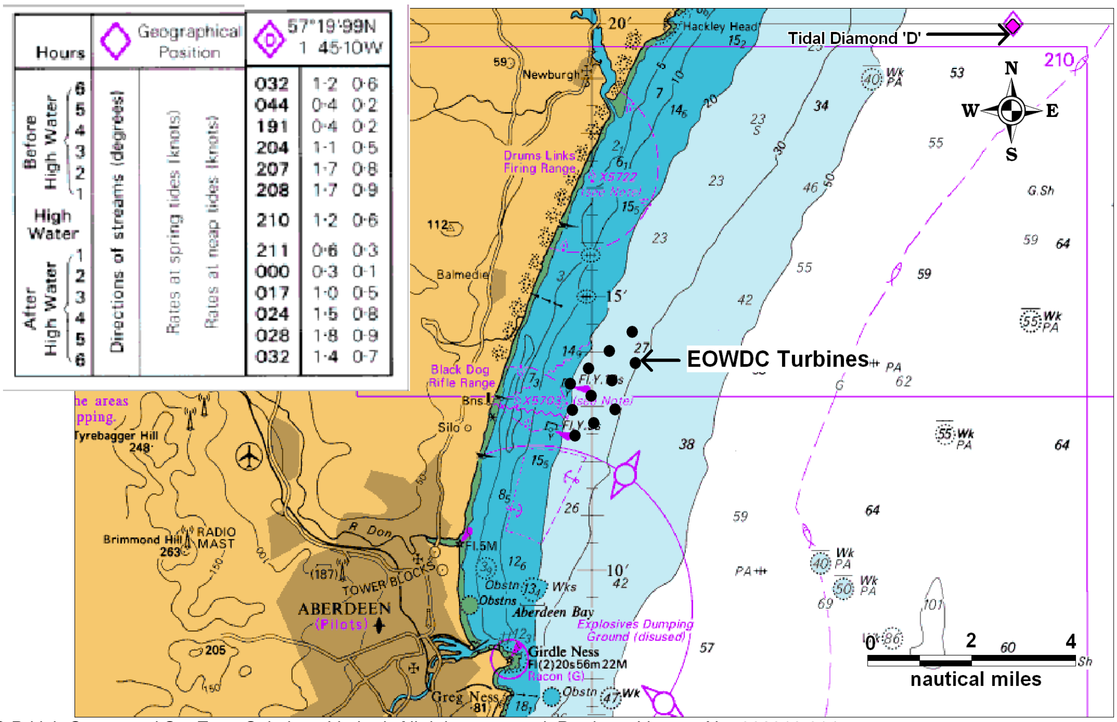
> *The offshore stream runs generally north and south from Rattray Head to Bells Rock and tidal streams in the North Sea generally run N/S parallel to the east coast of the UK.*
>
> *However, as the entrance to Aberdeen is approached the streams heading south become more easterly and the streams running north become more westerly and the tidal stream runs SE/NW across the approach to Aberdeen.*

Tidal levels for Aberdeen above Chart Datum (CD) are presented below.

Table 6.3 Tidal Levels above Chart Datum at Aberdeen

Tidal Level	Height above Chart Datum
Highest Astronomical Tide (HAT)	4.9m
Mean High Water Springs (MHWS)	4.3m
Mean High Water Neaps (MHWN)	3.4m
Mean Sea Level (MSL) (approx.)	2.6m
Mean Low Water Neaps (MLWN)	1.7m
Mean Low Water Springs (MLWS)	0.6m
Lowest Astronomical Tide (LAT)	0.1m

Admiralty Chart 213 (Tidal Diamond "D" approximately 10nm NE of the EOWDC site - Ref. viii) indicates that currents in the area set in a generally SSW direction on the flood and NNE direction on the ebb, with a peak spring tidal rate of 1.8 knots and peak neap rate of 0.9 knots. This has been considered within the drifting scenario modelling for this development (Section 13).



Hours		Directions of streams (degrees)	Rates at spring tides (knots)	Rates at neap tides (knots)
Geographical Position	D	57°19·99N 1 45·10W		
Before High Water	6	032	1·2	0·6
	5	044	0·4	0·2
	4	191	0·4	0·2
	3	204	1·1	0·5
	2	207	1·7	0·8
	1	208	1·7	0·9
High Water		210	1·2	0·6
After High Water	1	211	0·6	0·3
	2	000	0·3	0·1
	3	017	1·0	0·5
	4	024	1·5	0·8
	5	028	1·8	0·9
	6	032	1·4	0·7

Figure 6.13 Tidal Stream Data for Aberdeen Bay (Tide Point "D")

7. MARITIME INCIDENTS

7.1 Introduction

This section reviews maritime incidents that have occurred in the vicinity of the proposed EOWDC site in recent years.

The analysis is intended to provide a general indication as to whether the area of the proposed development is currently low or high risk in terms of maritime incidents. If it was found to be a particularly high risk area for incidents, this may indicate that the development could exacerbate the existing maritime safety risks in the area.

Data from the following sources has been analysed:

- Marine Accident Investigation Branch (MAIB)
- Royal National Lifeboat Institution (RNLI)

(It is noted that the same incident may be recorded by both sources.)

7.2 Marine Accident Investigation Branch (MAIB)

All UK-flagged commercial vessels are required to report accidents to MAIB. Non-UK flagged vessels do not have to report unless they are within a UK port/harbour or within UK 12 nm territorial waters and carrying passengers to or from a UK port (including those in inland waterways). However, the MAIB will record details of significant accidents of which they are notified by bodies such as the Coastguard, or by monitoring news and other information sources for relevant accidents. The MCA, harbour authorities and inland waterway authorities also have a duty to report accidents to MAIB.

The locations[1] of accidents, injuries and hazardous incidents reported to MAIB within 10nm of the proposed EOWDC turbines between January 1994 and March 2010 are presented in Figure 7.1, colour-coded by type. (It is noted that several incidents may have taken place in coastal areas around Aberdeen Bay and therefore a symbol may represent more than one incident.)

[1] MAIB aim for 97% accuracy in reporting the locations of incidents.

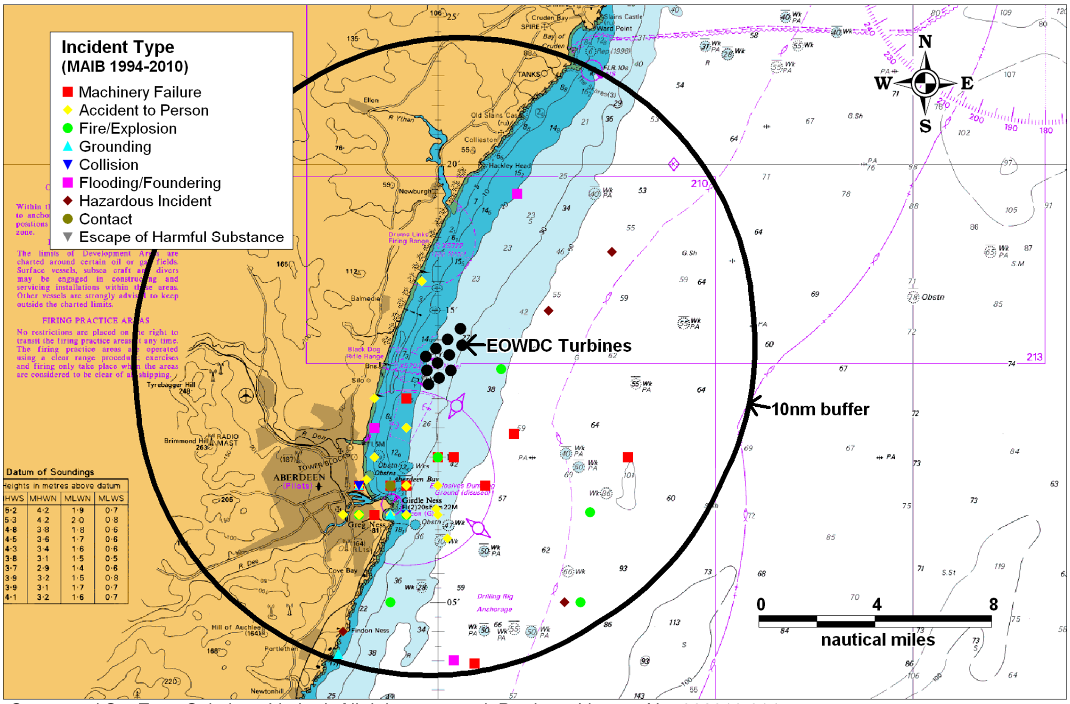


Figure 7.1 MAIB Incident Locations by Type within 10nm of EOWDC Turbines

A total of 162 incidents were reported in the area, corresponding to an average of 9-10 per year. The majority of the incidents occurred in and around Aberdeen Harbour. The distribution by incident type and year is presented in Figure 7.2 and Figure 7.3, respectively.

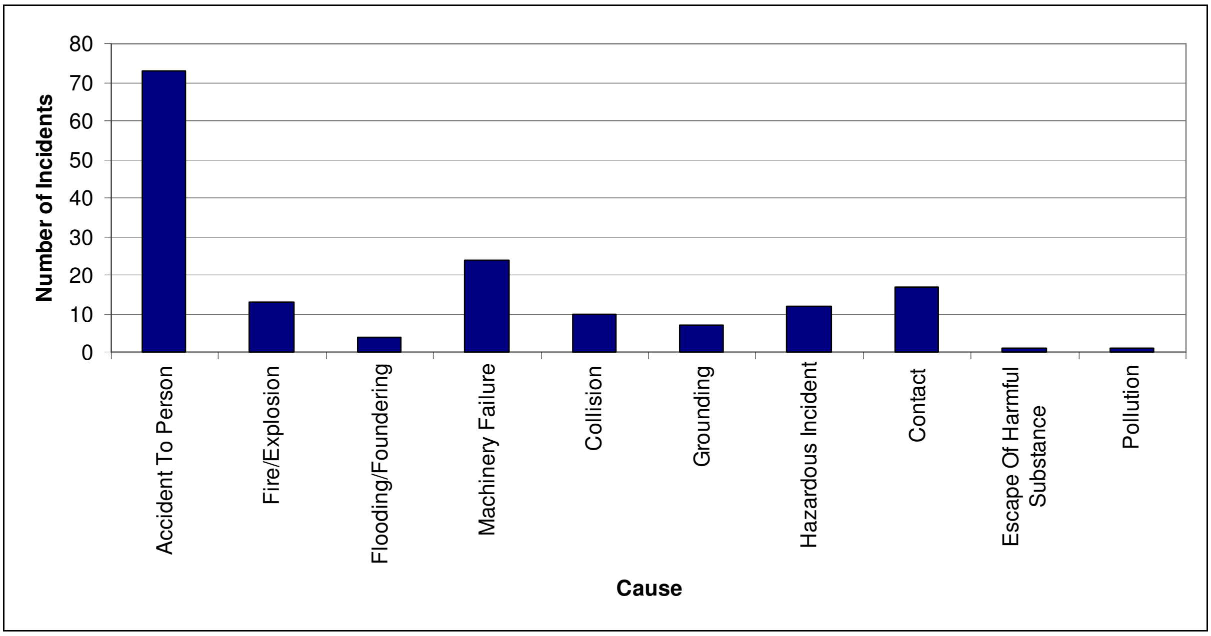


Figure 7.2 MAIB Incidents by Type within 10nm of EOWDC turbines (1994-2010)

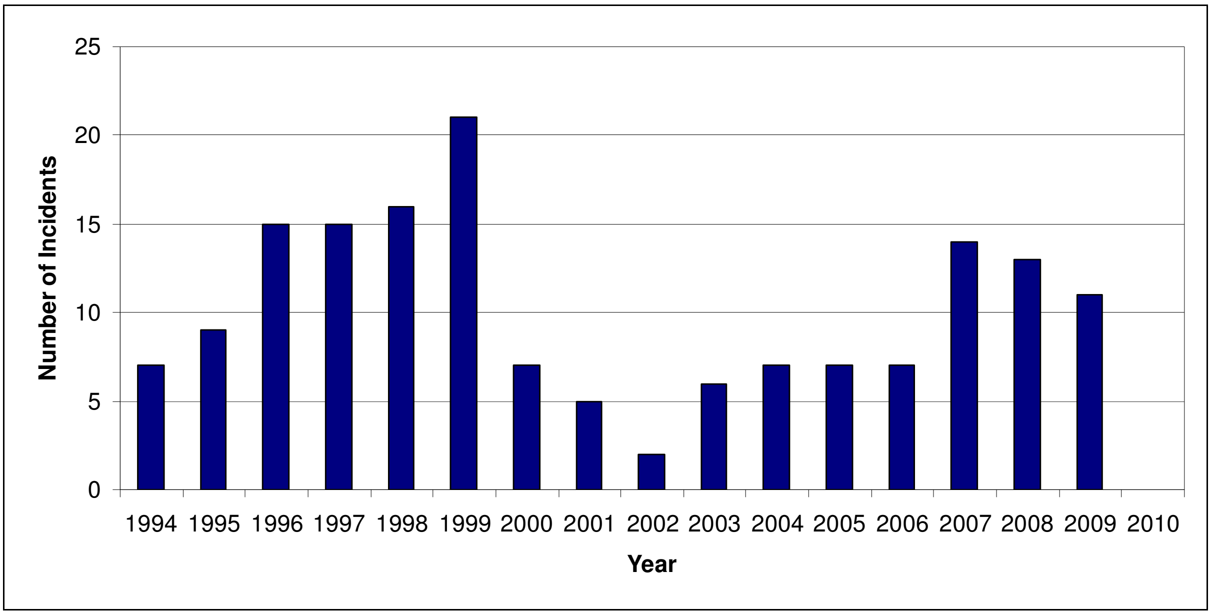


Figure 7.3 MAIB Incidents by Year within 10nm of EOWDC Turbines (1994-March 2010)

The most common incident type recorded within 10nm of the site boundary was accident to person. 1999 was the year with the most recorded incidents with 21 incidents reported during this year. It is noted that 2010 data was obtained up to March and there were no incidents recorded during this period.

There were no incidents reported within the EOWDC turbine locations. The closest incident to the proposed turbines was a machinery failure approximately 0.9nm to the southwest of the most southern turbine on 17 February 2007. The incident involved a non-commercial pleasure craft which broke down and had no working radio. After a considerable search the vessel was located and towed to port with no major damage reported.

Five collisions were recorded within 10 nm of the proposed EOWDC turbines, all within the harbour. Details are as follows:

1. On 31 May 1996 two offshore supply boats collided. Both vessels suffered material damage but no injuries or casualties were reported. One of the vessels was manoeuvring in Aberdeen Harbour and contacted the other vessel which was secured at berth.
2. On 2 November 1998 two anchor handling tug supply boats collided when a manoeuvring vessel collided with a berthed vessel due to a fault in pitch overload. The earth fault was subsequently found and eliminated meaning only material damage was caused to both vessels.
3. On 28 February 1999 an offshore support vessel suffered minor damage after colliding with scaffolding hung off a berthed vessel. This happened while manoeuvring alongside due to a navigational misjudgement.

4. On 30 June 1999 a commercial vessel collided with another berthed vessel after failing to respond to the controls quickly enough when approaching the berth. The system was operating correctly but with a new master and pilot the orders were not given in time. This caused material damage to the colliding vessel.
5. On 10 November 2000 a pilot boat collided with a commercial vessel due to a delay in engine control. The mechanical fault was investigated and rectified and no damage was reported.

None of the reported collisions reported any injuries or fatalities. There were no reported MAIB collision incidents from November 2000 onwards.

7.3 Royal National Lifeboat Institution (RNLI)

Data on RNLI lifeboat responses within 10nm of the EOWDC turbines in the ten-year period between 2000 and 2009 have been analysed. A total of 173 launches were recorded by the RNLI (excluding hoaxes and false alarms).

Figure 7.4 presents the geographical location of incidents colour-coded by casualty type. It can be seen that the vast majority occurred near the coast, with relatively few further out to sea. The area of interest includes various stretches of beach.

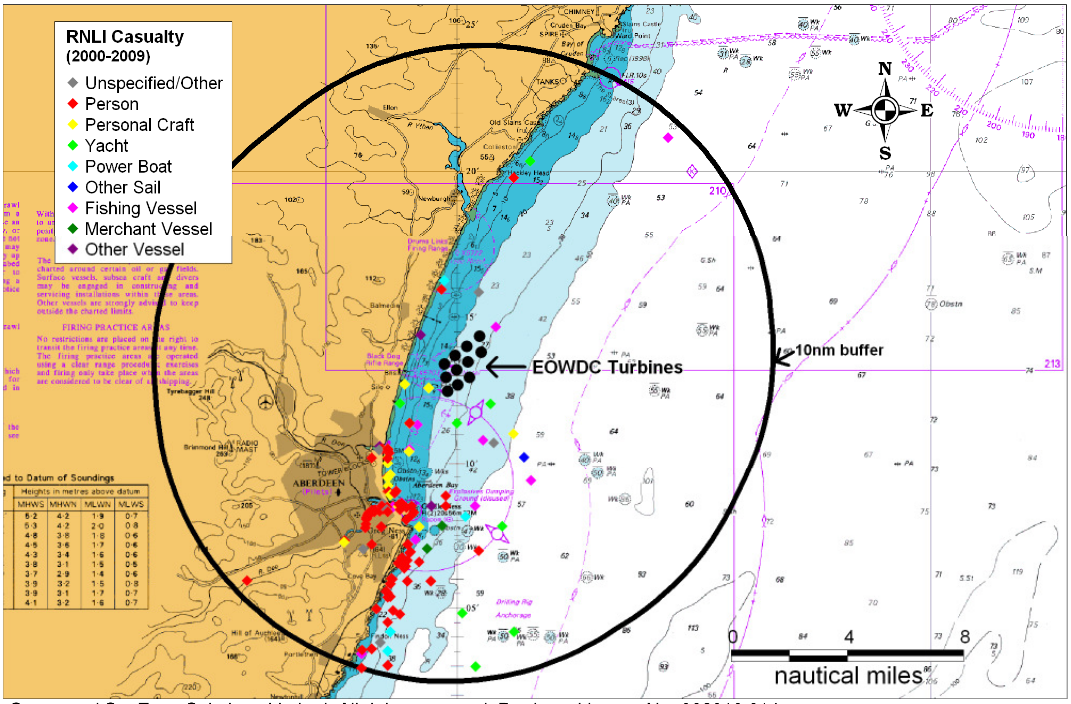


Figure 7.4 RNLI Incidents by Casualty Type within 10nm of EOWDC Turbines

The overall distribution by casualty type is summarised in Figure 7.5. People were the most common casualty type involved, responsible for 60% of RNLI launches.

Personal craft accounted for 12% of all incidents and fishing vessels accounted for 10% with various other vessel types making up the remainder of incidents.

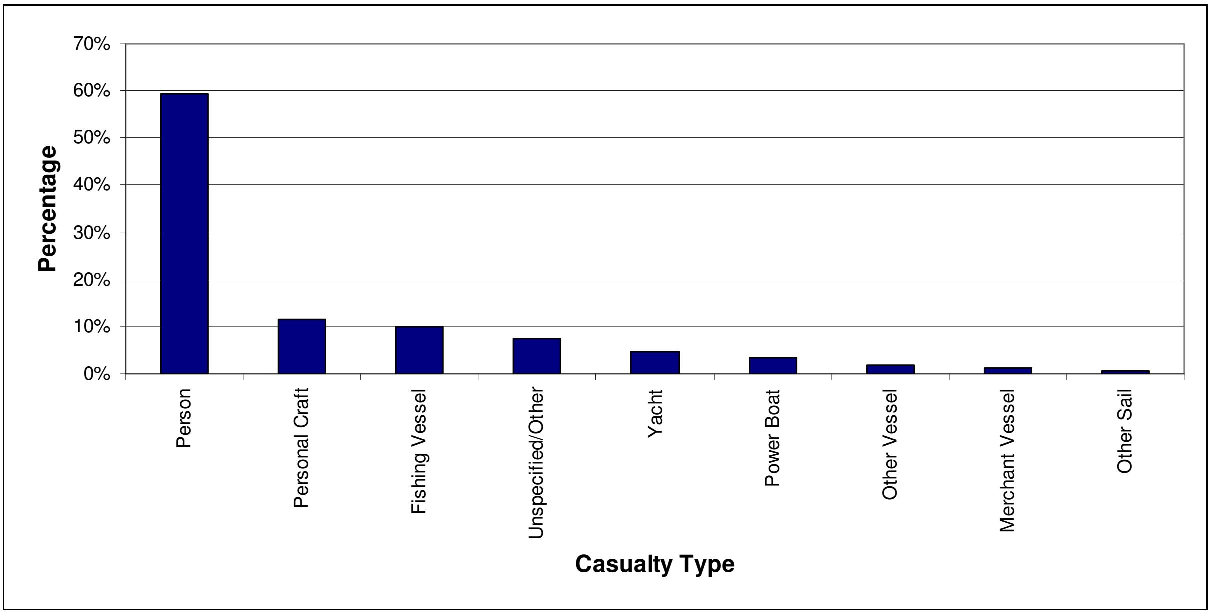


Figure 7.5 RNLI Incidents by Casualty Type within 10nm of EOWDC Turbines (1998-2007)

A chart of the incidents by cause is presented in Figure 7.6.

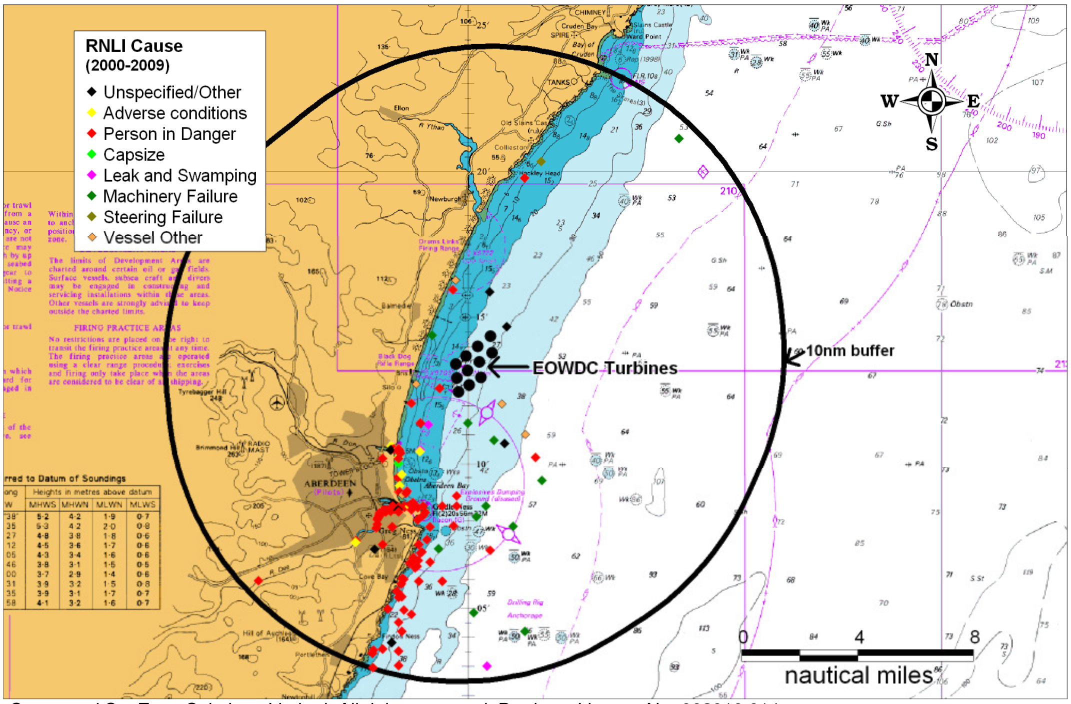


Figure 7.6 RNLI Incidents by Cause within 10nm of EOWDC Turbines

The reported causes are summarised in Figure 7.7. The main cause was "Person in Danger" contributing three-quarters of all incidents.

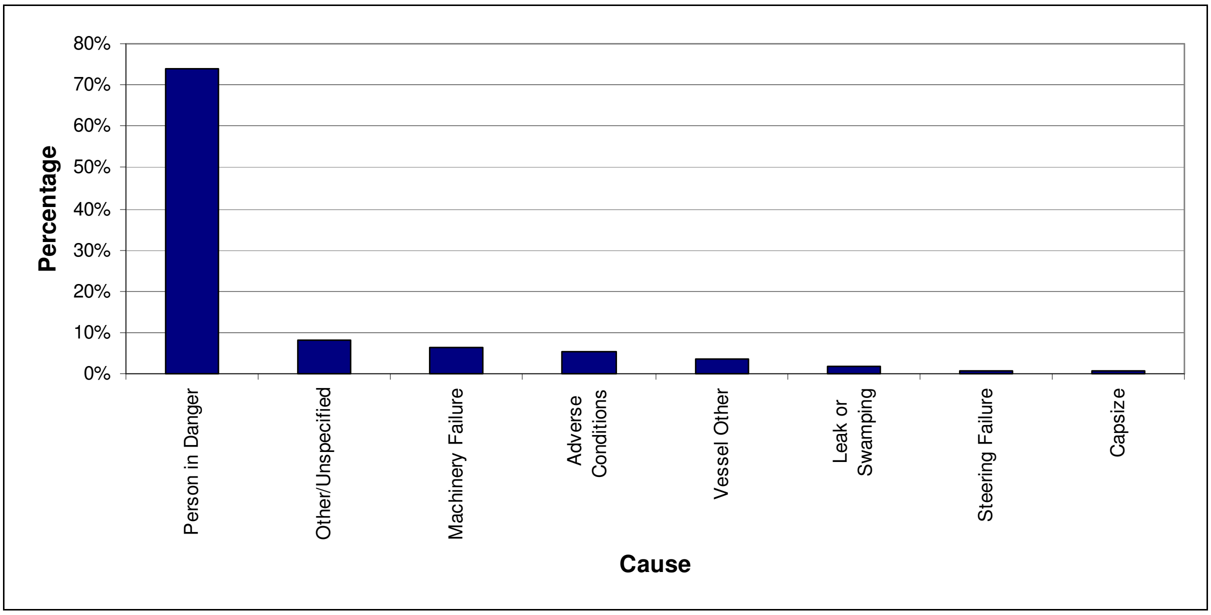


Figure 7.7 RNLI Incidents by Cause within 10nm of EOWDC Turbines (1998-2007)

The annual rate of incidents in the past ten years is summarised in Figure 7.8. The year with the most incidents was 2000.

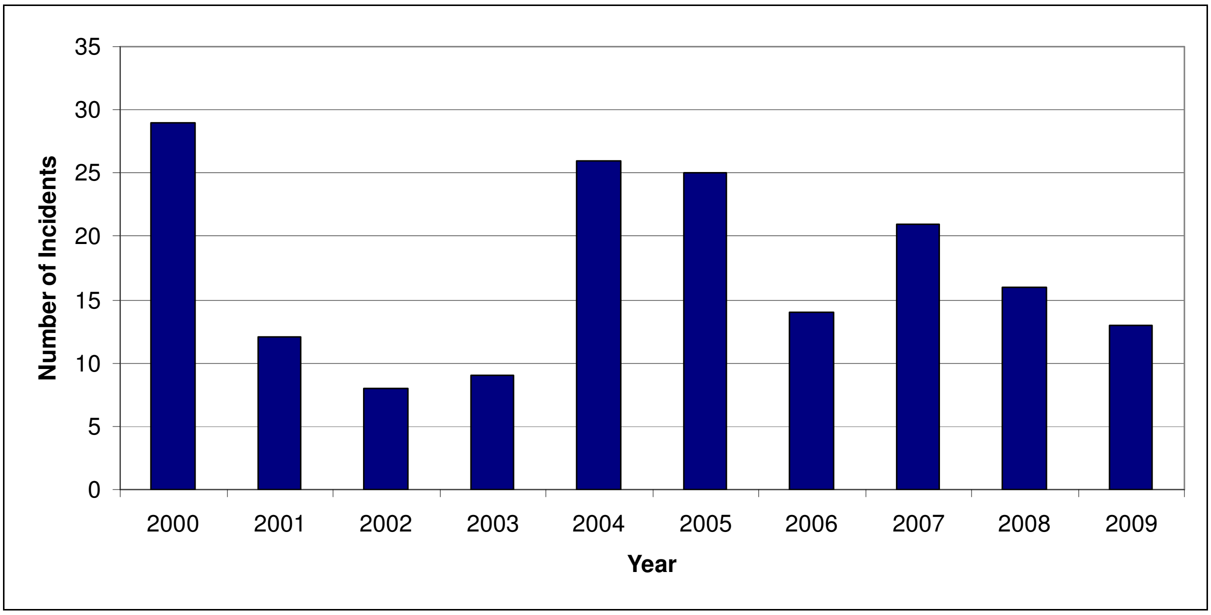


Figure 7.8 RNLI Incidents by Year within 10nm of EOWDC Turbines (1998-2007)

The stations and types of lifeboat responding to incidents (ALB = all-weather lifeboat and ILB = inshore lifeboat) are illustrated in Figure 7.9.

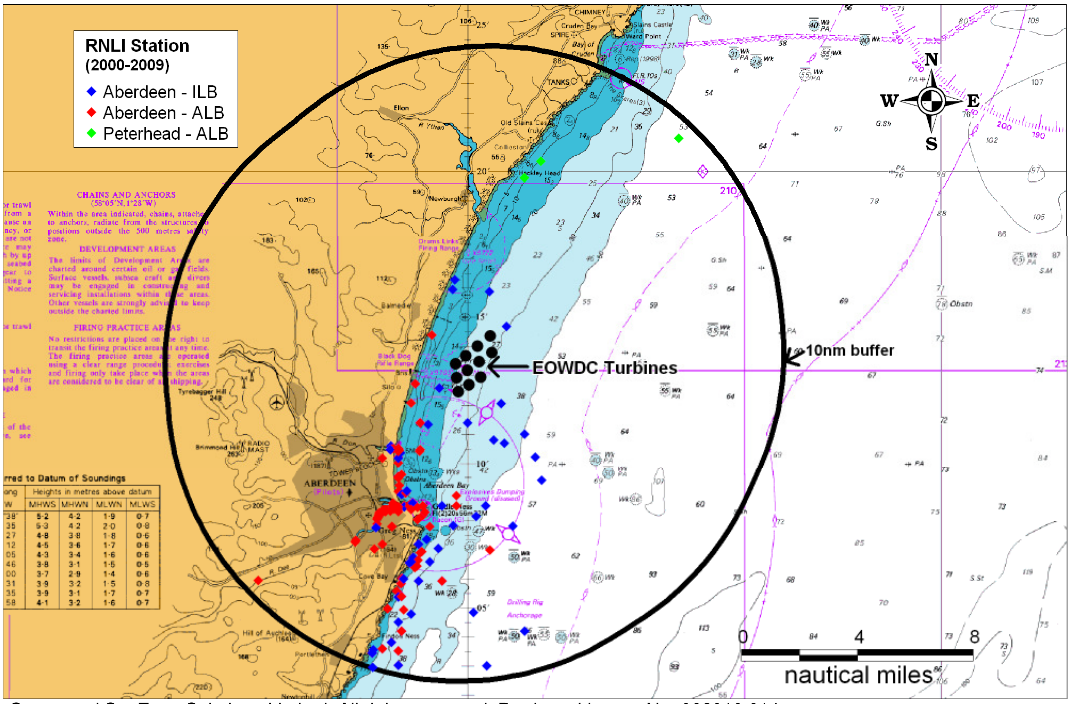


Figure 7.9 RNLI Incidents by Station within 10nm of EOWDC turbines

It can be seen that incidents away from the coast tended to be answered by the all weather lifeboat based in Aberdeen. The inshore lifeboat from Aberdeen tended to respond to calls closer to the coast and the Peterhead all weather lifeboat attended calls further to the north.

There were no incidents responded to by the RNLI within the proposed EOWDC turbine locations between 2000 and 2009.

7.4 Conclusions

Based on the review of incidents, it can be seen that the proposed EOWDC site and its immediate vicinity has experienced a relatively low rate of accidents in recent years. Most incidents in the area have occurred on the coast in and around Aberdeen.

8. MARITIME TRAFFIC SURVEYS

8.1 Introduction

This section summarises the results of the maritime traffic surveys carried out from Girdle Ness Lighthouse in Aberdeen, using a combination of shore-based radar, AIS and visual observations.

Further analysis of survey vessel types according to the DECC Methodology classification (Ref. i) is presented in Appendix B.

8.2 Survey Details

Four 14-day traffic surveys (total of 56 days) were carried out during the following periods:

1. 24 March – 7 April 2009.
2. 21 September – 5 October 2009.
3. 9 April – 23 April 2010.
4. 1 November – 15 November 2010.

(Note: A fifth survey has been carried out between18th February and 4th March 2011 (Ref. ix). Due to it being conducted recently, this has not been fully reported within the NRA but the findings of the survey were well-aligned with the previous four surveys.)

Full details of the survey analyses are presented in separate reports prepared by Anatec (Ref.x, xi, xii, and xiii).

The radar was set up at Girdle Ness Lighthouse (57° 08'.364 N, 2° 02'.916 W) giving good coverage to the north and Aberdeen Bay, including the harbour entrance. The survey location relative to the proposed EOWDC site is shown in Figure 8.1.

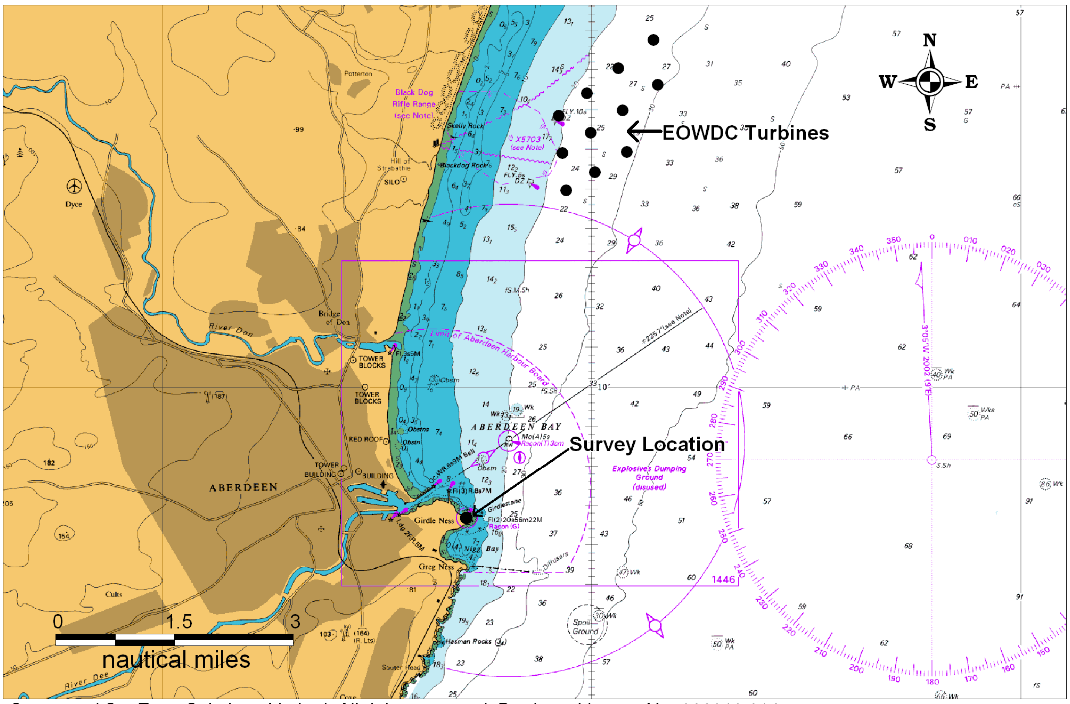


Figure 8.1 Chart Overview of the Survey Location

Figure 8.2 presents the equipment setup at the site.

Figure 8.2 Radar Scanner located next to Girdle Ness Lighthouse

The surveys covered a full range of tidal and weather conditions.

8.3 Survey Analysis

The following filters were applied to the survey data collected in each survey period:

- Removal of tracks more than 20 nm from the survey location.
- Removal of tracks wholly within harbour, i.e., berthed for the entire survey.
- Removal of Aberdeen Harbour pilot vessels.

Plots of the tracks by type recorded on radar and AIS during each fortnight are presented below.

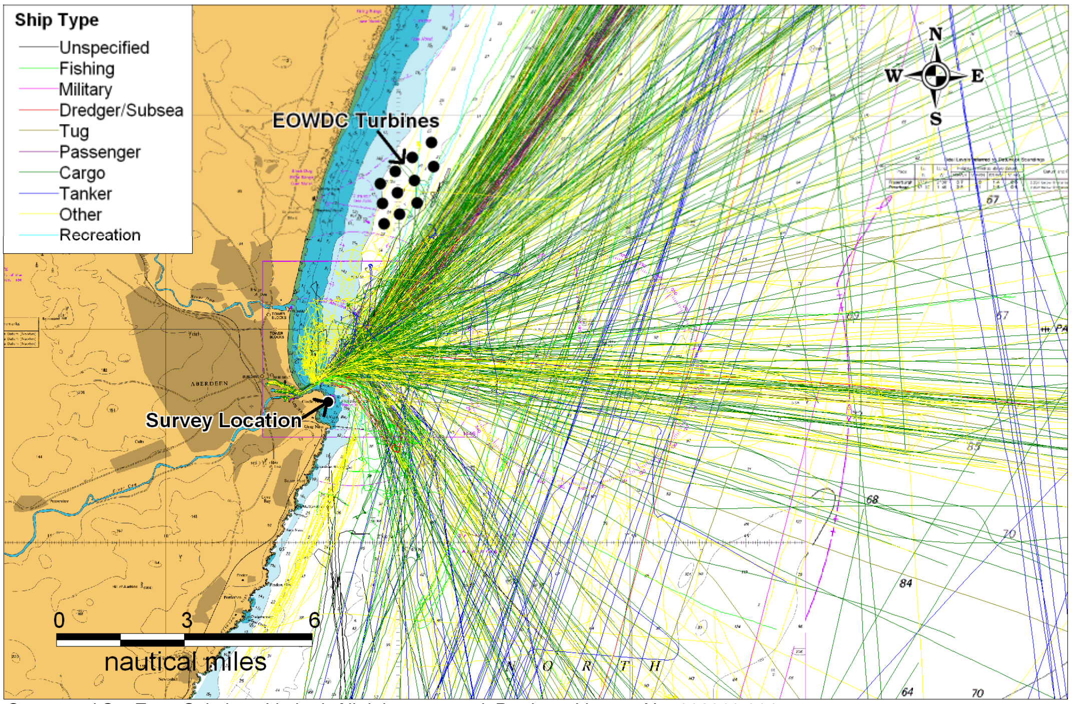


Figure 8.3 Survey 1: 24 March – 7 April 2009 (AIS & Radar tracks)

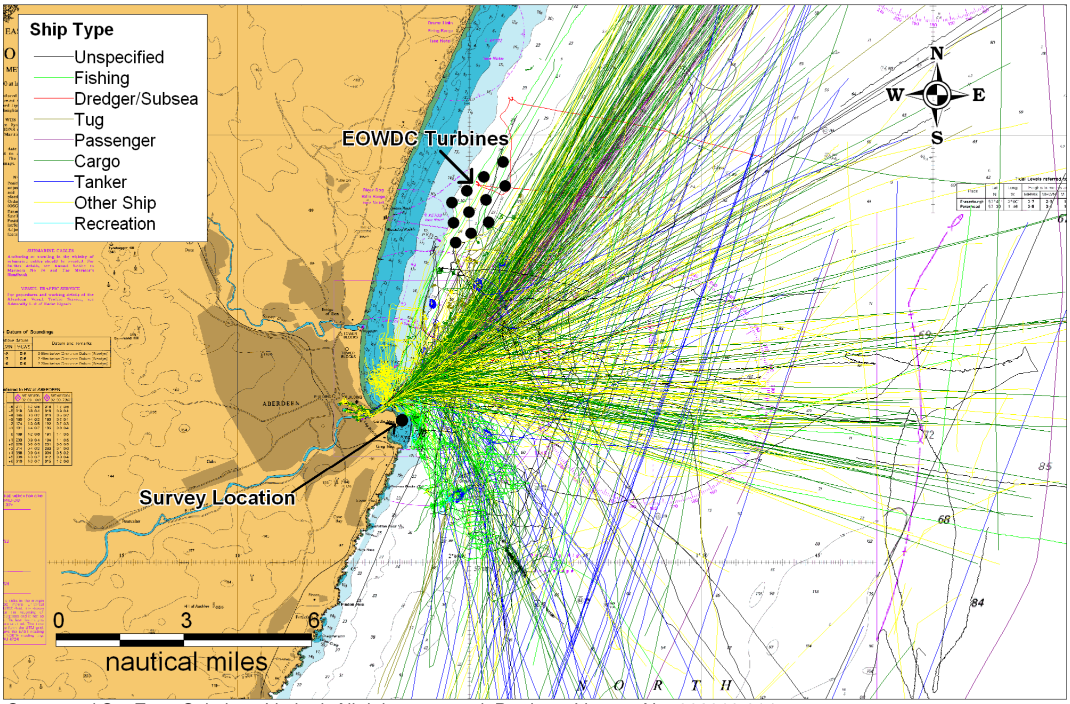


Figure 8.4 Survey 2: 21 September - 5 October 2009 (AIS & Radar tracks)

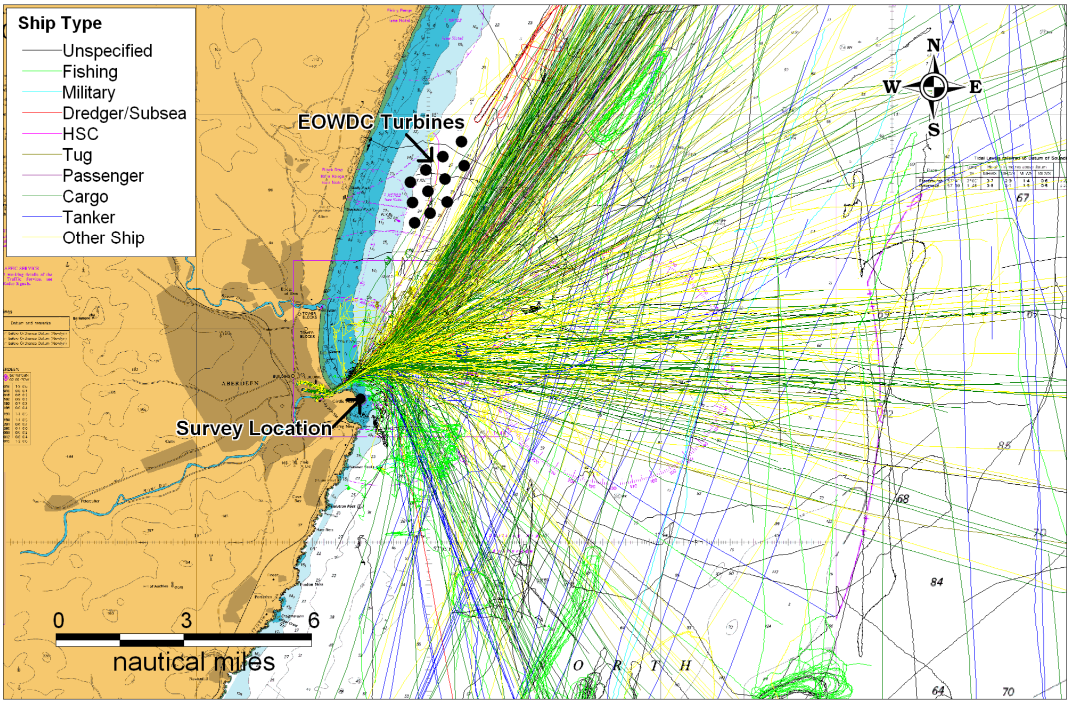


Figure 8.5 Survey 3: 9 April - 23 April 2010 (AIS & Radar tracks)

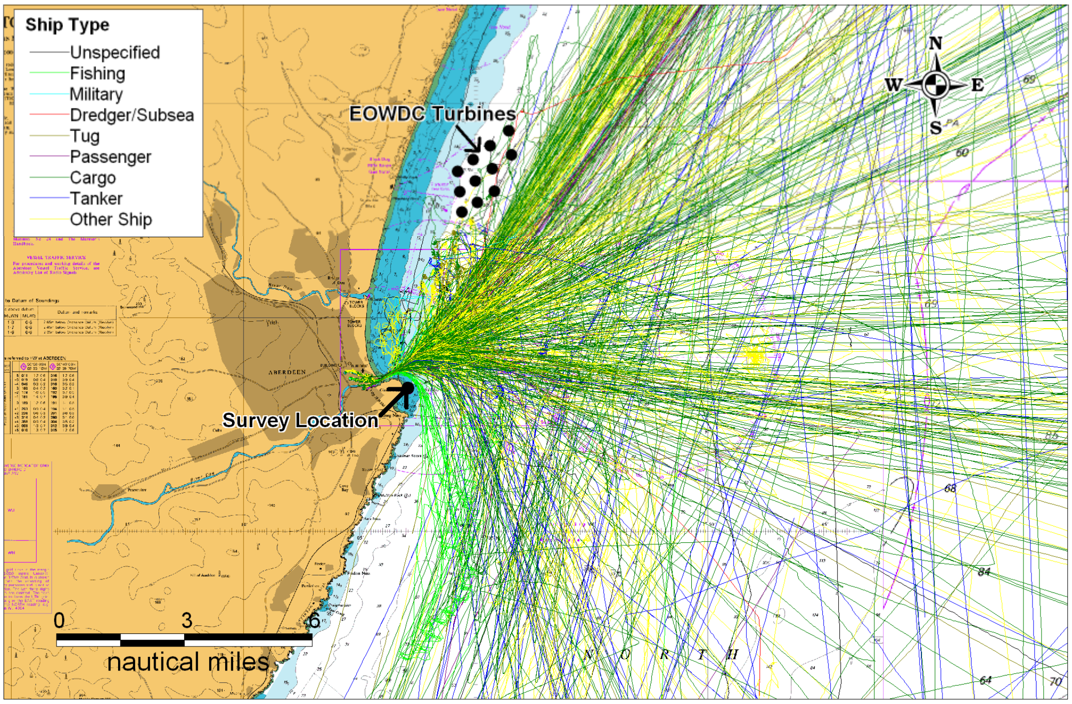


Figure 8.6 Survey 4: 1 November - 15 November 2010 (AIS & Radar tracks)

The number of unique vessels within 20nm of the survey location at Girdle Ness averaged approximately 50-55 vessels per day over the combined 56 days of surveying. The majority of tracks were associated with Aberdeen Harbour with approximately equal numbers inwards and outwards per day.

To put the traffic into a daily context, the tracks recorded on the busiest day during the two most recent surveys are presented below.

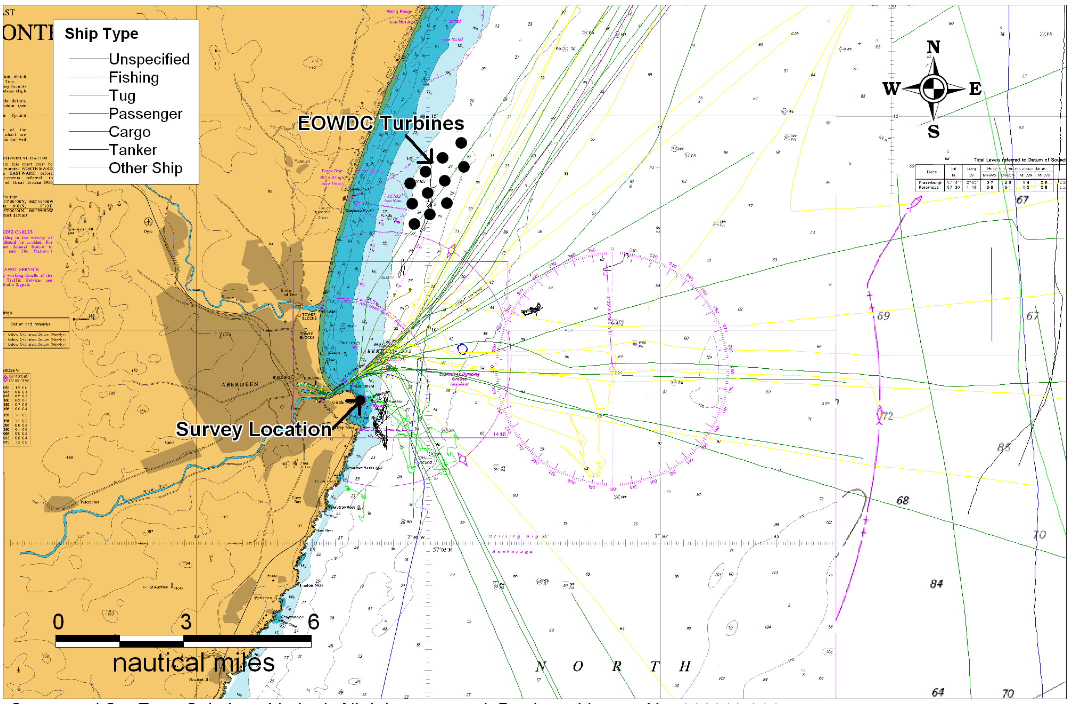


Figure 8.7 Survey 3 Busiest Day – 11 April 2010 (68 Unique Tracks)

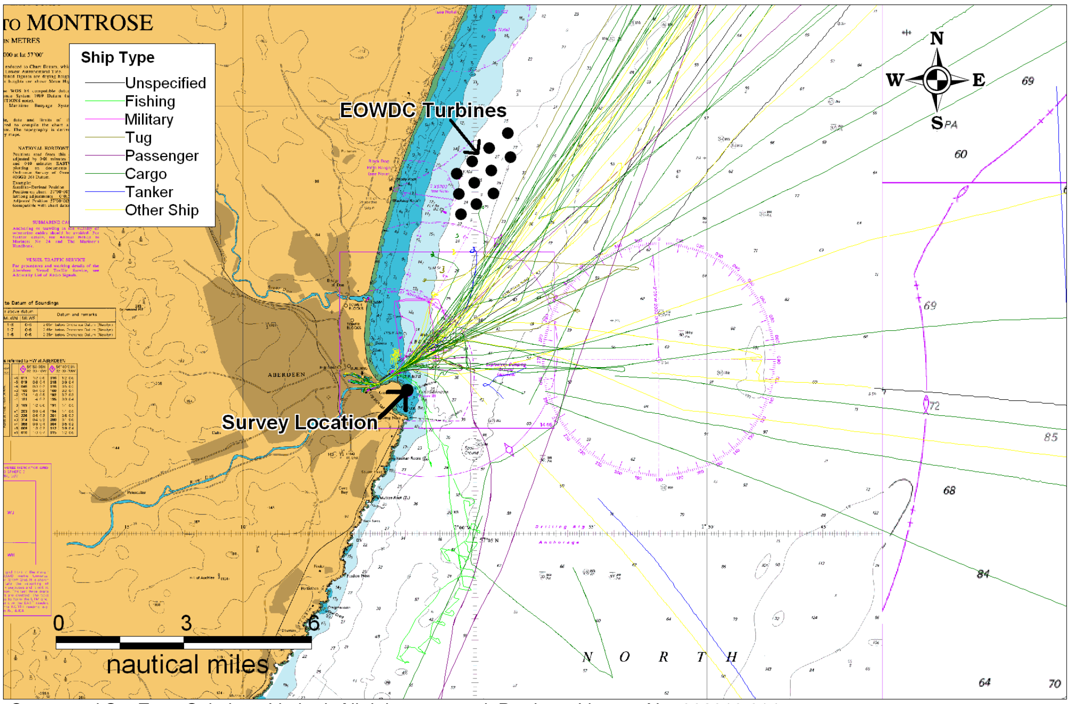


Figure 8.8 Survey 4 Busiest Day –10th November 2010 (74 Unique Tracks)

The breakdown of ships by type for vessels within 20nm of the survey location is presented in Figure 8.9. This considers all vessels recorded during the 56 days of the combined 4 surveys.

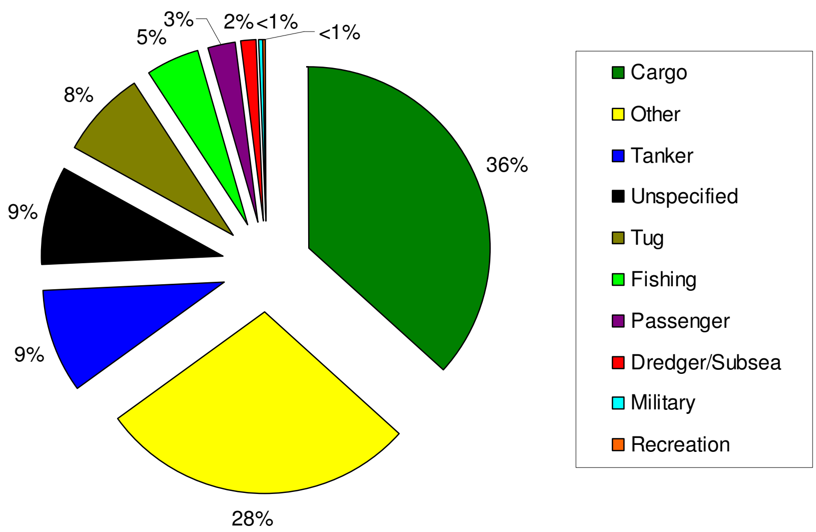


Figure 8.9 Vessel Types identified during the Combined Surveys

The most commonly recorded vessel type during the four surveys was cargo ships (36%) with 'other' vessels the second most commonly tracked (28%). It is noted that a large percentage of both these categories were offshore oil and gas industry related.

The distribution of vessels by draught (excluding unspecified) for the combined 4 surveys is presented in Figure 8.10. It can be seen that the majority of vessels had draughts between 4 and 6 m. Plots of all tracks colour-coded by draught for the two most recent surveys are shown in Figure 8.11 and Figure 8.12.

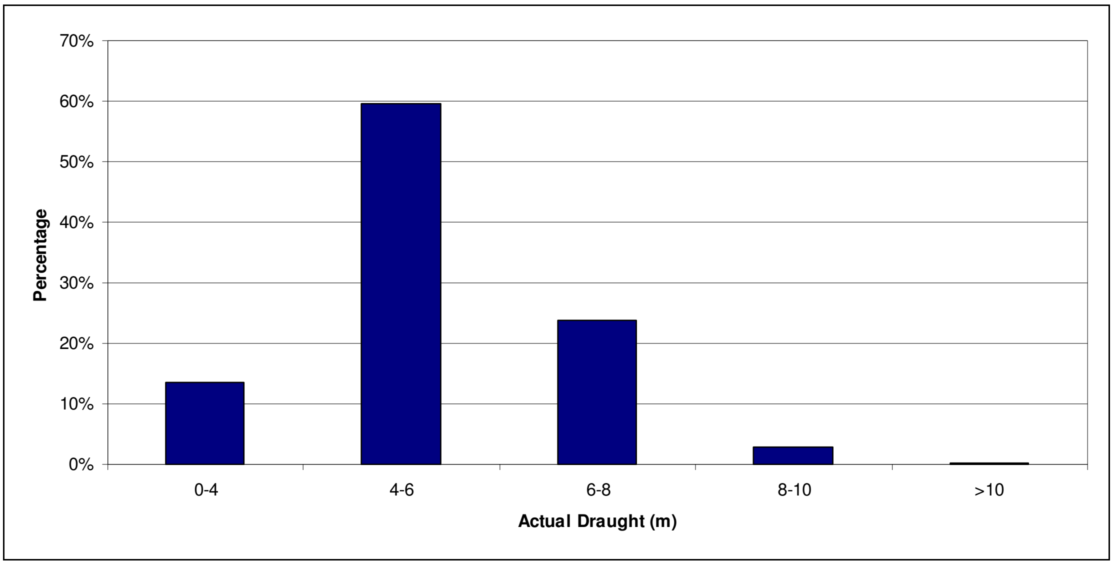


Figure 8.10 Distribution of Vessels by Actual Draught for the Combined 4 Surveys

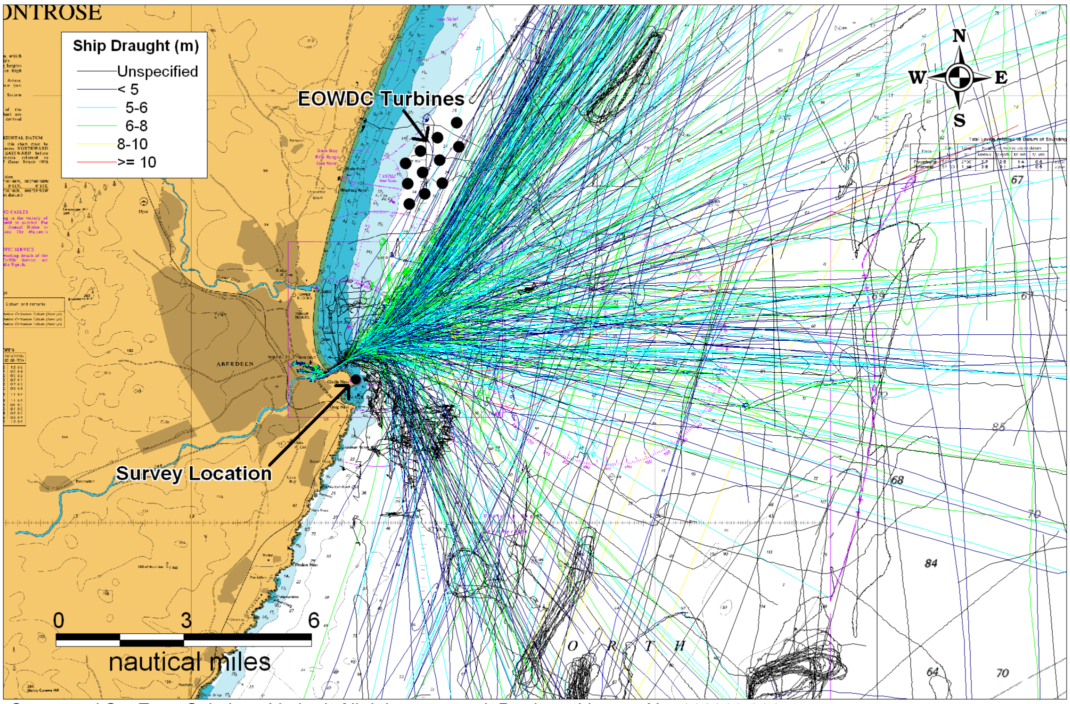


Figure 8.11 Survey 3 Tracks by Ship Draught

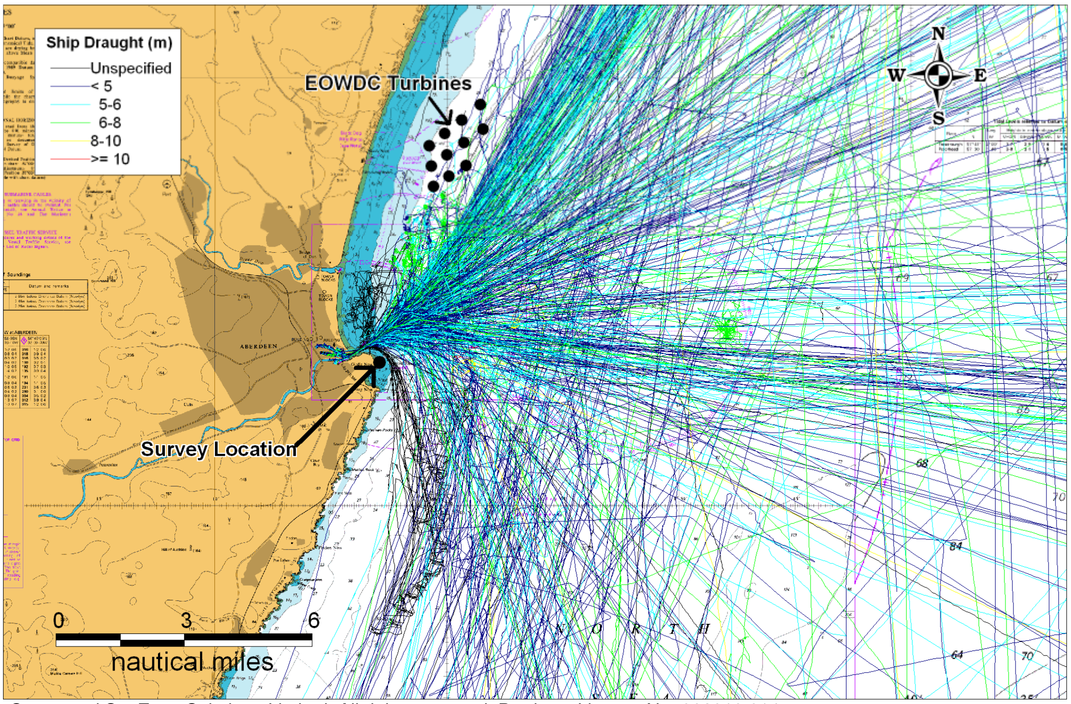


Figure 8.12 Survey 4 Tracks by Ship Draught

The vessel with the deepest draught overall was the shuttle tanker *Navion Fennia* (Figure 8.13) which broadcasted a draught of 11.5m on 10th November 2010 (Survey 4). This vessel approached Aberdeen Bay from the NE, stopping briefly approximately 1.8nm to the east of the survey location before leaving to the SE. It has a deadweight tonnage (DWT) of 95,195 tonnes.

Figure 8.13 Shuttle Tanker *Navion Fennia* (Library Picture)

The distribution of vessels by length (excluding unspecified) for the combined 4 surveys is presented in Figure 8.14. Plots of all tracks colour-coded by length for the two most recent surveys are presented in Figure 8.15 and Figure 8.16. It can be seen that the majority of vessels had lengths between 70 and 90 m.

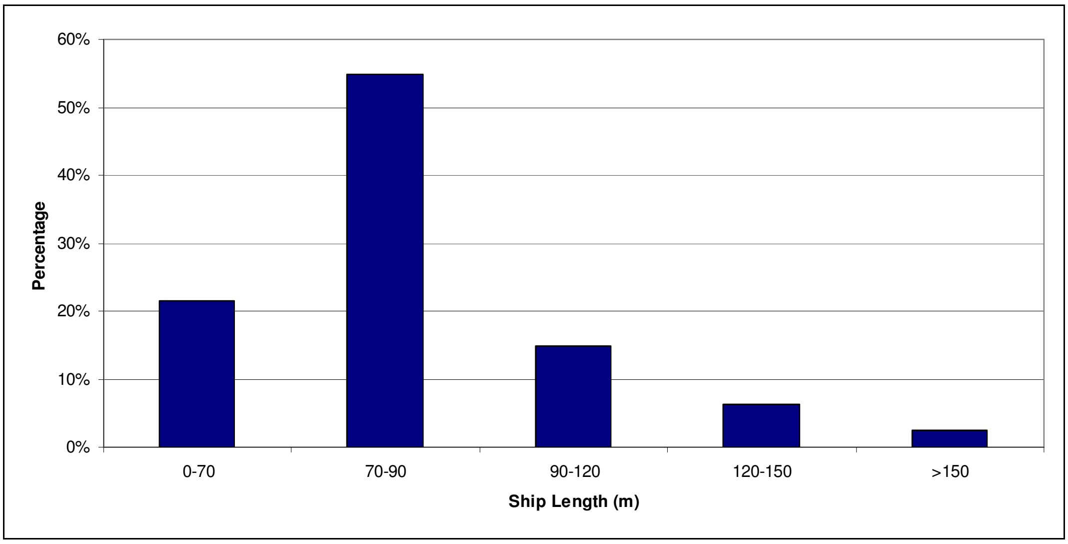


Figure 8.14 Distribution of Vessels by Length for the Combined 4 Surveys

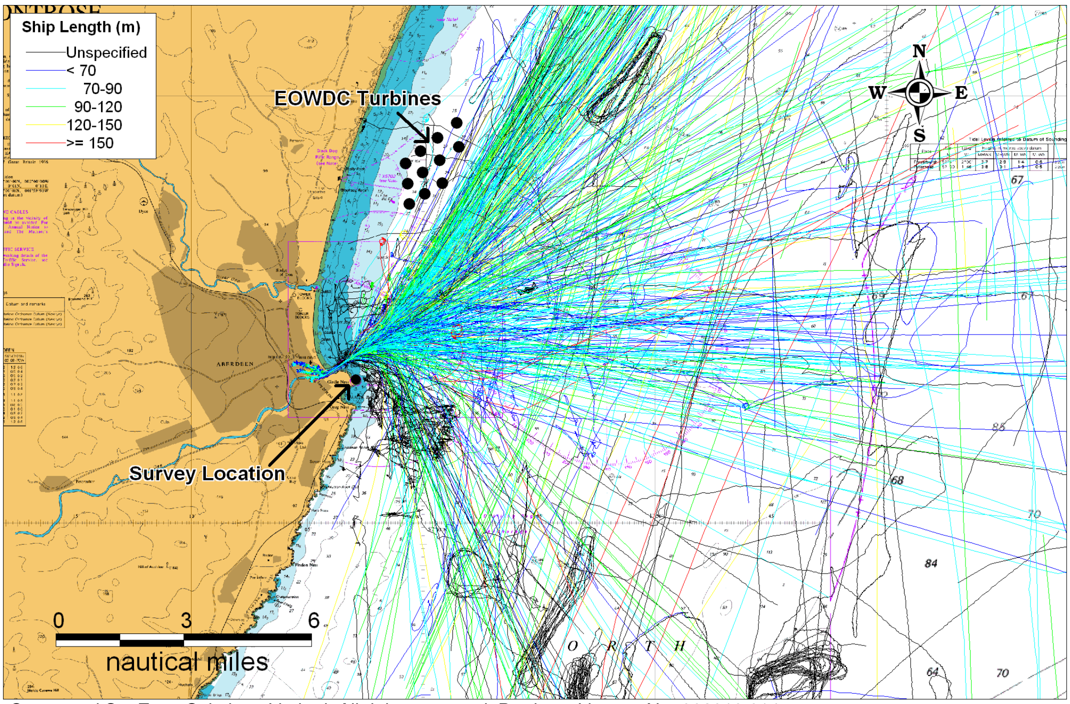


Figure 8.15 Survey 3 Tracks by Ship Length

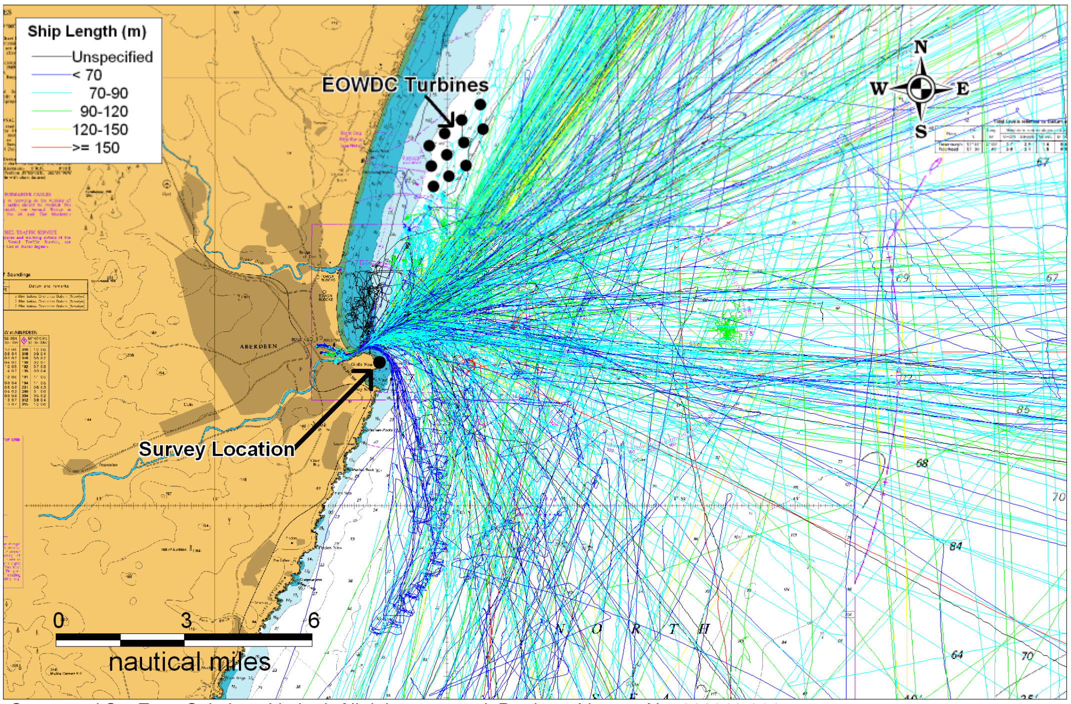


Figure 8.16 Survey 4 Tracks by Ship Length

The longest vessel tracked was the shuttle tanker *Grena* (272m) (Figure 8.17). This vessel anchored for 3 days approximately 1.9nm to the ESE of the survey location before heading to the Captain Oil Field on 23rd September 2009 (Survey 3).

Figure 8.17 Shuttle Tanker *Grena* (Library Picture)

Figure 8.18 presents the distributions of average speed for each of the four surveys.

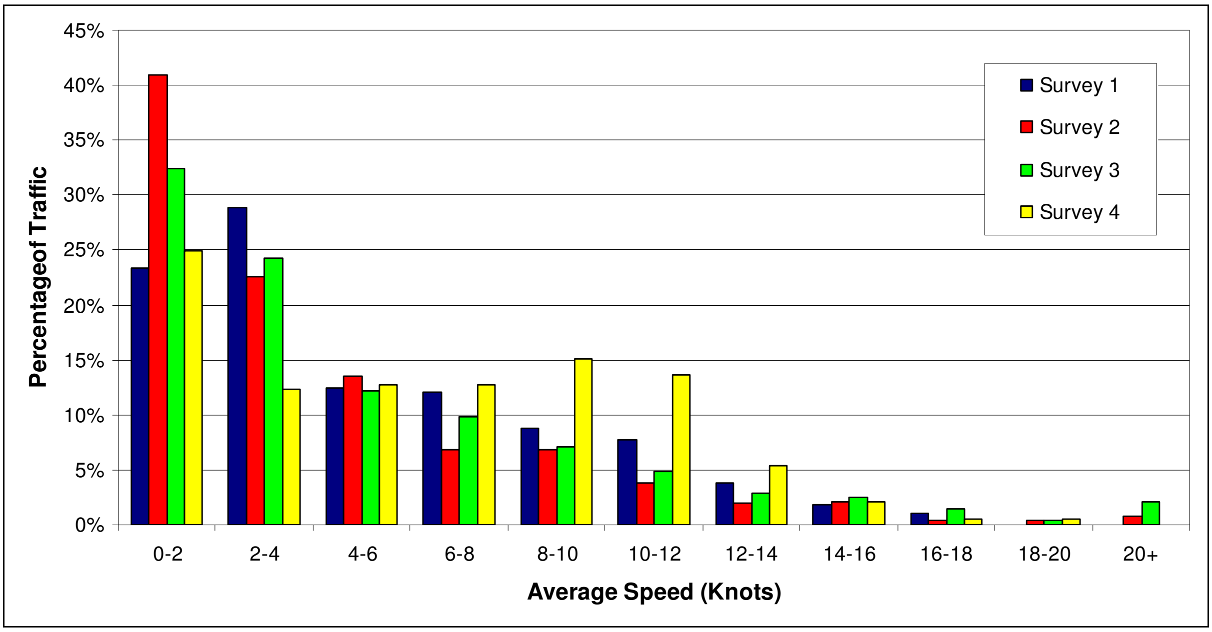


Figure 8.18 Average Speed Distributions for each Survey

The average speeds per survey ranged from 4-6 knots. These relatively low averages can be explained by the large proportion of tracks made by vessels visiting Aberdeen which either were berthed, at anchor or waiting to enter the harbour for part of the tracking period.

Additional analysis indicated the average speed of steaming vessels crossing the Radio Reporting point was 11.7 knots, which reduced to 10 knots crossing the Harbour Limit. At both points the fastest vessels recorded regularly were the NorthLink ferries *Hrossey* and *Hjaltland* travelling at 20-30 knots.

8.4 EOWDC Site-Specific Review

A detailed plot of the 56 days survey tracks passing the proposed EOWDC turbines is presented in Figure 8.19.

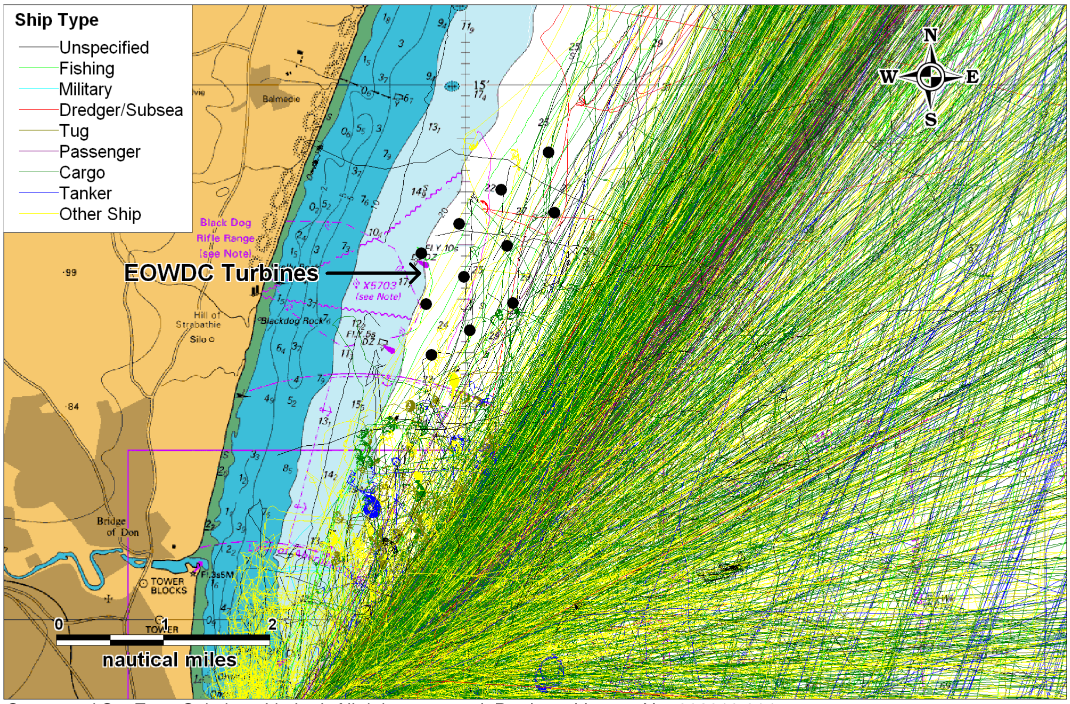


Figure 8.19 Detailed Plot of the Combined 4 Surveys Tracks Passing the Site

In the following figures the plots of vessel tracks passing close to the turbines are broken down into individual types with the following vessel types considered:

- Tankers (Figure 8.20)
- Passenger Ships (Figure 8.21)
- Offshore Oil and Gas Vessels (consisting mainly of cargo and 'other' ships on AIS) (Figure 8.23)

The closest passing tanker to the proposed turbines was the chemical/products tanker *Brovig Bora* recorded approximately 0.2nm from turbine 10 on 2 November 2010 travelling southbound.

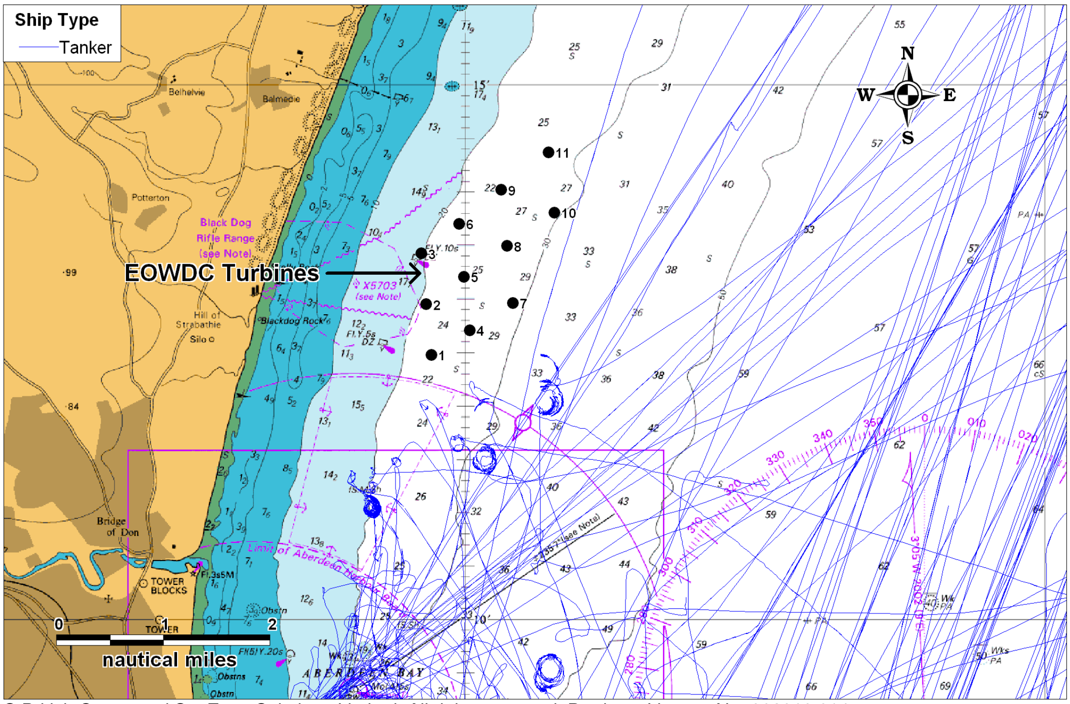


Figure 8.20 Plot of Tanker Tracks Passing Close to the Proposed Turbines

The vast majority of the passenger ships were the NorthLink ferries *Hrossey* and *Hjaltland* between Aberdeen and Orkney/Shetland. A photograph of *Hjaltland* during Survey 4 is presented in Figure 8.22. There was one instance of *Hrossey* passing within 100m of the proposed turbine 7 on 15 April 2010 but generally the vessels pass at least 0.6nm to the east of the proposed turbines with an average Closest Point of Approach (CPA) of 1.3nm.

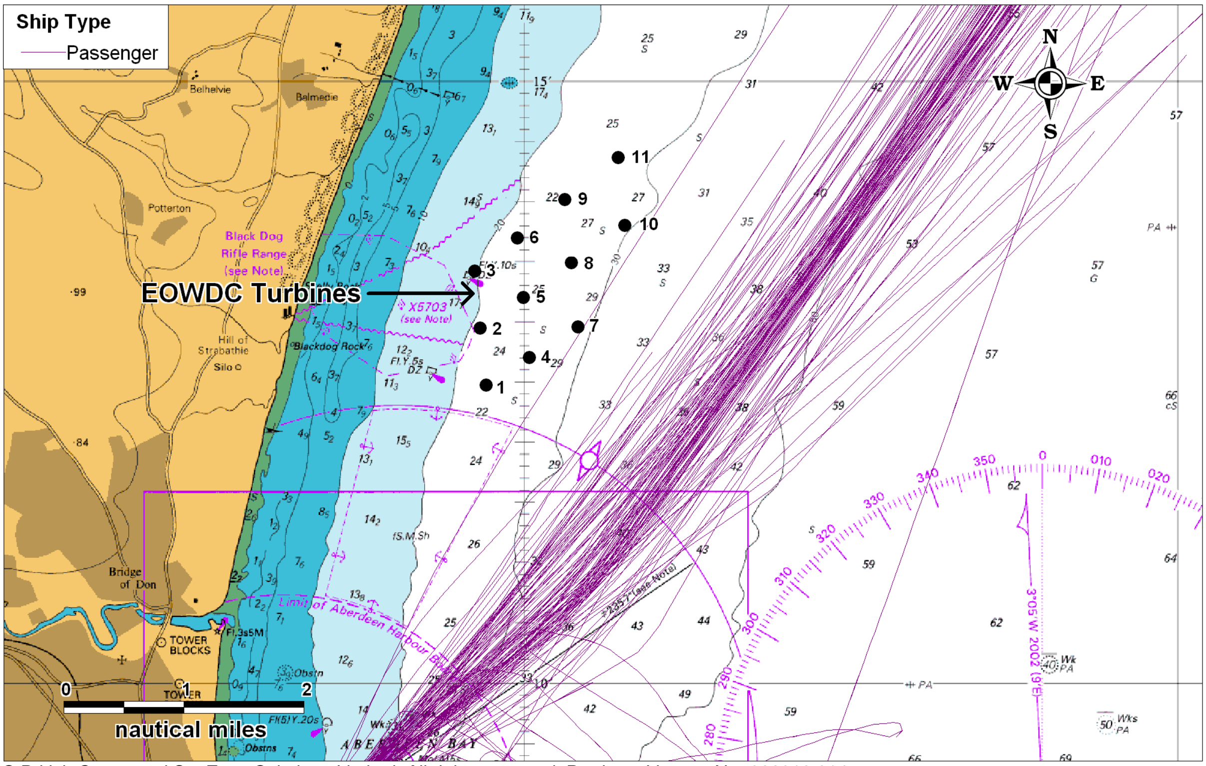


Figure 8.21 Plot of Passenger Ships Passing close to the Proposed Turbines

Figure 8.22 Picture of the passenger ferry *Hjaltland* during Survey 4

A small proportion of offshore oil and gas industry vessels passed through the proposed turbine locations, with the vast majority passing to the east.

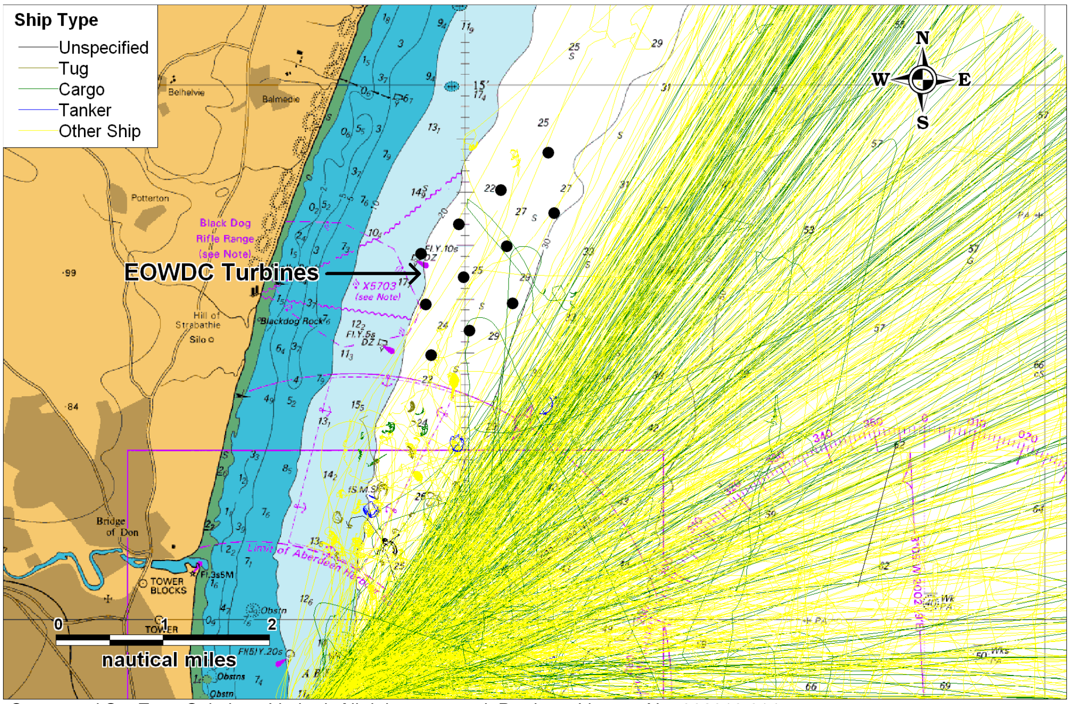


Figure 8.23 Plot of Offshore Industry Vessels passing close to the Proposed Turbines

Figure 8.24 presents the tracks of all vessels which were identified to pass within the proposed turbine locations during the combined 56-day survey period.

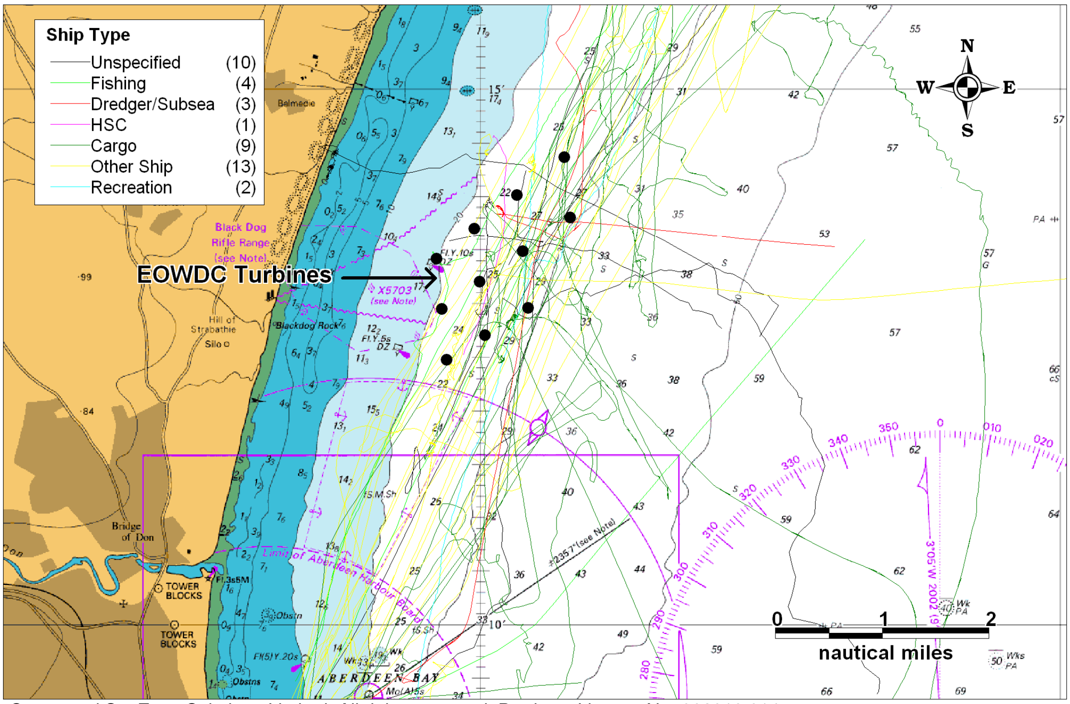


Figure 8.24 Tracks passing within EOWDC Site (All Surveys)

A total of 42 tracks were identified to pass within the proposed turbine locations during the four surveys, corresponding to an average of less than one per day. Excluding unspecified vessels (mainly radar targets which were not identified visually), the most common types of ship passing through the area were 'other' and cargo ships, a large portion of which were offshore industry related.

The traffic on passage through the site was mainly heading in a NNE-SSW direction. Details of the 26 vessels tracked on AIS through the site are given in Table 8.1.

Table 8.1 Details of Merchant Vessels Intersecting EOWDC Site on AIS

Ship Name	Type	Length (m)	Destination	Survey	Tracks
Aberdonian	Other	45	Aberdeen	1	1
Amanda	Cargo	81	Aberdeen	3	1
ARRC03	Other	19	Miller	3	1
Balityskiy-202	Cargo	90	Klaipeda (Lithuania) / Peterhead	3	1
Dea Pilot	Other	11	Aberdeen Bay	1	1
Dea Searcher	Cargo	11	Aberdeen	1	1
Geobay	Dredging	88	Aberdeen	4	1
Grampian Defender	Other	47	J.W. McLean	2	1

Ship Name	Type	Length (m)	Destination	Survey	Tracks
Grampian Frontier	Other	61	Aberdeen	3	1
Havila Fortress	Cargo	83	Aberdeen	4	1
Hellespont Dione	Cargo	73	Aberdeen	4	2
Island Express	Cargo	77	Elgin	1	1
M.V. Skandi Falcon	Other	82	Aberdeen	4	1
North Fortune	Cargo	80	Aberdeen	3	1
Ocean Clever	Other	73	Aberdeen	1 & 3	2
Ocean Seeker	Dredging	Unspecified	Phylis	2	2
Onward BF440	Fishing	25	Unspecified	2 & 4	2
Skagerak	Unspecified	17	Whitehaven	2	1
Toisa Coral	Cargo	73	Aberdeen	4	1
VOS Lismore	Other	54	Buzzard	2	1
VOS Mariner	Other	53	Aberdeen	1 & 3	2

The table above shows that in terms of AIS-equipped ships, no vessels passed through the site on more than two occasions with only 5 vessels passing more than once. The majority of vessels passing through the site were offshore oil and gas industry related vessels travelling to and from Aberdeen. The number of vessels on AIS intersecting the site for each survey was similar with 6 vessels intersecting in Surveys 1 and 2 and 7 vessels intersecting in Surveys 3 and 4.

Sixteen tracks were recorded on radar passing within EOWDC turbine locations during the 4 surveys. Details of these are provided, where available, in the fishing and recreation sections.

8.5 Detailed Analysis of Main Shipping Lane

The main shipping lane in closest proximity to the proposed EOWDC site is the NE-SW lane to/from Aberdeen Harbour. The AIS tracks using this lane during the surveys have been isolated for analysis.

Figure 8.25 presents the aforementioned shipping lane tracks colour-coded by ship type and Figure 8.26 shows the percentage distribution of these tracks.

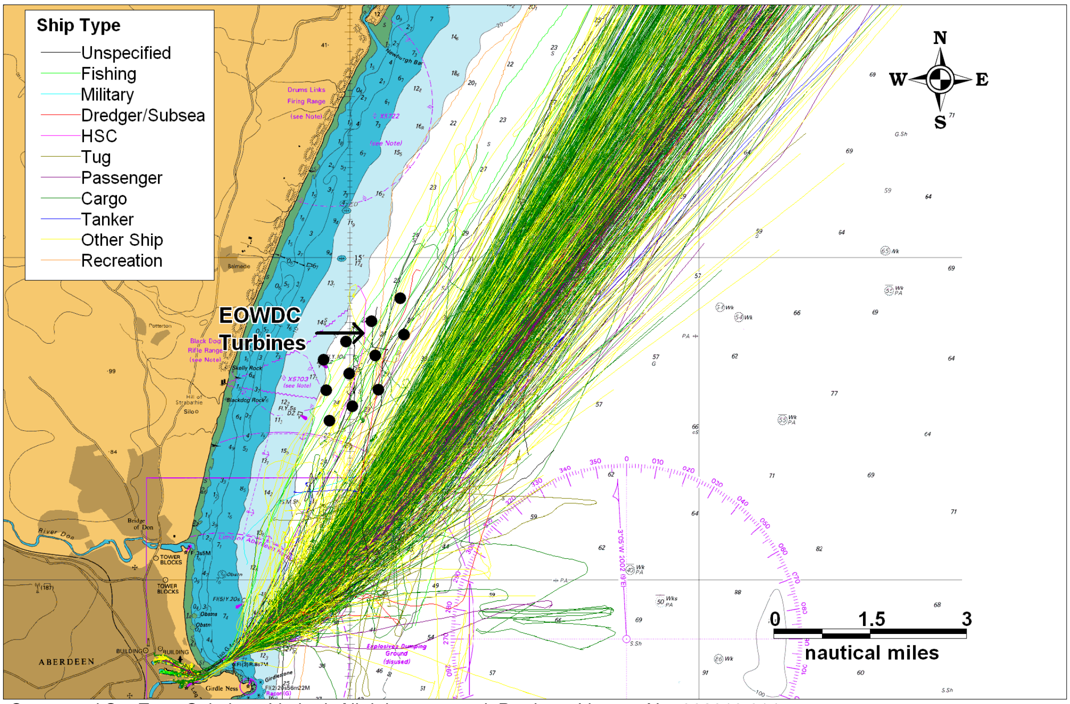


Figure 8.25 Tracks by Type on NE-SW Shipping Lane

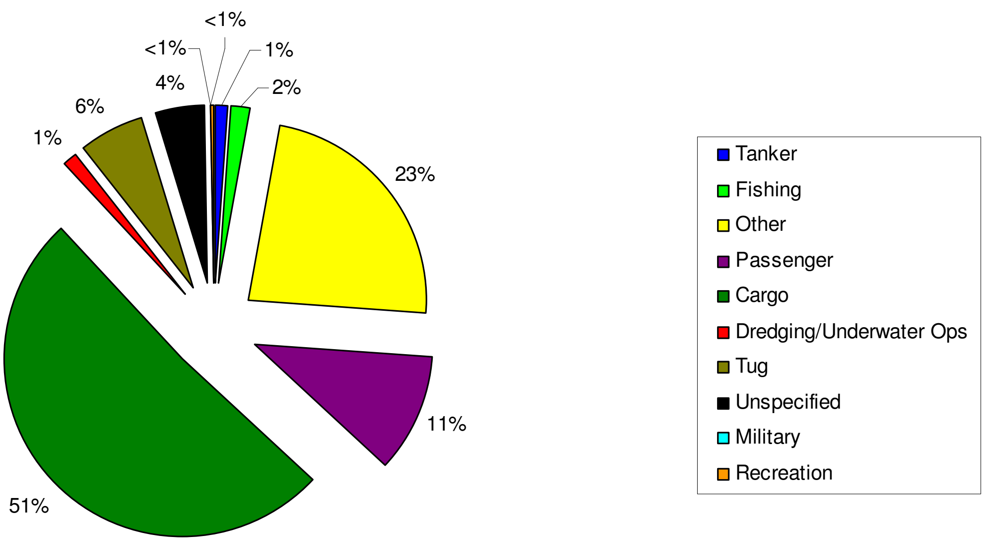


Figure 8.26 Distribution of Vessel Types Recorded on the NE-SW Shipping Lane

During the surveys there was an average of 12 to 13 ships per day using the lane, with offshore industry vessels (cargo and other) the most frequent users.

The tracks are analysed in more detail in Figure 8.27 to Figure 8.29.

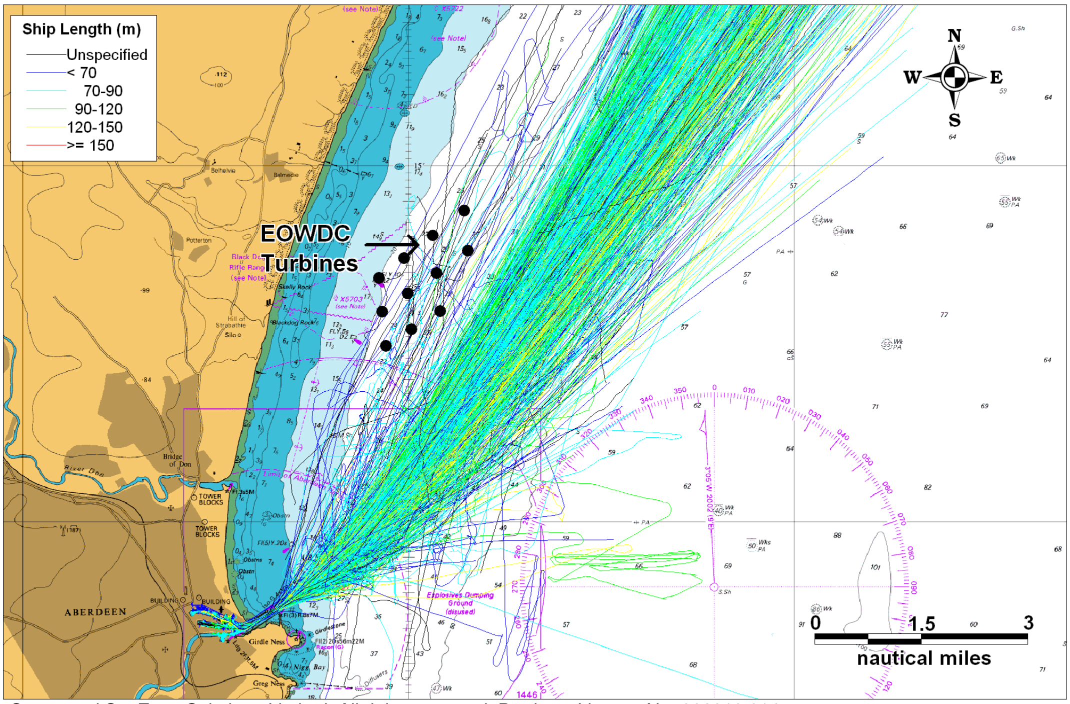


Figure 8.27 Tracks by Ship Length on NE-SW Route

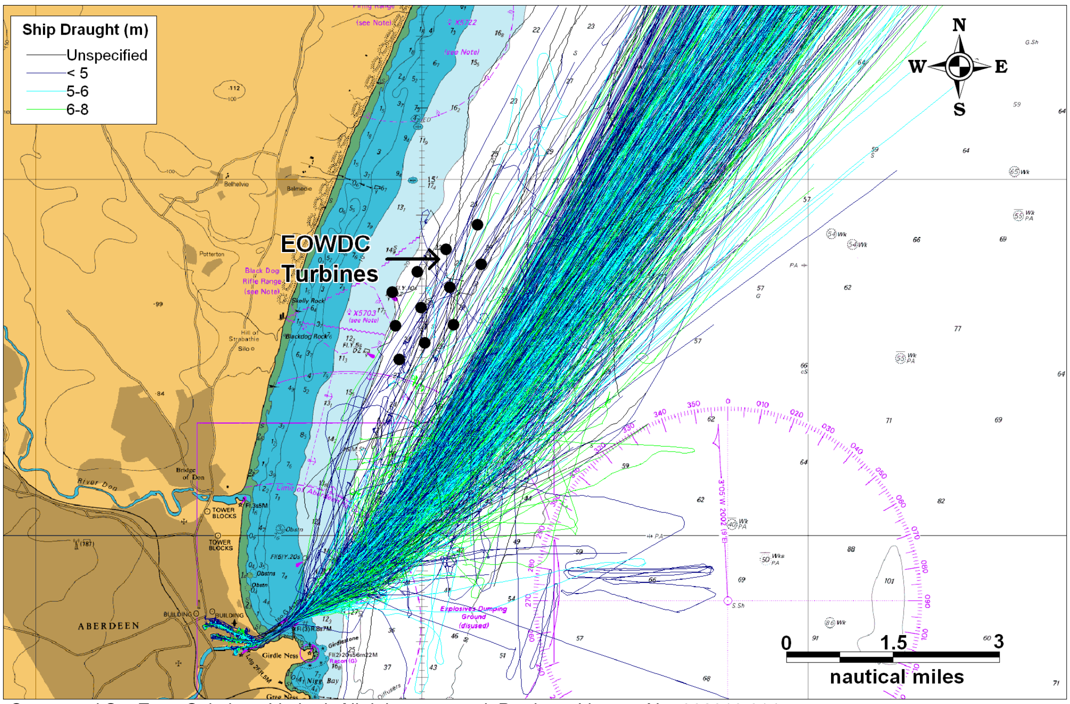


Figure 8.28 Tracks by Ship Draught on NE-SW Route

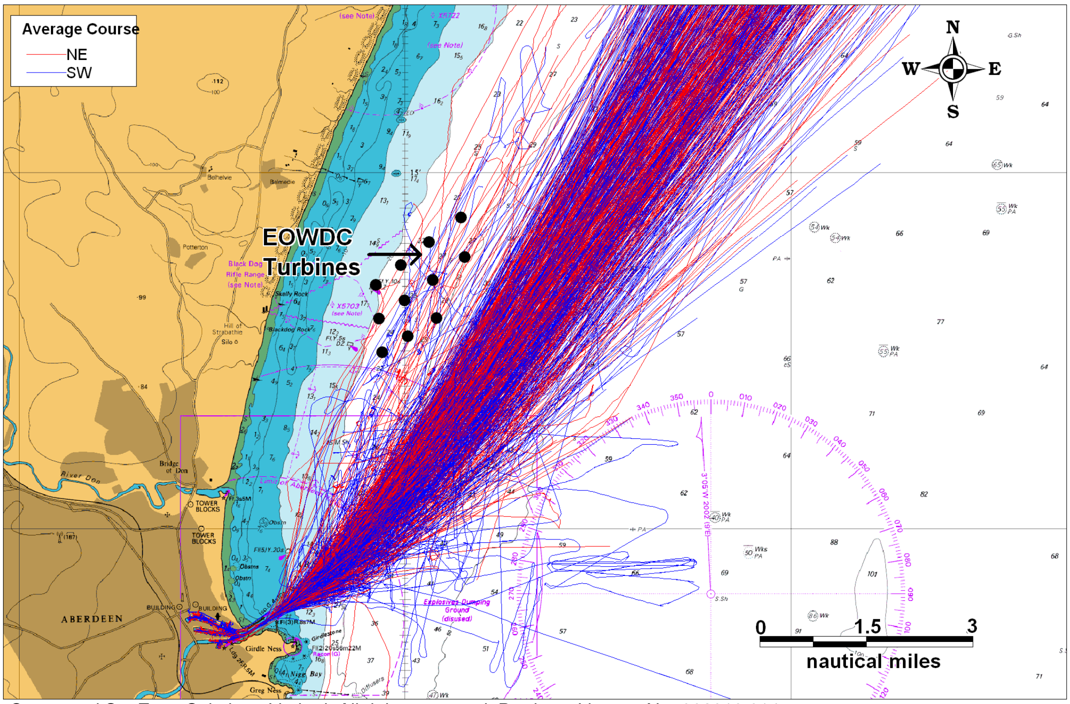


Figure 8.29 Tracks by Average Course on NE-SW Route

Approximately 52% of vessels on the NE-SW shipping lane were travelling NE, while 48% of vessels were heading SW.

8.6 Anchored Vessels

The positions of vessels at anchor recorded during the four surveys are presented in Figure 8.30 to Figure 8.33.

Between Survey 3 and Survey 4, a charted anchorage area was designated off Aberdeen.

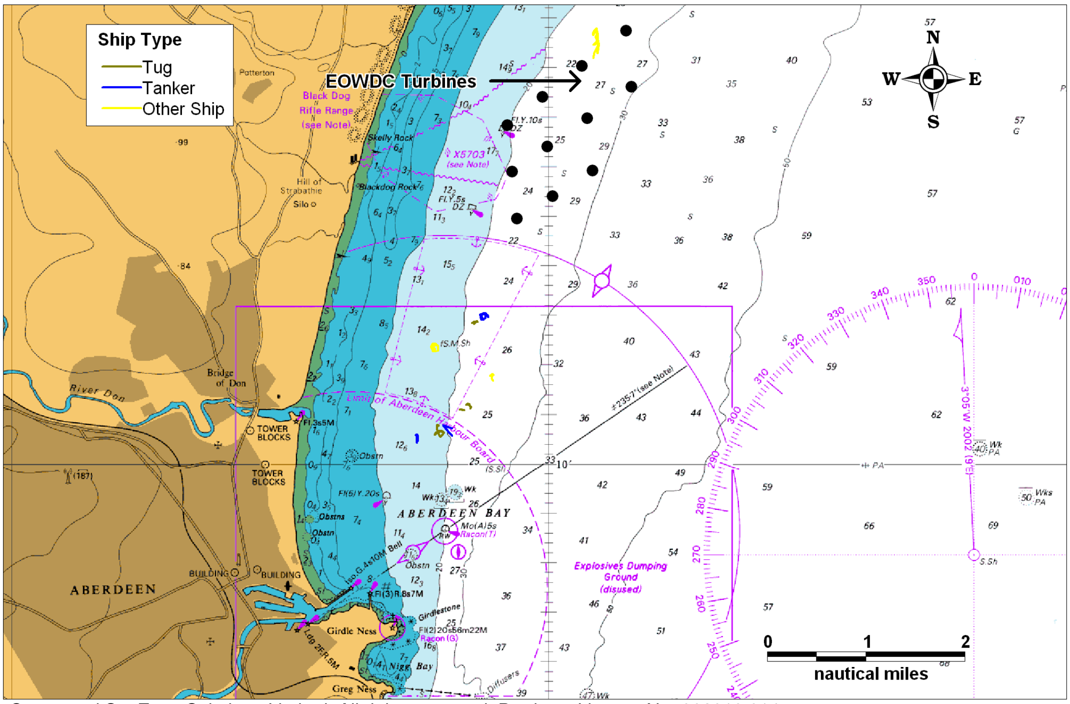


Figure 8.30 Anchored Vessels during Survey 1 (prior to anchorage area being designated)

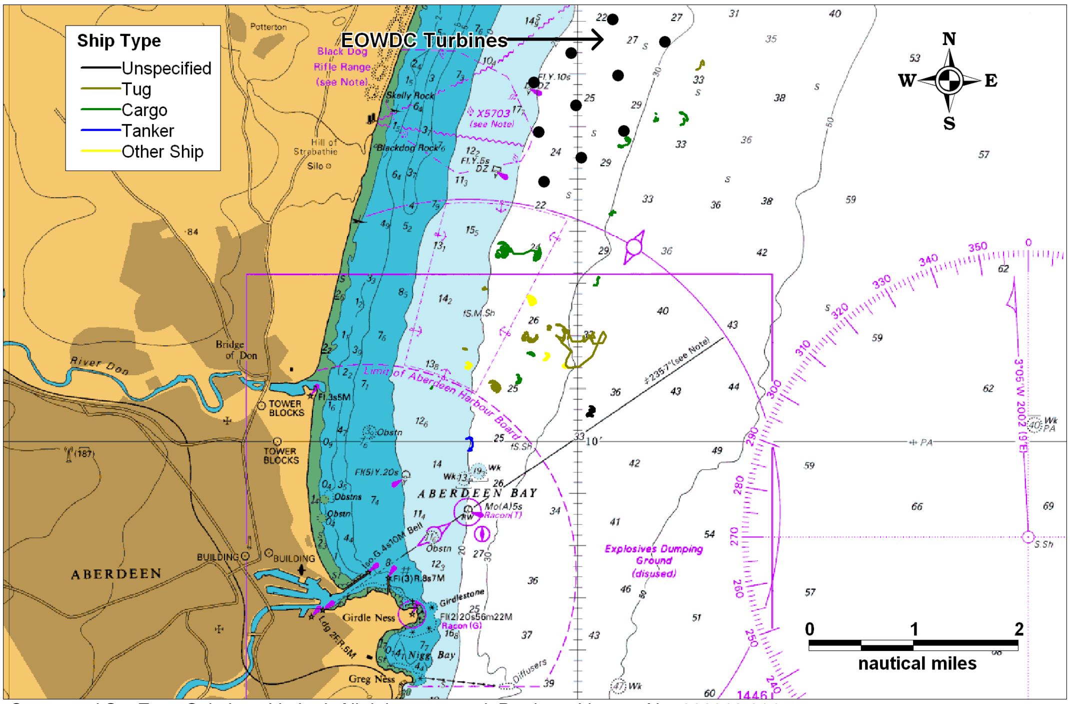


Figure 8.31 Anchored Vessels during Survey 2 (prior to anchorage area being designated)

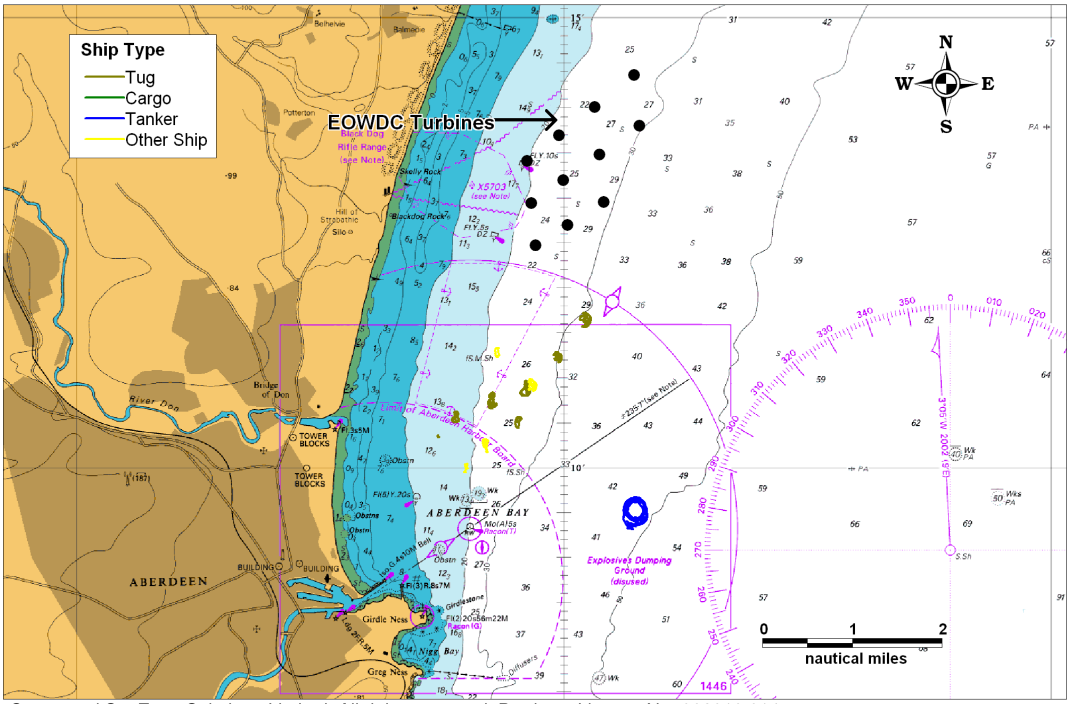


Figure 8.32 Anchored Vessels during Survey 3 (prior to anchorage area being designated)

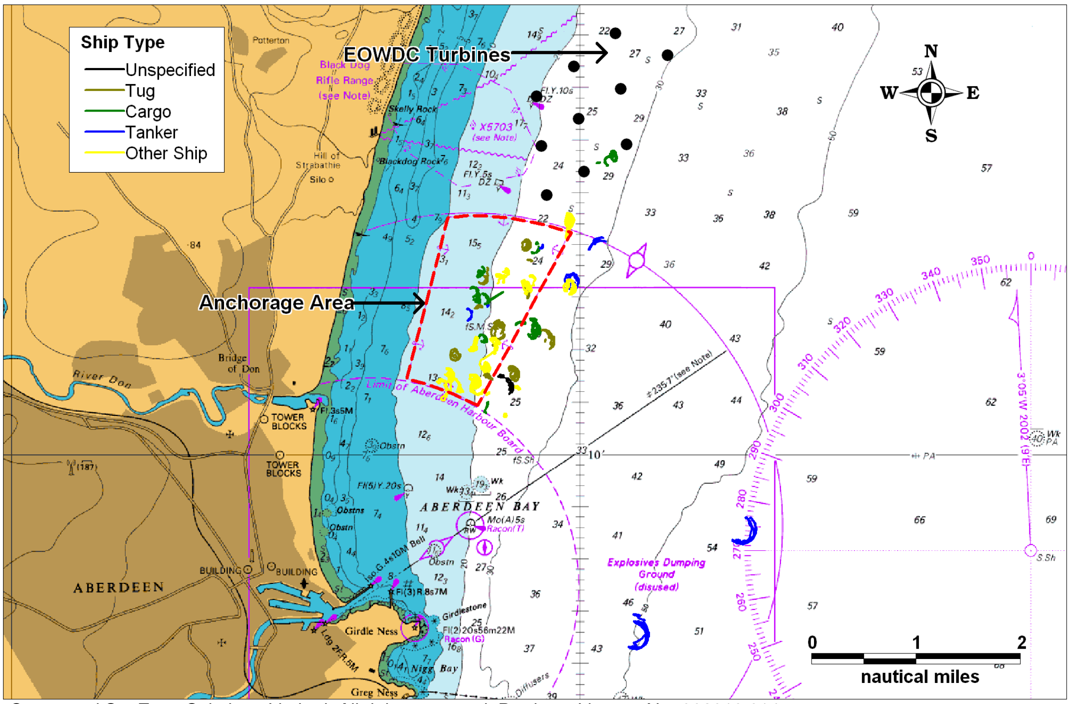


Figure 8.33 Anchored Vessels during Survey 4 (with Charted Anchorage Area shown in red)

There were 10, 29, 20 and 37 vessels observed at anchor during Surveys 1-4, respectively. During part of Survey 4, Aberdeen Harbour was experiencing high winds and pilotage ceased for a period, leading to the higher number of vessels at anchor.

It can be seen from the above figures that most masters have responded to the introduction of the charted anchorage area by anchoring within or close to the designated area. Two cargo vessels anchored for a short time within the EOWDC turbine locations during Survey 4 before entering Aberdeen Harbour. (The fifth survey carried out in 2011 showed most vessels were using the charted anchorage area – see Figure 13.10.)

More detailed analysis of anchoring practices in Aberdeen using long-term data is presented in Appendix C.

9. IMPACT ON COMMERCIAL SHIPPING NAVIGATION

9.1 Passing Ships

Based on the analysis of the shipping survey data presented in Section 8, it is considered that the proposed EOWDC site will not significantly affect passing ships not bound to or from Aberdeen Harbour as they mostly pass well to the east of the proposed EOWDC site (generally at least 3nm away).

In terms of Aberdeen traffic, the majority of traffic also passes well clear of the proposed EOWDC site (i.e., shipping lanes to the east and south of Aberdeen). The only route that will be partly affected is the NE-SW shipping lane to/from Aberdeen. Approximately 12 to 13 vessels per day use this route on average, the majority of which are associated with the oil & gas industry. The current position of this traffic lane is analysed in Section 8.5. A small proportion of tracks currently pass through the site but the vast majority pass to the east, with a Closest Point of Approach (CPA) of approximately 1.1nm from the nearest proposed turbine location. The CPA distribution for these vessels (excluding vessels passing through the turbine perimeter) is presented in Figure 9.1.

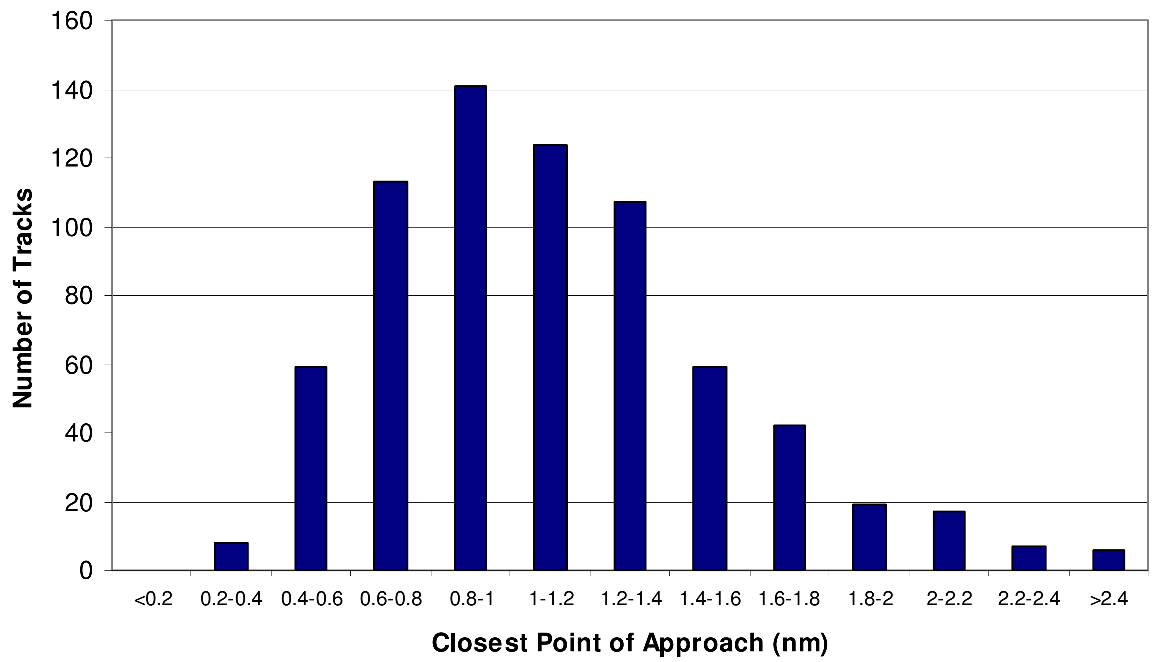


Figure 9.1 CPA Distribution for Vessels travelling on the NE-SW Shipping Lane

The MCA has published draft "Guidance to Mariners Operating in the Vicinity of UK Offshore Renewable Energy Installations (OREIs)". It does not provide guidance on a safe distance at which to pass, as this depends upon individual vessels and conditions, but states that:

> *"In planning a voyage mariners must assess all hazards and associated risks. The proximity of wind farms and turbines should be included in this assessment. "*

Based on experience at other sites, the introduction of the proposed EOWDC is not expected to affect the majority of the NE shipping lane although vessels currently passing near the site are likely to shift to the east, which will result in an increased mean passing distance of approximately 1.5nm. There is sufficient sea room for vessels to make this change. The route is also expected to narrow slightly.

An average track estimated to be taken by a NE/SW vessel prior to the construction of the proposed EOWDC is presented in Figure 9.2. This was calculated by finding the average position of tracks currently using the NE-SW shipping lane. The anticipated deviation is also shown in the chart.

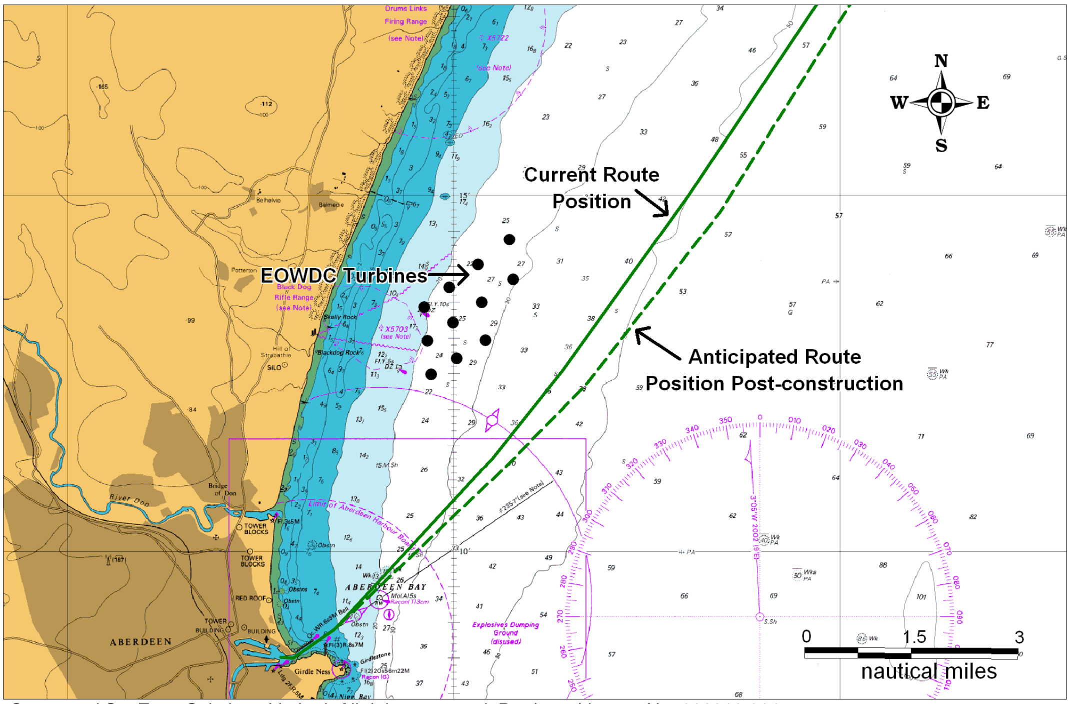


Figure 9.2 Current and Anticipated NE-SW Mean Route Position

The risks associated with the shipping changes anticipated due to the proposed project have been quantified as part of the Formal Safety Assessment (see Sections 12 and 13). The proposed EOWDC may also have an affect on marine radar. This potential impact is discussed in Section 15.

9.2 Anchored Ships

From the maritime surveys it was observed that vessels frequently anchor in Aberdeen Bay. This may be for a number of reasons, such as their intended berth being occupied, awaiting the tide or lack of space in the harbour.

A detailed analysis of anchoring data for Aberdeen Bay, including a review of one-year of AIS data (see Appendix C), was conducted. Following this, discussions with the port and other maritime stakeholders, such as via the MSF, were conducted.

It was identified that the previous turbine locations would have significantly reduced the sea room available for anchored vessels in Aberdeen Bay. Therefore, in consultation with stakeholders, the site has been relocated to the north and reduced in size. Separate to this, an anchorage area has been designated and charted in Aberdeen Bay. This has an area of $1.6nm^2$ and its closest limit is 0.25 nautical miles from the nearest turbine (see Section 6.3.4).

Based on these actions, it is considered that following the EOWDC installation there will be sufficient sea room available for the levels of anchoring experienced in the Aberdeen Bay area, as identified in the long-term survey data analysis.

10. RECREATIONAL VESSEL ACTIVITY

10.1 Introduction

This section reviews recreational vessel activity at the EOWDC site based on information published by the Royal Yachting Association (RYA) and radar tracking of recreational vessels during the maritime traffic surveys.

10.2 RYA Data

10.2.1 Introduction

The RYA, supported by the Cruising Association (CA), have identified recreational cruising routes, general sailing and racing areas around the UK in the Coastal Atlas (Ref. xiv). This work was based on extensive consultation and qualitative data collection from RYA and CA members, through the organisations' specialist and regional committees and through the RYA affiliated clubs. The consultation was also sent to berth holder associations and marinas.

10.2.2 Aberdeen Area Recreational Data

A summary plot of the recreational sailing activity and facilities in the Aberdeen area is presented in Figure 10.1.

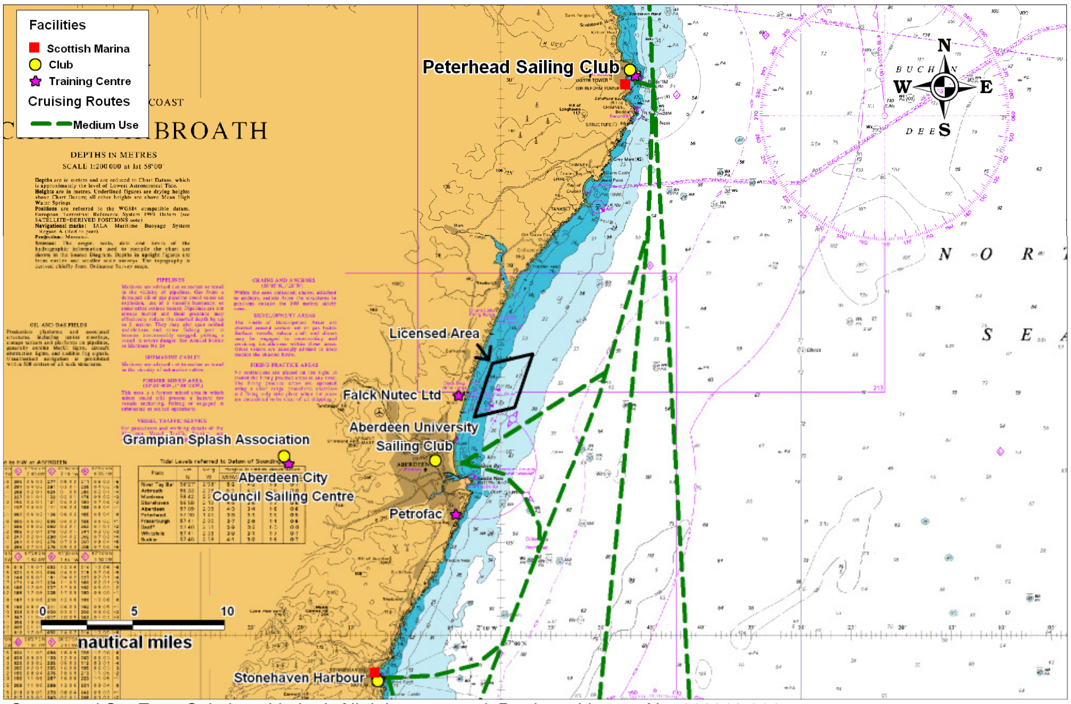


Figure 10.1 Recreational Information for the Aberdeen Area

Based on the RYA published data, the site is close to a few medium-use[1] RYA sailing routes, with the closest indicated route passing approximately 1.7nm to the south of the EOWDC site.

In terms of facilities, there are a few clubs and training centres for recreational vessels located on the coast around Aberdeen. The nearest marina is in Peterhead to the north.

10.3 Survey Data

A total of three recreational vessels (two yachts and one jet ski) were tracked on radar in Survey 1 and three yachts were recorded on radar during Survey 2, as presented in Figure 10.2. There were no recreational vessels tracked on radar during Surveys 3 or 4, although four vessels were manually sighted during Survey 3 - a white sailing boat, a jet ski and two kayaks.

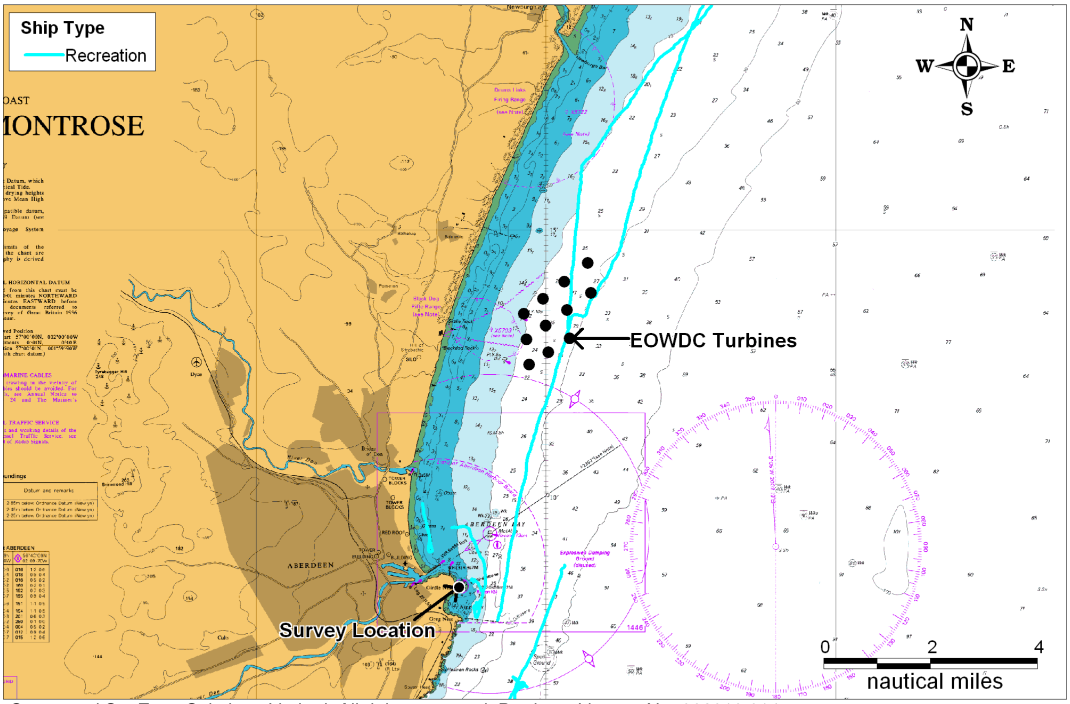


Figure 10.2 Recreational Vessels Tracked during Surveys (56 Days)

Two yachts passed within the proposed turbines and a picture of one of these yachts is shown below.

[1] Popular route on which some recreational craft will be seen at most times during summer daylight hours.

Figure 10.3 Photograph of a Yacht observed on 2nd April 2009 (Survey 1)

10.4 Impact Assessment

The air clearance between turbine rotors and sea level conditions at Mean High Water Springs (MHWS) will not be less than 22m, as recommended by the MCA and RYA. This minimises the risk of interaction between rotor blades and yacht masts.

In terms of vessel routeing, recreational vessels should be able to pass between turbines in suitable conditions, as well as being able to pass inshore and offshore. Based on the activity review, this is not expected to be a frequent event and hence the impact on recreational vessels is considered to be minor.

The Macmillan REEDS Nautical Almanac (Ref. xv) indicates that yachts are generally not encouraged within the busy commercial port of Aberdeen.

11. FISHING VESSEL ACTIVITY

11.1 Introduction

This section reviews the fishing vessel activity at the EOWDC site based on the maritime traffic survey and Commercial Fisheries assessment (Ref. xvi).

11.2 Survey Tracks

The fishing vessels tracked during the combined 56 days maritime traffic survey are plotted in Figure 11.1. Overall, 146 fishing vessels were tracked during the combined survey period, an average of 2 to 3 per day.

The majority of fishing vessels were small trawlers and potters working out of Aberdeen, mainly working south of Girdle Ness, where a number of buoys marking pots were visible from the coastline.

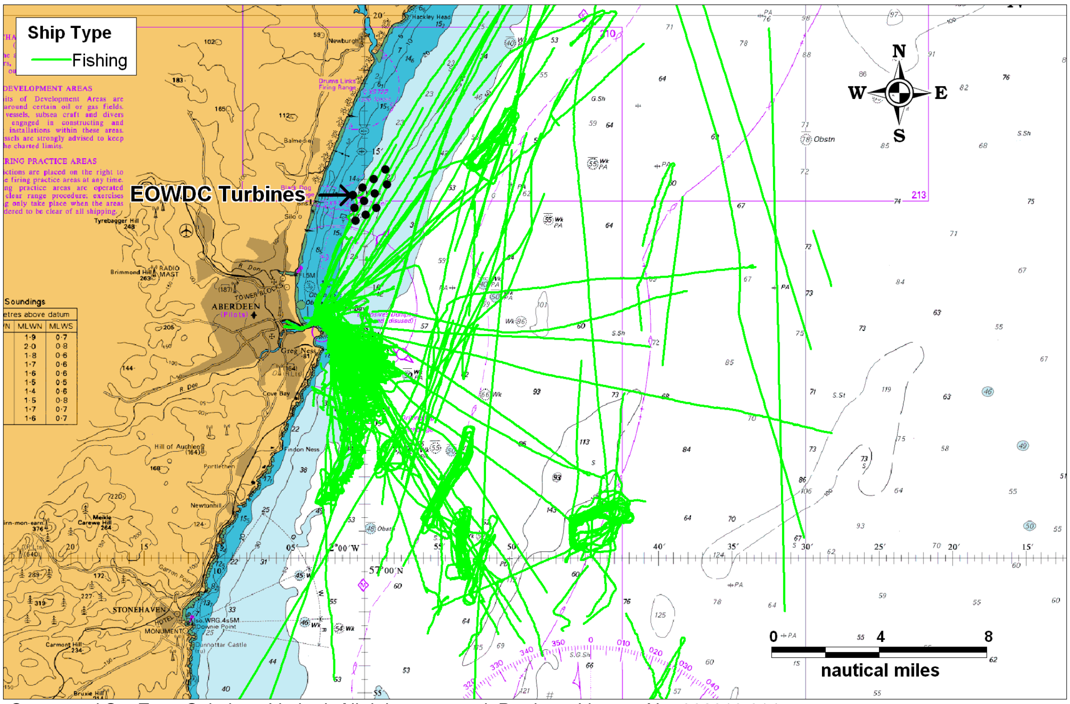


Figure 11.1 All Fishing Vessel Survey Tracks (56 Days)

A total of 4 fishing vessel tracks were logged passing through the proposed EOWDC site during the combined survey period, averaging 1 per fortnight. Details of the vessels are provided in Table 11.1.

Table 11.1 Details of Fishing Vessels Intersecting EOWDC Site during Surveys

Vessel Name	Type	Length (m)	Registered Tonnage	AIS / Radar	Survey
Crystal Tide AH135	Trawler	18.5	75	Radar	1
Boy John INS110	Trawler	20.8	174	Radar	2
Onward BF440	Trawler	21.3	202	AIS	2
Onward BF440	Trawler	21.3	202	AIS	2

Note that all instances of fishing vessels intersecting the proposed site were observed during the first two survey periods in 2009.

Examples of fishing vessels observed during the survey are presented the figures below. It is noted that the photographs are of vessels observed leaving Aberdeen port during the survey. Not all the vessels intersecting the area were photographed due to range and conditions.

Figure 11.2 Photograph of *Fame* A17 during Survey 1

Figure 11.3 Photograph of *Boy Gordon* A441 during Survey 2

Figure 11.4 Photograph of *Crystal Tide* AH135 during Survey 4

11.3 Commercial Fisheries Study

The commercial fishing aspects report (Ref.xvi) carried out for the proposed EOWDC uses the following principal sources of data and information:

- International Council for the Exploration of the Sea (ICES)
- Marine Management Organisation (MMO)
- Marine Scotland, Marine Scotland Science (MS)
- Scottish Fisheries Protection Agency (SFPA)
- European Fisheries Commission (Europa)

Based on the current fishing activity in the area, and the assumption that this will continue after the EOWDC is built, there will be a limited risk of collision between fishing vessels and turbines. In general this is due to the low levels of fishing activity in this area.

There is also potential to impact on the navigation of vessels to and from fishing grounds, for example, increased steaming distances and times. This is mainly an issue during the construction and decommissioning phases when there will be a safety zone and hence there may be some increased steaming distances. During operation there should be sufficient spacing between turbines for vessels to steam through the site if the conditions are considered suitable.

The above was confirmed through consultation with the SFF (Ref. xvii) who indicated there were no major fishing vessel navigational issues associated with the EOWDC proposal.

The risk of interaction between fishing gear and subsea cabling associated with the development is discussed in Section 13.4.

12. FORMAL SAFETY ASSESSMENT

12.1 Introduction

The IMO Formal Safety Assessment process (Ref. xviii) as approved by the IMO in 2002 under SC/Circ.1023/MEPC/Circ392 has been applied within this study. This is a structured and systematic methodology based on risk analysis and cost benefit assessment (if applicable). There are five basic steps within this process:

1. Identification of hazards (a list of all relevant accident scenarios with potential causes and outcomes);
2. Assessment of risks (evaluation of risk factors);
3. Risk control options (devising regulatory measures to control and reduce the identified risks);
4. Cost benefit assessment (determining cost effectiveness of risk control measures); and
5. Recommendations for decision-making (information about the hazards, their associated risks and the cost effectiveness of alternative risk control measures).

Figure 12.1 is a flow diagram of the FSA methodology applied.

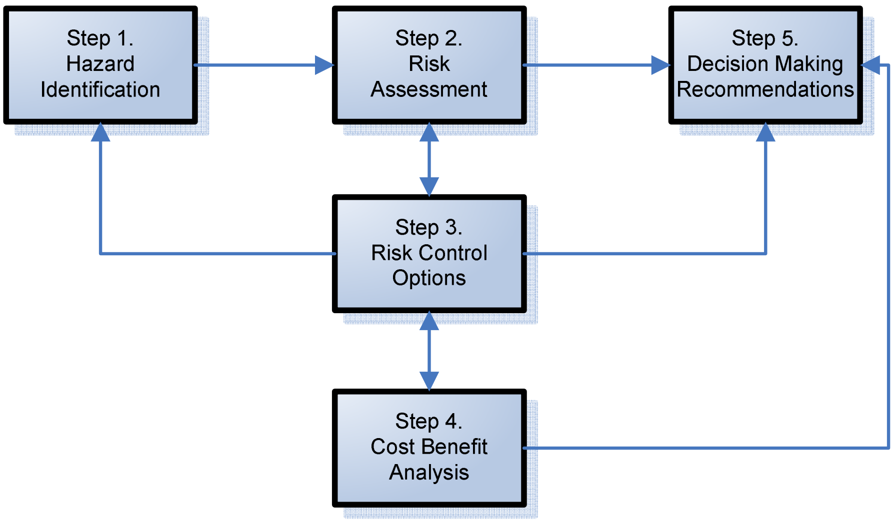


Figure 12.1 Overview of Formal Safety Assessment Methodology

As indicated within the IMO FSA guidelines and the DECC guidance on risk assessment methodology (Ref. i) for offshore renewable projects, the depth of the assessment should be commensurate with the nature and significance of the problem. Within the assessment of proportionality consideration was given to both the scale of the development and the magnitude of the risks/navigational impact.

From review it was concluded that the EOWDC project is a large scale development with the potential to impact navigational safety. As a result, the content and methods of the risk assessment were responsive to this and included the following:

- Comprehensive Hazard Log
- Risk Ranking
- Detailed and quantified Navigational Risk Assessment for selected hazards
- Preliminary search and rescue overview
- Preliminary emergency response overview
- Comprehensive risk control/mitigation measures log

12.2 Hazard Identification

A Hazard Review workshop was held in Aberdeen on 25 August 2010 attended by local stakeholders representing the port and shipping industry, as outlined in Table 12.1. Representatives from MCA, British Chamber of Shipping and NorthLink Ferries were also invited to attend but unfortunately could not make it on the day.

Table 12.1 Hazard Review Workshop Attendees

Name	Organisation
Colin Thomson	James Fisher
Daniel Stroud	Aberdeen Assistant Harbour Master
Brian Turnbull	Marine Safety Forum
David Kenwright	Emergency Response and Rescue Vessel Association
Steve Ferguson*	Marine Safety Forum
Jimmy Chestnutt	Anatec Ltd
Archie Johnstone	Northern Lighthouse Board
Frank Hall	Fisher Offshore
Ray Shaw	Aberdeen Harbour Master
Ian Todd*	AREG
John Sutcliffe	Technip
Nicola Fry	Technip
Liam Dallas-Ross	Anatec Ltd (secretary)
Michael Cain	Anatec Ltd (chairman)

*Attended for part of the meeting

12.3 Key Findings

The focus of the meeting was on shipping navigational hazards and the key findings from the meeting are summarised below:

- It was agreed that all phases of the development need to be appropriately managed to ensure safe navigation:
    - Construction
    - Operation
    - Decommissioning
- Due to the project being a test facility, construction and maintenance activities may be intermittent and would require careful management.
- It was agreed that the construction phase was likely to be prolonged and result in the greatest impact to navigation. This phase was considered as the base case for the Hazard Workshop.
- It was agreed that a project website would provide a useful mechanism for circulating information on the project to the marine industry and keep stakeholders informed about activities associated with the proposed development.
- The main identified impact on shipping was that vessels currently passing close to the East of the site would migrate further east. It was estimated that this displacement of shipping would provide clearance of around 1nm to the turbines. There are no significant sea room restrictions to the East to prevent this happening.
- Concern was expressed that a figure recently circulated showed that the cables could be laid through the anchorage area. This was not acceptable to the marine stakeholders.
- Anatec are to provide more information on the potential effects of wind farms on Marine Radar and other navigational equipment.
- The standard navigational control measures that have been applied to other sites were generally considered the most effective in reducing risks at the site, e.g., marking and lighting.
- Overall the workshop concluded that with the correct mitigation measures in place the navigational risks were likely to be Low.
- It was assessed that although the use of a dedicated support vessel and/or permanent VTS would be beneficial they were not justifiable. It was also agreed that the introduction of a TSS would be unnecessary.

12.4 Risk and Mitigation Measures

The risks involved with the proposed project and the associated mitigation measures are summarised in the following table. In all cases, the competency of mariners has been assumed when assigning the risk of each hazard.

Hazard	Key Points	Mitigation
Commercial ship (powered) collision with turbine.	The vast majority of commercial vessels passing the site tend to naturally avoid it, although it was agreed that shipping will move further to the East passing about 1nm off the turbines. An East Cardinal Mark will result in pushing shipping even further East, and is likely to be swept away. Overall this was not considered necessary. The project are to hold discussions with the Northern Lighthouse Board and UKHO to ensure the project is appropriately marked, lit and depicted on charts, etc. Notices to Mariners to be used to circulate information on the project to stakeholders Competent mariners and the "rules of the road" will contribute to risk reduction. Overall the risks were identified as **LOW**.	Marking and Lighting Sound signal Chart Markings Safety Zones Development Area Notices to Mariners Consultation with Local Users Website
NUC vessel collision	It was highlighted that it was difficult to estimate how often vessels become NUC as this often goes unreported.	Marking and Lighting

Hazard	Key Points	Mitigation
	It was suggested that vessels become NUC most often within 5nm of the port/harbour, when they change engine settings or move from passage to manoeuvring mode. Generally a result of human error. Overall the risks were identified as **LOW** as it was considered unlikely that a vessel would become NUC and drift toward the turbines without sufficient time to drop anchor.	Sound signal Chart Markings (cables) Notices to Mariners Consultation with Local Users Website Cable route away from shipping Appropriate cable protection/burial
Vessel anchoring / dragging anchor	Incident rates of vessels dragging anchor were difficult to quantify for the area. Overall risks were identified as **LOW** as it was considered unlikely that a vessel would drag anchor undetected and drift towards the turbines without starting engines. The main modes of detection were noted as alarm on the bridge, watch keeper/crew detection, and also other vessels at anchor in the anchorage. In addition to this the VTS sets a guard zone with alarm around each vessel when at anchor in the anchorage.	Marking and Lighting Sound signal Chart Markings (cables) Notices to Mariners Consultation with Local Users Website Cable route away from shipping Appropriate cable protection/burial

Hazard	Key Points	Mitigation
Vessel-to vessel-collision due to avoidance of site (includes fishing, recreational and attendant/construction/ maintenance vessels)	An increase in ship-to-ship encounters was identified to be the most likely outcome of the proposed development. However with competent crew/seamanship it was agreed that the risks of ship to ship collision were still likely to be **LOW**. In poor weather it was indicated that vessels are likely to give more sea room to the turbines thereby reducing congestion in periods when visual observation of other vessels was compromised. The vast majority of ships (excluding fishing and recreational) using Aberdeen Harbour have AIS and as a result detection levels will be high so there should be good situational awareness at all times. Radar returns for larger vessels passing 0.7 to 1nm off the turbines are unlikely to be impacted significantly. However smaller vessels exiting the EOWDC site itself have potential to go undetected which could pose difficulty to passing vessels. It was noted that it was extremely unlikely for this event to happen as there was limited small vessel navigation in this area (fishing and recreational) and	Marking and Lighting Sound signal Chart Markings Safety Zones Development Area Notices to Mariners Consultation with Local Users Website Effective Management of Vessels working in site Consultation with fishing and recreational stakeholders.

Hazard	Key Points	Mitigation
	when there was it was very local to Aberdeen so unlikely to exit/enter the site from/to the East. However it was agreed that further discussions should be held with these stakeholders. It is noted that fishing and recreational activity is very limited in the area, however, it is expected that these will both increase within the EOWDC site once it is operational (only small fishing vessels). Further discussions are to be held with both stakeholder groups. A particularly undesirable scenario was recorded as a vessel leaving anchor to go offshore in bad visibility, encountering an inbound vessel. It was agreed that in this instance the vessel leaving anchor would take particular care and that the inbound vessel was likely to pass further off the turbines creating more sea room. In these circumstances most competent mariners would broadcast their intentions to leave the anchorage. With the use of AIS and radar it was concluded that the risks were likely to be well managed by a competent mariner.	

12.5 Risk Analysis

Following identification of the key navigational hazards, risk analyses were carried out to investigate selected hazards in more detail. This allowed more attention to be focused upon the high risk areas to identify and evaluate the factors which influence the level of risk with a view to their effective management. Four risk assessments were carried out as per the DECC guidelines:

1. Base case without wind farm level of risk
2. Base case with wind farm level of risk
3. Future case without wind farm level of risk
4. Future case with wind farm level of risk

The following scenarios were investigated in detail, quantitatively or qualitatively.

Without Wind Farm:

- Vessel-to-vessel collisions

With Wind Farm

- Vessel-to-vessel collisions
- Vessel-to-wind farm collisions (powered and drifting)
- Cable interaction

All the quantified risk assessments were carried out using Anatec's COLLRISK software which conforms to the DECC methodology as outlined in Annex D3 in the Guidance (Ref. i). In line with this, Anatec makes the declaration that the models used within this work have been validated and are appropriate for the intended use. As required the following have been considered and justified:

- Tuning of parameters
- Consistency checks
- Behavioural reasonableness
- Sensitivity analysis
- Comparison with the real world

The results of the detailed risk analyses are presented in Section 13. Where considered appropriate in high risk scenarios, the change in individual and societal risk (based on Potential Loss of Life), as well as the risk of pollution, were calculated and compared to background risk levels in the UK.

12.6 Risk Control Measures

A summary of measures is presented in Section 20.

13. RISK ASSESSMENT

13.1 Introduction

This section assesses the risks identified from the hazard review to require more detailed assessment. This is divided into without EOWDC (pre-installation) and with EOWDC (post-installation) risks.

The base case assessment uses the present day vessel activity level identified from the maritime traffic survey, consultation and other data sources. The future case assessment makes conservative assumptions on shipping traffic growth over the life of the project.

The modelling is based on the current proposed EOWDC set-up, i.e., 11 turbines and assumes the maximum jacket structure (21 m x 21 m (see Section 3.4) (worst case).

13.2 Without Wind Farm Risk

13.2.1 Encounters

An assessment of current ship-to-ship encounters has been carried out by replaying at high-speed two weeks of survey data from Survey 3 in April 2010.

Encounter distances between vessels of 1nm, 0.5nm and 0.25nm were considered. The tracks of vessels during encounters, and heat maps based on the geographical distribution of encounters within a grid of cells, are presented in Figure 13.1 to Figure 13.3. This helps to illustrate where existing shipping congestion is highest and therefore where offshore developments, such as the proposed EOWDC, could potentially exacerbate congestion and hence increase the risk of encounters / collisions.

It can be seen that in all cases, the density of encounters in the vicinity of the proposed EOWDC is minimal.

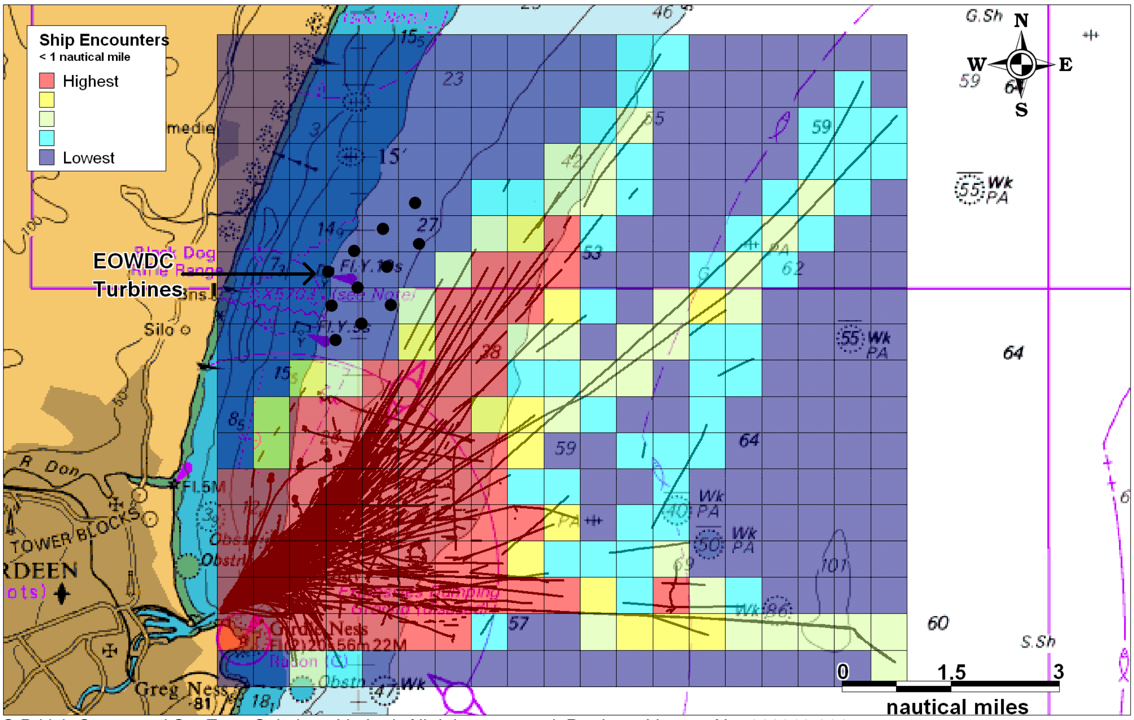


Figure 13.1 Ship Encounters within 1nm

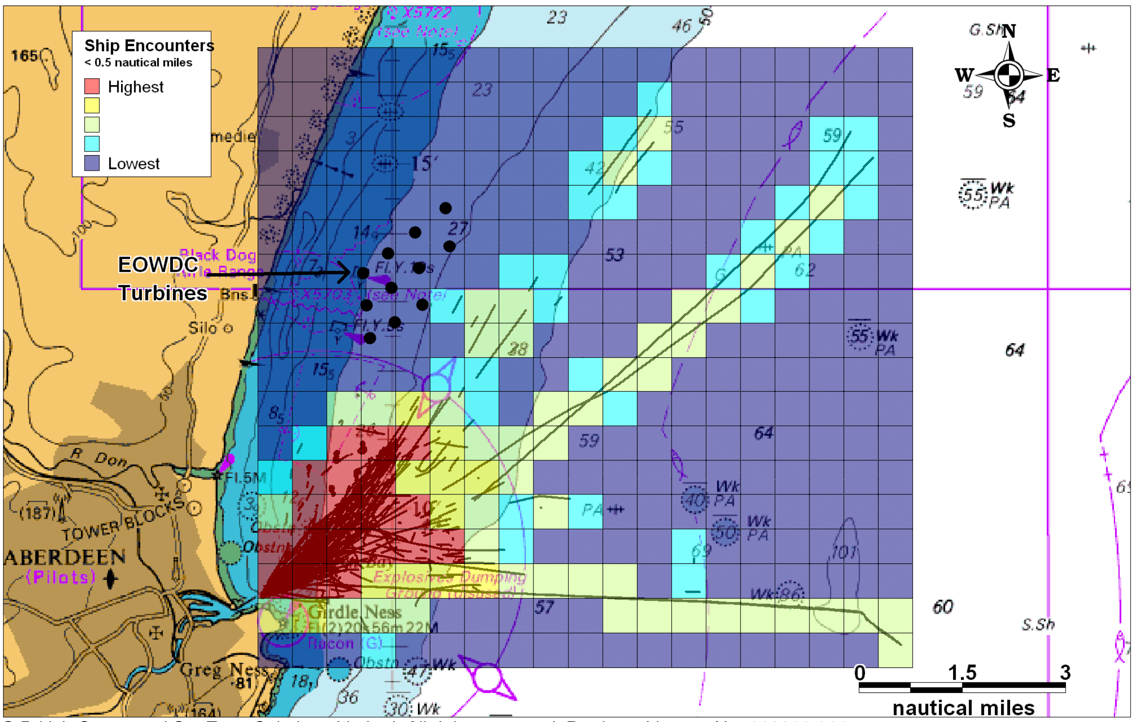


Figure 13.2 Ship Encounters within 0.5nm

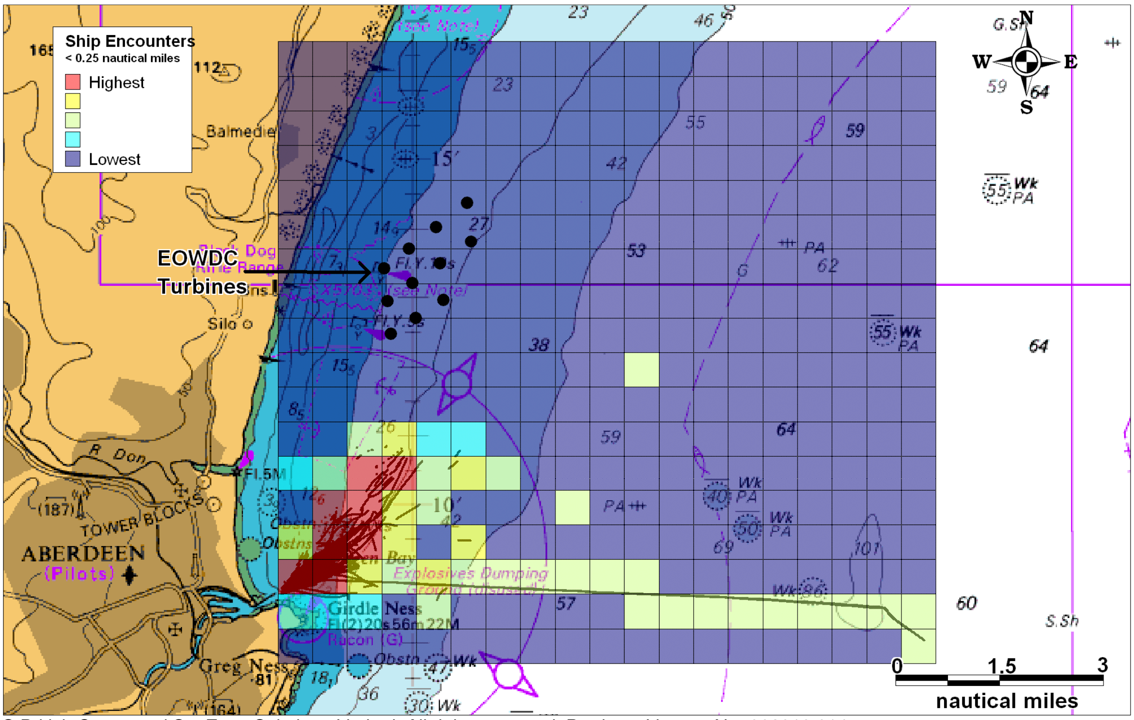


Figure 13.3 Ship Encounters within 0.25nm

Due to the location of the proposed EOWDC site (i.e., near a port), an encounter distance of 0.5nm has been used for further analysing encounters.

There were 789 encounters during the 14-day period. Figure 13.4 presents the number of encounters per day.

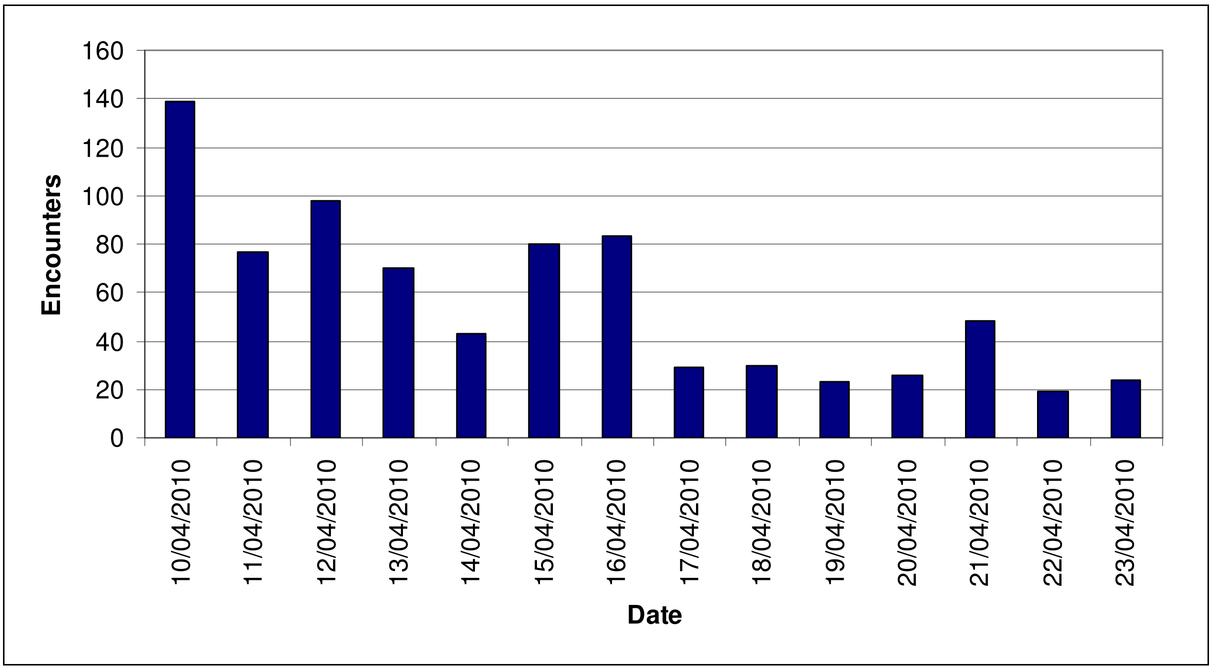


Figure 13.4 Number of Encounters per Day

The average number of encounters was 56 per day, with the highest number (139 encounters) observed on 10 April 2010.

Figure 13.5 presents the distribution of vessel types involved in encounters (excluding unspecified).

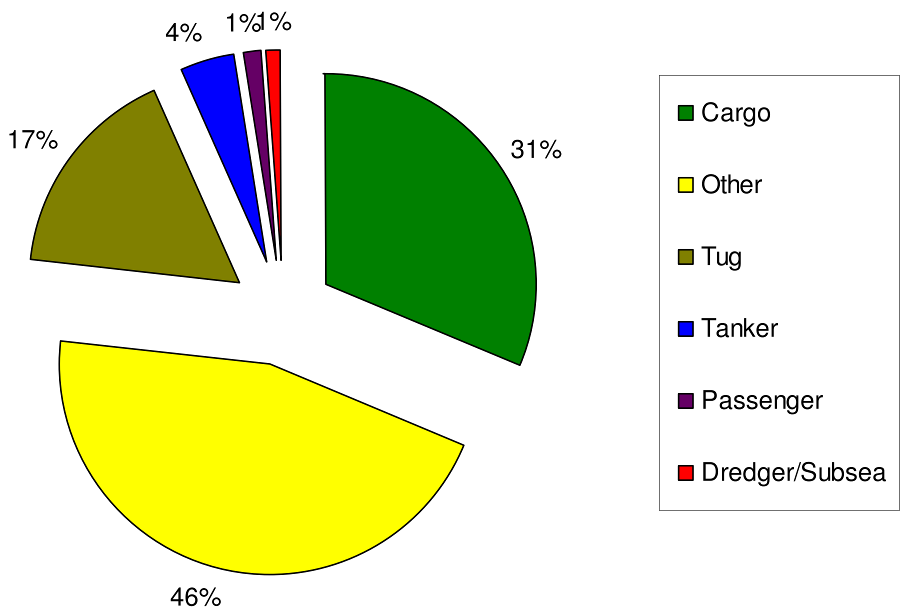


Figure 13.5 Vessel Types Involved in Encounters

It can be seen that the majority of encounters involved 'other ships' (46%) and cargo vessels (31%). The majority of both are offshore industry support vessels.

The locations of encounters during the 14 day period are presented in Figure 13.6. A density map of the encounters is presented in Figure 13.7.

The vast majority of encounters occurred where ships converge on approach to or departure from Aberdeen Harbour to the south of the proposed EOWDC site. There were no encounters recorded within the proposed turbine locations although there were a few close to the eastern boundary of the proposed site.

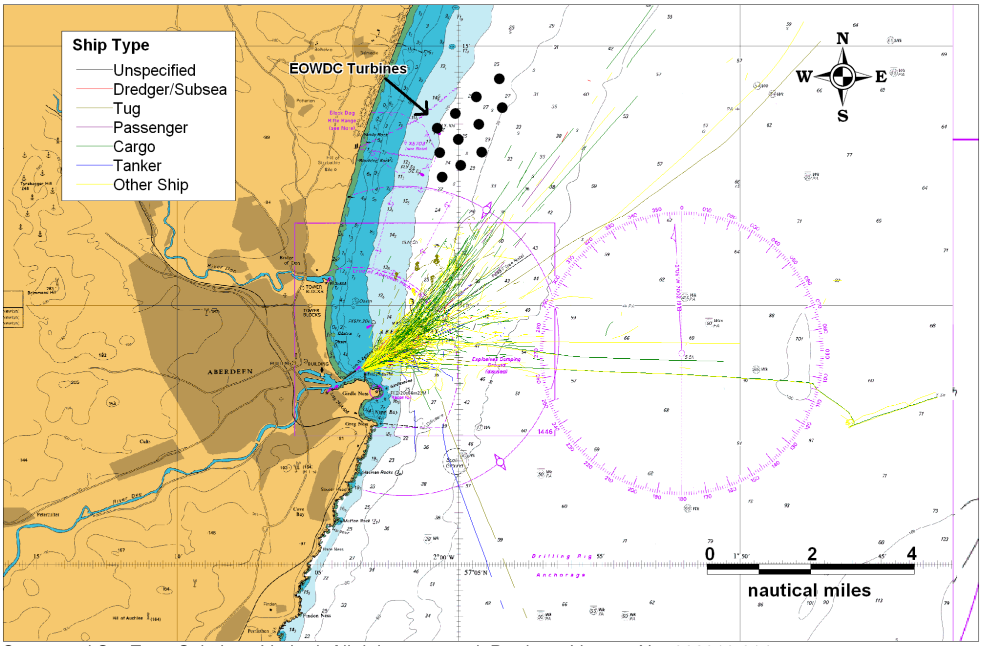


Figure 13.6 Overview of Encounters <0.5nm during 14 Days (AIS)

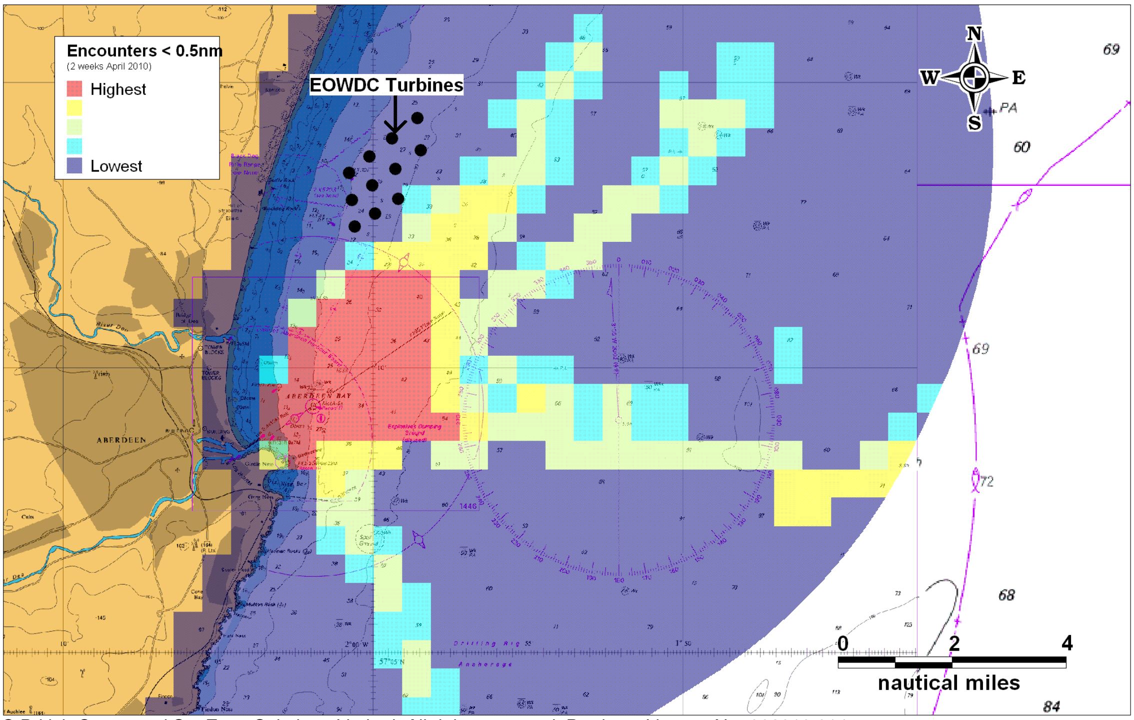


Figure 13.7 Density Distribution of Encounters < 0.5nm

13.2.2 Vessel-to-Vessel Collisions

Based on the existing routeing and encounter levels in the area, Anatec's COLLRISK model has been run to estimate the existing vessel-to-vessel collision risks in the local area around the proposed EOWDC site. The route positions and widths are based on the survey analysis with the annual densities based on port logs and Anatec's ShipRoutes database, which takes seasonal variations into consideration.

Based on the model run for the area, the baseline vessel-to-vessel collision risk level pre-wind farm is in the order of 1 serious collision in just over 153 years[1].

It is emphasised the model is calibrated based on major incident data at sea which allows for benchmarking but does not cover all incidents, such as minor impacts, or incidents occurring within port. Other incident data from RNLI and MAIB is presented in Section 7. This includes other minor incidents including collisions in port (all five collisions reported by MAIB within 10nm of the site were in Aberdeen Harbour).

13.3 With Wind Farm Risk (Base Case)

13.3.1 Vessel-to-Vessel Collisions – Change in Risk

The revised routeing pattern following construction of the proposed EOWDC project has been estimated based on the review of impact on navigation (see Section 8.6). The main change is displacement of ships passing close to the site area on approach/departure from Aberdeen. It is assumed that ships will be able to pre-plan their revised passage in advance of encountering the proposed site due to effective mitigation in the form of information distribution about the development to shipping through Notices to Mariners, updated charts, liaison with ports, etc. Fishing vessels may also be displaced from the site to other areas, which could increase the frequency of encounters.

Based on vessel-to-vessel collision risk modelling of the revised traffic pattern, the collision risk was estimated to increase to 1 major collision in 150 years. The change in collision frequency due to the proposed EOWDC was estimated to be 1.3×10^{-4} per year.

As noted earlier, the model is calibrated based on major incidents at sea which allows for benchmarking but does not cover all incidents, such as minor impacts, or incidents occurring within port.

[1] Note that the models have been calibrated against 'serious' casualty data at sea. This excludes incidents in port, e.g., minor bumps during berthing, requires the incident to be of a defined degree of seriousness in terms of loss of life, environmental damage and/or financial impact. Non-serious casualties are estimated to be in the order of 4 times more frequent than serious casualties. Anatec's models are calibrated against serious casualties as this minimises the probability of under-reporting and provides a benchmark level when comparing the frequency of accidents in different parts of the World.

The following potential effects have not been quantified but may indirectly influence the vessel-to-vessel collision risk:

- Radar interference
- Visual obscuration when ships approach each other

Radar interference is discussed in Section 15. It is noted that any potential impact is only likely to be a problem during bad visibility and this is mitigated to an extent by the widespread adoption of AIS which will assist vessels in discriminating genuine targets (although AIS is not currently mandatory for smaller vessels, e.g., fishing and recreational vessels). Ships may also call Aberdeen VTS if unsure whether a radar target is genuine.

The visual aspect is reviewed in Section 19.2 and is not considered a significant factor for the proposed EOWDC site due to its position and orientation relative to the shipping lanes and the other navigational features in the area.

13.3.2 Ship Collision with Structure

There are two main scenarios for passing ships colliding with offshore structures such as wind turbines:

- Powered Collision:
  - Where the vessel is under power but errant
- Drifting Collision:
  - Where a ship on a passing route experiences propulsion failure and drifts under the influence of the prevailing conditions.

Each scenario is assessed below.

<u>Powered Ship Collision</u>
Based on the ship routeing identified for the area and the anticipated change in routeing due to the site, and assuming effective mitigation in terms of making mariners aware of the site through Notices to Mariners, charts, lights and markings, etc., the frequency of an errant ship under power deviating from its route to the extent that it comes into proximity with the proposed EOWDC site is not considered to be a likely event.

From consultation with the shipping industry it is assumed that merchant ships will not attempt to navigate between turbines due to the restricted sea room and will be directed by the navigational aids in the area.

The main risk of powered collision with a wind farm structure is from human error on the bridge of the ship, however, the proximity to the coastline and Aberdeen port should mean that mariners are already very attentive to their vessel's position and proximity to other vessels and obstructions in this area.

Based on modelling the revised ship routeing pattern estimated with the proposed EOWDC structures in place and using local metocean data, the risk of a passing powered ship collision was estimated to be 1.1 x 10^{-3} per year (approximately 1 in 871 years) for all 11 turbines.

The individual turbine collision frequencies ranged from 4 x 10^{-4} for Turbine 7 to 8.6 x $10^{-6}$for Turbine 3 This compares to the historical average of 5.3 x 10^{-4} per installation-year for offshore installations on the UKCS. A bar chart showing the passing powered collision frequency for each structure relative to the historical benchmark is presented in Figure 13.8. The risk per turbine is below the historical average, which reflects the smaller size of turbines compared to typical North Sea installations, as well as the shipping characteristics of the area.

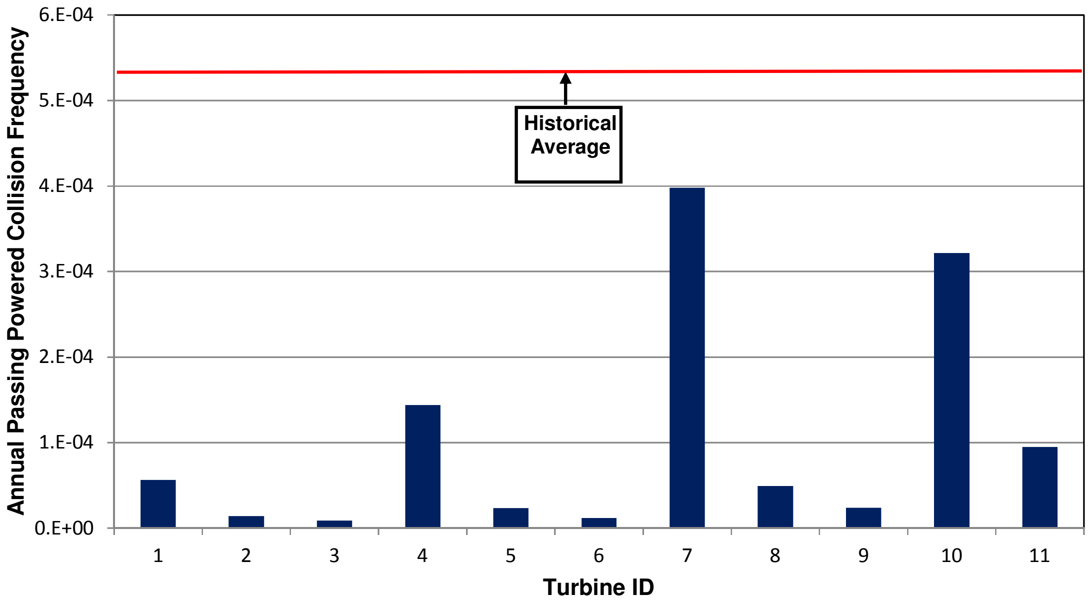


Figure 13.8 Annual Passing Powered Collision Frequency for the 11 Turbines

<u>Drifting Ship Collision</u>

The risk of a ship losing power and drifting into an EOWDC structure was assessed using Anatec's COLLRISK model. This model is based on the premise that propulsion on a vessel must fail before a vessel will drift. The model takes account of the type and size of the vessel, number of engines and average time to repair in different conditions.

The exposure times for a drifting scenario are based on the ship-hours spent in proximity to the proposed EOWDC site (up to 10nm from turbines). These have been estimated based on the traffic levels, speeds and revised routeing pattern. The exposure is divided by vessel type and size to ensure these factors, which based on analysis of historical accident data have been shown to influence accident rates, are taken into account within the modelling.

Using this information the overall rate of breakdown within the area surrounding the project was estimated. The probability of a ship drifting towards a structure and the drift speed are dependent on the prevailing wind, wave and tide conditions at the time of the accident.

The following drift scenarios were modelled:

- Wind
- Peak Spring Flood Tide
- Peak Spring Ebb Tide

The probability of vessel recovery from drift is estimated based on the speed of drift and hence the time available before reaching the wind farm structure. Vessels that do not recover within this time are assumed to collide.

After modelling the three scenarios it was established that wind-dominated drift produced the worst case results for the proposed EOWDC, therefore, this result is presented. This was mainly due to the majority of tidal based drifts being parallel to the site rather than towards it.

The annual drifting ship collision frequency with the Aberdeen structures (all 11 turbines) was estimated to be 5.4×10^{-5} per year corresponding to an average of one drifting ship collision in 18,600 years. The low risk levels reflect the fact that a drifting collision is a low probability event. (There have been no reported ‘passing’ drifting ship collisions with offshore installations on the UKCS in over 6,000 operational-years. Whilst a large number of drifting ships have occurred each year in UK waters, most vessels have been recovered in time, e.g., anchored, restarted engines or taken in tow. There have also been a small number of ‘near-misses’.)

The majority of the drifting vessel collision frequency is associated with the more easterly turbines, e.g., Turbines 4, 7 and 10. The westerly turbines tend to be partially shielded from drifting events.

13.3.3 Fishing Vessel Collision

Anatec’s COLLRISK fishing vessel risk model has been calibrated using fishing vessel activity data along with offshore installation operating experience in the UK (oil and gas) and the experience of collisions between fishing vessels and UKCS offshore installations (published by HSE).

The two main inputs to the model are the fishing vessel density for the area and the structure details. The fishing vessel density in the area of the proposed EOWDC was based on the number of sightings per patrol in the five-year period 2005-09. The maximum dimensions of the 11 proposed turbines have also been input.

Using the above site-specific data as input to the model, the annual fishing vessel collision frequency with the proposed EOWDC turbines was estimated to be 1.1 x 10^{-3}, which corresponds to an average of 1 collision in 873 years. This collision frequency reflects the relatively low density of fishing vessels operating in the area.

13.3.4 Recreational Vessel Collision

There are two main collision hazards from recreational vessels interacting with wind farms:

1. Turbine Rotor Blade to Yacht Mast Collision
2. Vessel Collision with Main Structures

Blade/Mast Collision:
A collision between a turbine blade and the mast of a yacht could result in structural failure of the yacht.

For a blade/mast collision to occur, the air draught of the yacht (from water-line to top of masthead) must be greater than the available clearance under the area swept by the rotating blade.

The planned minimum rotor blade clearance for the turbines is at least 22m above Mean High Water Springs (MHWS), which matches the MCA minimum requirement and recommendation of RYA. This is the clearance when the blade is in its lowest ('6 o'clock') position. The actual clearance at a given time will depend upon the prevailing tide and wave conditions, i.e., lower clearance at high water and rough seas, greater clearance at low water and calm seas.

To determine the extent to which yacht masts could interact with the rotor blades, details on the air draughts of the IRC fleet are provided in Figure 13.9 based on a fleet size of over 3,000 vessels. IRC is a rating (or 'handicapping' system) used Worldwide which allows boats of different sizes and designs to race on equal terms. The UK IRC fleet, although numerically only a small proportion of the total number of sailing yachts in the UK, is considered representative of the range of modern sailing boats in general use in UK waters.

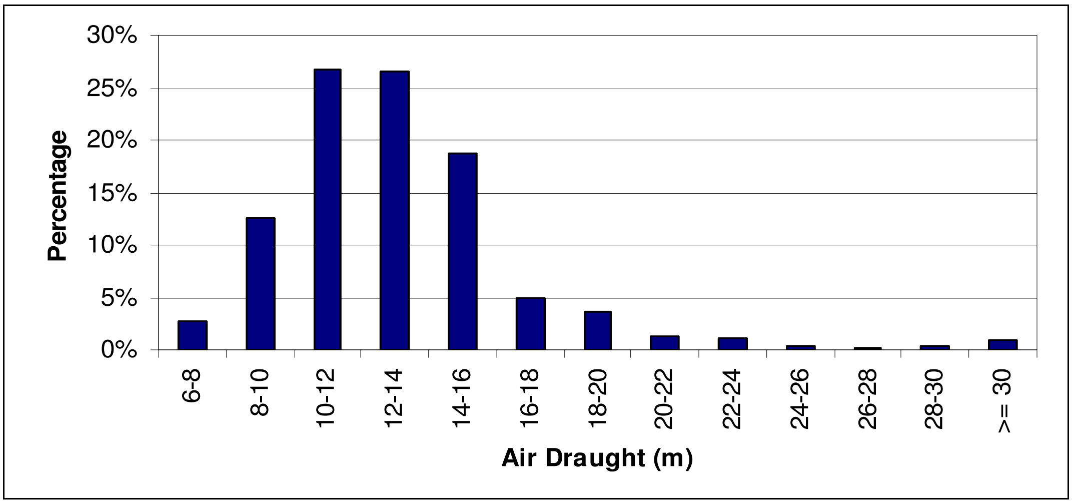


Figure 13.9 Air Draught Data – IRC Fleet (2002)

From this data, just under 3% of boats have air draughts exceeding 22m. Therefore, only a fraction of vessels could potentially be at risk of dismasting if they were directly under a rotating blade in the worst-case conditions. It is also noted that with these larger vessels, crews are likely to be greater in numbers and passage planning will give particular attention to air draught and safe avoidance of potential hazards.

It is further noted that the proposed EOWDC will be designed and constructed to satisfy the requirement of the Maritime & Coastguard Agency in respect of control functions and safety features, as specified in the MCA standards (Ref. ii).

The most likely reason for the Emergency Management System being ineffective is considered to be the mariner failing to alert the Coastguard either directly or indirectly using VHF, mobile phone, flares, etc. It is noted that very large yachts, which are the only boats that could potentially interact with the rotor blades, are also most likely to be equipped with VHF radio and other safety equipment.

Based on the information presented in this section, the risk of the dismasting of a yacht by a rotating blade of an EOWDC turbine is assessed to be minimal, and has not been further quantified.

Vessel/Structure Collision

In good conditions the proposed EOWDC should be visible, especially as most activity occurs during daylight hours. In this case, vessels, if competently skippered, will be able to navigate safely to avoid the structures. Even if a vessel were to get into difficulty, most should be able to keep clear of the structures or anchor or moor if necessary to avoid drifting closer to the proposed EOWDC whilst they fix the problem or call for assistance.

The main risk of collision is considered to be in bad weather, especially poor visibility, where a small craft could fail to see the proposed EOWDC and inadvertently end up closer than intended.

If there were poor visibility combined with adverse weather and/or strong tides, the vessel may not be able to anchor.

The risk of small craft being in the area during bad weather is reduced by the fact that most craft are fitted with radio receivers and VHF so will be able to listen to regular broadcasts of the weather forecast by the BBC and Coastguard. It is also standard practice for local clubs to post weather forecasts on notice boards.

Given the ready availability of weather forecasts and growing use of GPS, the risk of a vessel being in proximity to the proposed EOWDC in bad weather is considered to be low but not negligible. In this scenario, a vessel unable to make way from the proposed EOWDC and at risk of collision may alert Aberdeen VTS and the Coastguard using mobile phone, VHF or flares.

To minimise the risk of collision in this worst case scenario, mitigation in line with regulator guidance will be put in place. It will be ensured, consistent with the requirements of NLB, that the structures are marked in such a way as to enhance the prospect of visual observation by passing recreational craft even in adverse conditions.

The Operator will also ensure notification of the development to the recreational craft community is widespread and effective throughout all phases.

These measures mean that whilst the collision risk cannot be completely eliminated it will be reduced to a level as low as reasonably practicable. In terms of consequences, any collisions with the turbines would be relatively low speed and hence low energy. If the seaworthiness of the recreational craft was threatened by the impact, the turbines will be equipped with access ladders for use in emergency, placed in the optimum position taking into account the prevailing wind, wave and tidal conditions, as required by the MCA. This should provide a place of safety/refuge until such time as the rescue services arrive.

13.4 Cable Interaction – Anchor and Trawl

The following figure provides an overview of the export cable corridor versus the most recent survey data on vessel anchoring (survey 5 from 18th February 2011 to the 4th March 2011).

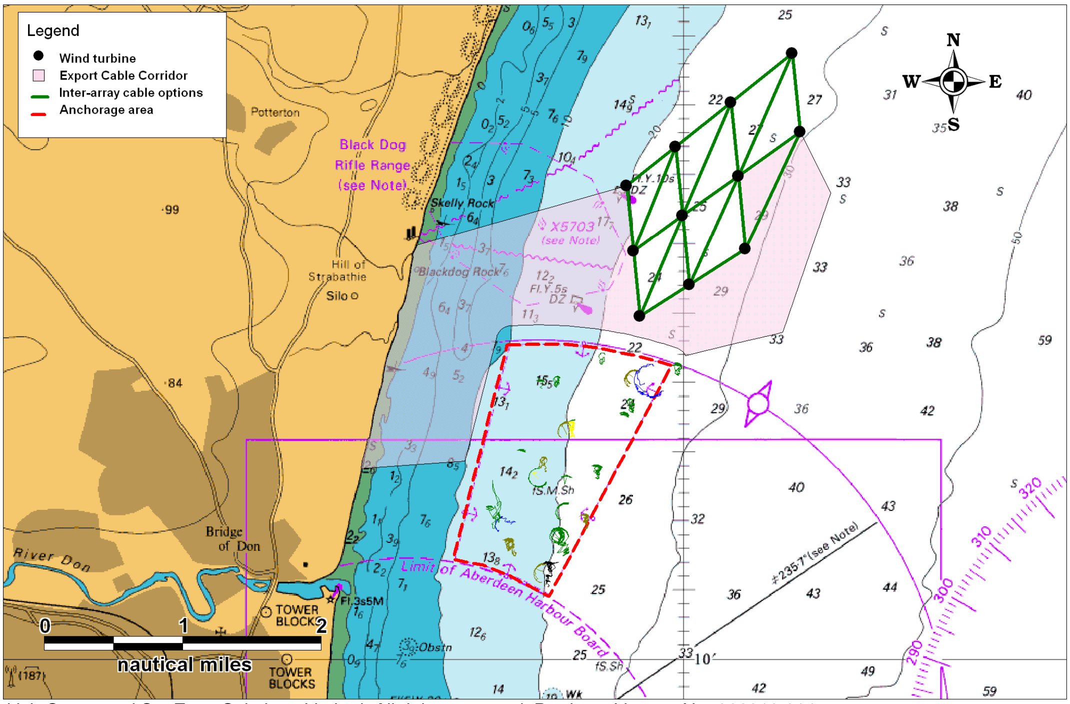


Figure 13.10 Indicative Export Cable Corridor

The main points to note from the figure are:

- There is a 200m buffer between the corridor and the designated anchorage to reduce the risks of interaction between anchoring vessels and the cable.

- Anchored vessels are observed to anchor within the newly designated area thereby staying clear of the cable corridor

There is limited fishing vessel activity in this area (see Section 11) and that the cables are to be buried to a depth between 0.6 and 3m, to reduce the likelihood of interaction.

13.5 Future Case Level of Risk

13.5.1 Shipping

The main factor that is likely to influence the future levels and composition of shipping in the vicinity of the proposed EOWDC is the traffic using Aberdeen Harbour.

Aberdeen Harbour is one of the busiest Trust Ports in the UK. An economic impact assessment of Aberdeen Harbour (Ref. xix), identified its principal activities as follows:

- Marine support for the offshore oil and gas industry in North-west Europe: Aberdeen is well placed to take advantage of the North Sea sector due to its strategic location and comprehensive infrastructure.

- The principal commercial port for North-east Scotland: The Harbour handles a range and scale of general cargo to and from other ports in Europe and has positioned it as the principal commercial port for North-east Scotland, the major mainland port serving the Northern Isles of Orkney and Shetland and as a centre of international trade. Aberdeen Harbour is the nearest port on the UK mainland to Norway, Sweden, Finland, Russia and the Faroe Islands and is the closest Scottish port to the German and Baltic ports. The Harbour is also an international port, with direct, regular connections to around 30 countries including countries in West Africa and the Far East.

- Ferry and cruise services: Aberdeen Harbour has become a principal mainland terminal for ferry services to Norway and to the Northern Islands of Orkney and Shetland. It is also a port of call for cruise ships.

- A gateway for the agriculture industry: Aberdeen Harbour's proximity to rural hinterland makes it ideal for the import and export of agricultural products. In recent years a transit shed has been dedicated for grain export. The Harbour also handles seasonal imports of livestock including sheep and cattle from the Northern Isles.

- A major centre for the import of forest products and the export of finished paper products

Data published by Aberdeen Harbour Board indicates the following changes in ship numbers and goods handled in recent years.

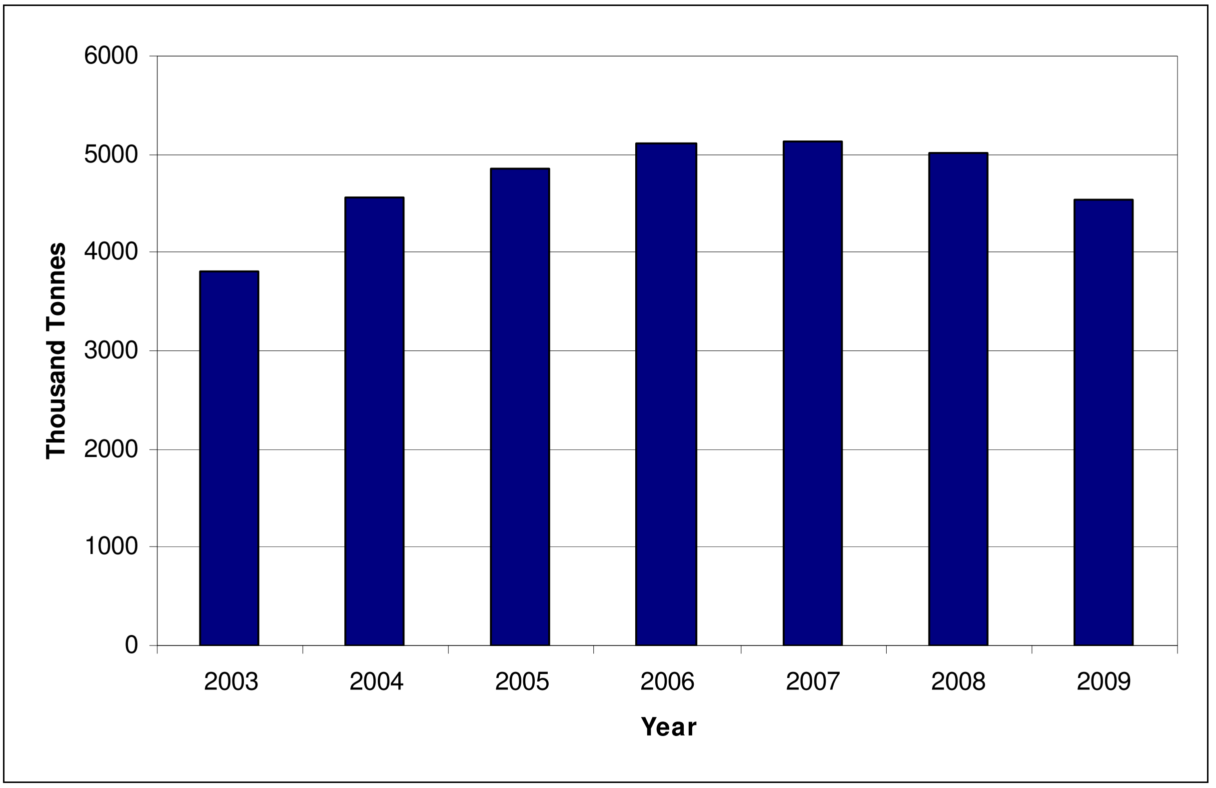


Figure 13.11 Tonnage through Aberdeen Harbour (AHB)

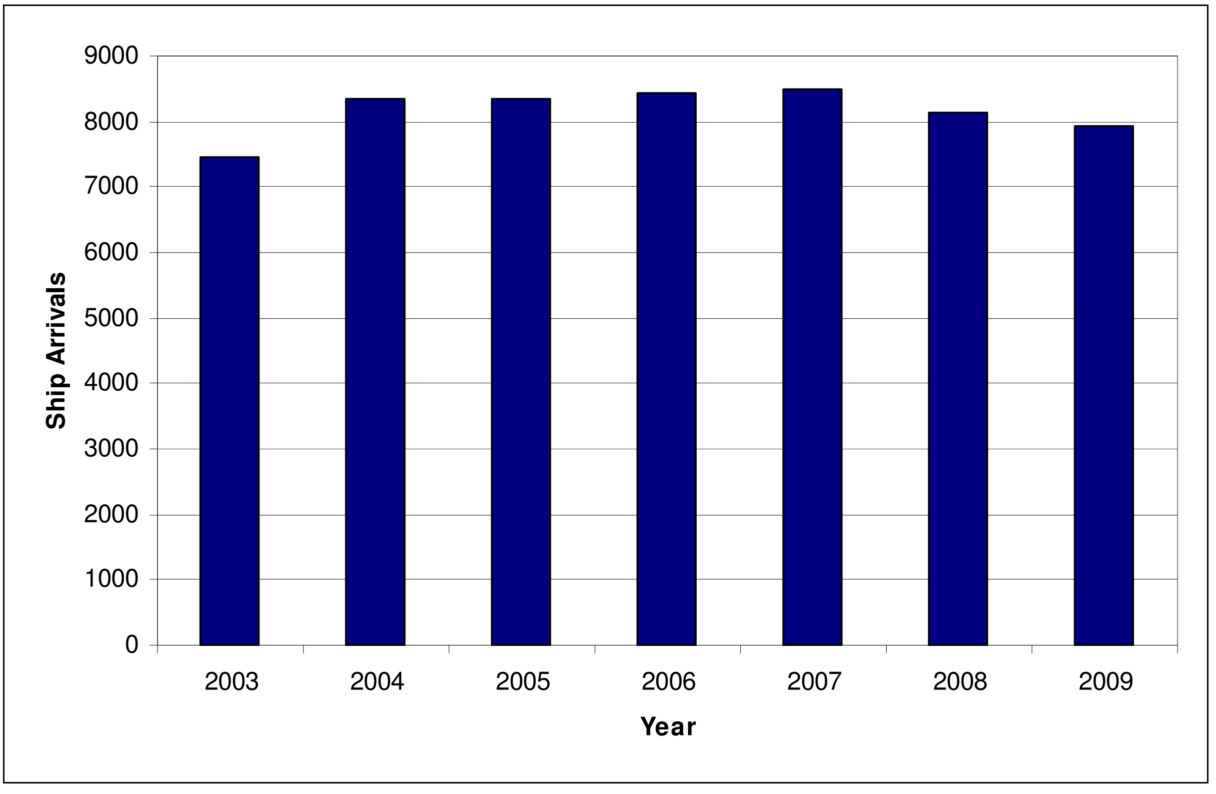


Figure 13.12 Ships through Aberdeen Harbour (AHB)

The number of ships has increased by 6% compared to a tonnage increase of 19% over the period 2003-09. This reflects a general trend in the shipping industry where increased trading tonnages are mainly being achieved through the use of larger vessels as opposed to increased ship movements.

Longer term tonnage data for Aberdeen based on Department for Transport statistics (Ref.xx) are presented in Figure 13.13. (The DfT tonnages for 2003-09 differ slightly from the AHB data but they are reasonably well aligned.)

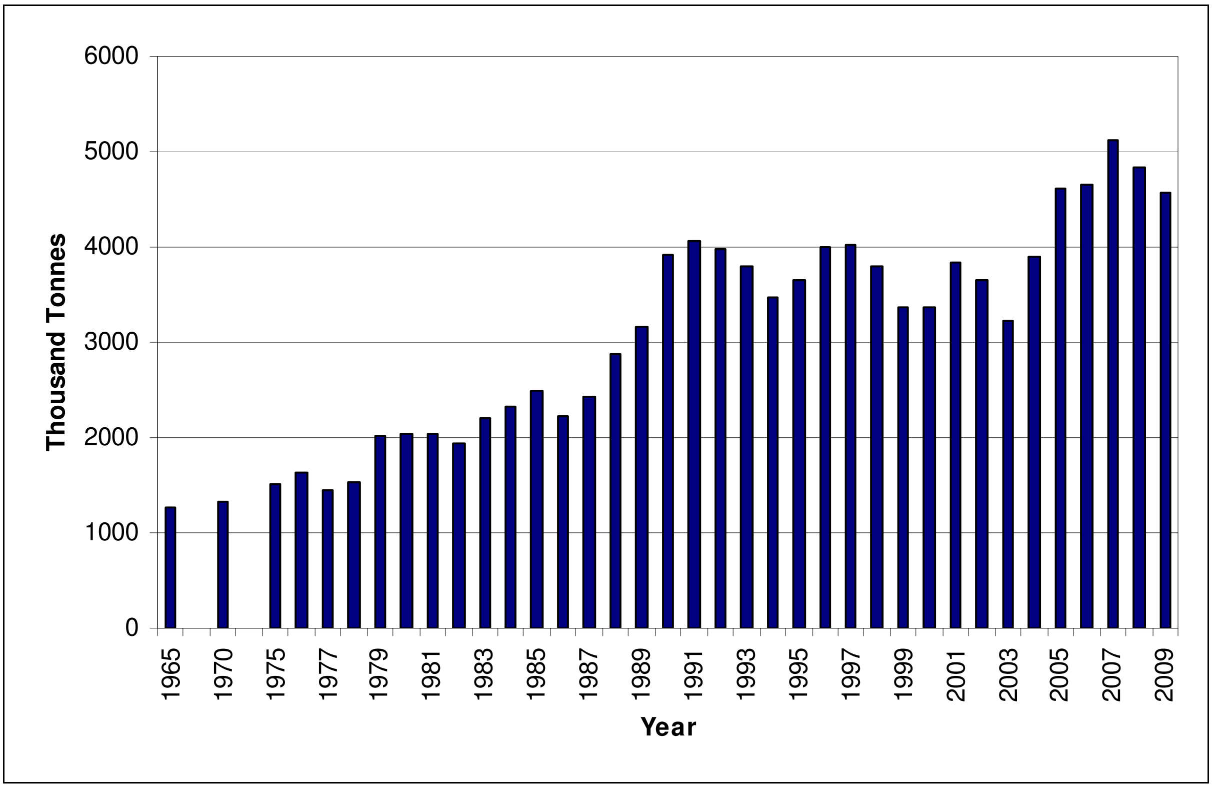


Figure 13.13 Total Tonnage through Aberdeen Harbour (DfT 1965-2009)

Between 1965 and 2009, tonnage has more than trebled. However, in the last 20 years between 1990 and 2009, the overall increase has only been 17%.

Based on the consultation meetings carried out during the project, including several meetings with AHB, no proposals were identified which are likely to have a significant impact on the volume of shipping using the Harbour in the next few years.

The key NW-SW route passing to the east of the proposed EOWDC site is predominantly used by oil & gas industry vessels, and to a lesser extent cargo and passenger ferry services to the Northern Isles. The key factor influencing ship numbers is likely to be the strength of the oil & gas sector in future years. In the long-term, this is expected to decline but the timescale for this is uncertain.

It has been conservatively assumed that over the life of the proposed EOWDC (22 years), there will be a 10% increase in shipping movements.

13.5.2 Fishing

The Commercial Fisheries assessment (Ref.xvi) carried out for the proposed EOWDC Environmental Statement considered the potential changes to the fishing baseline over the life of the development. It is recognised this is a speculative exercise due to numerous unpredictable, direct and indirect factors which can materially affect fisheries.

It stated the following:

> *"At present no new fisheries are foreseen in the area surrounding Aberdeen Bay, and in all probability there is unlikely to be an increase in either fishing effort or vessel numbers. It is also possible that increasing conservation concerns will lead to the implementation of designated protected marine conservation areas which will conceivably have the effect of enforcing further restrictions upon certain commercial fishing activities.*
>
> *There exists the possibility that fishing practices within the proposed EOWDC site could change during its operational life. An example is the appearance of large shoals of squid inshore during the summer in the Moray Firth, providing a valuable fishery which previously did not exist. Furthermore, squid has been recorded at low levels in inshore areas in the proximity of the proposed EOWDC site. It is however considered that this species favours rockier grounds and that the substrate in Aberdeen Bay is not suitable.*
>
> *Finally, future environmental and/or economic constraints may force fishermen to alter or amend current fishing practices. It is possible that vessels may be reconfigured with alternative gear, either to target the same species, or a different fishery."*

The Hazard Review Workshop also indicated that fishing by smaller vessels within the EOWDC site may increase slightly due to the development of the proposed EOWDC.

Based on the discussion presented, the future level of activity has been assumed to increase by 10% over the life of the proposed EOWDC compared to current levels.

13.5.3 Recreational

In terms of recreational vessel activity, there are no major developments known of that will increase the activity of these vessels in the area. There have been suggestions from time to time that a marina for recreational vessels could be established in Aberdeen but there are no known plans for this.

It was suggested at the Hazard Review workshop that the turbines could attract sightseers, given their proximity to the shore.

Based on the discussion presented, the future level of activity has been assumed to increase by 10% over the life of the proposed EOWDC compared to the current, low levels.

13.5.4 Collision Probabilities

The potential increase in vessel activity levels would increase the probability of ship-to-structure collisions (both powered and drifting). Whilst in reality the risk would vary by vessel type, size and route, it is roughly estimated this would lead to a linear 10% increase in the base case collision risks.

The increased activity would also increase the probability of vessel-to-vessel encounters and hence collisions. Whilst this is not a direct result of the proposed project, the increased congestion caused by the site and potential displacement of traffic in the area may have an influence. Again a 10% overall increase is assumed over the life of the proposed EOWDC.

13.6 Risk Results Summary

The base case and future case annual levels of risk without and with the proposed EOWDC site are summarised in Table 13.1 and Figure 13.14. The change in risk is also shown, i.e., the estimated collision risk with the EOWDC minus the baseline collision risk without the EOWDC (which is zero except for vessel-to-vessel collisions).

Table 13.1 Summary of Results

Collision Scenario	Base Case			Future Case		
	Without	With	Change	Without	With	Change
Passing Powered	--	1.1E-03	1.1E-03	--	1.3E-03	1.3E-03
Passing Drifting	--	5.4E-05	5.4E-05	--	5.9E-05	5.9E-05
Vessel-to-Vessel	6.6E-03	6.7E-03	1.3E-04	7.2E-03	7.3E-03	1.4E-04
Fishing	--	1.1E-03	1.1E-03	--	1.3E-03	1.3E-03
Total	6.6E-03	9.0E-03	2.5E-03	7.2E-03	9.9E-03	2.7E-03

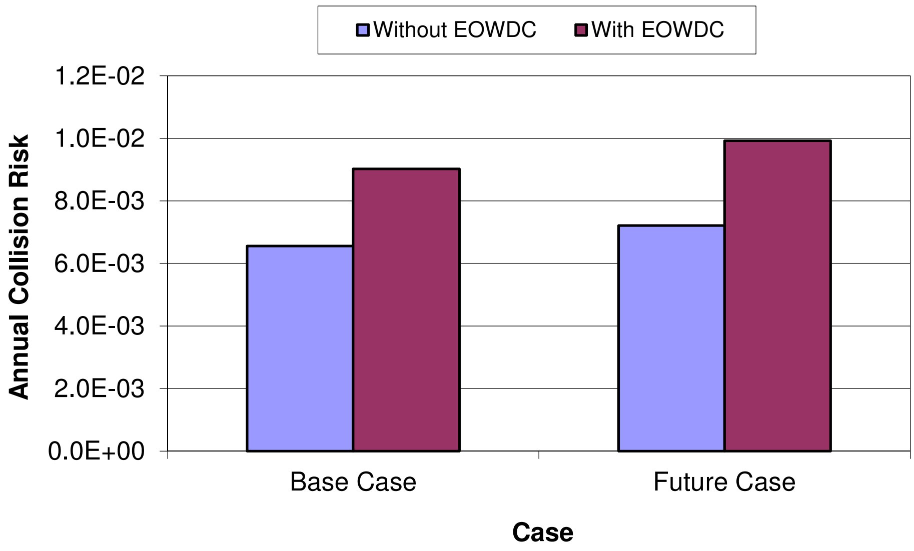


Figure 13.14 Summary of Results

The overall annual level of collision risk is estimated to increase due to the proposed project by approximately 1 in 404 years (base case) and 1 in 367 years (future case). The majority of this risk is from passing powered ship collisions with the turbines on the closest passing route heading in and out of Aberdeen (SSW/NNE), followed by fishing vessel collisions.

The increases are relatively low compared to the existing maritime risks in the area.

13.7 Consequences

The probable outcomes for the majority of hazards are expected to be minor. However, the worst case outcomes could be severe, including events with potentially multiple fatalities.

A collision involving a larger ship is likely to result in collapse of a turbine with limited damage to the ship. Breach of a ship's fuel tank is considered unlikely and in the case of vessels carrying hazardous cargoes, e.g., tanker or gas carrier, the additional safety features associated with these vessels would further mitigate the risk of pollution. Similarly, in a drifting collision the proposed EOWDC structure is likely to absorb the majority of the impact energy, with some energy also being retained by the vessel in terms of rotational movement (glancing blow).

In terms of smaller vessels such as fishing and recreational craft, the worst case scenario would be risk of vessel damage leading to foundering of the vessel and potential loss of life.

A quantitative assessment of the potential consequences of collision due to the proposed EOWDC project is presented in Appendix D. This applies the site-specific collision frequency results presented above with estimated outcomes in terms of fatalities onboard and oil pollution from the vessel based on research into historical collision incidents (MAIB, ITOPF, etc.). The results are summarised in Table 13.2. It is noted that these are based on a conservative approach to give account to the uncertainty surrounding the jacket sub-structure foundation type.

Table 13.2 Annual Predicted Change in Collision Risk due to the proposed EOWDC

Criteria	Base Case	Future Case
Potential Loss of Life (PLL)	1 fatality in 43,000 years	1 fatality in 39,000 years
Oil Spill	0.039 tonnes	0.043 tonnes

Comparing the above estimates with the background marine accident risk levels in the UK (29 fatalities and 16,111 Tonnes of Oil Spilt per annum), the incremental increase in risk to both people and the environment caused by the proposed EOWDC was estimated to be low.

However, it should be noted that this is the localised impact of a single project and there will be additional maritime risks associated with other offshore wind farm projects in Scotland as well as in the UK as a whole.

14. CONSTRUCTION AND DECOMMISIONING IMPACTS

14.1 Introduction

This study has primarily focused on the operational and maintenance phase of the proposed EOWDC, however, it is recognised that there will be additional potential impacts during the construction and decommissioning phases of the project.

In general, whilst the same hazards apply as during the operational and maintenance phase, there are additional hazards which are distinctly associated with these phases of the project and require different risk control measures.

14.2 Hazards during Construction/Decommissioning

During the construction/decommissioning phase there will be an increased level of vessel activity within the proposed EOWDC site and along the cable route.

The presence of construction vessels within the area is likely to pose an additional navigational risk, although such vessels can also provide on-site response and mitigation. The main hazards associated with construction/decommissioning which have been identified over and above those associated with all phases (i.e., where the same risk control measures and emergency response will apply during all phases) are listed below.

- Construction vessel collision with another vessel on-site
- Construction vessel collision with structure
- Construction vessel collision with passing vessel en route to or from site
- Construction vessel encounters (jack-ups or anchors on) underwater obstruction (e.g., cable, pipeline etc).
- Construction vessel jacks-up or anchors onto unexploded ordnance
- Man overboard during personnel transfer operations
- Dropped object during major lifting operations

It is noted that to a large extent the hazards will depend on the vessels and procedures which are to be used for these operations. This will not be known in detail until the structures, construction methods and vessels/contractors have been selected. It is therefore planned that hazard/risk assessment workshops be carried out as part of the project-planning process. The objective of the workshops will be to identify all of the different activities which will be taking place and identify any potential hazards as well as appropriate mitigation measures and operating procedures relevant to the selected vessels and construction methods.

An example measure might be that, wherever possible, construction vessels would follow prescribed transit corridors. These corridors would be defined in consultation with local maritime stakeholders, such as Aberdeen Harbour Board.

The suggested attendees for the workshops are as follows:

- Project Team
- Contractor Representatives (e.g., barges, cable-laying)
- Harbour Representatives
- HM Coastguard (MCA)
- Fishing Representative
- Recreational Vessel Representative
- RNLI Representative

This process will build mutual understanding of the activities and operating constraints of the different parties involved and allow effective procedures to be developed. Separate workshops should be held for each phase of the project as well as for distinct activities.

It is noted that the construction company appointed will have their own internal health and safety procedures that they will adhere to during the work, providing additional security. Experience and lessons learned from the construction of other offshore wind farm projects will be considered prior to the proposed EOWDC being constructed. The same process will apply during the decommissioning phase of the project

14.3 Risk Control/Mitigation during Construction/Decommissioning

Details of risk control/mitigation measures which will apply during these phases of the work are summarised in Section 20.

15. IMPACT ON MARINE RADAR SYSTEMS

15.1 Introduction

In 2004 the MCA conducted trials at the North Hoyle Offshore Wind Farm off North Wales to determine any impact of wind turbines on marine communications and navigations systems (Ref. iii).

The trials indicated that there is minimal impact on VHF radio, Global Positioning Systems (GPS) receivers, cellular telephones and AIS. UHF and other microwave systems suffered from the normal masking effect when turbines were in the line of the transmissions.

This trial identified areas of concern with regard to the potential impact on ship borne and shore based radar systems. This is due to the large vertical extent of the wind turbine generators returning radar responses strong enough to produce interfering side lobe, multiple and reflected echoes (ghosts). This has also been raised as a major concern by the maritime industry with further evidence of the problems being identified by the Port of London Authority around the Kentish Flats Offshore Wind Farm in the Thames Estuary. Based on the results of the North Hoyle trial, the MCA produced a wind farm/shipping route template (see Section 2.2) to give guidance on the distances which should be established between shipping routes and offshore wind farms.

A second trial was conducted at Kentish Flats Offshore Wind Farm on behalf of BWEA (Ref. iv). The project steering group had members from BERR, the MCA and the Port of London Authority (PLA). The trial took place between 30 April and 27 June 2006. This trial was conducted in Pilotage waters and in an area covered by the PLA VTS. It therefore had the benefit of Pilot advice and experience but was also able to assess the impact of the generated effects on VTS radars.

The trial concluded that:

- The phenomena referred to above detected on marine radar displays in the vicinity of wind farms can be produced by other strong echoes close to the observing ship although not necessarily to the same extent.
- Reflections and distortions by ships structures and fittings created many of the effects and that the effects vary from ship to ship and radar to radar.
- VTS scanners static radars can be subject to similar phenomena as above if passing vessels provide a suitable reflecting surface but the effect did not seem to present a significant problem for the PLA VTS.
- Small vessels operating in or near the proposed EOWDC site were detectable by radar on ships operating near the array but were less detectable when the ship was operating within the array.

15.2 Impact on Collision Risk

The potential radar interference is mainly a problem during periods of bad visibility when mariners may not be able to visually confirm the presence of other vessels in the vicinity.

The onset range from the turbines of false returns is about 1.5 nautical miles, with progressive deterioration in the radar display as the range closes. Figure 15.1 presents the combined 56 days of survey tracks relative to the Aberdeen turbine locations, based on the 11 turbine layout. 500m, 1.5nm and 2nm buffers have been applied around each turbine location to illustrate current passing distances.

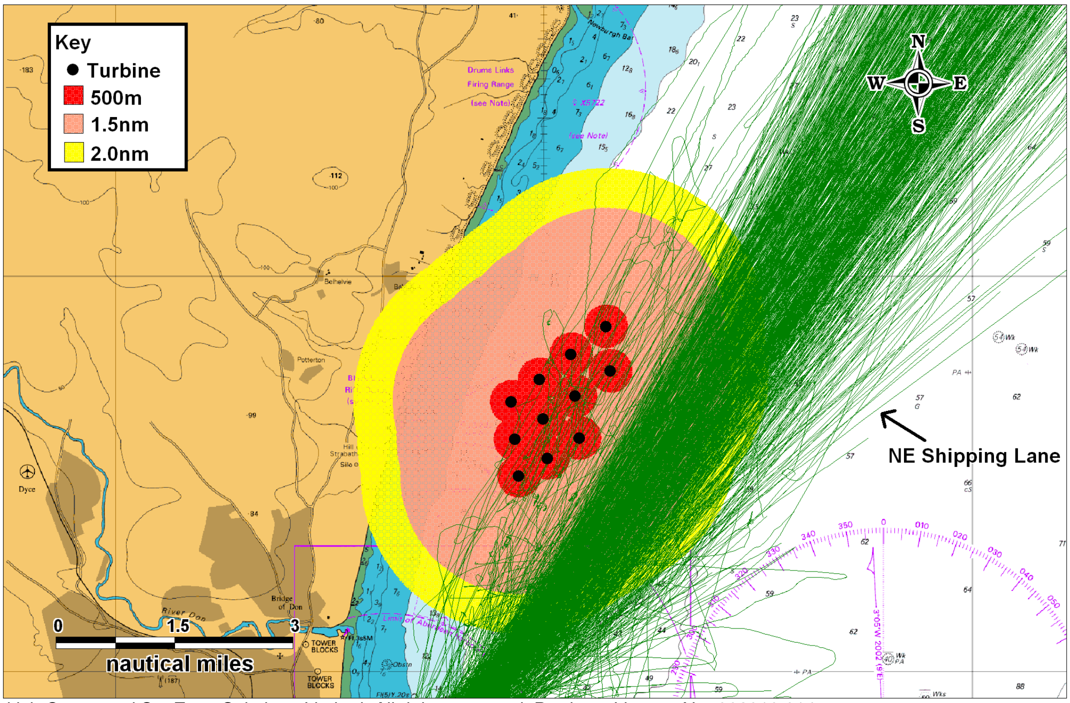


Figure 15.1 Buffer Zones versus Current Shipping Tracks (56 Days Survey Tracks)

It can be seen that, at present, ships pass inside the 1.5nm range from turbines at which radar interference could be experienced.

Assuming an average speed of 11 knots for NE-SW ships based on the survey data, the exposure of a typical ship to the turbines during a 10 mile transit from Aberdeen port travelling northeast is illustrated in Figure 15.2 for the current mean route position and anticipated mean route position (see Figure 9.2).

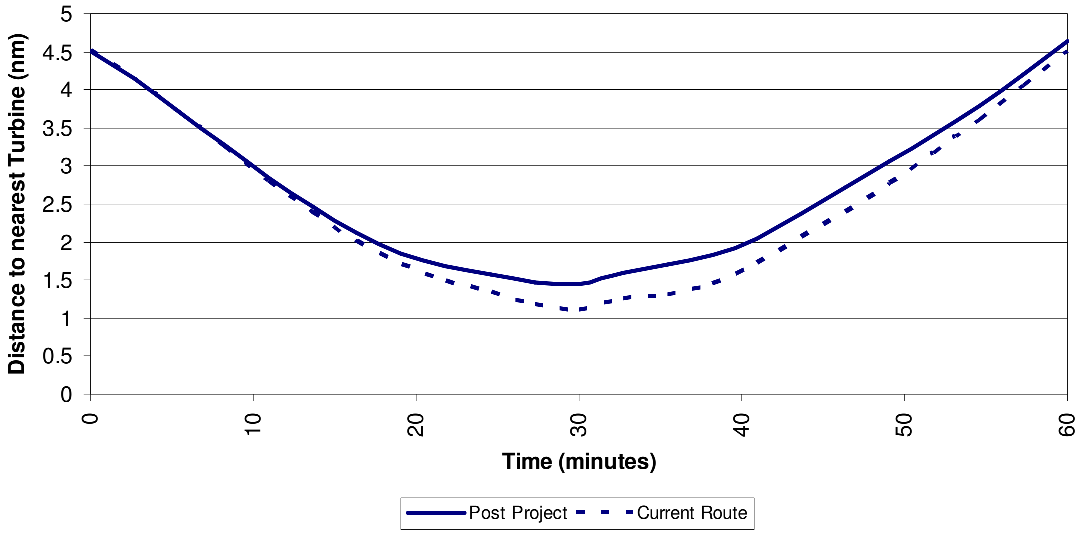


Figure 15.2 Typical Exposure Time versus Distance of Northbound Ship to Turbines

Based on the current transit vessels will be within 1.5nm of the turbines for a total duration of approximately 20 minutes and have a minimum CPA of 1.1nm. Based on the anticipated transit post-project, the typical ship will have a minimum CPA of 1.5nm from the turbines.

Experienced mariners should be able to suppress the observed problems to an extent and for short periods (a few sweeps) by careful adjustment of the receiver amplification (gain), sea clutter and range settings of the radar. However, there is a consequent risk of losing targets with a small radar cross section, which may include buoys or small craft, particularly yachts or GRP constructed craft, therefore due care is needed in making such adjustments. The Kentish Flats Offshore Wind Farm study observed that the use of an easily identifiable reference target (a small buoy) can help the operator select the optimum radar settings.

The performance of a vessel's automatic radar plotting aid (ARPA) could also be affected when tracking targets in or near the wind farm. However, although greater vigilance is required, it appears that during the Kentish Flats Offshore Wind Farm trials, false targets were quickly identified as such by the mariners and then the equipment itself.

Although the evidence from mariners operating in the vicinity of existing wind farms is that they quickly learn to work with and around the effects, it is possible that the radar impacts may result in an increase in the risk of collision. The MCA have produced guidance to mariners operating in the vicinity of UK OREIs which highlights this issue amongst others to be taken into account when planning and undertaking voyages in the vicinity of offshore renewable energy installations (OREIs) off the UK coast (Ref. xxi).

AIS information can be used to verify the targets of larger vessels, generally ships above 300 tonnes. Finally, Aberdeen VTS may be able to assist a vessel if in doubt as to whether a target is genuine during periods of reduced visibility.

The VTS radar may also be affected by the turbines. Discussions are being held with Aberdeen Harbour Board as to how this can be managed / mitigated. At other wind farm sites in the UK, a scanner will be fitted to one of the turbines, linked to the VTS.

16. CUMULATIVE AND IN-COMBINATION EFFECTS

Cumulative impacts with maritime activities (shipping, fishing, recreation and associated facilities) are assessed in the main part of this report.

In terms of other potential cumulative impacts, the only known development in the area was the associated Ocean Laboratory. This is likely to be a Met Mast type structure located in proximity to the proposed EOWDC.

The details available on this development were obtained from the Rochdale Envelope document, as summarised below.

Maximum Height above LAT (m)	120 m
Platform size	20 m x 20 m
Height of platform above LAT	18-20 m
Depth of Platform	Max 4 m including containers and ancillary equipment.
Foundation Type/Size	As per wind turbines
Navigation lighting requirements and colour scheme	The final scheme is to be determined in accordance with British law (IALA requirements) Aviation lighting in accordance with CAA requirements.

There is a potential location identified for this site (see Chapter 3 Description of the Proposed Project) however the final location will be such that it gives full consideration to navigational stakeholders in the area, also allowing for the proposed EOWDC and as a result, cumulative impacts will be negligible.

It is noted that the cumulative assessment also included a review of all Round 1 and 2 offshore wind farms, Round 3 Zones and Scottish Territorial Water sites as presented in Figure 16.1. It can be seen from the figure that the proposed EOWDC is not in close proximity to any other developments. The nearest is the Firth of Forth Round 3 Zone, over 30nm to the south.

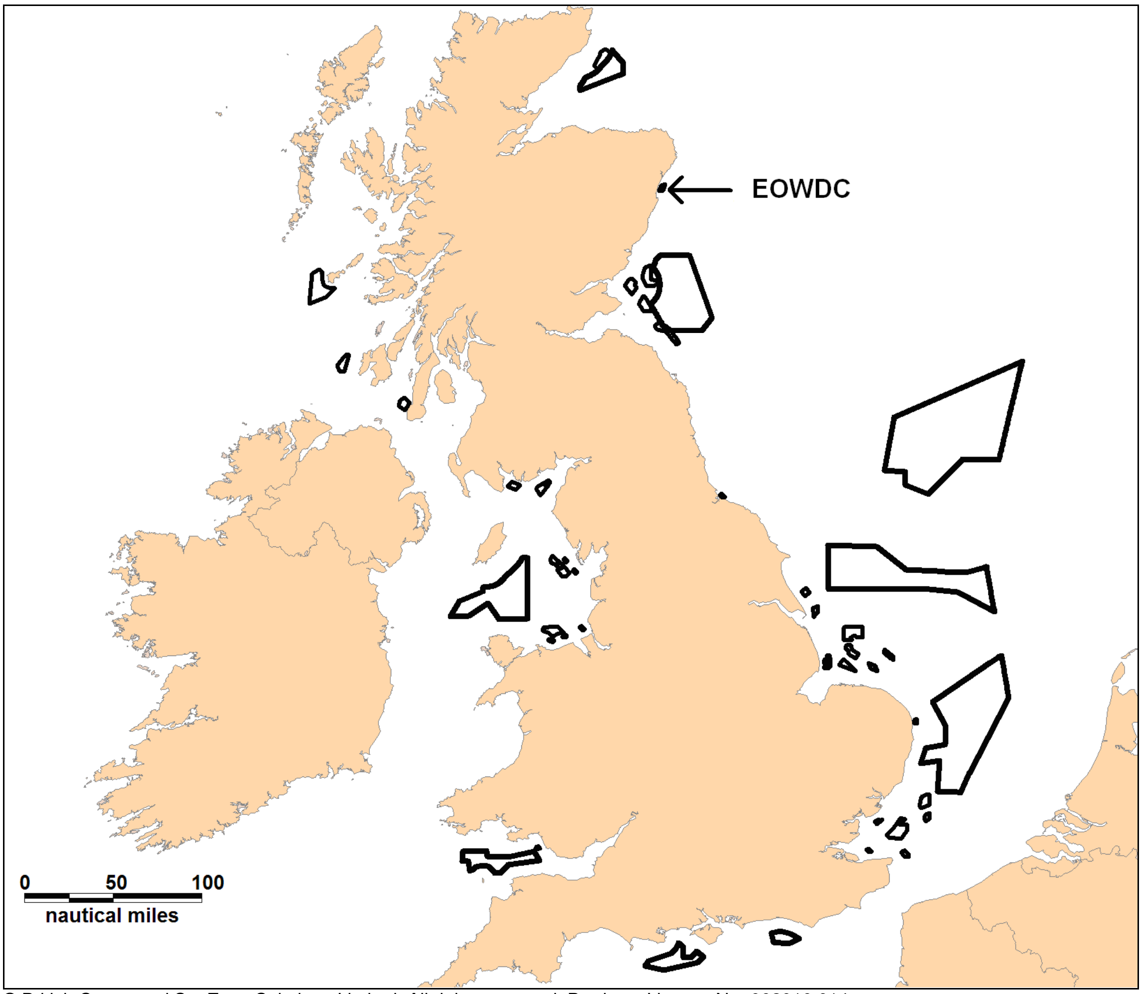


Figure 16.1 Overview of Wind Farm Sites in UK

As mentioned in Section 6.8 there are military practice areas in the vicinity, such as the rifle firing range at Black Dog, but these should not lead to any cumulative navigational impacts.

There are no identified in-combination impacts.

17. SAFETY ZONES

17.1 Construction and Decommissioning Phases

During this phase of the development there will be large construction vessels, working personnel and support craft in operation within and around the proposed EOWDC site area. Further, heavy lifting, piling and cable laying operations will be carried out which have inherent dangers.

In addition the cost of operating construction vessels, and the cost of delay can be significant. A means of controlling 3rd party navigation during these periods of high activity is required. Without this it will not be possible to exclude vessels and carry out their offshore operations in a controlled manner.

Therefore, to ensure the personnel carrying out these activities and those navigating in this sea area are not exposed to unnecessary risk, 500m safety zones may be applied for around each construction activity whilst work is being performed, as indicated by the presence of construction vessels. This will provide a means of regulating the rights of navigation so as to preserve the safety of those working in the proposed EOWDC site and those onboard other vessels that may be navigating in this area. These safety zones will apply to all vessel types not involved in the project operations.

During the construction and decommissioning phases, operational procedures will be implemented for radar and AIS monitoring of vessel activities within the working area, to detect safety zone infringements. Procedures will also be established to ensure that any infringements are formally reported in line with the regulatory requirements.

17.2 Operational Phase

During normal operations the working activities will be limited to general and emergency maintenance work and as such the benefits and requirements for safety zones were reassessed giving account to the working vessels likely to be present within and around the proposed EOWDC site. These vessels will generally be smaller than those involved in the construction phases of the project and therefore smaller safety zones may be applied for during normal operations.

In terms of third-party vessels, it is considered highly unlikely that merchant ships would elect to pass between turbines due to the limited sea room and the fact that the closest routes tend to naturally avoid the location. Therefore, it is only a limited number of fishing and recreational vessels which may choose to pass between turbines.

These vessels were observed in the survey to be mostly heading NE-SW when on passage. It will be up to individual Masters, taking into account the prevailing weather and sea conditions, to decide whether it is safe to navigate, or fish, within the turbine array.

At present 50m safety zones around turbines are planned, which is in-line with other UK offshore wind farm sites. A 200m anchor exclusion is also planned around cables.

17.3 Summary

The safety zones being considered for the project are as follows:

- Construction/Decommissioning:
  - 500m safety zones may be applied for around each construction activity whilst work is being performed.
- Operation:
  - A permanent exclusion zone of 50m around each structure, with a 200m anchor exclusion zone around cables.

The existence of safety zones will be published electronically and via Notices to Mariners.

18. Search and Rescue (SAR)

18.1 Introduction

This section summarises the existing Search & Rescue resources in the region and the issues being considered in relation to the design of the project.

(A detailed review of the historical incidents in the area, including RNLI launches, has been presented in Section 7.)

18.2 SAR Resources

18.2.1 SAR Helicopters

A review of the assets in the area of the proposed EOWDC site indicated that the closest SAR helicopter base is located at Lossiemouth, operated by the RAF, approximately 52nm to the northwest of the proposed EOWDC site. This base has Sea King helicopters with a maximum endurance of 6 hours giving a radius of action of approximately 250nm which is well within the range of the proposed EOWDC site. One helicopter is available at 15 minutes readiness between 0800 and 2200 hours, with another available at 60 minutes readiness between 0800 hours and evening civil twilight (ECT). Between 2200 and 0800 hours, one helicopter is held at 45 minutes readiness.

All RAF SAR helicopters are equipped for full day/night all weather operations over land and sea (some limitations exist with regard to freezing conditions, but in general terms the helicopters are all weather capable) and have a full night vision goggle (NVG) capability. Crews are well practised in NVG operations which is a major enhancement to search capability. In addition, all RAF SAR helicopter rear crew are medically trained, with the winchman trained up to paramedic standard.

Up to 18 persons can be carried, however this is dependent on weather conditions and the distance of the incident from the helicopter's operating base. All RAF SAR helicopters are equipped with VHF (Marine and Air Band), UHF and HF radios. They are also capable of homing to all international distress frequencies.

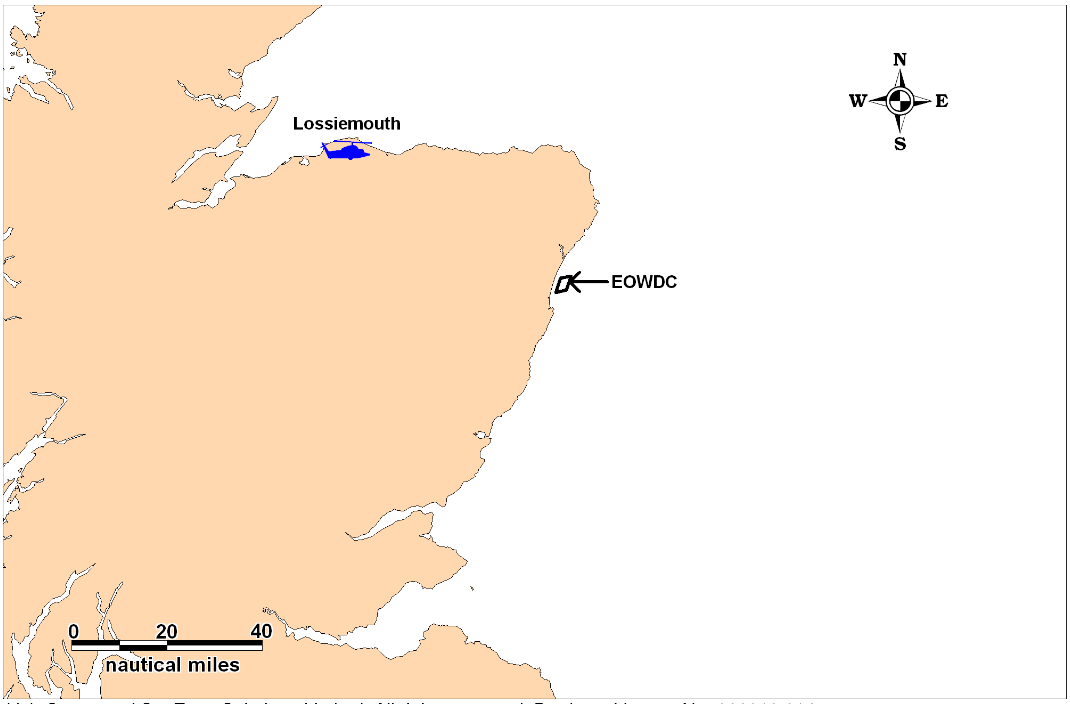


Figure 18.1 SAR Helicopter Bases relative to proposed EOWDC site

Based on the above information, the day-time response to the proposed EOWDC site will be in the order of 1 hour. At night time this will increase by 30 minutes to approximately 1 and a half hours due to the additional response time at the base. It is noted that these calculations are based on still air and will vary depending on the prevailing conditions.

18.2.2 RNLI Lifeboats

The Royal National Lifeboat Institution maintains a fleet of over 400 lifeboats of various types at 235 stations round the coast of the UK and Ireland. The RNLI stations in the vicinity of the proposed EOWDC site are presented in Figure 18.2.

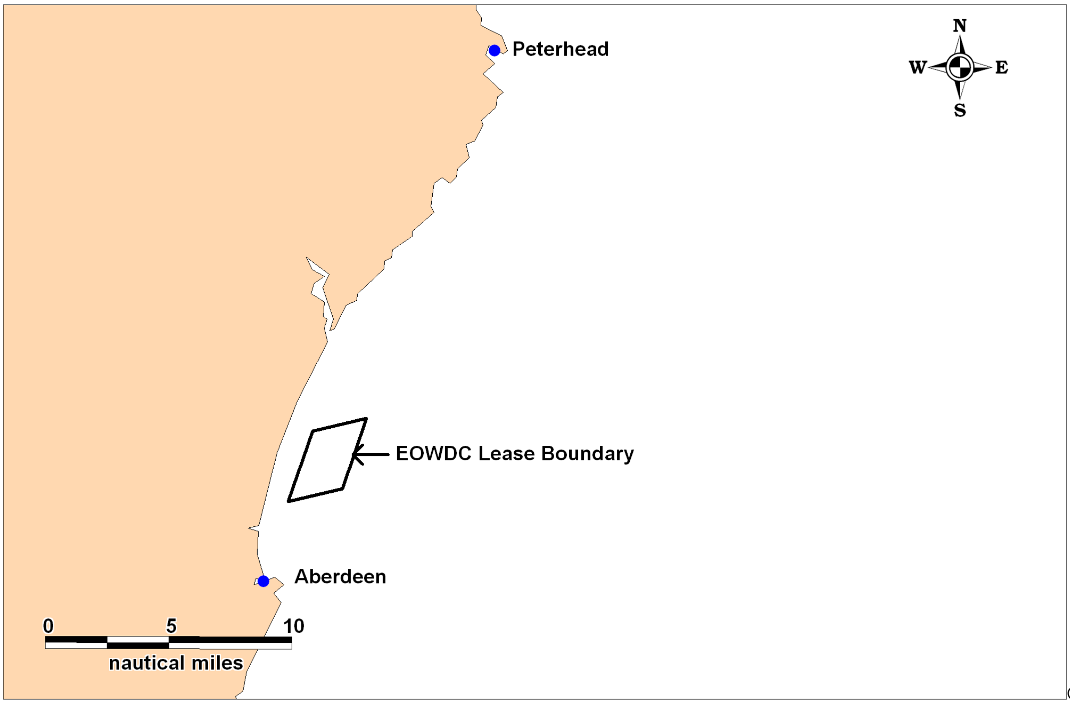


Figure 18.2 RNLI Bases near the proposed EOWDC site

At each of these stations crew and lifeboats are available on a 24-hour basis throughout the year. Table 18.1 provides a summary of the facilities at the stations closest to the proposed EOWDC site.

Table 18.1 Lifeboats held at nearby RNLI Stations

Station	Lifeboats	ALB Spec	ILB Spec	Distance to Site Boundary
Aberdeen	ALB/ILB	Severn	D Class	4.5nm
Peterhead	ALB	Tamar	--	17nm

The Severn class lifeboat has a speed of 25 knots, range of 250nm and can operate in all-weather. The Tamar is also an all weather boat and has a speed of 25 Knots and a 250nm range All-weather lifeboats are fitted with the latest in navigation, location and communication equipment, including electronic chart plotter, VHF radio with direction finder, radar and global positioning systems (GPS).

The D class lifeboat is small and highly manoeuvrable, making it ideal for rescues close to shore in fair to moderate conditions. It has a speed of 25 knots, range of 3 hours at maximum speed and is equipped with VHF radio and GPS.

Response times vary but an average declared by RNLI is 14 minutes for all-weather lifeboats and 7 minutes for inshore lifeboats. This is the time from callout, i.e., first intimation from Coastguard to the lifeboat station to launch. This means the ALB at Aberdeen could be on the scene within 30 minutes.

18.2.3 Coastguard Stations

HM Coastguard is responsible for requesting and tasking SAR resources made available by other authorities and for co-ordinating the subsequent SAR operations (unless they fall within military jurisdiction).

HM Coastguard co-ordinates SAR through its network of 18 Maritime Rescue Co-ordination Centres (MRCC), although this is currently under review. A corps of over 3100 volunteer Auxiliary Coastguards around the UK coast form over 400 local Coastguard Rescue Teams (CRT) involved in coastal rescue, searches and surveillance.

All of the MCA's operations, including SAR, are divided into three geographical regions. The East of England Region covers the East and South Coasts of England from the Scottish border down to the Dorset/Devon border. The Wales and West of England Region extends from Devon and Cornwall to cover the coast of Wales, North West England and the Moray Firth. The Scotland and Northern Ireland Region covers the remainder of the UK coastline including the Western Isles, Orkney and Shetland.

Each region is divided into six districts with its own Maritime Rescue Co-ordination Centre (MRCC), which co-ordinates the Search and Rescue response for maritime and coastal emergencies within its district boundaries (East of England Region includes an additional station, London Coastguard, for co-ordinating Search and Rescue on the River Thames).

The proposed EOWDC site lies within the Scotland and Northern Ireland Region with the nearest rescue coordination centre being Aberdeen. MRCC Aberdeen's area of responsibility provides search and rescue coverage from Cape Wrath to Doonies Point.

MRCC Aberdeen is subdivided into fourteen sectors with the proposed EOWDC site within the Aberdeen sector between Balmedie in the North to Doonies Point in the South.

18.2.4 Salvage

MCA charters four Emergency Towing Vessels (ETVs) to provide emergency towing cover in winter months in the four areas adjudged to pose the highest risk of a marine accident: the Dover Strait, the Minches, the Western Approaches and the Fair Isle Channel.

These are a considerable distance from the proposed EOWDC site; however, each MRCC also holds comprehensive databases of harbour tugs available locally.

Procedures are also in place with Brokers and Lloyd's Casualty Reporting Service to quickly obtain information on towing vessels that may be able to respond to an incident.

MCA has an agreement with the British Tug owners Association (BTA) for emergency chartering arrangements for harbour tugs. The agreement covers activation, contractual arrangements, liabilities and operational procedures, should MCA request assistance from any local harbour tug as part of the response to an incident.

Tugs are available within Aberdeen Harbour through a licensed Tug Operator. An agreement exists which retains one tug permanently in Aberdeen, however in practice there are two tugs most of the time. The tugs *Cultra* and *Carrickfergus* have a bollard pull of 30 tonnes each. A third tug is available with notice. There are also a number of offshore industry vessels with towing capability based in Aberdeen.

18.3 Wind Farm SAR Matters

The proposed EOWDC site will meet the MCA's requirements in terms of standards and procedures for generator shutdown and other operational requirements in the event of a search and rescue, counter pollution or salvage incident in or around the site. These are laid out in Annex 5 of MGN 371 (Ref. ii).

This includes the development of an Emergency Response Co-operation Plan (ERCoP) for the proposed project, which will be in place pre-construction.

Examples of features to be incorporated are as follows:

Design:

- All wind turbine generators (WTGs) and other OREI individual structures will each be marked with clearly visible unique identification characters which can be seen by both vessels at sea level and aircraft (helicopters and fixed wing) from above.

- The identification characters shall each be illuminated by a low-intensity light visible from a vessel thus enabling the structure to be detected at a suitable distance to avoid a collision with it. The size of the identification characters in combination with the lighting will be such that, under normal conditions of visibility and all known tidal conditions, they are clearly readable by an observer, stationed 3 m above sea level, and at a distance of at least 150 m from the turbine.

Operation:

- The Central Control Room, or mutually agreed single contact point, will be manned 24 hours a day.

- All MRCCs will be advised of the contact telephone number of the Central Control Room, or single contact point (and vice versa)

- The control room operator, or single contact point, will immediately initiate the shut-down procedure for WTGs as requested by the MRCC, and maintain the WTG in the appropriate shut-down position, as requested by the MRCC, until receiving notification from the MRCC that it is safe to restart the WTG.

19. ADDITIONAL NAVIGATION ISSUES

19.1 Introduction

There are a number of additional navigational issues identified within MGN 371 (Ref. ii) which require to be addressed by the developer. The following subsections cover additional navigation related issues which have not been covered elsewhere within this report.

19.2 Visual Navigation and Collision Avoidance

19.2.1 Introduction

MGN 371 identifies the potential for visual navigation to be impaired by the location of offshore wind farm structures, based on vessels not being visible to each other (hidden behind structures) and navigational aids and/or landmarks not being visible to shipping.

19.2.2 Visual Impact (Other Vessels)

Based on the position, orientation, number of turbines and spacing between turbines it is not considered there will be any significant issue of visual impact between vessels on the main commercial shipping routes in the area, which should all pass to the east. There is an anchorage area just over 2nm to the south of the proposed EOWDC site, but the vessels using it should also remain visible and will generally be travelling at low speeds when entering or leaving the area.

There is limited small craft activity in the area which limits the likelihood of a small craft emerging from the proposed EOWDC site towards shipping traffic. Even if that were the case, the vessel should be visible for the vast majority of the time due to the small size of the turbines relative to the large spacing between them.

19.2.3 Visual Impact (Navigational Aids and/or Landmarks)

Depending on the approach direction of vessels, the proposed project could hamper the view of existing navigational aids and landmarks, such as the firing range buoys to the west, Girdle Ness Lighthouse, the Fairway Buoy and the lights located on the breakwaters.

However, the proposed EOWDC site itself will form a significant aid to navigation, which will be very visible to shipping with lights on significant peripheral structures as well as selected intermediate structures in accordance with NLB requirements (see Section 4). It is therefore not considered that the EOWDC site will degrade the ability of ships to navigate in the area through visual impairment of navigation aids or landmarks.

19.3 Potential Effects on Waves and Tidal Currents

Based on a specialist study, it was concluded that there will be no significant impact from the proposed project on local tidal currents or waves.

19.4 Impacts of Structures on Wind Masking/Turbulence or Shear

The offshore turbines have the potential to affect vessels under sail when passing through the site from effects such as wind shear, masking and turbulence. From previous studies of offshore wind farms it was concluded that turbines do reduce wind velocity by in the order of 10% downwind of a turbine. The temporary effect is not considered as being significant and similar to that experienced passing a large ship or close to other large structures (e.g., bridges) or the coastline. In addition, practical experience to date from RYA members taking vessels into other sites indicates that this is not likely to be an issue. Finally, it is noted that there is limited sailing activity in the Aberdeen Bay area.

19.5 Sedimentation/Scouring Impacting Navigable Water Depths in Area

There exists the potential for structures in the tidal stream to produce siltation, deposition of sediment or scouring which could affect the navigable water depths in the proposed EOWDC site area or adjacent to the area. The specialist work carried out as part of the ES has shown that no significant impact on navigation will result from the potential effects of the EOWDC development on the physical environment.

19.6 Structures and Generators affecting Sonar Systems in Area

No evidence has been found to date with regard to existing wind farms to suggest that they produce any kind of sonar interference which is detrimental to the fishing industry, or to military systems. No impact is anticipated for the EOWDC project.

19.7 Electromagnetic Interference on Navigation Equipment

Based on the findings of the trials at the North Hoyle Offshore Wind Farm (Ref. iii), the wind turbines and their cabling, inter-turbine and onshore, did not cause any compass deviation during the trials. However, it is stated that as with any ferrous metal structure, caution should be exercised when using magnetic compasses close to turbine towers.

It is noted that all equipment and cables will be rated and in compliance with design codes. In addition the cables associated with the wind farm will be buried to a minimum of 0.6 m and any generated fields will be very weak and will have no impact on navigation or electronic equipment. No impact is anticipated for the EOWDC project.

19.8 Impacts on Communications and Position Fixing

The following summarises the potential impacts of the different communications and position fixing devices used in and around offshore wind farms. The basis for the assessment is the trials carried out by the MCA at North Hoyle Offshore Wind Farm and experience of personnel/vessels operating in and around other offshore wind farm sites.

19.8.1 VHF Communications (including Digital Selective Calling)

Vessels operating in and around offshore wind farms have not noted any noticeable effects on VHF (including voice and DSC communications). No significant impact is anticipated at the proposed EOWDC site.

19.8.2 Navtex

The Navtex system is used for the automatic broadcast of localised Maritime Safety Information (MSI). The system mainly operates in the Medium Frequency radio band just above and below the old 500 kHz Morse Distress frequency. No significant impact has been noted at other sites and none are expected at the proposed EOWDC site.

19.8.3 VHF Direction Finding

During the North Hoyle Offshore Wind Farm trials, the VHF direction equipment carried in the lifeboats did not function correctly when very close to turbines (within about 50 m). This is deemed to be a relatively small scale impact and provided the effect is recognised, it should not be a problem in practical search and rescue.

19.8.4 Automatic Identification System (AIS)

In theory there could be interference when there is a structure located between the transmitting and receiving antennas (i.e., blocking line of sight). This was not evident in the trials carried out at the North Hoyle Offshore Wind Farm site and no significant impact is anticipated for AIS signals being transmitted and received at the proposed EOWDC site.

19.8.5 Global Positioning System (GPS)

No problems with basic GPS reception or positional accuracy were reported during the trials at North Hoyle Offshore Wind Farm and this has been confirmed from other vessels which have been inside offshore wind farms. Consideration will require to be given to any potential degradation of DGPS signals being used to position construction equipment when close to a turbine tower.

19.8.6 LORAN-C

LORAN-C is a low frequency electronic position-fixing system using pulsed transmissions at 100 kHz. The absolute accuracy of Loran-C varies from 0.1 to 0.25 nm. Its use is in steep decline, with GPS being the primary replacement. It is mostly used in ships on and near the US coast, although some GPS receivers have built-in Loran C software.

Attempts were made to test a system during the North Hoyle Offshore Wind Farm trial, but there were difficulties which were probably attributable to operational errors or lack of a nearby transmitter.

Although a position could not be obtained using LORAN-C in the wind farm area, the available signals were received without apparent degradation. The proposed EOWDC is not expected to have a significant impact on LORAN-C. It is noted that the Department for Transport are funding an enhanced LORAN (eLORAN) service in the UK.

19.9 Noise Impact

19.9.1 Acoustic Noise Masking Sound Signals

The concern which must be addressed under MGN 371 is whether acoustic noise from the wind farm could mask prescribed sound signals.

The sound level from a wind farm at a distance of 350m has been predicted to be 51 dB (A) to 54 dB (A) and it should therefore be well below a background sound level which is typically 63-68 dB. A ship's whistle for a vessel of 75m should generate in the order of 138 dB and be audible at a range of 1.5nm, so this should be heard above the background noise of the site. Foghorns will also be audible over the background noise of the project.

Therefore, there is no indication that the sound level of the proposed EOWDC will have any significant influence on marine safety.

19.9.2 Noise Impacting Sonar

Once in operation it is not believed that there will be any subsea acoustic noise generated by the proposed EOWDC that will have any significant impact on sonar systems.

20. RISK MITIGATION MEASURES & MONITORING

20.1 Mitigation

This section summarises the main risk mitigation measures adopted by AOWFL for the proposed EOWDC to reduce the navigational impact of the project.

Table 20.1 Mitigation Measures

Mitigation	Description
Site selection	Site selected to avoid significant navigational impacts, e.g., located away from main anchorage area and navigation lanes to/from Aberdeen following consultation with Aberdeen Harbour, etc.
Marked on Admiralty Charts	EOWDC will be charted by the UK Hydrographic Office using the magenta turbine tower chart symbol found in publication "NP 5011 - Symbols and Abbreviations used in Admiralty Charts". Submarine cables associated with the project will also be charted on the appropriate scale charts.
Information Circulation	Appropriate liaison to ensure information on the wind farm and special activities is circulated in Notices to Mariners, Navigation Information Broadcasts and other appropriate media.
Marking and Lighting	Structures to be marked and lit in-line with NLB and IALA guidance. (See Section 4.)
Turbine Air Draught	Lowest point of rotor sweep at least 22m above Mean High Water Springs as per RYA and MCA recommendations.
Cable Protection	Cables to be buried to suitable depth based on cable protection study taking into account fishing and anchoring practices in Aberdeen Bay. Periodic inspection of the cable to ensure it remains buried. Positions of cable routes notified to Kingfisher Information Services (KIS) for inclusion in cable awareness charts and plotters for the fishing industry.
Compliance with MCA's Marine Guidance Notice (MGN) 371 including Annex 5	Annex 5 specifies "Standards and procedures for generator shutdown and other operational requirements in the event of a search and rescue, counter pollution or salvage incident in or around an OREI."
Formulation of an Emergency Response Cooperation Plan (ERCoP) as per MCA template	AOWFL will use the draft template created by the MCA to formulate an emergency response plan and site Safety Management Systems, in consultation with the MCA.

Discussions on other measures will continue both pre- and post-construction and during the life of the project with the MCA, Aberdeen Harbour Board and other relevant stakeholders.

20.2 Future Monitoring

From a navigation risk perspective, monitoring will take place through the project's Safety Management System (SMS). The Safety Management System will include an incident/accident reporting system which will allow incidents and near misses to be recorded and reviewed to monitor the effectiveness of the risk control measures in place at the site. In addition to this any information gleaned from near misses/accidents at other offshore wind farm sites will be considered with respect to the control measures applied at the proposed EOWDC.

Whilst no radar monitoring of vessel movements has been proposed for the site, AIS monitoring is being considered which can be used to monitor and record the movements of vessels around the proposed EOWDC site and associated export cables to shore, as well as company vessels working at the site.

During maintenance, there will regularly be vessels operating in the site which can monitor any third party vessel activity both visually and on radar, although this will not be their primary function.

The subsea cable routes will be subject to periodic inspection to ensure they remain buried.

Finally, it is noted that the site and cable route are within coverage of Aberdeen VTS, and the VTS will be vigilant to hazardous navigational practices within the general area.

21. CONCLUSIONS

The main conclusions of this work are as follows:

- The proposed EOWDC site has been relocated and reduced in size such that it will not affect the main navigation routes in the area, including the bulk of shipping heading to/from Aberdeen Harbour.
- Moving the site to the north has provided a 0.25 nm separation between the nearest turbine and the designated anchorage area in Aberdeen Bay.
- Consultation with Aberdeen Harbour Board and other users of the area, such as NorthLink Ferries, indicated the site is acceptable.
- There is limited fishing and recreational vessel activity in the area.
- In the hazard review workshop involving local navigational stakeholders, all hazards were identified to be low.
- Following identification of the key navigational hazards, risk analyses were carried out to investigate selected hazards in more detail. The overall annual level of risk was estimated to increase due to the proposed EOWDC by approximately 1 in 404 years (base case) and 1 in 367 years (future case based on traffic growth estimates over the life of the development). The majority of this risk is from passing powered ship collisions with the turbines from the closest passing route headed to/from Aberdeen, followed by fishing vessel collisions.
- The risks associated with recreational craft interaction with the proposed EOWDC structures (blade/mast and vessel/structure collisions) were qualitatively assessed and concluded to be as low as reasonably practicable given the mitigation measures planned.
- A quantitative assessment estimated that, compared to the background marine accident risk levels in the UK, the increase in risk to both people and the environment caused by the proposed EOWDC is low.

22. REFERENCES

i DECC, U.K. Government, Methodology for Assessing the Marine Navigational Safety Risks of Offshore Windfarms, Version Date: 7th September 2005.

ii MCA Marine Guidance Notice 371, Offshore Renewable Energy Installations (OREIs) - Guidance on UK Navigational Practice, Safety and Emergency Response Issues.

iii Results of the EM Investigations and assessments of marine radar, communications and positioning systems undertaken at the North Hoyle Wind Farm by QinetiQ and the Maritime & Coastguard Agency; 29 September 2004.

iv Investigation of Technical and Operational Effects on Marine Radar Close to Kentish Flats Offshore Wind Farm, BWEA, DTI, MCA & PLA; April 2007.

v The Proposed Aberdeen Bay Wind Turbine Location Maritime Safety Concerns Opinion document. http://www.marinesafetyforum.co.uk/upload-files/notices/wind_deployment_centre_-_wind_farm_maritime_safety_concerns_info_sheet_rev_043%7D.pdf

vi Aberdeen Harbour Annual Report and Financial Statements 2009, Aberdeen Harbour Board, 2010.

vii Admiralty Sailing Directions - North Sea (West) Pilot, NP 54, 6th Edition, 2003.

viii Chart 213, Fraserburgh to Newburgh, Tidal Diamond D, 57 19’.99 N, 001 45’.10 E.

ix Anatec Ltd, Maritime Traffic Survey 5, Report No: A2622-AREG -TS-5, 4 April 2011.

x Anatec Ltd, Maritime Traffic Survey 1, Report No: A2185-AREG-TS-1, 9 June 2009.

xi Anatec Ltd, Maritime Traffic Survey 2, Report No: A2185- AREG -TS-2, 13 November 2009.

xii Anatec Ltd, Maritime Traffic Survey 3, Report No: A2185- AREG -TS-3, 12 July 2010.

xiii Anatec Ltd, Maritime Traffic Survey 4, Report No: A2555- AREG -TS-4, 12 January 2011.

xiv RYA, UK Coastal Atlas.

xv The Macmillan REEDS Nautical Almanac 2001

xvi EOWDC Commercial Fisheries Aspects, Brown and May Ltd.

xvii Meeting with SFF on 22nd September 2010 – attended by Iain Todd (AOWFL) and Mike Cain (Anatec)

xviii IMO, Guidelines for Formal Safety Assessment (FSA) for use in the IMO rule Making Process, 5th April 2002.

xix Aberdeen Harbour Board, Economic Impact Assessment of Aberdeen Harbour, Final Report, May 2007.

xx Department for Transport, Maritime Statistics, 2009.

xxi MCA Marine Guidance Notice 372 (M+F), Guidance to Mariners Operating in the Vicinity of UK OREIs, August 2008.

MCA MGN 371 Checklist

European Offshore Wind Deployment Centre

(Appendix A)

Prepared by:	Anatec Limited
Presented to:	Aberdeen Offshore Wind Farm Limited
Date:	9 June 2011
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Anatec	**Aberdeen Office**	**Cambridge Office**
Address:	36 Upperkirkgate, Aberdeen, AB10 1BA, Scotland, UK	16 Ward Way, Witchford, Ely, Cambs, CB6 2JR, UK
Tel:	01224 633711	01353 661200
Fax:	0709 2367306	0709 2367306
Email:	aberdeen@anatec.com	cambs@anatec.com

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A1. Introduction

This Appendix presents the MCA checklist based on the requirements set out in MGN 371 which was the guidance set by the MCA during the NRA preparation.

Reference notes/remarks are made within the table based on which sections of the NRA, or other documents, address the issue noted in the MGN 371 checklist.

A2. MGN 371 Compliance Checklist

Table 1 MGN 371 Compliance Checklist for the European Offshore Wind Deployment Centre

MGN 371 COMPLIANCE			
Issue	**Yes**	**No**	**Remarks**
Considerations on Site Position, Structures and Safety Zones			
1. Traffic Survey			
All vessel types	✔		Section 8 of NRA.
Four weeks duration, within 12 months prior to submission of the Environmental Statement	✔		Survey period comprised two weeks of data from April 2009, September 2009, April 2010 and November 2010 totalling 56 days.
Seasonal variations	✔		Surveys have been carried out in April, September and November. Other long-term data sets and consultation were used to identify variations in recreational and fishing vessel activity. (Also refer to the Commercial Fisheries study carried out for the ES.)
Recreational and fishing vessel organisations	✔		Sections 10 and 11 of NRA.
Port and navigation authorities	✔		Sections 5, 6 and 8 of NRA.
Assessment			
Proposed OREI site relative to areas used by any type of marine craft.	✔		Sections 8-11 of NRA.
Numbers, types and sizes of vessels presently using such areas	✔		Sections 8-11 of NRA.
Non-transit uses of the areas, e.g. fishing, day cruising of leisure craft, racing, aggregate dredging, etc.	✔		Sections 8-11 of NRA.
Whether these areas contain transit routes used by coastal or deep-draught vessels on passage.	✔		Section 8 of NRA.
Alignment and proximity of the site relative to adjacent shipping lanes	✔		Sections 8 and 9 of NRA.
Whether the nearby area contains prescribed routeing schemes or precautionary areas	✔		Sections 6, 8 and 9 of NRA.
Whether the site lies on or near a prescribed or conventionally accepted separation zone between two opposing routes	✔		Sections 6, 8 and 9 of NRA.
Proximity of the site to areas used for anchorage, safe haven, port approaches	✔		Sections 6, 8 and 9 of NRA.

MGN 371 COMPLIANCE			
Issue	**Yes**	**No**	**Remarks**
and pilot boarding or landing areas.			
Whether the site lies within the limits of jurisdiction of a port and/or navigation authority.	✔		Section 6.2 of NRA.
Proximity of the site to existing fishing grounds, or to routes used by fishing vessels to such grounds.	✔		Section 11 of NRA and Commercial Fisheries study.
Proximity of the site to offshore firing/bombing ranges and areas used for any marine military purposes.	✔		Section 6.8 and Section 16 of NRA.
Proximity of the site to existing or proposed offshore oil / gas platform, marine aggregate dredging, or other exploration/exploitation sites	✔		Section 6.7 and Section 16 of NRA.
Proximity of the site relative to any designated areas for the disposal of dredging spoil	✔		Not applicable.
Proximity of the site to aids to navigation and/or Vessel Traffic Services (VTS) in or adjacent to the area and any impact thereon.	✔		Sections 6 of NRA.
Researched opinion using computer simulation techniques with respect to the displacement of traffic and, in particular, the creation of 'choke points' in areas of high traffic density.	✔		Sections 8, 9 and 13 of NRA.
Type(s) of simulation used in analysis Limitation of system (s)	✔		Sections 8, 9 and 13 of NRA
2. OREI Structures			
Whether any features of the OREI, including auxiliary platforms outside the main generator site and cabling to the shore, could pose any type of difficulty or danger to vessels underway, performing normal operations, or anchoring	✔		Sections 9-15 of NRA. (Note: The final design has not yet been selected therefore the current expected layout has been assumed).
Clearances of wind turbine blades above the sea surface *not less than 22 metres*	✔		Section 3.4 of NRA.
Least depth of current turbine blades	✔		Not applicable.
The burial depth of cabling	✔		0.6m to 3m (Ref Rochdale Envelope Requirements for the European Offshore Wind Development Centre – RE18554-W-02-11)
Whether any feature of the installation could create problems for emergency rescue services, including the use of lifeboats, helicopters and emergency towing vessels (ETVs)	✔		Section 18 of NRA.
How rotor blade rotation and power	✔		Section 18 of NRA.

MGN 371 COMPLIANCE			
Issue	**Yes**	**No**	**Remarks**
transmission, etc., will be controlled by the designated services when this is required in an emergency.			
3. Assessment of Access to and Navigation Within, or Close to , an OREI To determine the extent to which navigation would be feasible within the OREI site itself by assessing whether:			
a. Navigation within the site would be safe:	✔		
i. by all vessels, or ii. by specified vessel types, operations and/or sizes. iii. in all directions or areas, or iv. in specified directions or areas. v. in specified tidal, weather or other conditions			Entire NRA.
b. Navigation in and/or near the site should be:	✔		
i. prohibited by specified vessels types, operations and/or sizes. ii. prohibited in respect of specific activities, iii. prohibited in all areas or directions, or iv. prohibited in specified areas or directions, or v. prohibited in specified tidal or weather conditions, or simply vi. recommended to be avoided.			Entire NRA.
c. Exclusion from the site could cause navigational, safety or routeing problems for vessels operating in the area.	✔		See Sections 8-11 for discussion of likely impacts of site on vessel activity.
Relevant information concerning a decision	✔		Section 17 of NRA.

MGN 371 COMPLIANCE			
Issue	**Yes**	**No**	**Remarks**
to seek a "safety zone" for a particular site during any point in its construction, operation or decommissioning.			
Navigation, collision avoidance and communications			
1. The Effect of Tides and Tidal Streams : It should be determined whether or not:			
Current maritime traffic flows and operations in the general area are affected by the depth of water in which the proposed installation is situated at various states of the tide i.e. whether the installation could pose problems at high water which do not exist at low water conditions, and vice versa.	✔		Sections 3, 6, 8 of NRA
Set and rate of the tidal stream, at any state of the tide, has a significant affect on vessels in the area of the OREI site.	✔		Sections 6,.7, 8 and 13 of NRA
Maximum rate tidal stream runs parallel to the major axis of the proposed site layout, and, if so, its effect.	✔		Section 6.9 of NRA.
The set is across the major axis of the layout at any time, and, if so, at what rate.	✔		Section 6.9 of NRA.
In general, whether engine failure or other circumstance could cause vessels to be set into danger by the tidal stream.	✔		Section 6.9, 9 and 13.3 of NRA. (Tides in the area used to model risk of drifting ship collision.)
Structures themselves could cause changes in the set and rate of the tidal stream.	✔		Section 19.3 of NRA.
Structures in the tidal stream could be such as to produce siltation, deposition of sediment or scouring, affecting navigable water depths in the windfarm area or adjacent to the area	✔		Section 19.5 of NRA.
			.
2. Weather: To determine if:			
The site, in normal, bad weather, or restricted visibility conditions, could present difficulties or dangers to craft, including sailing vessels, which might pass in close proximity to it.	✔		Sections 3, 6.9, 7, 8-13, 15, 19 and 20 of NRA.
The structures could create problems in the area for vessels under sail, such as wind masking, turbulence or sheer.	✔		Section 19.4 of NRA.
In general taking into account the prevailing winds for the area, whether engine failure or other circumstances could cause vessels to drift into danger, particularly if in conjunction with a tidal set.	✔		Section 13.3 of NRA (Drifting collision risk model).

MGN 371 COMPLIANCE			
Issue	**Yes**	**No**	**Remarks**
3. Visual Navigation and Collision Avoidance: To assess the extent to which			
Structures could block or hinder the view of other vessels under way on any route.	✔		Section 19.2 of NRA.
Structures could block or hinder the view of the coastline or of any other navigational feature such as aids to navigation, landmarks, promontories, etc	✔		Section 19.2 of NRA.
4. Communications, Radar and Positioning Systems : To provide researched opinion of a generic and, where appropriate, site specific nature concerning whether or not:			
Structures could produce radio interference such as shadowing, reflections or phase changes, with respect to any frequencies used for marine positioning, navigation or communications, including Automatic Identification Systems (AIS), whether ship borne, ashore or fitted to any of the proposed structures.	✔		Section 15 of NRA.
Structures could produce radar reflections, blind spots, shadow areas or other adverse effects: a. Vessel to vessel; b. Vessel to shore; c. VTS radar to vessel; d. Racon to/from vessel.	✔		Section 15 of NRA.
OREI, in general, would comply with current recommendations concerning electromagnetic interference.	✔		Section 15 of NRA.
Structures and generators might produce sonar interference affecting fishing, industrial or military systems used in the area.	✔		Section 19.6 of NRA.
Site might produce acoustic noise which could mask prescribed sound signals.	✔		Section 19.9 of NRA.
Generators and the seabed cabling within the site and onshore might produce electro-magnetic fields affecting compasses and other navigation systems.	✔		Section 19.7 of NRA.
5. Marine Navigational Marking : To determine:			
How the overall site would be marked by day and by night taking into account that there may be an ongoing requirement for	✔		Section 4 of NRA.

MGN 371 COMPLIANCE			
Issue	**Yes**	**No**	**Remarks**
marking on completion of decommissioning, depending on individual circumstances.			
How individual structures on the perimeter of and within the site, both above and below the sea surface, would be marked by day and by night.	✔		Section 4 of NRA.
If the specific OREI structure would be inherently radar conspicuous from all seawards directions (and for SAR and maritime surveillance aviation purposes) or would require passive enhancers	✔		Section 4 of NRA.
If the site would be marked by one or more racons and/ or,	✔		Section 6.4 of NRA.
If the site would be marked by an Automatic Identification System (AIS) transceiver, and if so, the data it would transmit.	✔		Sections 20 of NRA. (under consideration)
If the site would be fitted with a sound signal, and where the signal or signals would be sited	✔		Section 12.4 of NRA (potential mitigation measure).
If the structure (s) would be fitted with aviation marks, and if so, how these would be screened from mariners or potential confusion with other navigational marks & lights resolved.	✔		Not applicable
Whether the proposed site and/or its individual generators would comply in general with markings for such structures, as required by the relevant General Lighthouse Authority (GLA) or recommended by the Maritime and Coastguard Agency, respectively.	✔		Section 4 of NRA.
The aids to navigation specified by the GLAs are being maintained such that the 'availability criteria', as laid down and applied by the GLAs, is met at all times.	✔		Section 4 of NRA.
The procedures that need to be put in place to respond to casualties to the aids to navigation specified by the GLAs, within the timescales laid down and specified by the GLAs.	✔		Section 4 of NRA.
5. Hydrography : In order to establish a baseline, detailed and accurate hydrographic surveys are required to IHO Order 1 standard multibeam bathymetry with final data being supplied as a digital full density data set, and erroneous surrounding flagged as deleted but included in the data set. A full report detailing survey methodology and equipment should accompany the			

MGN 371 COMPLIANCE			
Issue	**Yes**	**No**	**Remarks**
surveys.			
	✔		This was a requirement of the Hydrographic Surveys contract.
Safety and mitigation measures recommended for OREI during construction, operation and decommissioning.			
Mitigation and safety measures will be applied to the OREI development appropriate to the level and type of risk determined during the Environmental Impact Assessment (EIA).The specific measures to be employed will be selected in consultation with the Maritime and Coastguard Agency and will be listed in the developer's Environmental Statement (ES). These will be consistent with international standards contained in, for example, the Safety of Life at Sea (SOLAS) Convention - Chapter V, IMO Resolution A.572 (14)[3] and Resolution A.671(16)[4] and could include any or all of the following:	✔		Sections 18 and 20 of NRA.
Promulgation of information and warnings through notices to mariners and other appropriate media.	✔		Sections 18 and 20 of NRA.
Continuous watch by multi-channel VHF, including Digital Selective Calling (DSC).	✔		Sections 18 and 20 of NRA.
Safety zones of appropriate configuration, extent and application to specified vessels	✔		Section 17 of NRA.
Designation of the site as an area to be avoided (ATBA).	✔		Not applicable.
Implementation of routeing measures within or near to the development.	✔		Not applicable. (See Section 9 of for Impact on Commercial Shipping Navigation).
Monitoring by radar, AIS and/or closed circuit television (CCTV).	✔		Sections 18 and 20 of NRA.
Appropriate means to notify and provide evidence of the infringement of safety zones or ATBA's.	✔		Sections 17, 18 and 20 of NRA.
Any other measures and procedures considered appropriate in consultation with other stakeholders.	✔		Sections 18 and 20 of NRA.
Standards and procedures for wind turbine generator shutdown in the event of a search and rescue, counter pollution or salvage incident in or around a wind farm. The wind farm should be designed and constructed to satisfy the following design requirements for emergency rotor shut-down in the event of a search and rescue (SAR), counter pollution or salvage operation in or around a wind farm:			

MGN 371 COMPLIANCE			
Issue	**Yes**	**No**	**Remarks**
All wind turbine generators (WTGs) will be marked with clearly visible unique identification characters which can be seen by both vessels at sea level and aircraft (helicopters and fixed wing) from above.	✔		Sections 4 and 18 of NRA.
The identification characters shall each be illuminated by a low intensity light visible from a vessel this enabling the structure to be detected at a suitable distance to avoid a collision with it. The size of the identification characters in combination with the lighting should be such that, under normal conditions of visibility and all known tidal conditions, they are clearly readable by an observer, stationed 3 metres above sea levels, and at a distance of at least 150 metres from the turbine. It is recommended that lighting for this purpose be hooded or baffled so as to avoid unnecessary light pollution or confusion with navigation marks. (Precise dimensions to be determined by the height of lights and necessary range of visibility of the identification numbers).	✔		Sections 4 and 18 of NRA
For aviation purposes, OREI structures should be marked with hazard warning lighting in accordance with CAA guidance and also with unique identification numbers (with illumination controlled from the site control centre and activated as required) on the upper works of the OREI structure so that aircraft can identify each installation from a height of 500ft (150 metres) above the highest part of the OREI structure.	✔		Sections 4 and 18 of NRA.
Wind Turbine Generators (WTG) shall have high contrast markings (dots or stripes) placed at 10 metre intervals on both sides of the blades to provide SAR helicopter pilots with a hover reference point.	✔		Section 18 of NRA.
All WTGs should be equipped with control mechanisms that can be operated from the Central Control Room of the wind farm or through a single contact point.	✔		Section 18 of NRA.
Throughout the design process for a wind farm, appropriate assessments and methods for safe shutdown should be established and agreed, through consultation with MCA and other emergency support services.	✔		Sections 18 and 20 of NRA.
The WTG control mechanisms should allow	✔		Sections 18 and 20 of NRA.

MGN 371 COMPLIANCE			
Issue	**Yes**	**No**	**Remarks**
the Control Room Operator to fix and maintain the position of the WTG blades as determined by the Maritime Rescue Co-ordination Centre or Maritime Rescue Sub Centre (MRCC/SC).			
Nacelle hatches should be capable of being opened from the outside. This will allow rescuers (e.g. helicopter winch-man) to gain access to the tower if tower occupants are unable to assist and when sea-borne approach is not possible.	✔		Sections 18 and 20 of NRA.
Access ladders, although designed for entry by trained personnel using specialised equipment and procedures for turbine maintenance in calm weather, could conceivably be used, in an emergency situation, to provide refuge on the turbine structure for distressed mariners. This scenario should therefore be considered when identifying the optimum position of such ladders and take into account the prevailing wind, wave and tidal conditions.	✔		Section 13 of NRA.
Although it may not be feasible for mariners in emergency situations to be able to use wave or tidal generators as places of refuge, consideration should nevertheless be given to the provision of appropriate facilities.	✔		Section 18 of NRA
2. Operational Requirements			
The Central Control Room, or mutually agreed single point of contact, should be manned 24 hours a day.	✔		Sections 18 and 20 of NRA.
The Central Control Room operator, or mutually agreed single point of contact, should have a chart indicating the Global Positioning System (GPS) position and unique identification numbers of each of the WTGs in the wind farm.	✔		Sections 18 and 20 of NRA.
All MRCCs will be advised of the contact telephone number of the Central Control Room, or mutually agreed central point of conatct.	✔		Sections 18 and 20 of NRA.
All MRCCs will have a chart indicating the GPS position and unique identification number of each of the WTGs in all wind farms.	✔		Sections 18 and 20 of NRA.

MGN 371 COMPLIANCE			
Issue	**Yes**	**No**	**Remarks**
3. Operational Procedures			
Upon receiving a distress call or other emergency alert from a vessel which is concerned about a possible collision with a WTG or is already close to or within the wind farm, or when the MRCC receives a report that persons are in actual or possible danger in or near a wind farm and search and rescue aircraft and/or rescue boats or craft are required to operate over or within the wind farm, the MRCC will establish the position of the vessel and the identification numbers of any WTGs which are visible to the vessel. This information will be passed immediately to the Central Control Room, or single contact point, by the MRCC. A similar procedure will be followed when vessels are close to or within other types of OREI site	✔		Sections 18 and 20 of NRA.
The control room operator should immediately initiate the shut-down procedure for those WTGs as requested by the MRCC, and maintain the WTG in the appropriate shut-down position, again as requested by the MRCC, or as agreed with MCA Navigation Safety Branch or Search and Rescue Branch for that particular installation, until receiving notification from the MRCC that it is safe to restart the WTG.	✔		Sections 18 and 20 of NRA.
The appropriate procedure to be followed in respect of other OREI types, designs and configurations will be determined by these MCA branches on a case by case basis, in consultation with appropriate stakeholders, during the Scoping and Environmental Impact Assessment processes.	✔		Section 19 of NRA
Communication and shutdown procedures should be tested satisfactorily at least twice a year. Shutdown and other procedures should be tested as and when mutually agreed with the MCA.	✔		Sections 18 and 20 of NRA.

DECC Ship Type Checklist

European Offshore Wind Deployment Centre

(Appendix B)

Prepared by:	Anatec Limited
Presented to:	Aberdeen Offshore Wind Farm Limited
Date:	9 June 2011
Revision No.:	02
Ref.:	A2555-AOWF-NRA-2 App B

Anatec	Aberdeen Office	Cambridge Office
Address:	36 Upperkirkgate, Aberdeen, AB10 1BA, Scotland, UK	16 Ward Way, Witchford, Ely, Cambs, CB6 2JR, UK
Tel:	01224 633711	01353 661200
Fax:	0709 2367306	0709 2367306
Email:	aberdeen@anatec.com	cambs@anatec.com

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B1. Introduction

The AIS type classification has been converted to the DECC (formerly BERR) Methodology "Vessel Types involved in Navigational Activities - Example Checklist", reproduced below (Ref. i).

H6	Types of Vessel
1	*All*
2a	Large Vessels
	1. Bulk Carriers
	2. Bulk/Oil Carriers
	3. Chemical Tankers
	4. Container Vessels
	5. Cruise Vessels
	6. Liquefied Gas Carriers
	7. Oil Tankers
2b	Medium Vessels
	1. General Cargo
	2. Specialised Carriers
	3. Passenger
	4. Passenger Ferries
2c	High Speed Craft (HSC's)
	1. High speed ferries
	2. Other high speed recreational and commercial craft
3	Fishing Vessels
	1. Fish Processing
	2. Fishing Vessels (Various types and operations)
4	Recreational Vessels
	1. Sailing dinghies and Yachts
	2. Motor Boats
	3. Small Personal Watercraft
	4. Rowing boats
	5. Sports Fishing
	6. Windsurfer
	7. Kite Boards
	8. Tall Ships
	9. Recreational Submarines and dive support craft
5	Anchored Vessels
	All
6	Other Operational Vessels
	1. Barges
	2. Dredgers
	3. Dry Cargo Barge
	4. Offshore Production and Support
	5. Salvage
	6. Tank Barges
	7. Tugs and Tows
7	Military Vessels
	1. Warships
	2. Submarines
	3. Royal Fleet Auxiliaries
8	Other Vessels
	1. Seaplanes
	2. Wing-In-Ground Craft (WIG)
	3. Hovercraft

Figure 1.1 Vessel Types involved in Navigation Activities – Example Checklist

It is noted that the DECC list is not comprehensive, for example, it does not include explicit categories for vessels such as Ro-Ro and Wind Farm Support. Where this is the case, marine knowledge has been used to classify vessels, e.g., Ro-Ro vessels classified as "Medium Vessels – Ro-Ro" and Wind Farm as "Other Operational Vessels – Wind Farm".

The general commercial ship types identified in the traffic survey were:

2a. Large Vessels
2b. Medium Vessels
3. Fishing Vessels
6. Other Operational Vessels
7. Military Vessels
8. Other Vessels

[Note: Anchored Vessels (DECC Type 5) were also recorded in the survey. This reflects navigational status rather than vessel type, as all vessels may anchor at certain times. Therefore, anchored vessels have not been presented as a separate type in the plots but are discernible from the track behaviour.]

B2. Ship Types

The overall percentage distribution of ships passing within 20nm of the proposed European Offshore Wind Deployment Centre (EOWDC) site based on the general (top-level) DECC categorisation (excluding undefined vessels) and is presented below.

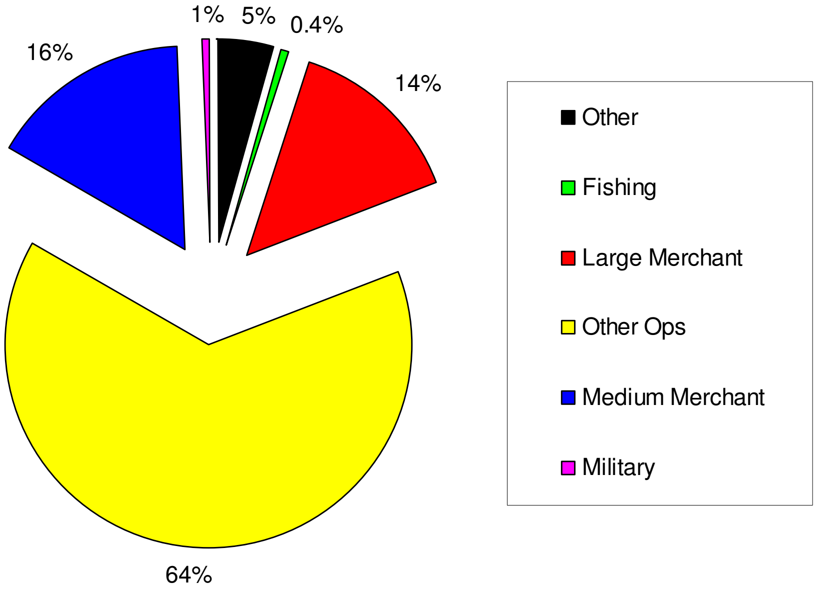

Figure 2.1 DECC General Ship Type Categorisation within 20nm of the Wind Farm

The majority of ships were other operational vessels according to the DECC classification and these are likely to be vessels related to the offshore oil and gas industry. The majority of the remaining vessels were medium and large merchant vessels with a small proportion of fishing vessels, military vessels and 'other' vessels.

A plot of the tracks colour-coded by the DECC general ship type categories is presented in Figure 2.2.

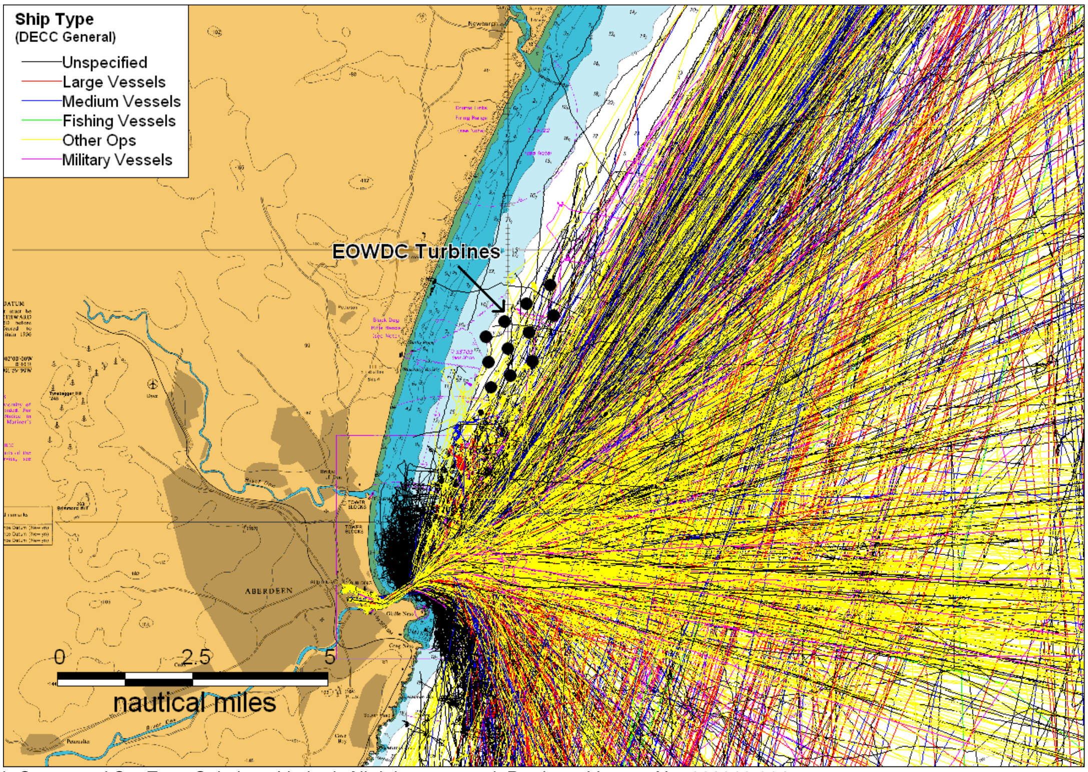

Figure 2.2 Tracks colour-coded by DECC General Ship Types

Dividing the types further using the more detailed (second-level) DECC categories, the distribution within 20nm was as follows:

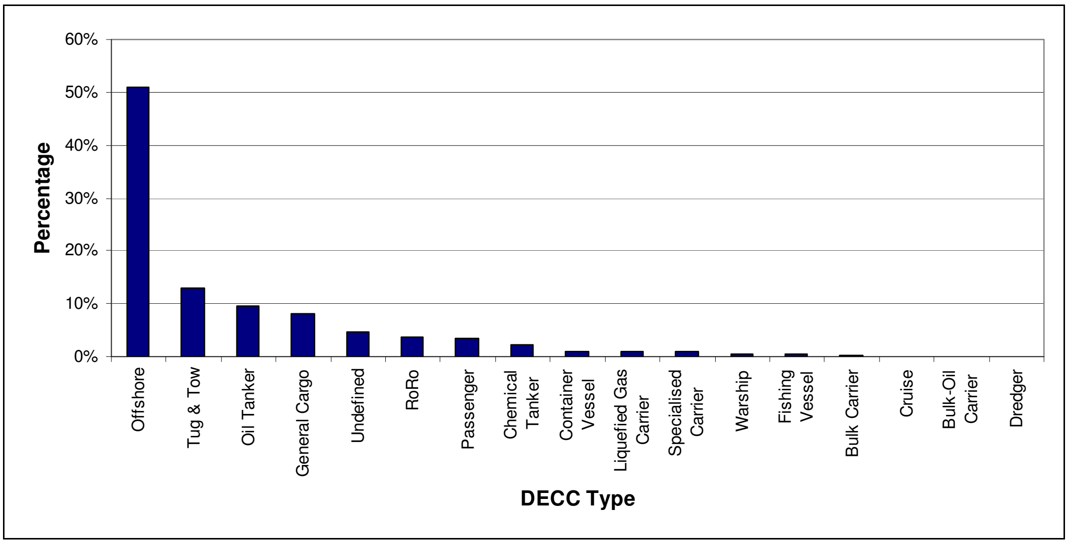

Figure 2.3 Detailed DECC Vessel Types identified within 20nm of the EOWDC Site

The most common category overall was offshore containing just over half of all vessels. There were also a large percentage of tug and tow vessels, oil tankers and general cargo ships.

A plot of the survey data colour-coded by the detailed DECC type classification is presented below.

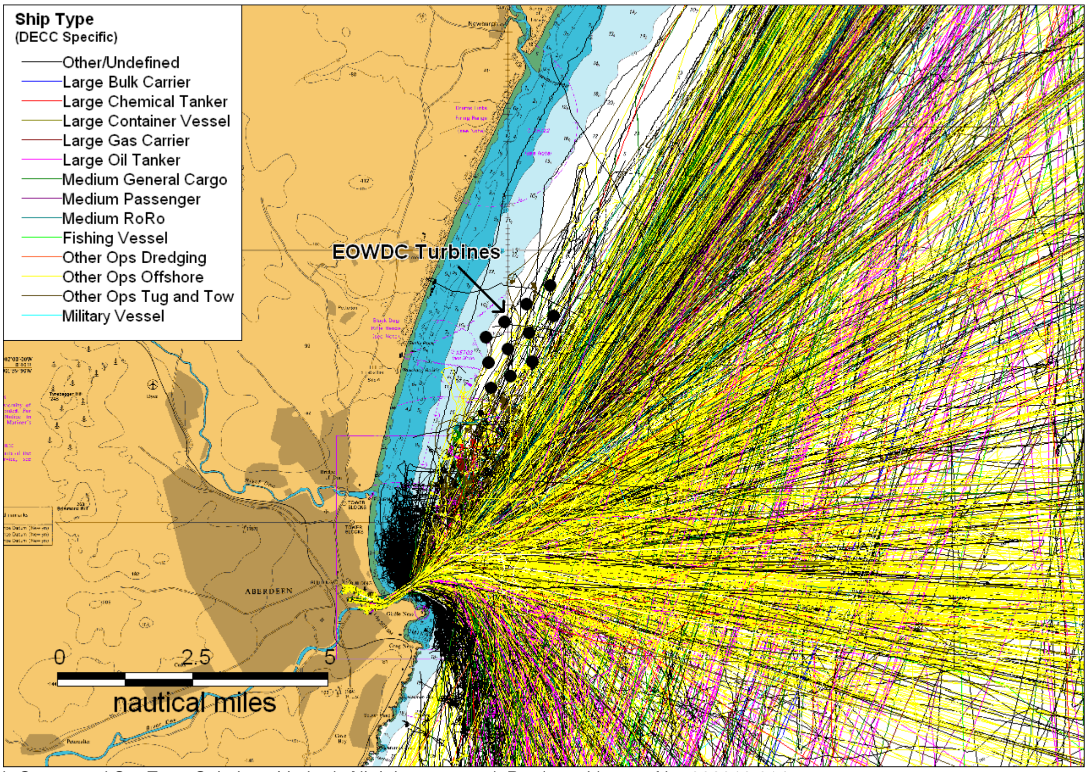

Figure 2.4 Tracks by DECC Detailed Type Categories

The majority of vessels passing between the proposed turbine locations during the surveys were "other operational vessels". This Appendix presents an assessment of the consequences of collision incidents, in terms of people and the environment, due to the impact of the proposed EOWDC.

B3. References

i DECC (formerly BERR), U.K. Government, Methodology for Assessing the Marine Navigational Safety Risks of Offshore Windfarms, Version Date: 7th September 2005

Anchoring Analysis

European Offshore Wind Deployment Centre

(Appendix C)

Prepared by:	Anatec Limited
Presented to:	Aberdeen Offshore Wind Farm Limited
Date:	9 June 2011
Revision No.:	01
Ref.:	A2555- AOWF-NRA-1 App C

Anatec	Aberdeen Office	Cambridge Office
Address:	36 Upperkirkgate, Aberdeen, AB10 1BA, Scotland, UK	16 Ward Way, Witchford, Ely, Cambs, CB6 2JR, UK
Tel:	01224 633711	01353 661200
Fax:	0709 2367306	0709 2367306
Email:	aberdeen@anatec.com	cambs@anatec.com

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C1. Introduction

This Appendix presents an assessment of anchoring by vessels off Aberdeen.

52 weeks of AIS data from October 2008 to October 2009 was examined to gain a broad overview of ships anchoring off Aberdeen. For a more in-depth analysis, 4 weeks of survey data was used which covered two weeks in winter and two weeks in summer. The winter survey took place from 25 March to 7 April 2009 (Survey 1) and the summer survey took place from 21 September to 5 October 2009 (Survey 2).

It should be noted this analysis was carried out before the introduction of an official anchorage area in 2010 to the North of Aberdeen port. With respect to this it is noted that the types and numbers of vessels using the new anchorage are likely to be in line with the information presented within this analysis, and that it is only the anchoring locations that are likely to vary.

To ensure the analysis of the 4 week survey was relevant to Aberdeen Harbour, only those vessels which used the Port were considered. Throughout the report when discussing the number of anchored vessels during the 4 week survey, this refers to those which anchored and visited the Port during this period.

It should be noted that the accuracy regarding the number of anchorings relies on the officers of the ships to manually update their navigation status on their AIS.

C2. Vessel Type

The distribution of vessel type for vessels which anchored off Aberdeen during the 52 week period is presented in Figure 2.1 (excluding 3 % unspecified vessels).

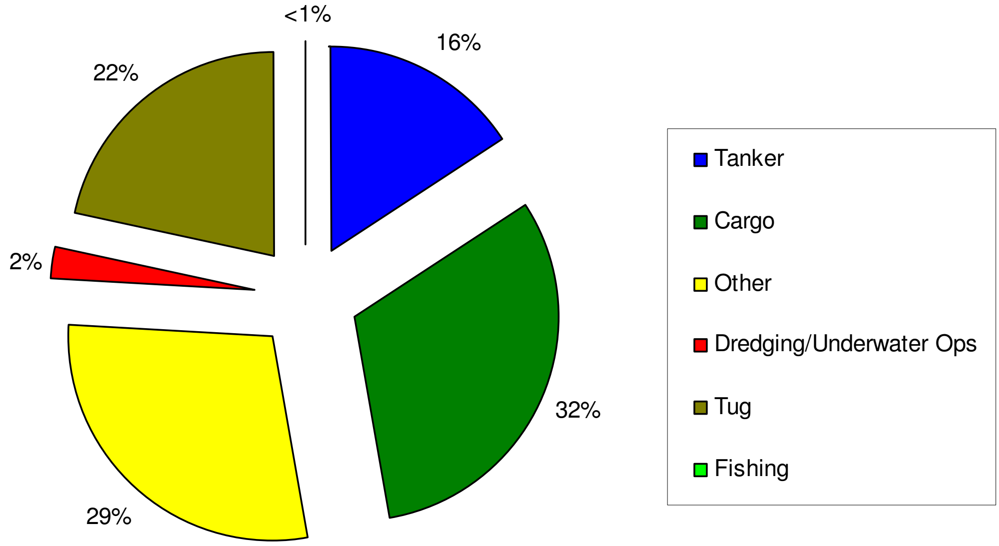


Figure 2.1 Distribution of Anchored Vessels by Type (52 Week Survey)

During this period the type of vessel which anchored most was cargo ships (32%). 'Other' vessels which comprise mainly of offshore support vessels also frequently anchored off Aberdeen (29%). There were no passenger, High Speed Craft (HSC) or military vessels recorded anchoring during the survey.

The distribution of vessel types during the 4 week survey is shown in Figure 2.2 below. There was a total of 36 recorded anchorings during this period.

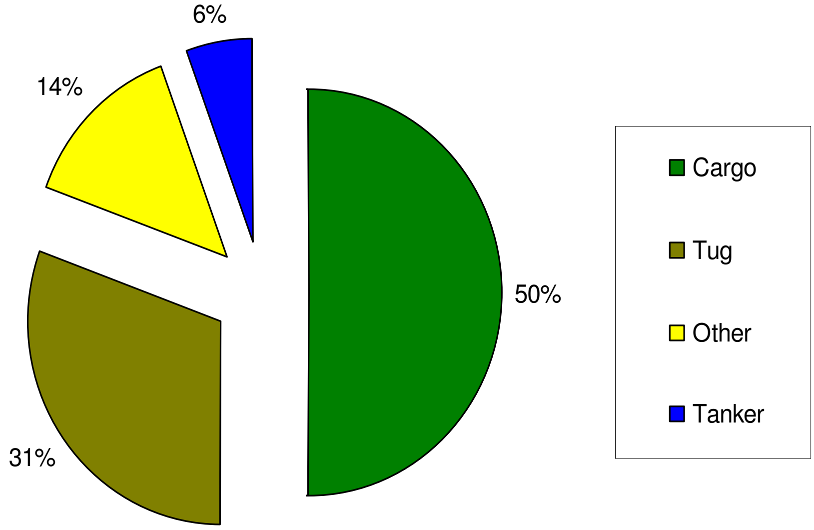


Figure 2.2 Distribution of Anchored Vessels by Type (4 Week Survey)

863 vessels were recorded using the port during the survey. The distribution of these vessels is shown in Figure 2.3 below (excluding 1% unspecified). Pilot vessels and vessels which stayed in the Harbour for the duration of the survey have also been omitted.

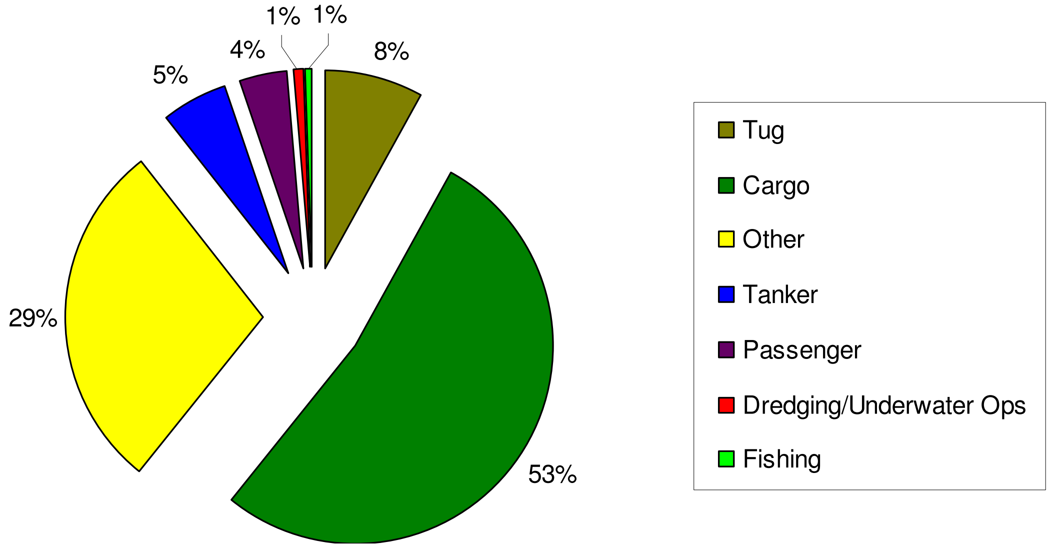


Figure 2.3 Distribution of Vessels using the Port by Type (4 Week Survey)

It can be seen from Figure 2.2 and Figure 2.3 that during the survey approximately half of the vessels using both the anchorage area and the port were cargo ships (50% and 53%, respectively). A bar chart comparing anchoring with port usage is presented in Figure 2.4.

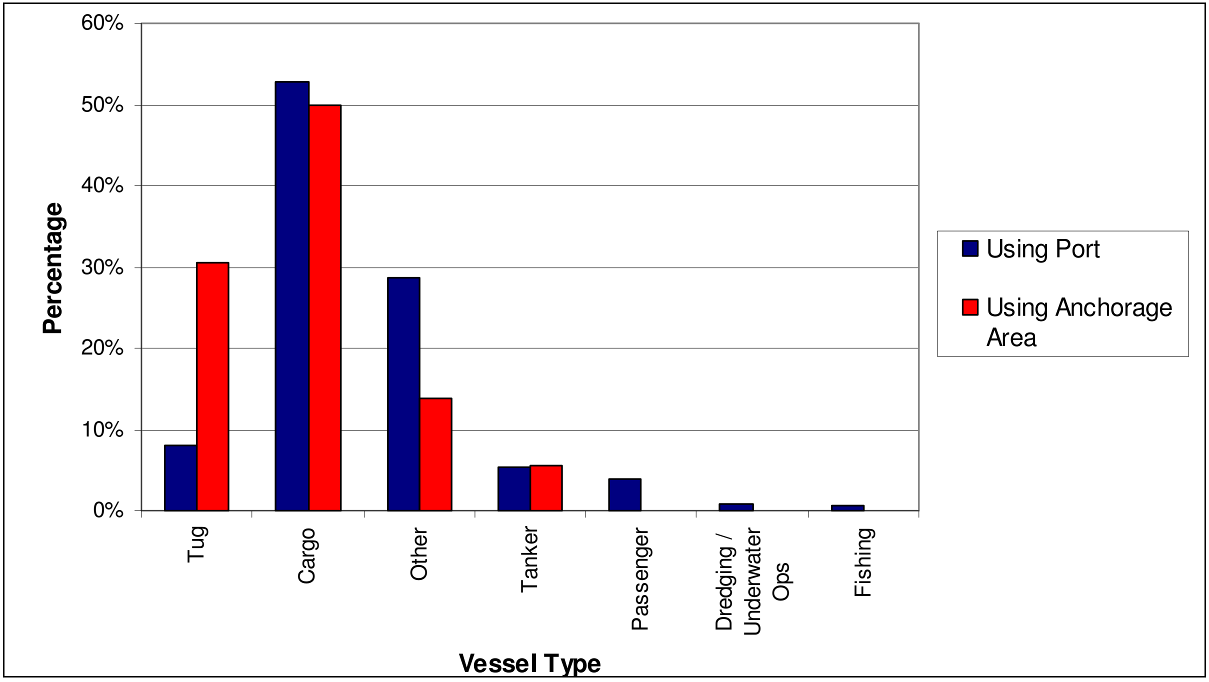


Figure 2.4 Comparison of Port Usage and Anchorage Usage (4-Week Survey)

It can be seen that during the 4 week survey tankers and cargo vessels anchored off Aberdeen in similar proportion to those which used the port. The type of vessel which anchored most frequently relative to how often it used the Port was tugs. With the exception of passenger, dredging/underwater ops and fishing vessels which were all recorded visiting the Port but not anchoring, the type of vessel which anchored least relative to how often it used the Port was ‘other’ vessels.

The draught distributions of anchored vessels and of those using the Port during the 4 week survey are presented in Figure 2.5.

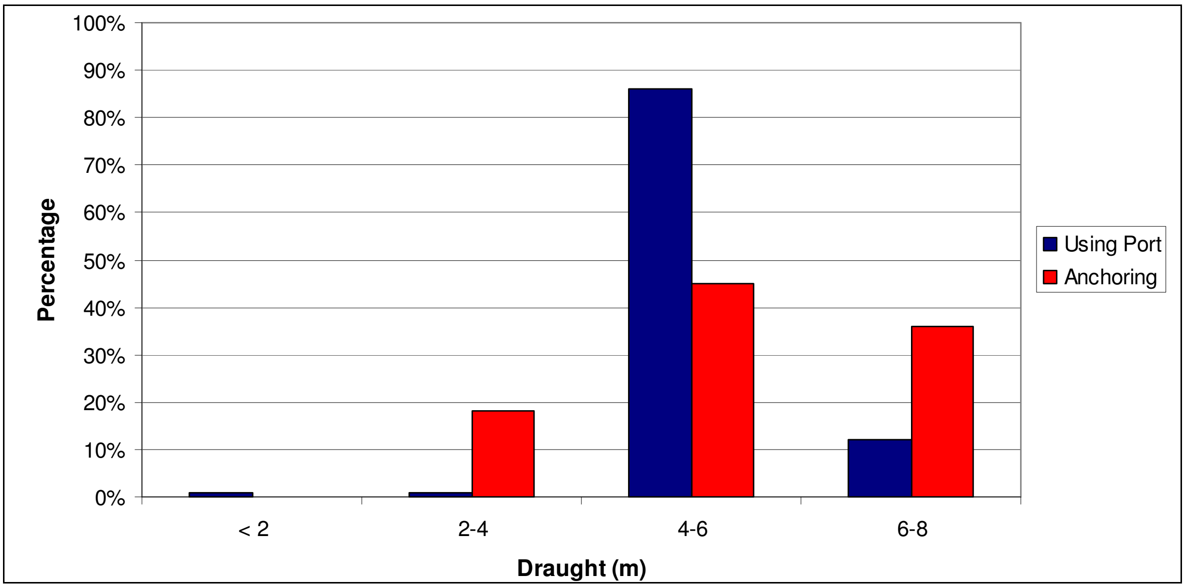


Figure 2.5 Comparison of Draught Distributions (Using Port vs. Anchoring)

In both cases the most common draught size was in the range of 4m to 6m. Vessels with draughts in this size range dominated within those which used the Port (86%) whereas the draughts of those which anchored were more evenly spread. 36% of the anchored vessels had draughts of 6m to 8m whereas only 12% of the vessels using the Port had draughts in this range. This suggests that vessels with a deeper draught are more likely to anchor than vessels with a smaller draught – most likely due to the deeper vessels having to 'wait for tide' before entering the port. It should also be noted that several vessels during the survey with draughts greater than 8m anchored off Aberdeen, but none of these vessels also used the Port.

C3. Anchorage Positions

Taken from the 52-week data set, the tracks of the 5 most common types of vessel to anchor off Aberdeen are shown in the following figures.

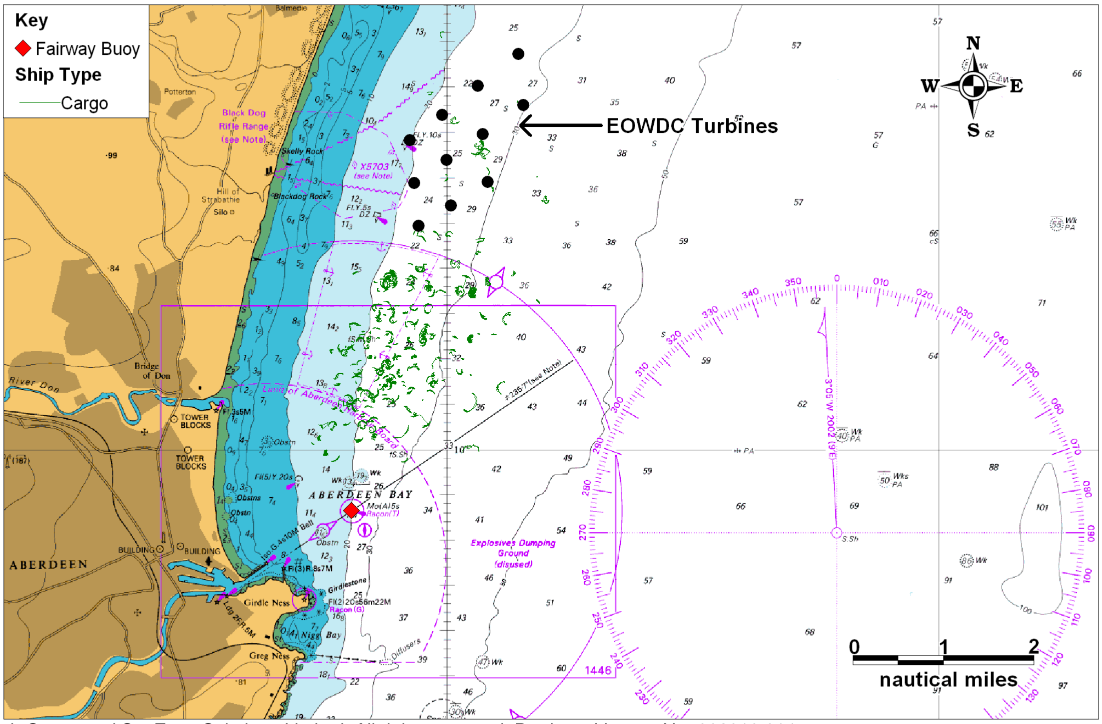


Figure 3.1 Anchored Cargo Vessels during 52 Week Survey (prior to anchorage being designated)

It can be seen that cargo ships were consistent in anchoring to the north, NNE and NE of the Fairway Buoy. Six cargo vessels anchored within the turbine area during the 52 week period.

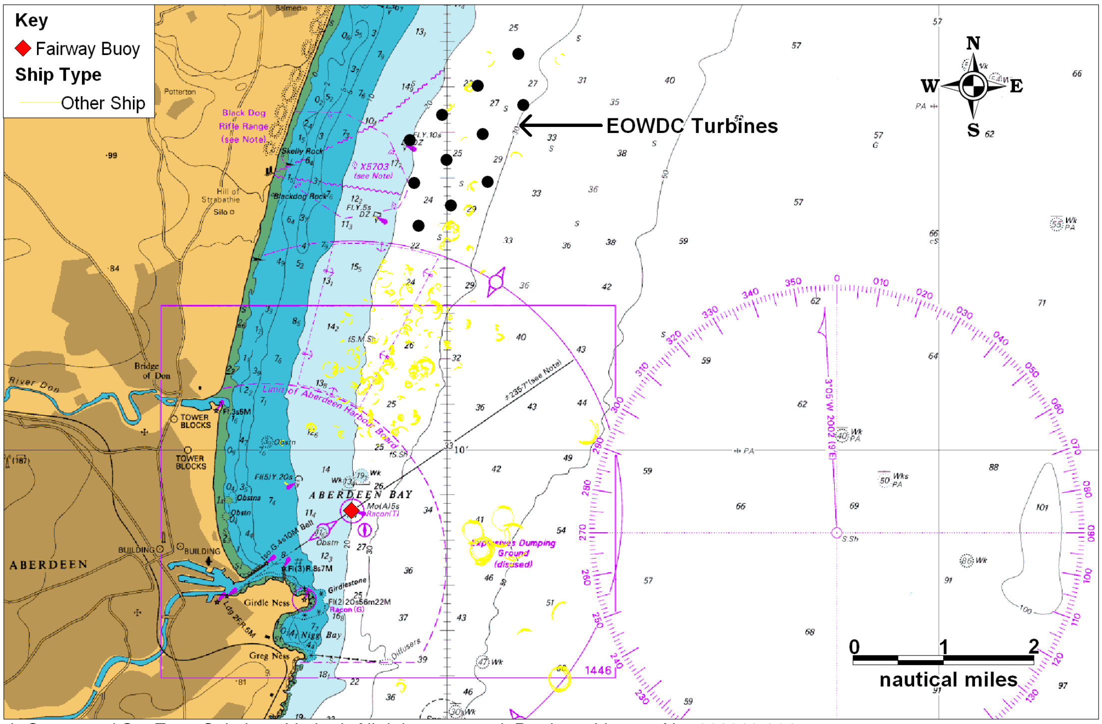


Figure 3.2 Anchored Other Vessels during 52 Week Survey (prior to anchorage being designated)

'Other' vessels generally anchored to the north and NNE of the Fairway Buoy. Almost all of the tracks to the south, SE and east of the Fairway Buoy were made by the shuttle tanker *Navion Fennia* – see discussion below on tankers anchoring in this area. Four 'other' ships anchored within the site during the 52 week period.

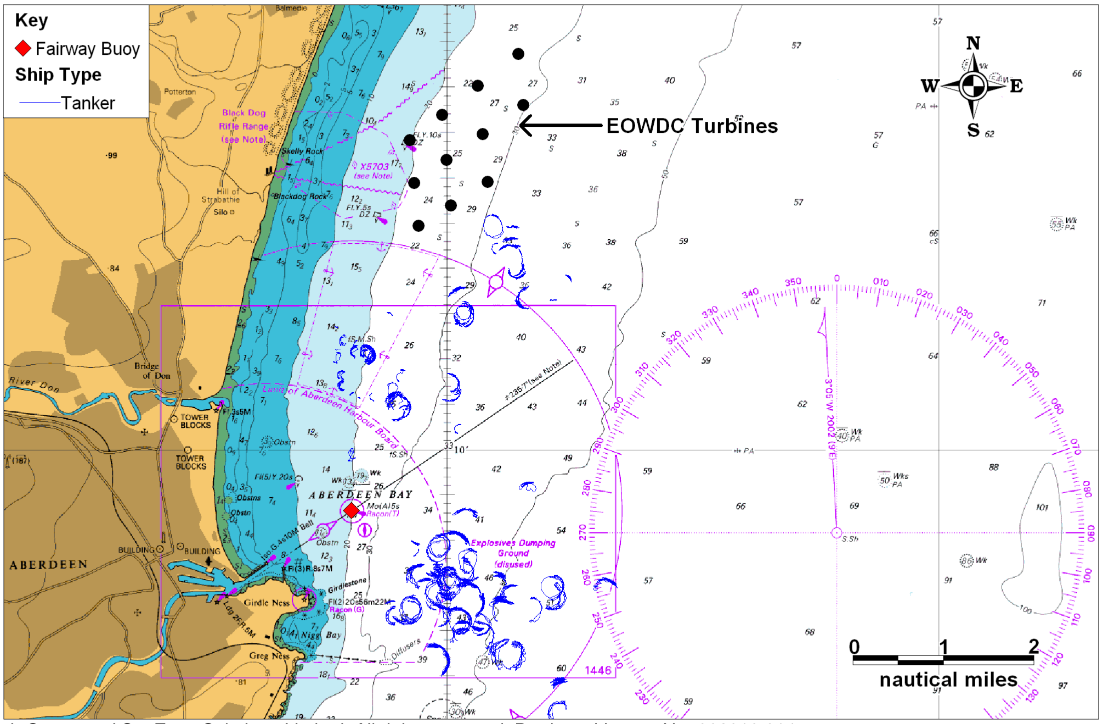


Figure 3.3 Anchored Tankers during 52 Week Survey (prior to anchorage being designated)

The majority of tankers anchored to the SE of the Fairway Buoy but several also anchored to the north and NE. Those to the north and NE and within 2nm of the Fairway Buoy generally had draughts less than 8m and were awaiting entry to Aberdeen Harbour, and the rest generally had draughts greater than 8m and were not visiting the Harbour.

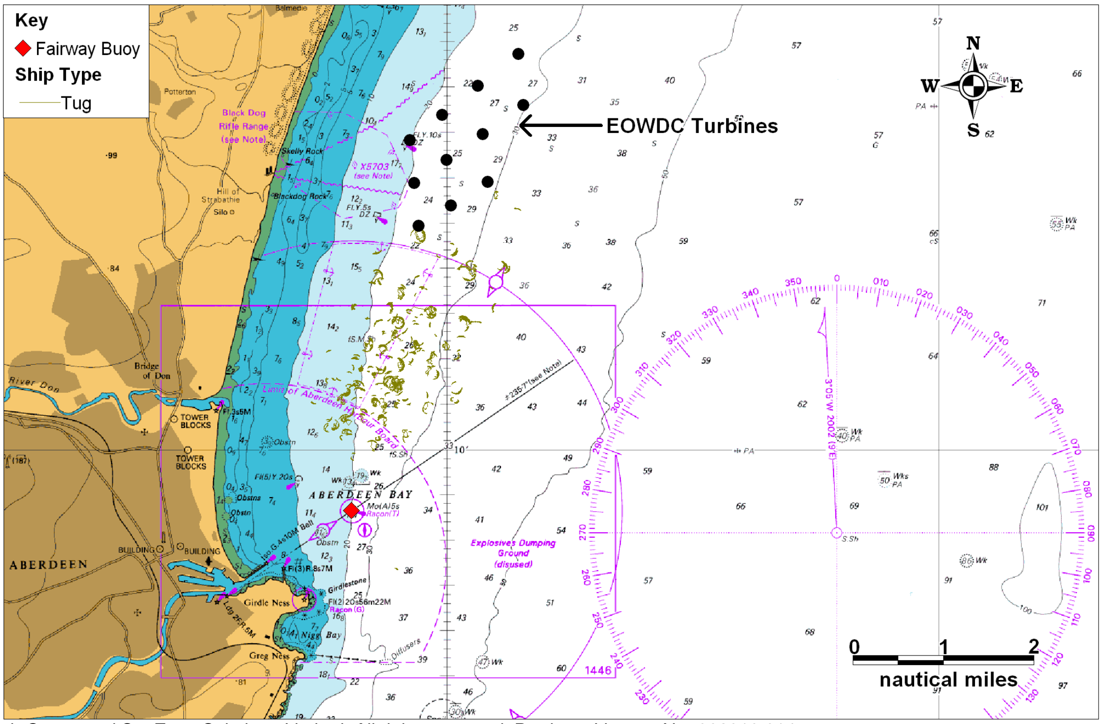


Figure 3.4 Anchored Tugs during 52 Week Survey (prior to anchorage being designated)

Tug vessels were consistent in anchoring to the north and NNE of the Fairway Buoy.

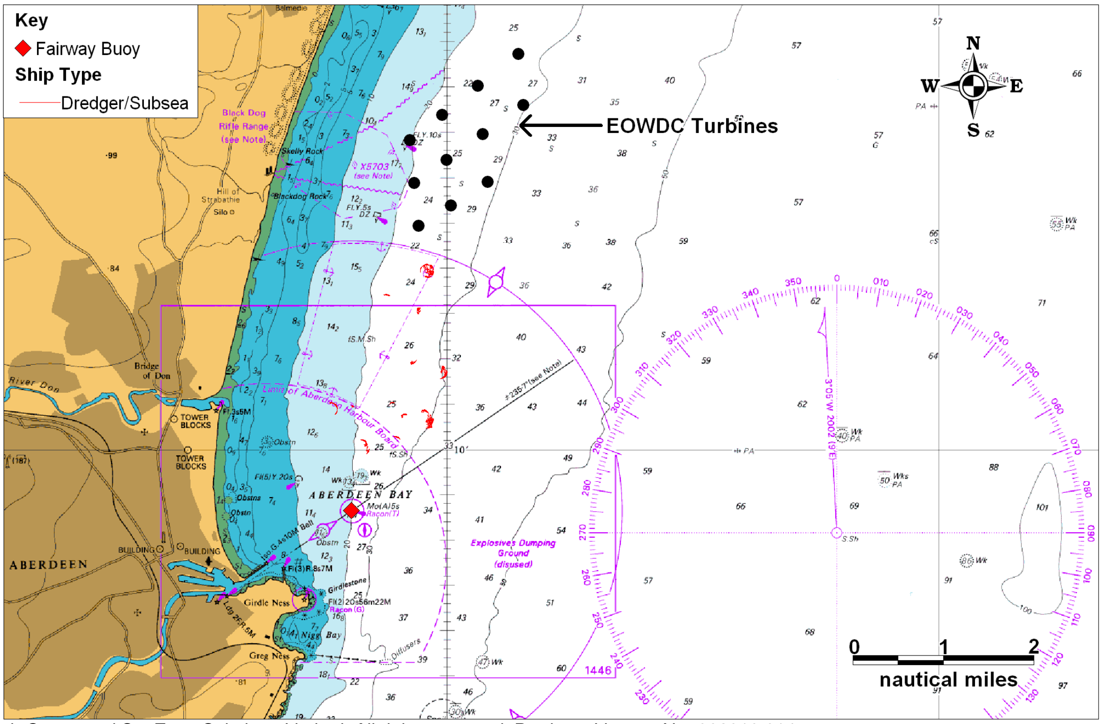


Figure 3.5 Anchored Dredging/Subsea Vessels during 52 Week Survey (prior to anchorage being designated)

Based on the limited data, it is assumed that dredging/subsea vessels tend to anchor to the north and NNE of the Fairway Buoy.

It can be concluded that all vessels visiting Aberdeen Harbour anchor off the Fairway Buoy to the north, NNE and NE, and vessels not visiting (i.e., large tankers) anchor elsewhere.

C4. Weather Analysis

The weather was recorded 4 times a day throughout the 4 week survey. During the winter survey the wind was predominantly from the SW, although for significant periods the wind came from the NE, and then the SE. During the summer survey the wind was predominantly from the west and SW, although for two days the wind came from the NW.

3 vessels were recorded anchoring during the winter survey and 33 during the summer survey. In Figure 4.1 below, each vessel which anchored during the survey periods is represented by a coloured dot, where the colour denotes the wind direction on the day the ship anchored, if wind direction is unknown then the plot has been omitted.

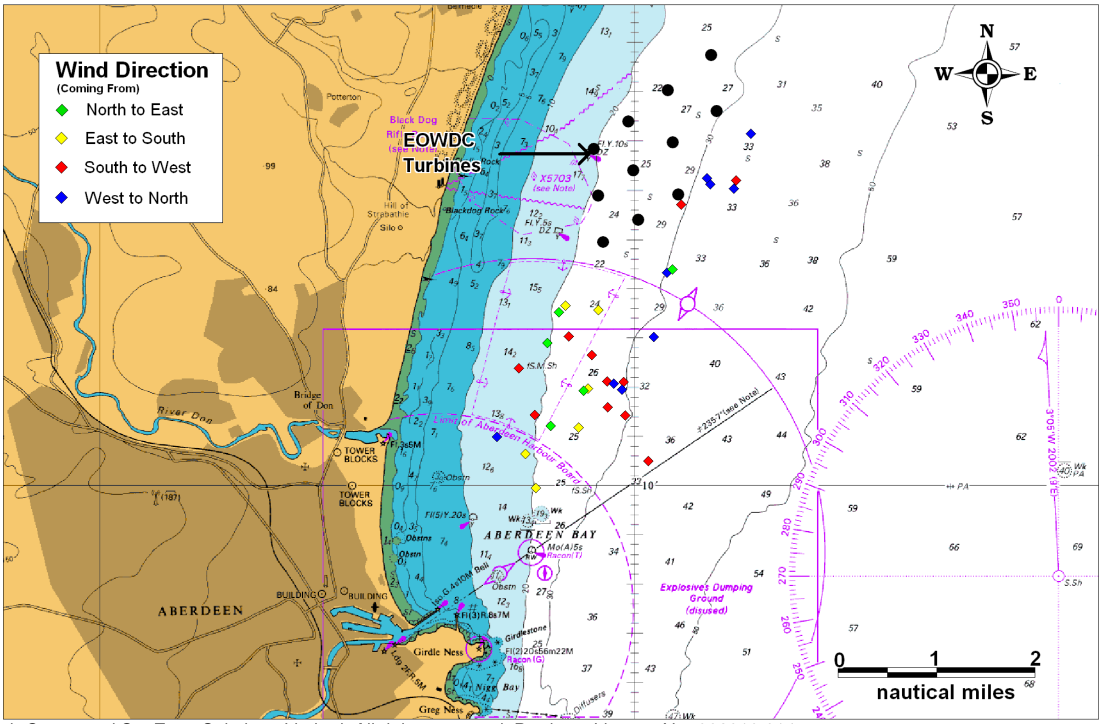


Figure 4.1 Preferred Anchorage Locations with Wind Direction (prior to anchorage being designated)

It should be noted first that in the legend key in the above figure, the second term is not inclusive, i.e., 'North to East' consists of wind coming from the north right through to, but not including, the east. There is no clear relation between the position of the anchored vessels and the wind direction. A more conclusive analysis might be more achievable with the use of further wind data.

C5. Tide Analysis

The tidal variations at Aberdeen during the winter and summer surveys are presented below.

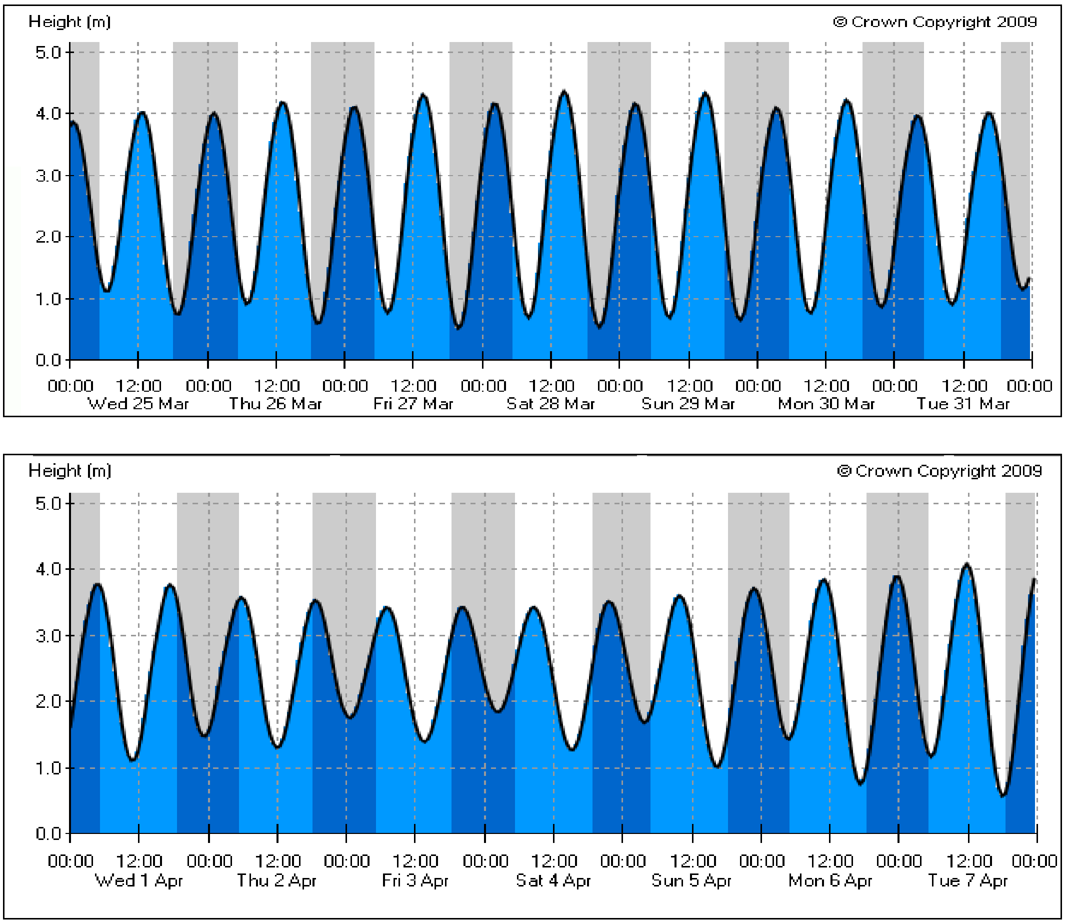
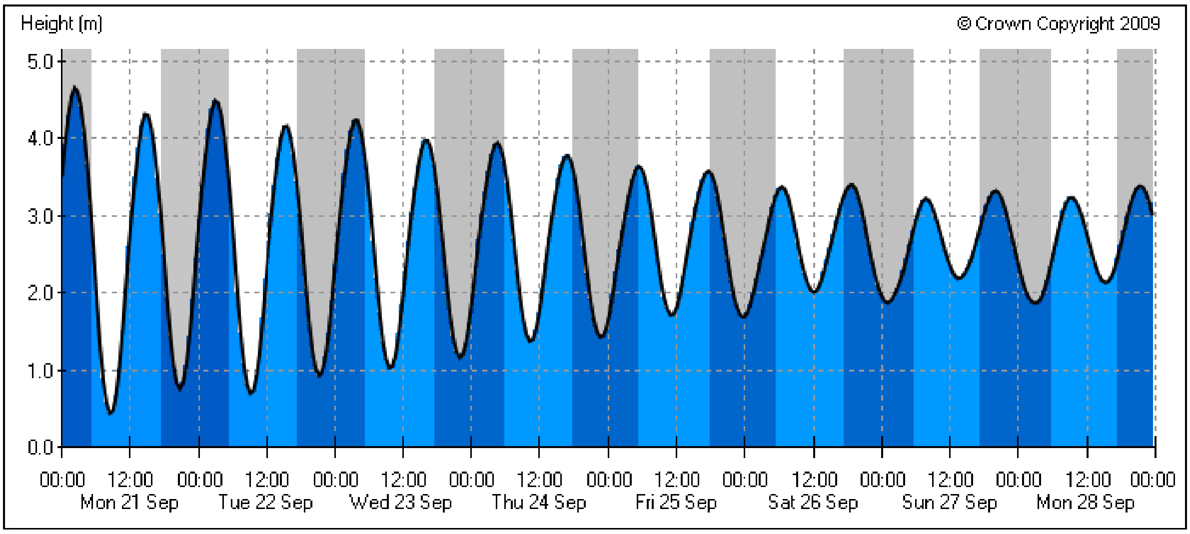


Figure 5.1 Tidal Predictions for Aberdeen during Winter Survey Period (Source: Admiralty Tides, UTC Times)

The 26-30 March has been treated as a spring period and the 1-5 April as a neap period. The remainder of days are considered to be 'neutral'.



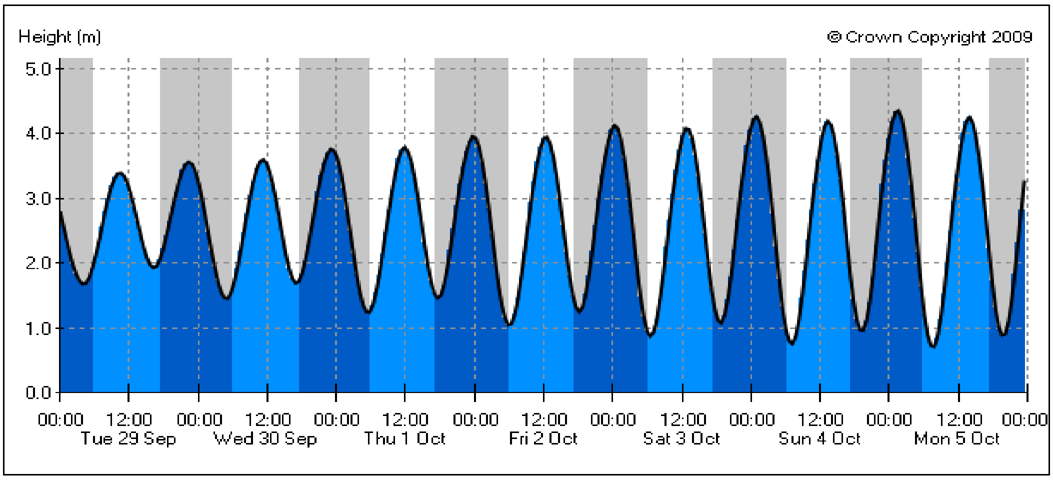


Figure 5.2 Tidal Predictions for Aberdeen during Summer Survey Period (Source: Admiralty Tides, UTC Times)

The periods between 21-22 September and 3-5 October have been classed as spring periods and 25-29 September has been classed as a neap period. Again, the remainder of days have been classed as 'neutral'.

Of the 28 days that make up the survey, 10 days represent spring tides (36%), 10 represent neap tides (36%) and 8 are 'neutral' (29%).

Figure 5.3 below presents the locations of anchored vessels during different tidal conditions.

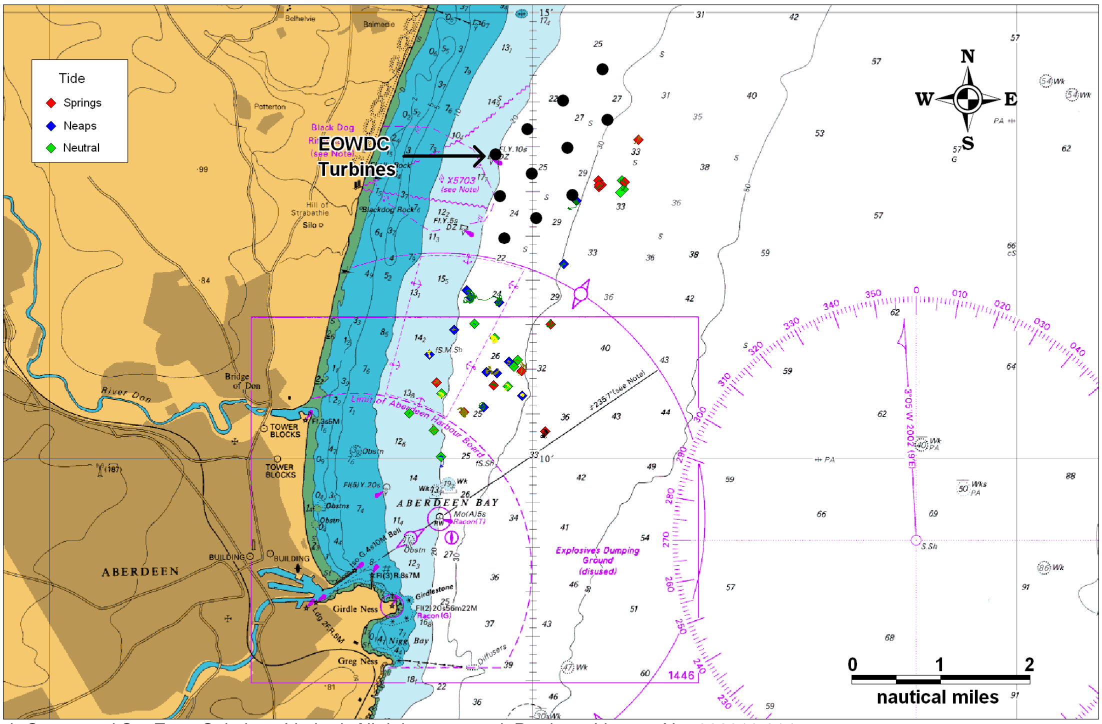


Figure 5.3 Preferred Anchorage Locations during different Tides (prior to anchorage being designated)

There is no clear pattern of anchorage locations by tidal conditions. A more conclusive analysis may be more achievable with the use of more tidal data. The frequency of anchoring during the different tidal conditions was quite equally spread, with 12 ships anchoring during each of the periods. The average numbers of anchorings per day has been calculated for each tidal condition and are presented in Figure 5.4 below.

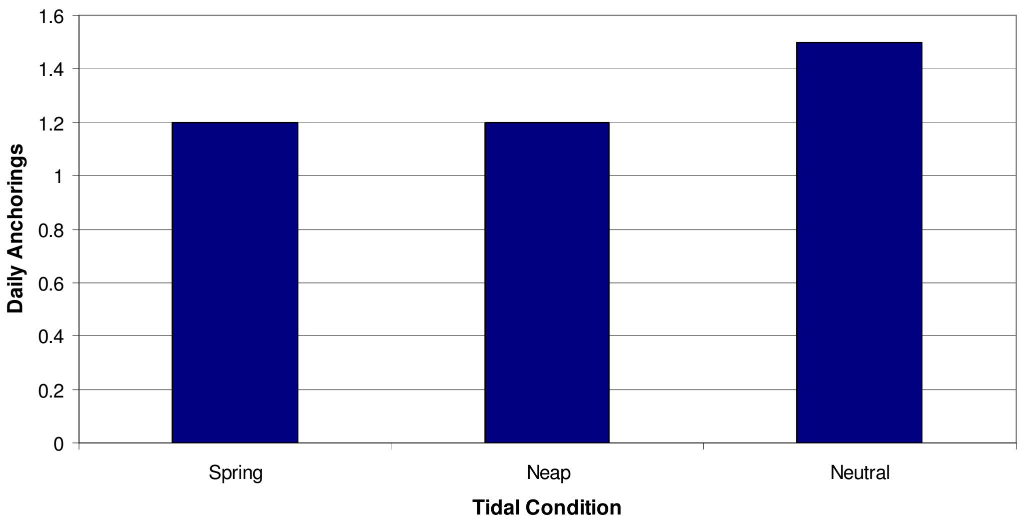


Figure 5.4 Average Number of Daily Anchorings during different Tidal Conditions

The average number of vessels to anchor each day was 1.2 during the spring and neap periods and 1.5 during the 'neutral' periods.

C6. Vessel Movements

The anchored vessels at Aberdeen were analysed visually for one week in September 2009 by replaying the AIS data at high-speed. During this week 22 vessels were observed anchoring off Aberdeen. Figure 6.1 below presents the percentages of these vessels which were in the Port prior to anchoring, and which vessels went on to enter the Port after anchoring.

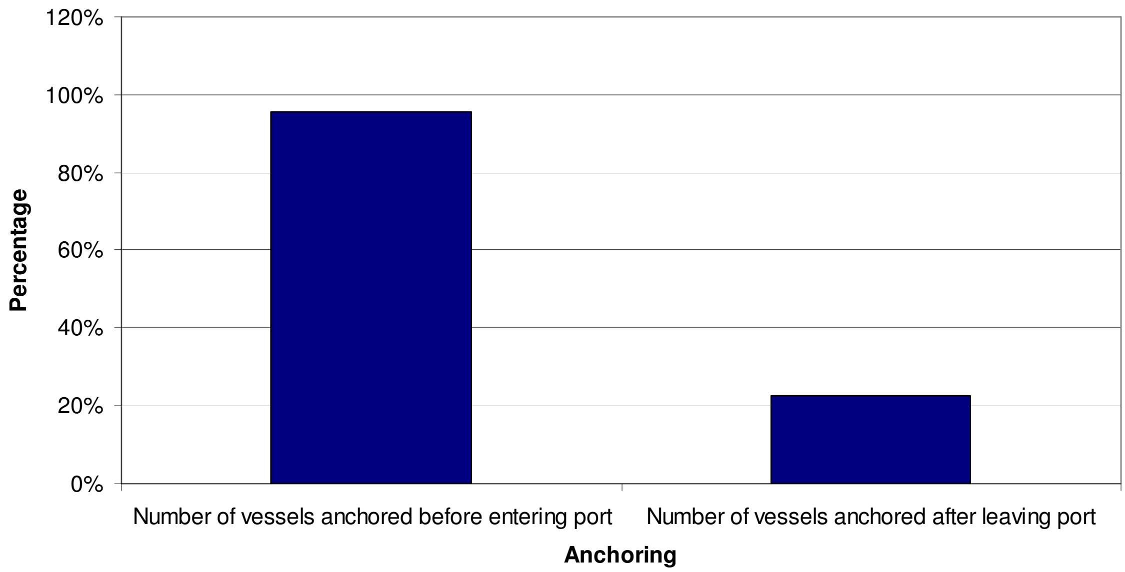


Figure 6.1 Pre- and Post-Anchor Locations

During this 1-week survey 23% of the anchored vessels had come directly from the Harbour with 77% coming from sea. For vessels leaving anchor, 95% went to the Harbour with the remainder going to sea. Of those that entered the Harbour after anchoring, 83% had been out at sea prior to anchoring..

C7. Anchorage Location Preference

Aberdeen bay always contained at least one anchored vessel throughout the summer survey but there were numerous periods during the winter survey when the area was empty. Figure 7.1 shows where vessels opted to anchor when they had the entire bay to choose from.

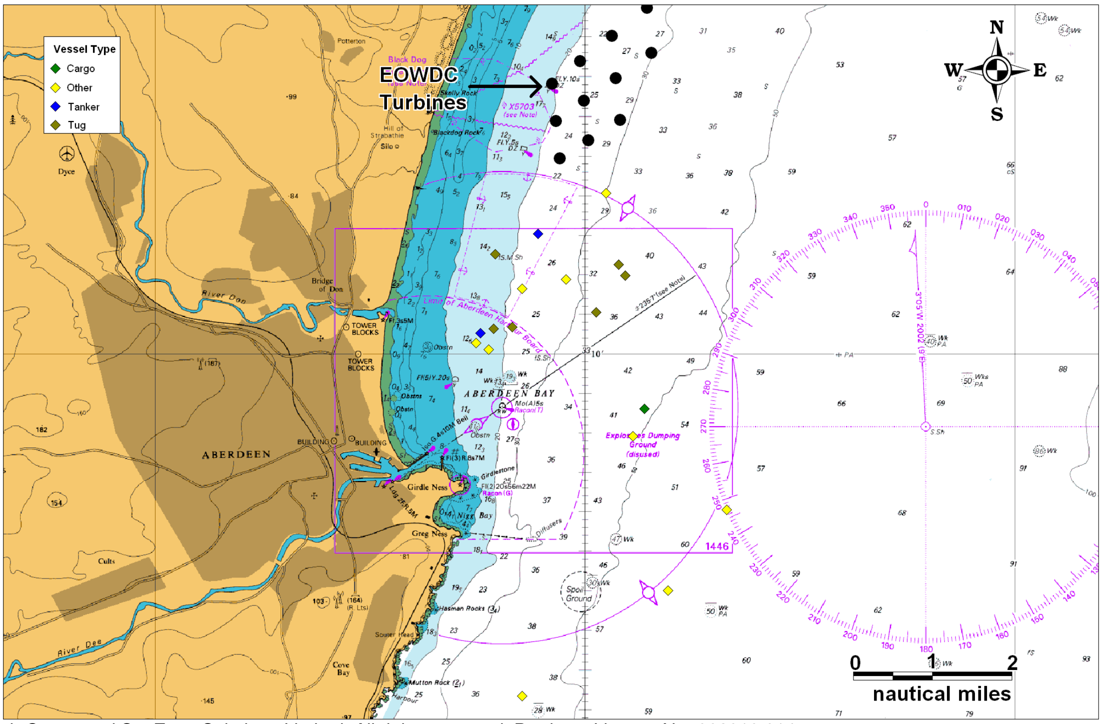


Figure 7.1 First Choice Anchorage Locations (prior to anchorage being designated)

It can be seen that the most common anchorage of choice was in the area to the north, NNE and NE of the Fairway Buoy. It should be noted that not all vessels were definitely visiting the Port and it is assumed that those which anchored to the east, ESE and SE of the Fairway Buoy were not, as comparing with previous figures shows that no ships visiting the Harbour anchored in this area.

C8. Anchorage Duration

The 36 recorded anchorings during the 4 week survey gave a combined anchoring duration of approximately 44 days, which corresponds to an average anchoring duration of 29 hours. The length of time which ships stayed at anchor ranged from under an hour to over 6 days.

Vessels which were not visiting the Port were recorded anchoring for up to 14 days. Figure 8.1 below presents the distribution of the time vessels spent at anchor.

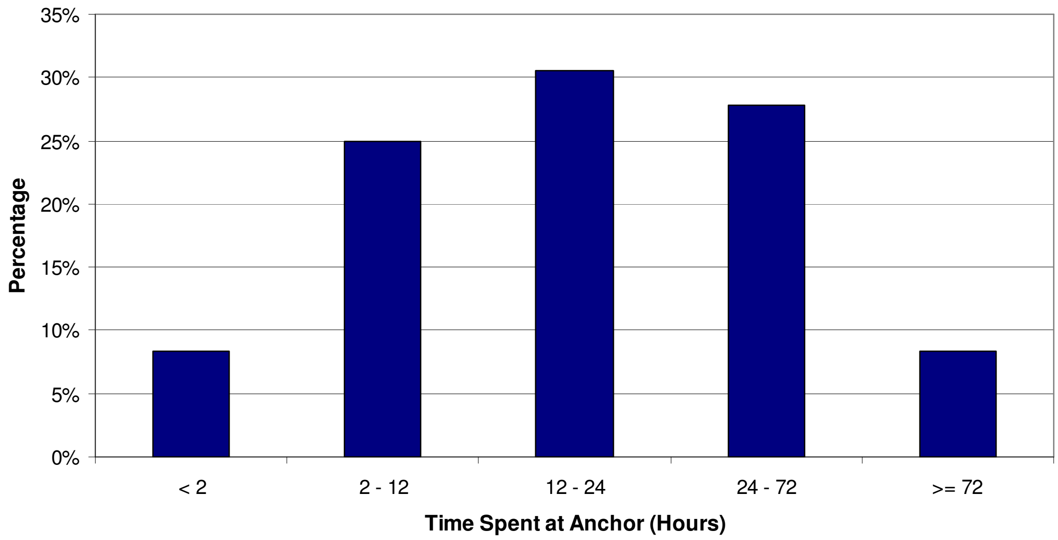


Figure 8.1 Distribution of Time Spent at Anchor

It can be seen that approximately a third of all vessels fall within the category of anchoring for 12 to 24 hours (31%). Another significant point to take from this figure is that 8% of vessels were anchored for less than 2 hours.

The dots in the plot below indicate the locations of the anchored vessels, colour-coded by the length of their stay.

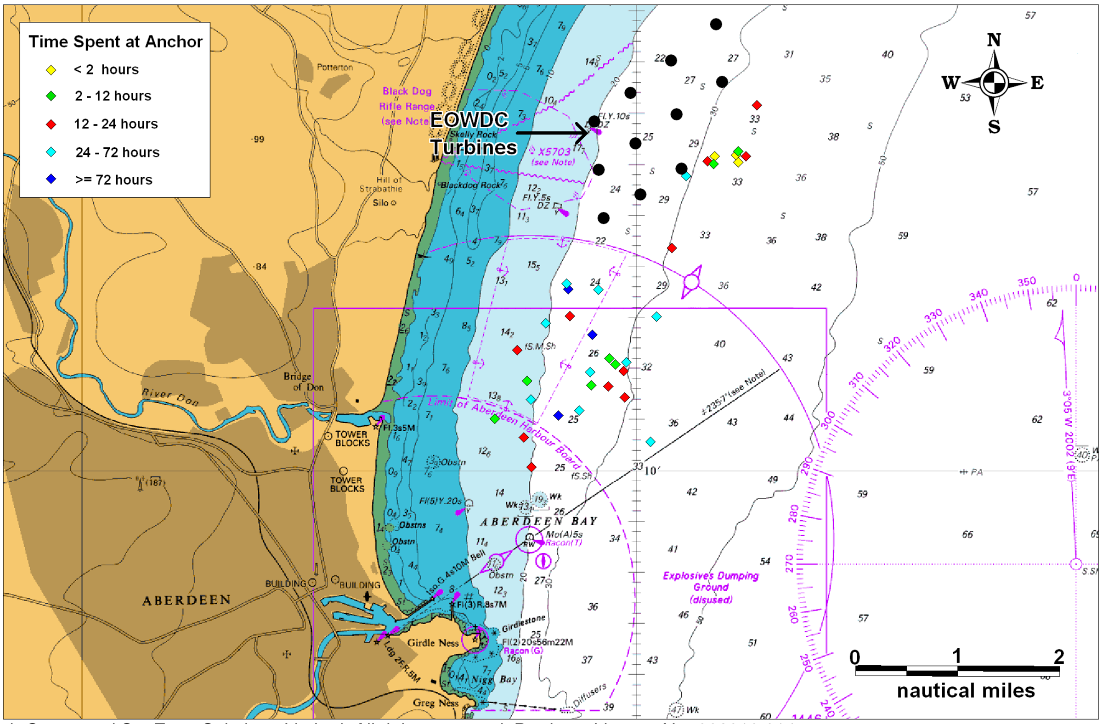


Figure 8.2 Locations of Anchored Vessels with Duration (prior to anchorage being designated)

From the data there is no clear relation between vessels' anchorage location and duration at anchor.

C9. Designation Anchorage

During the course of preparing this navigational impact assessment an anchorage was designated in Aberdeen Bay. The following figure provides an overview of the anchored vessels following this designation (14 day period).

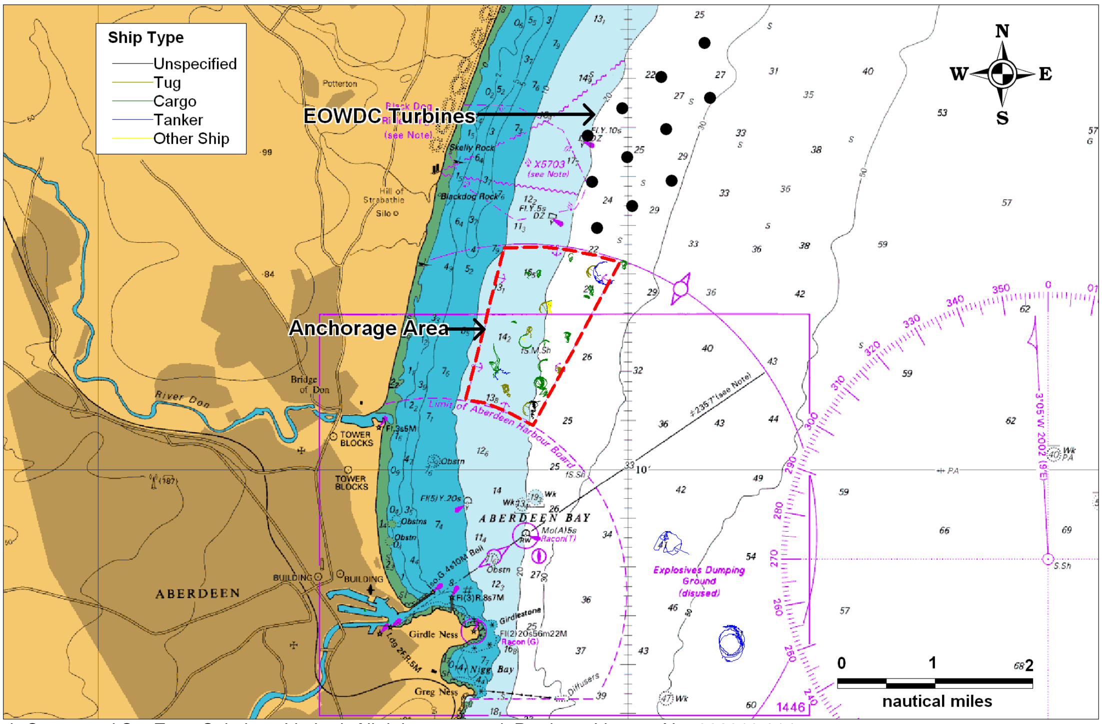


Figure 9-1 Anchored Vessels during Survey 5 (with Charted Anchorage Area shown in red)

Consequences Assessment

European Offshore Wind Deployment Centre

(Appendix D)

Prepared by:	Anatec Limited
Presented to:	Aberdeen Offshore Wind Farm Limited
Date:	9 June 2011
Revision No.:	01
Ref.:	A2555-AOWF-NRA-1 App D

Anatec	**Aberdeen Office**	**Cambridge Office**
Address:	36 Upperkirkgate, Aberdeen, AB10 1BA, Scotland, UK	16 Ward Way, Witchford, Ely, Cambs, CB6 2JR, UK
Tel:	01224 633711	01353 661200
Fax:	0709 2367306	0709 2367306
Email:	aberdeen@anatec.com	cambs@anatec.com

TABLE OF CONTENTS

D1. Introduction

This Appendix presents an assessment of the consequences of collision incidents, in terms of people and the environment, due to the impact of the proposed European Offshore Wind Deployment Centre (EOWDC).

The significance of the impact of the proposed EOWDC is also assessed based on risk evaluation criteria and comparison with historical accident data in the UK waters[1].

D2. Risk Evaluation Criteria

2.1 Risk to People

With regard to the assessment of risk to people two measures are considered, namely;

- Individual Risk
- Societal Risk

2.1.1 Individual Risk (per Year)

This measure considers whether the risk from an accident to a particular individual changes significantly due to the wind farm. Individual risk considers not only the frequency of the accident and the consequence (likelihood of death), but also the individual's fractional exposure to that risk, i.e., the probability of the individual of being in the given location at the time of the accident.

The purpose of estimating the Individual Risk is to ensure that individuals, who may be affected by the presence of the wind farm, are not exposed to excessive risks. This is achieved by considering the significance of the change in individual risk resulting from the presence of the wind farm, relative to the background individual risk levels.

Annual individual risk levels to crew (i.e., the annual fatality risk of an average crew member) for different ship types are presented in Figure 2.1 (Ref.i). The figure also highlights the risk acceptance criteria as suggested in IMO MSC 72/16.

[1] In this technical note, UK waters means the UK Exclusive Economic Zone and UK territorial waters means within the 12 nautical miles limit.

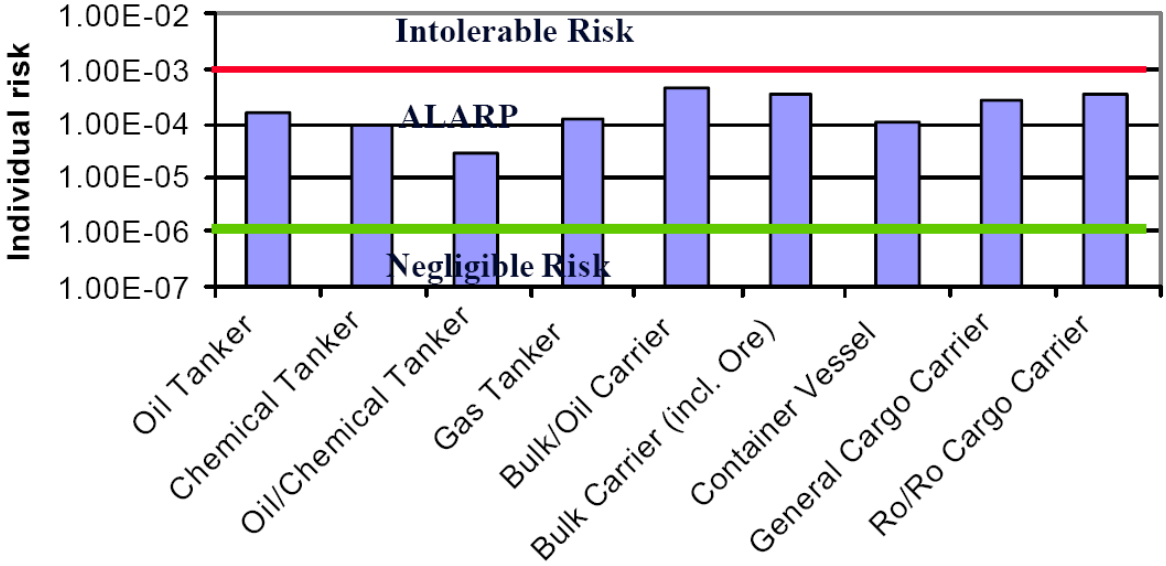


Figure 2.1 Individual Risk Levels and Acceptance Criteria per Ship Type

Typical bounds defining the ALARP regions for decision making within shipping are as follows.

Table 2.1 Individual Risk ALARP Criteria

Individual	Lower Bound for ALARP	Upper Bound for ALARP
To crew member	10^{-6}	10^{-3}
To passenger	10^{-6}	10^{-4}
3rd party	10^{-6}	10^{-4}
New ship target	10^{-6}	Above values reduced by one order of magnitude

On a UK basis, the MCA website presents individual risks for various UK industries based on HSE data for 1987-91 (Ref. ii). The risks for different industries are compared in Figure 2.2.

The individual risk for sea transport of 2.9 x 10^{-4} per year is consistent with the worldwide data presented in Figure 2.1, whilst the individual risk for sea fishing of 1.2 x 10^{-3} per year is the highest across all of the industries listed.

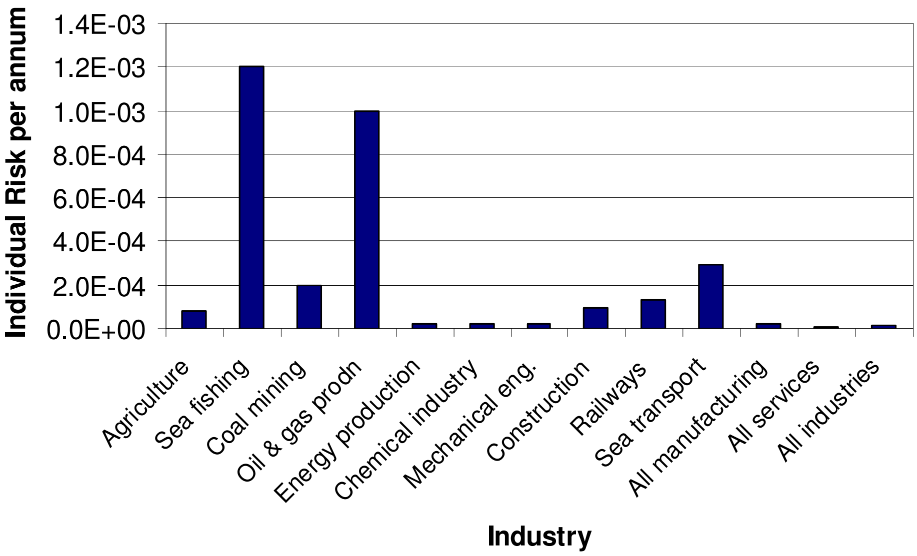


Figure 2.2 Individual Risk per Year for various UK Industries

2.1.2 Societal Risk

Societal Risk is used to estimate risks of accidents affecting many persons, e.g., catastrophes, and acknowledging risk averse or neutral attitudes. Societal Risk includes the risk to every person, even if a person is only exposed on one brief occasion to that risk. For assessing the risk to a large number of affected people, societal risk is desirable because individual risk is insufficient in evaluating risks imposed on large numbers of people.

Within this assessment societal risk (navigational based) can be assessed for the proposed EOWDC giving account to the change in risk associated with each accident scenario caused by the introduction of the structures. Societal risk may be expressed as:

- Annual fatality rate: frequency and fatality are combined into a convenient one-dimensional measure of Societal Risk. This is also known as Potential Loss of Life (PLL).

- FN-diagrams showing explicitly the relationship between the cumulative frequency of an accident and the number of fatalities in a multi-dimensional diagram.

When assessing societal risk this study focuses on PLL, which takes into account the number of people likely to be involved in an incident (which is higher for passenger ferries, for example), and assesses the significance of the change in risk compared to background risk levels for the UK.

2.2 Risk to Environment

For risk to the environment the key criteria considered in terms of the effect of the proposed EOWDC is the potential amount of oil spilled from the vessel involved in an incident.

It is recognised there will be other potential pollution, e.g., hazardous containerised cargoes, however, oil is considered the most likely pollutant and the extent of predicted oil spills will provide an indication of the significance of pollution risk due to the proposed EOWDC compared to background pollution risk levels for the UK.

D3. MAIB Incident Analysis

3.1 All Incidents

All UK commercial vessels are required to report accidents to MAIB. Non-UK vessels do not have to report unless they are in a UK port or are in 12 nautical mile territorial waters and carrying passengers to a UK port. There are no requirements for non-commercial recreational craft to report accidents to MAIB, however, a significant proportion of these incidents are reported and investigated by the MAIB.

A total of 19,130 accidents, injuries and hazardous incidents were reported to MAIB between 1 January 1994 and 27 September 2005 involving 21,140 vessels (some incidents such as collisions involved more than one vessel). 72% of incidents were in UK waters with 28% reported in foreign waters.

The locations[1] of incidents reported in the vicinity of the UK are presented in Figure 3.1, colour-coded by type.

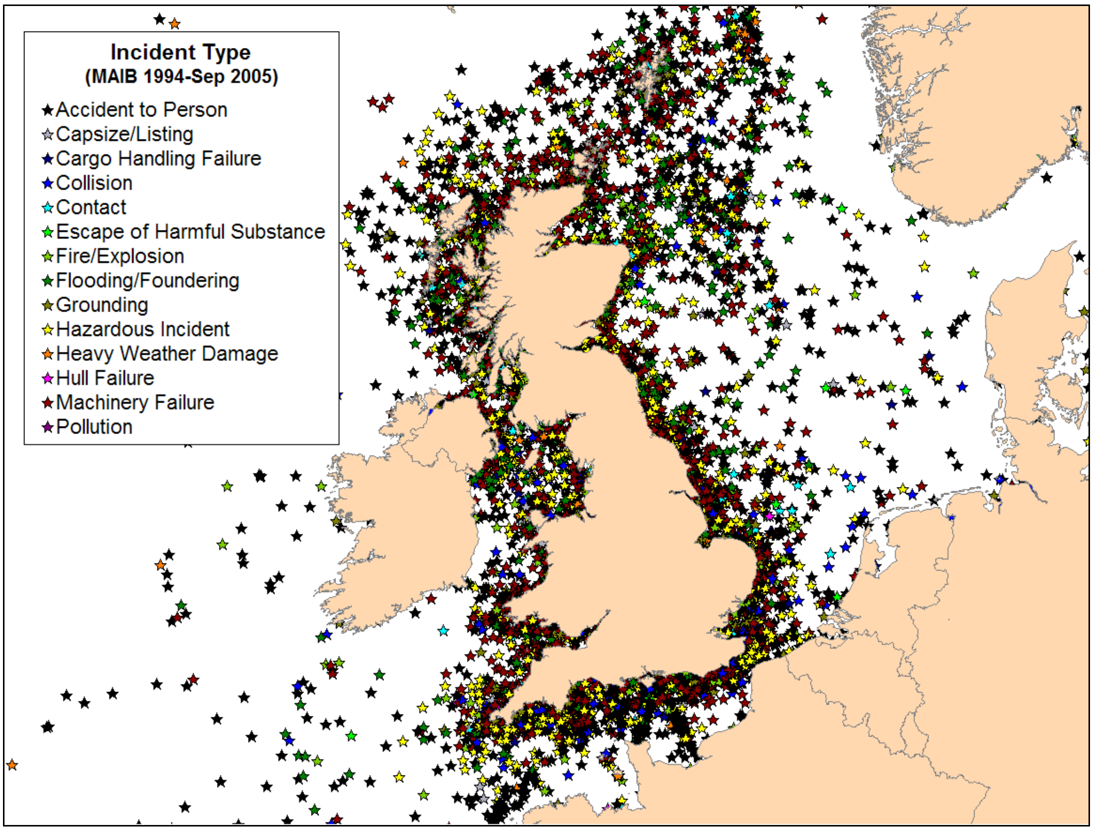


Figure 3.1 Incident Locations by Type (MAIB 1994-Sep 2005)

[1] MAIB aim for 97% accuracy in reporting the locations of incidents.

The distribution of incidents by year is presented in Figure 3.2.

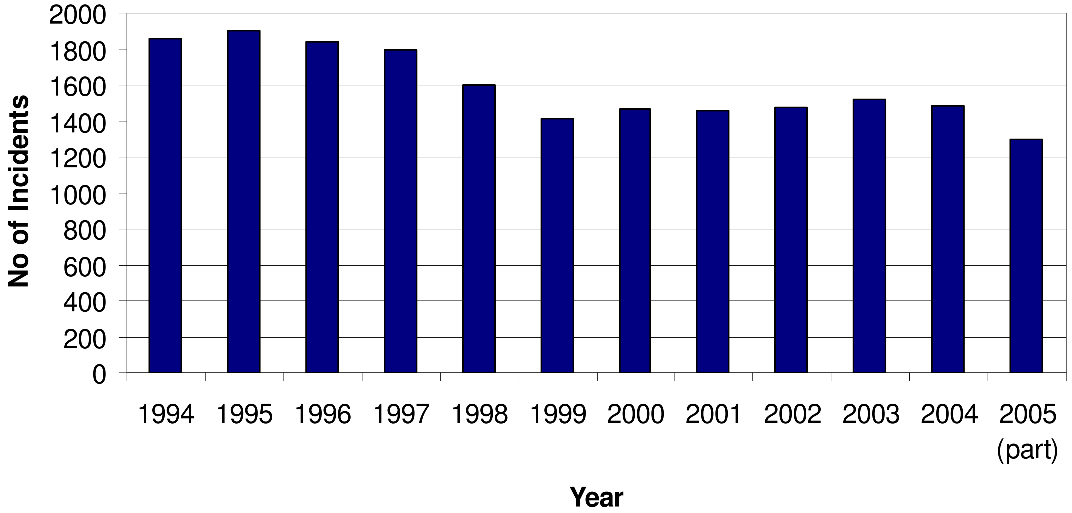


Figure 3.2 Incidents per Year (MAIB 1994-Sep 2005)

The average number of incidents per year, excluding 2005 which is a part-year, was 1,621. There is a declining trend in incidents.

The distribution by incident type is presented in Figure 3.3.

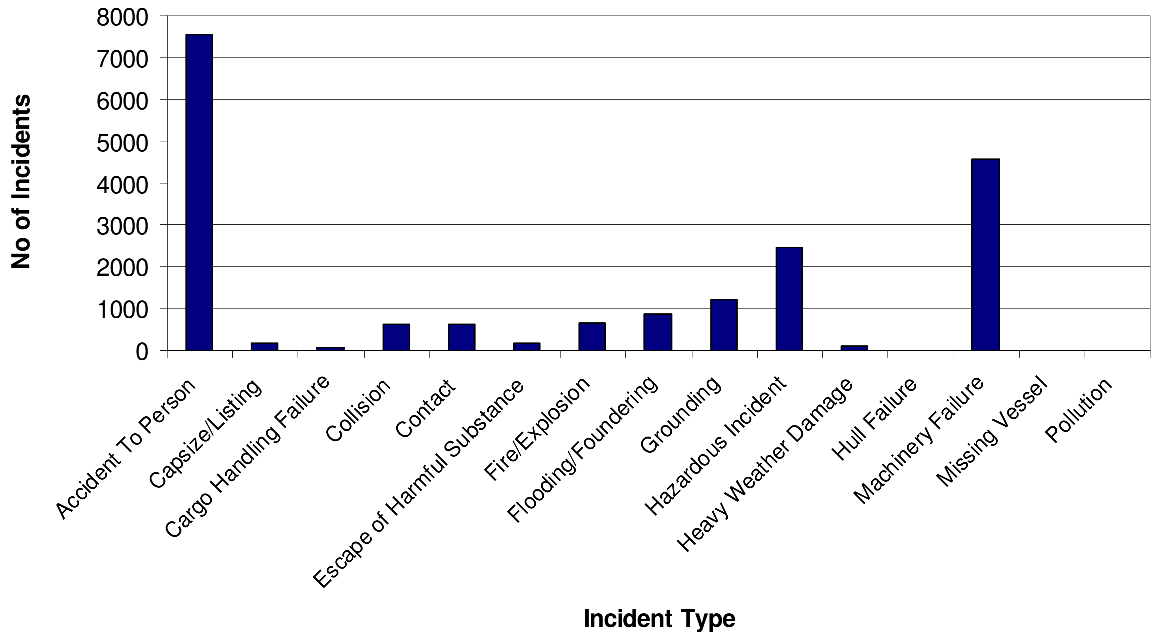


Figure 3.3 Incidents by Incident Type (MAIB 1994-Sep 2005)

Therefore, the most common incident types were Accident to Person[1] (40%), Machinery Failure (24%) and Hazardous Incident (13%). Collisions and Contacts each represented 3% of total incidents.

The distribution of vessel type categories involved in incidents is presented in Figure 3.4.

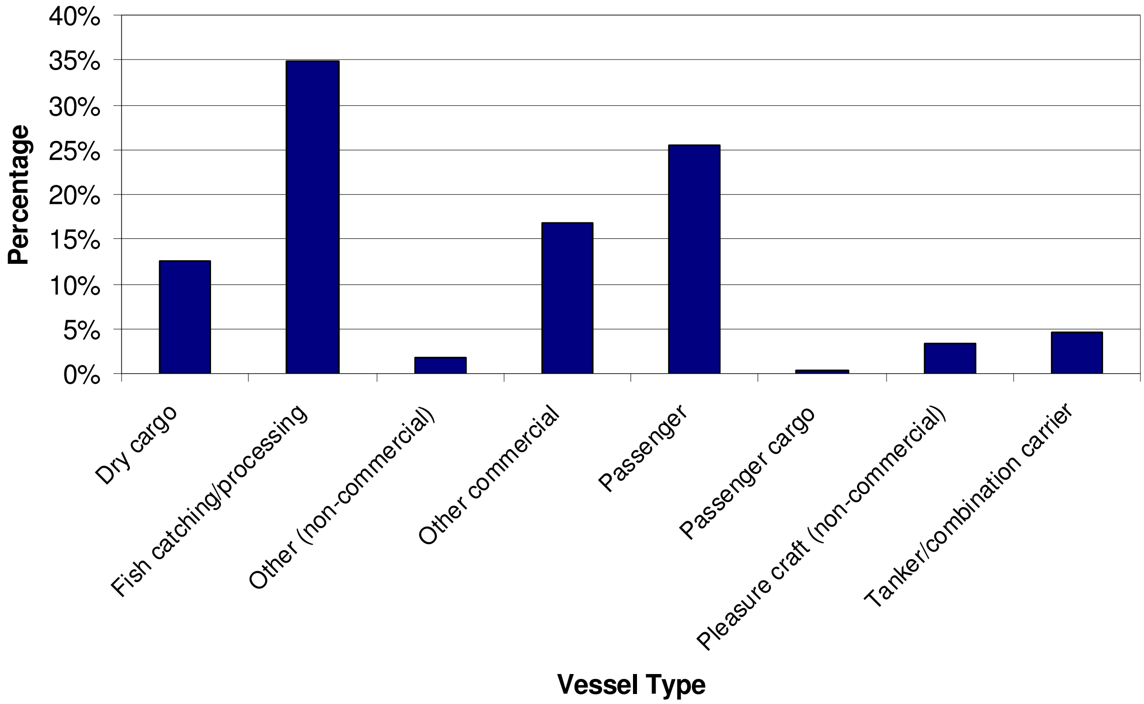


Figure 3.4 Incidents by Vessel Type (MAIB 1994-Sep 2005)

The most common vessel types involved in incidents were fishing vessels (35%), passenger vessels (25%) and other commercial vessels (17%), which includes offshore industry vessels, tugs, workboats and pilot vessels.

The total number of fatalities per year (divided into crew, passenger and other) reported in the MAIB incidents is presented in Figure 3.5.

[1] Where the incident is an accident to a vessel, e.g., collision or machinery failure, it would be reported under this vessel accident category.

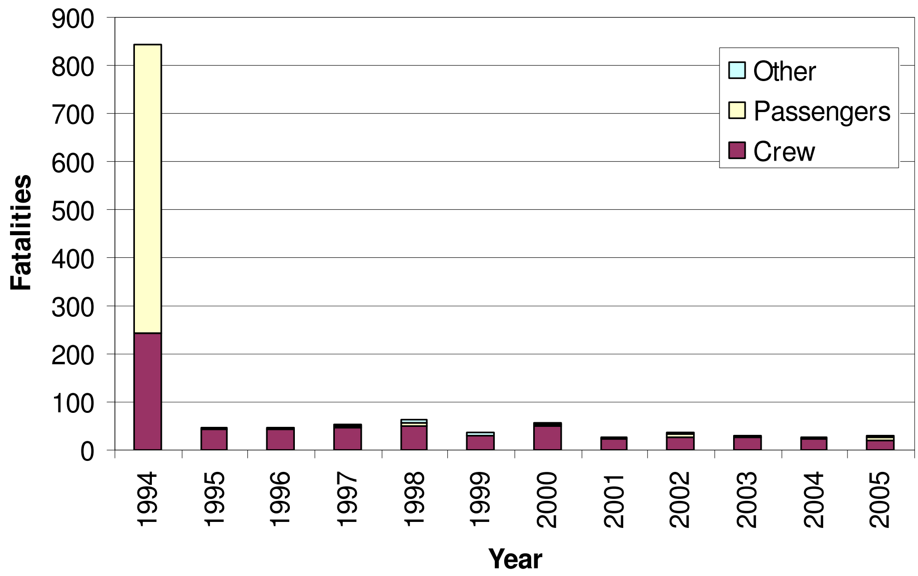


Figure 3.5 Number of Fatalities (MAIB 1994-Sep 2005)

The average number of fatalities per year, excluding 2005 which is a part-year, was 115. The sinking of the 'Estonia' passenger ferry in the Baltic Sea in 1994, which resulted in a reported 852 fatalities, dominates the figures. If 1994 were excluded, the average number of fatalities per year would drop to 42.

Considering only the incidents reported to have occurred in UK territorial waters, the number of fatalities per year is presented in Figure 3.6.

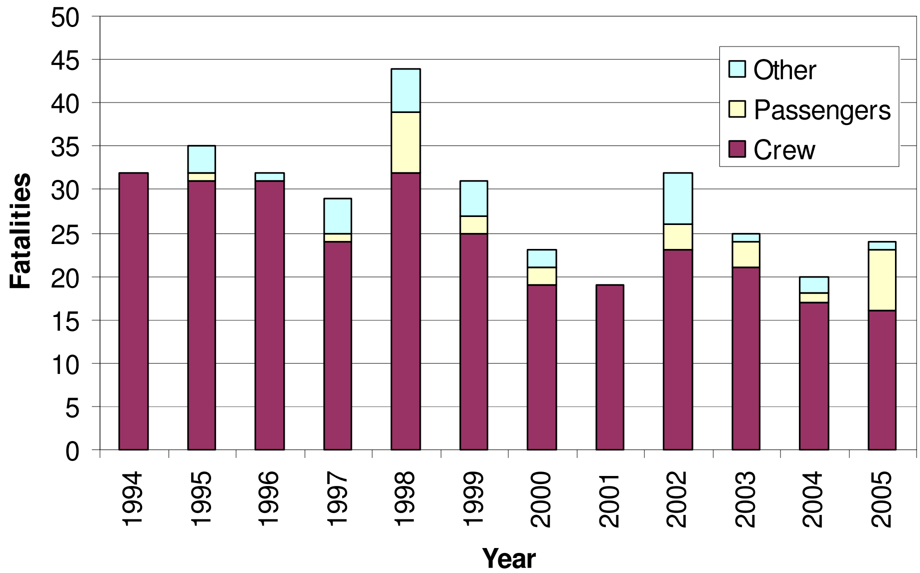


Figure 3.6 Number of Fatalities for Incidents in UK Waters (MAIB 1994-Sep 2005)

Therefore, the average number of fatalities per year in UK territorial waters between 1994 and 2004 was 29.

The distribution of fatalities in UK waters by vessel type and person category is presented in Figure 3.7.

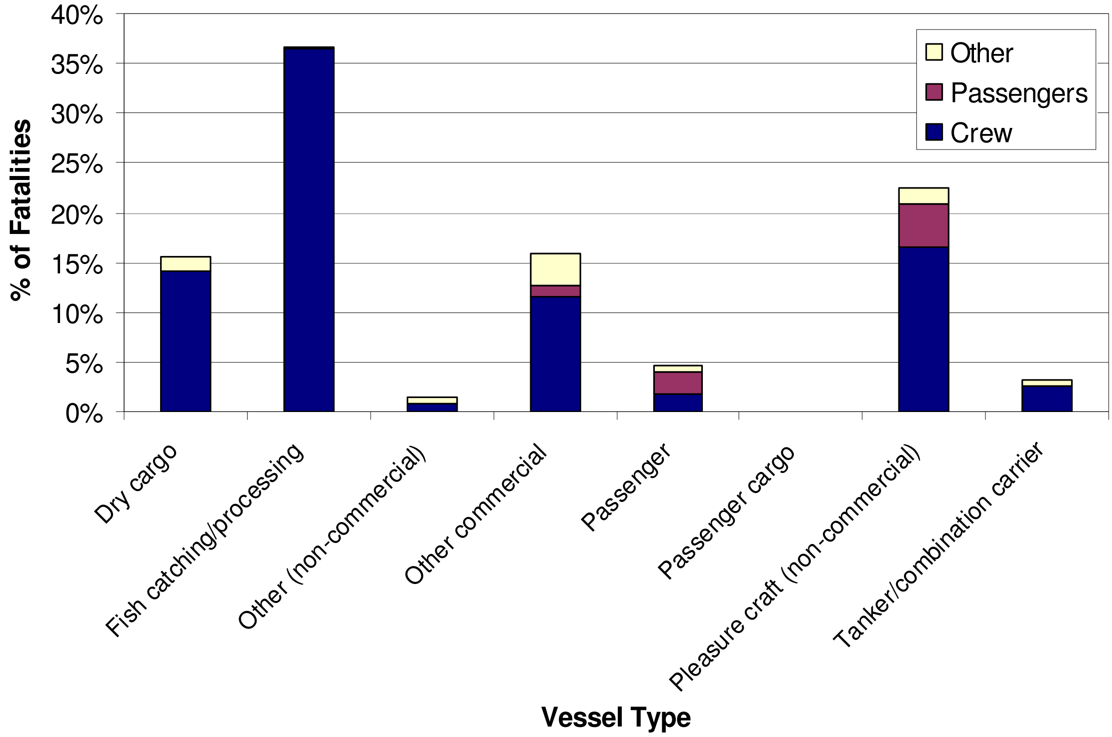


Figure 3.7 Fatalities by Vessel Type for Incidents in UK (MAIB 1994-Sep 2005)

It can be seen that the majority of fatalities in the UK occurred to fishing vessels and pleasure craft, with crew members the main people involved.

3.2 Collision Incidents

MAIB define a collision incident as “vessel hits another vessel that is floating freely or is anchored (as opposed to being tied up alongside).”

A total of 623 collisions were reported to MAIB between 1 January 1994 and 27 September 2005 involving 1,241 vessels (in a handful of cases the other vessel involved was not logged).

The locations of collisions reported in the vicinity of the UK are presented in Figure 3.8, colour-coded by type.

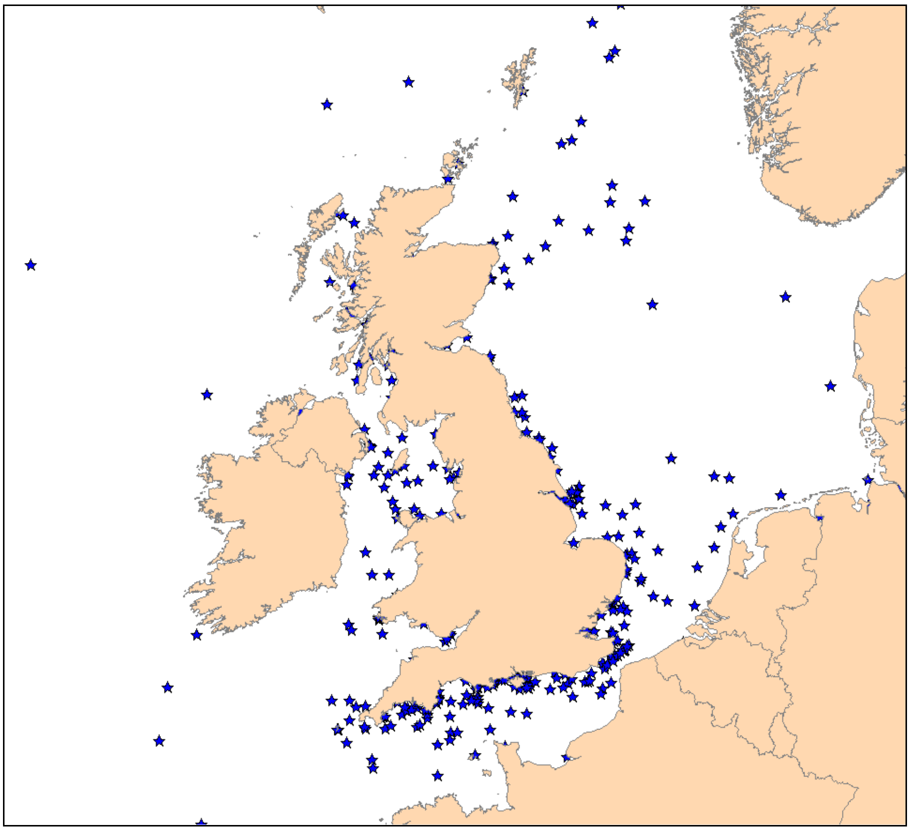


Figure 3.8 Collision Incident Locations (MAIB 1994-Sep 2005)

The distribution of all collision incidents by year is presented in Figure 3.9.

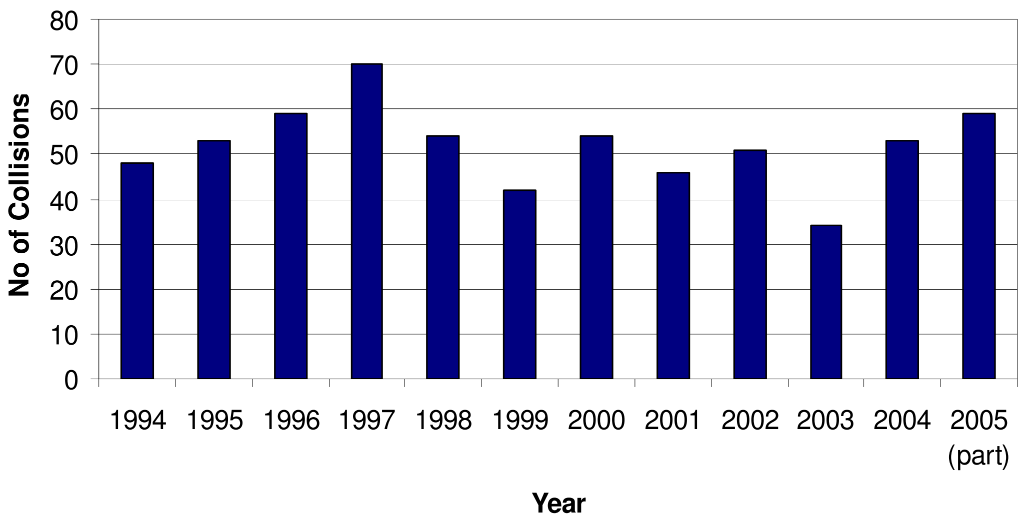


Figure 3.9 Collisions per Year (MAIB 1994-Sep 2005)

The average number of collisions per year, excluding 2005 which is a part-year, was 51.

The distribution of vessel types involved in collisions is presented in Figure 3.10.

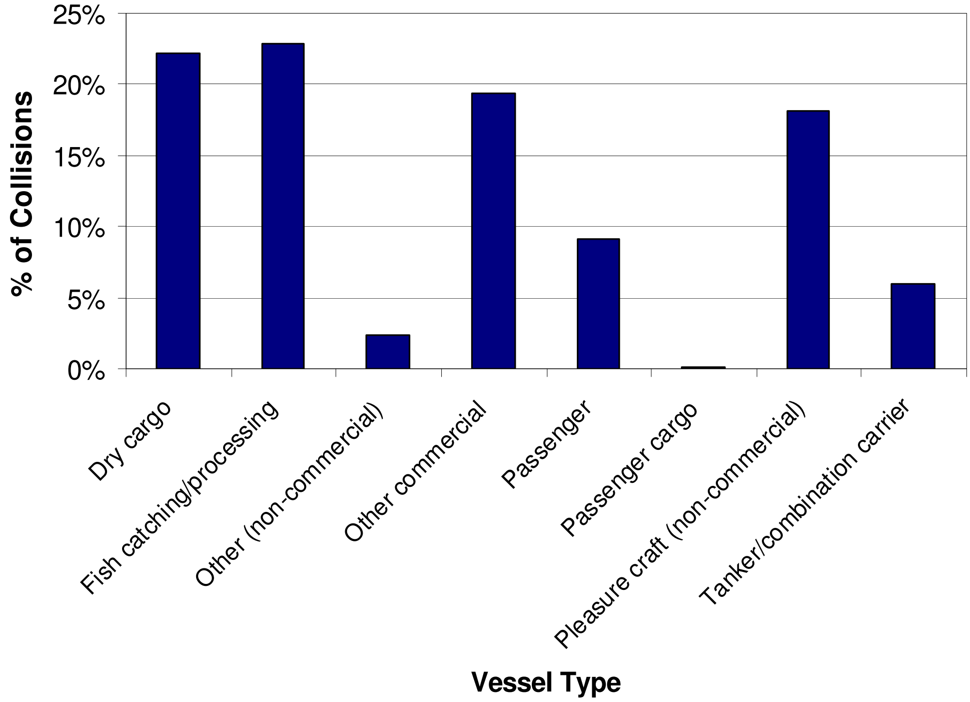


Figure 3.10 Collisions by Vessel Type (MAIB 1994-Sep 2005)

Therefore, the most common vessel type involved in collisions were fishing vessels (25%), dry cargo vessels (22%), other commercial vessels (19%) and non-commercial pleasure craft (18%).

Finally, the total number of fatalities per year (divided into crew and passenger) reported in all MAIB collisions is presented in Figure 3.11.

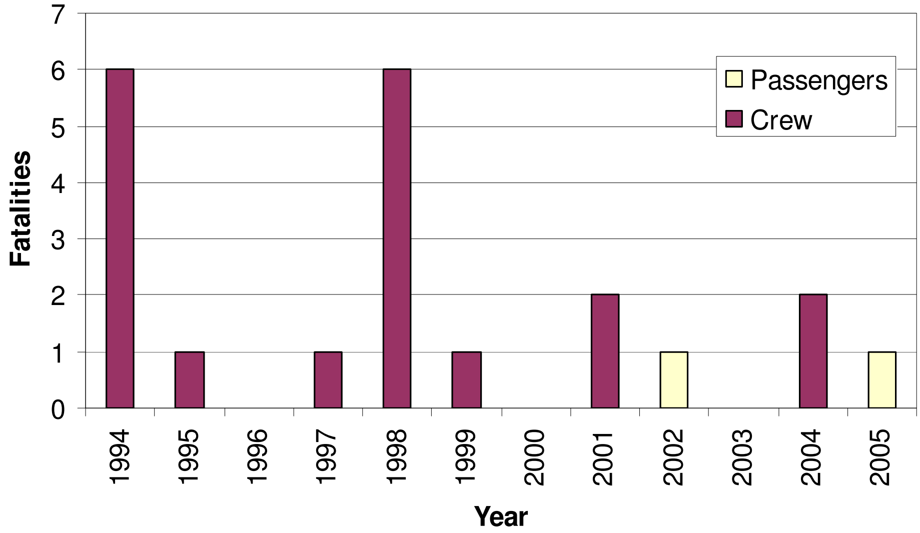


Figure 3.11 Fatalities from Collisions (MAIB 1994-Sep 2005)

The average number of fatalities per year, excluding 2005 which is a part-year, was 1.8.

Details on the 12 incidents reported by MAIB that involved fatalities are presented in Table 3.1. In each case the first vessel listed suffered the losses. It can be seen that most incidents involved fishing vessels and recreational craft.

Table 3.1 Fatal Collision Incidents (MAIB 1994-Sep 2005)

Date	Description	Fatalities
Nov 1994	Beam trawler collision with bulk carrier Foreign waters, high seas, moderate visibility and sea state	6
Jun 1998	Seine netter collision with container ship Foreign waters, high seas, good visibility, moderate seas	5
Feb 1995	Stern trawler collision with supply ship Foreign waters, river/canal, good visibility, moderate seas	1
Mar 1997	Stern trawler collision with other fishing vessel Foreign waters, good visibility, calm seas	1
Jun 1998	RIB collision with other RIB UK territorial waters, river/canal	1
Mar 1999	Fishing vessel collision with container ship Foreign waters, coastal waters, good visibility	1
Aug 2001	Pleasure craft collision with small commercial motor vessel UK territorial waters	1
Oct 2001	General cargo vessel collision with chemical tanker	1

Date	Description	Fatalities
	UK territorial waters, coastal waters, good visibility	
Aug 2002	Speed craft collision with another speed boat UK waters, unspecified location, good visibility, calm seas	1
May 2004	Port service tug collision with passenger ferry (during towing) Foreign waters, coastal waters	1
Jun 2004	Pleasure craft collision with other pleasure craft Foreign waters, river/canal	1
Jul 2005	Pleasure craft collision with (1 passenger fatality) UK territorial waters, coastal waters, good visibility, calm seas	1

A more detailed description of the two incidents which resulted in multiple fatalities is provided below:

- Collision between bulk carrier and beam trawler in eastward lane of Terschelling - German Bight TSS. Both vessels were on passage. Visibility was about 5 miles. Collision caused extensive damage to beam trawler and vessel rapidly flooded and sank with loss of her 6 crew, all of whom were Dutch nationals. Collision was primarily caused by Master of bulk carrier failing to take early and substantial action when complying with his obligation to keep out of the way.

- The fishing vessel was on an easterly course while on passage from Firth of Forth to Esbjerg, and the container ship was on a north-westerly course from Hamburg to Gothenburg. The fishing vessel was the give-way vessel but did not alter course and speed, the cause of which could not be established. The chief officer of the container ship did not alter course until it was too late and the two vessels collided. The fishing vessel foundered so quickly that all hands were trapped inside the accommodation and the container ship was so badly damaged that she had to use Esbjerg as a port of refuge.

3.3 Contact Incidents

MAIB define a contact incident as "vessel hits an object that is immobile and is not subject to the collision regulations e.g. buoy, post, dock (too hard), etc. Also, another ship if it is tied up alongside. Also floating logs, containers etc."

A total of 609 contacts were reported to MAIB between 1 January 1994 and 27 September 2005 involving 663 vessels.

The locations of contacts reported in the vicinity of the UK are presented in Figure 3.12, colour-coded by type.

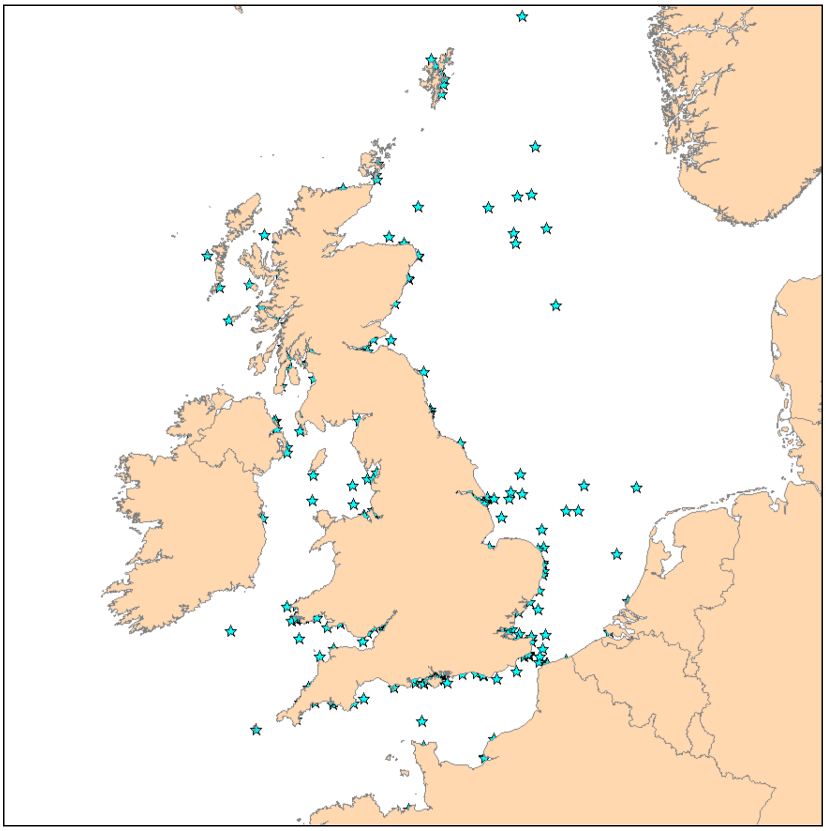


Figure 3.12 Contact Incident Locations (MAIB 1994-Sep 2005)

The distribution of contact incidents by year is presented in Figure 3.13.

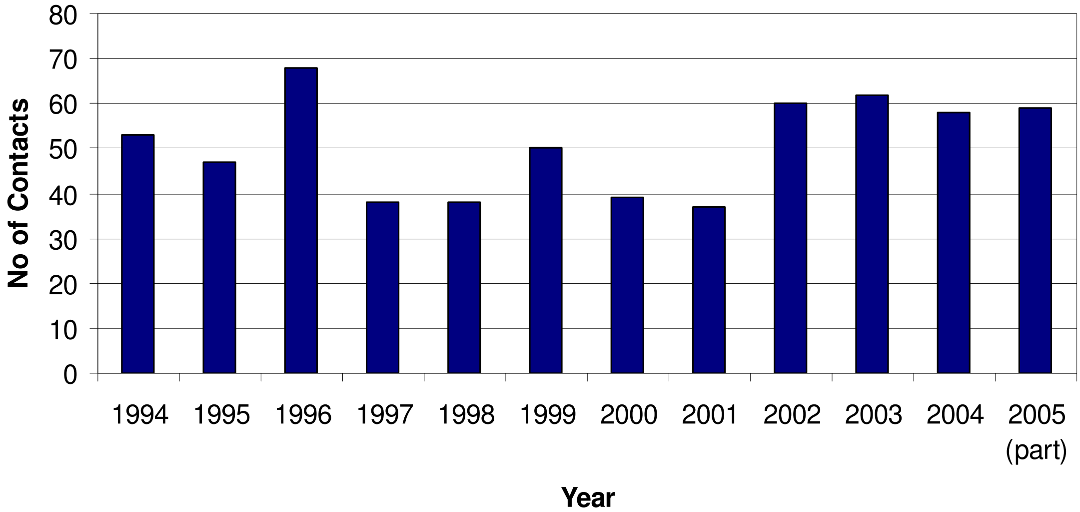


Figure 3.13 Contact Incidents per Year (MAIB 1994-Sep 2005)

The average number of contacts per year, excluding 2005 which is a part-year, was 50.

The distribution of vessel types involved in contacts is presented in Figure 3.14.

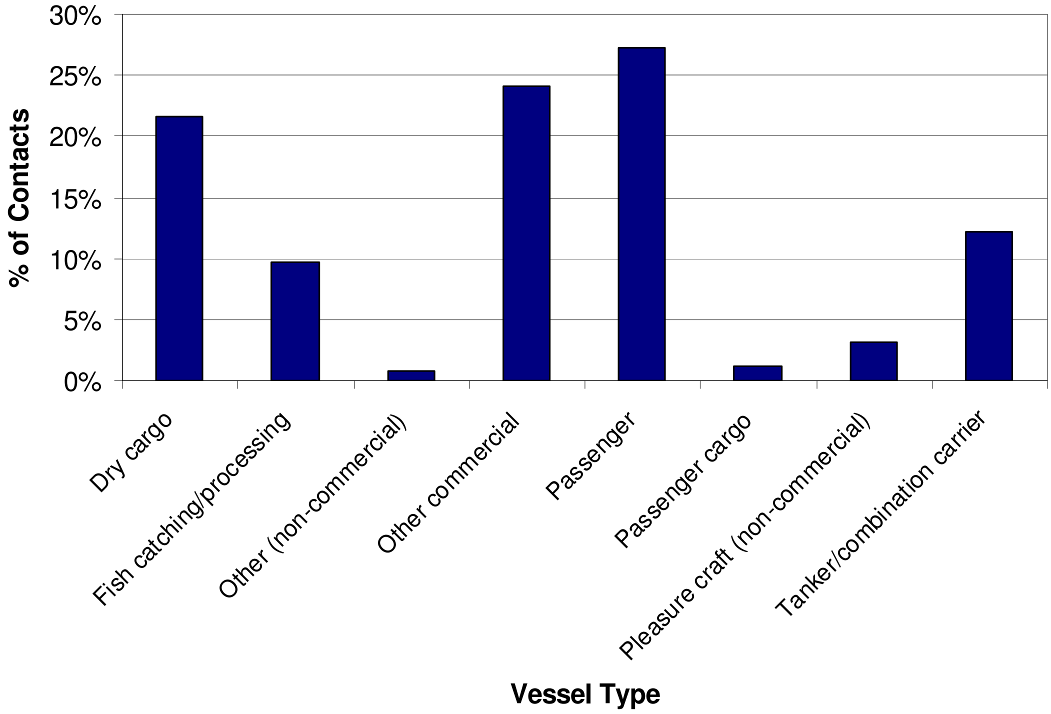


Figure 3.14 Contacts by Vessel Type (MAIB 1994-Sep 2005)

Therefore, the most common vessel type involved in contacts were passenger ferries (27%), other commercial vessels (24%) and dry cargo vessels (22%).

There were no fatalities in any of the contact incidents recorded by MAIB.

D4. Fatality Risk

4.1 Introduction

This section uses the MAIB incident data along with information on average manning levels per vessel type to estimate the probability of fatality in a marine incident associated with the proposed EOWDC development.

The proposed EOWDC is assessed to have the potential to affect the following incidents:

- Passing Powered Collision with Wind Farm Structure
- Passing Drifting Collision with Wind Farm Structure
- Vessel-to-Vessel Collision
- Fishing Vessel Collision with Wind Farm Structure

Of these incidents, only vessel-to-vessel collisions match the MAIB definition of collisions and hence the fatality analysis presented in Section 3.2 is considered to be directly applicable to these types of incidents.

The other scenarios of passing powered, passing drifting and fishing vessel collisions with the wind farm structures are technically contacts, i.e., vessel hits an immobile object in the form of a turbine or substation. From Section 3.3 it can be seen that none of the 609 contact incidents reported by MAIB between 1994 and 2005 resulted in fatalities.

However, as the mechanics involved in a vessel contacting a wind turbine may differ in severity from hitting, for example, a buoy, quayside or moored vessel, the MAIB collision fatality risk rate has also been conservatively applied for these incidents.

4.2 Fatality Probability

Twelve of the 623 collision incidents reported by MAIB resulted in one or more fatalities. This represents a 2% probability that a collision will lead to a fatal accident. A total of 21 fatalities resulted from the collision incidents.

To assess the fatality risk for personnel onboard a vessel, either crew, passenger or other, the number of persons involved in the incidents needs to be estimated. From an ILO survey of seafarers during 1998-99 (Ref. iii), the average commercial vessel had a crew of 17. For other (non-commercial vessels) such as naval craft and RNLI lifeboats the average crew has been estimated to be 20. Onboard fishing vessels and pleasure craft the average crew has been estimated to be 5. Finally, for passenger vessels it is estimated that the average number of passengers carried, in addition to crew, is 300 (based on UK sea passenger movements on principal ferry routes, Ref. iv).

It is recognised these numbers can be substantially higher or lower on an individual vessel basis depending on size, subtype, etc., but applying reasonable averages is considered sufficient for this analysis.

Using the average number of persons carried along with the vessel type information involved in collisions reported by MAIB (see Figure 3.10), gives an estimated 50,000 personnel onboard the ships involved in the collisions.

Based on 21 fatalities, the overall fatality probability in a collision for any individual onboard is approximately 4.3 x 10^{-4} per collision (0.04%).

It is considered inappropriate to apply this rate uniformly as the statistics clearly shown that the majority of fatalities tend be associated with smaller craft, such as fishing vessels and recreational vessels. Therefore, the fatality probability has been subdivided into two categories of vessel as presented in Table 4.1.

Table 4.1 Fatality Probability per Incident per Vessel Category

Vessel Category	Sub Categories	Fatalities	People Involved	Fatality Probability
Commercial	Dry cargo, passenger, tanker, etc.	3	46,200	6.5E-05
Non-Commercial	Fishing, pleasure, etc.	18	3,120	5.8E-03

From the above table it can be seen the risk is approximately two orders of magnitude higher for people onboard non-commercial vessels.

4.3 Fatality Risk due to the Proposed EOWDC

The base case and future case annual collision frequency levels without and with the proposed EOWDC site are summarised below.

Table 4.2 Summary of Annual Collision Frequency Results

Risk Scenario	Base Case			Future Case		
	Without	With	Change	Without	With	Change
Passing Powered	--	1.0E-03	1.0E-03	--	1.1E-03	1.1E-03
Passing Drifting	--	5.5E-05	5.5E-05	--	6.0E-05	6.0E-05
Vessel-to-Vessel	6.6E-03	6.7E-03	1.3E-04	7.2E-03	7.3E-03	1.4E-04
Fishing	--	2.5E-04	2.5E-04	--	2.8E-04	2.8E-04
Total	6.6E-03	8.0E-03	1.4E-03	7.2E-03	8.8E-03	1.6E-03

For the local vessels operating in the area of the site, the average manning has been estimated as follows.

Table 4.3 Vessel Types, Incidents and Average Persons exposed

Vessel Type	Collision Incidents	Average Manning
Cargo/Offshore	Passing powered, passing drifting, vessel-to-vessel.	17
Tanker	Passing powered, passing drifting, vessel-to-vessel.	20
Ferry	Passing powered, passing drifting, vessel-to-vessel.	250
Fishing Vessel	Vessel-to-vessel and fishing.	3
Recreational Vessel	Vessel-to-vessel.	4

From the detailed results of the collision frequency modelling, the distribution of the predicted change in collision frequency by vessel type due to the proposed EOWDC is as follows.

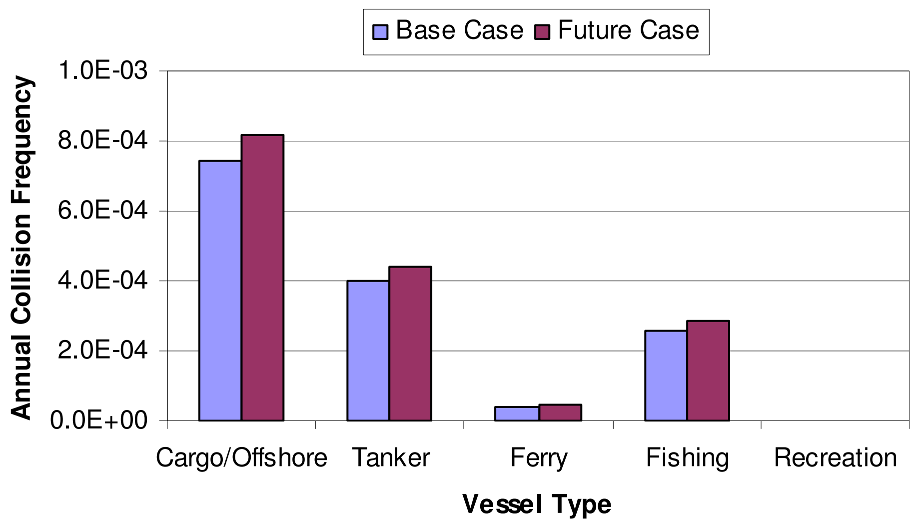


Figure 4.1 Collision Frequency by Vessel Type estimated for the proposed EOWDC

It can be seen the change in collision frequency is highest for cargo/offshore ships and tankers. The change in frequency is lowest for ferries and recreational vessels.

Combining the collision frequency (Table 4.2), the estimated number of persons onboard each vessel type (Table 4.3) and the estimated fatality probability for that vessel category (Table 4.1), the annual increase in Potential Loss of Life (PLL) due to the impact of the proposed EOWDC is estimated to be as follows:

- Base Case PLL: 6.8×10^{-6} fatalities per year
- Future Case PLL: 7.4×10^{-6} fatalities per year

The estimated base case PLL increase equates to an average of one additional fatality in 148,000 years, whilst the future case PLL increase corresponds to an average of one additional fatality in 135,000 years.

The predicted incremental increases in PLL due to the wind farm, distributed by vessel type for the base and future cases, are presented in Figure 4.2.

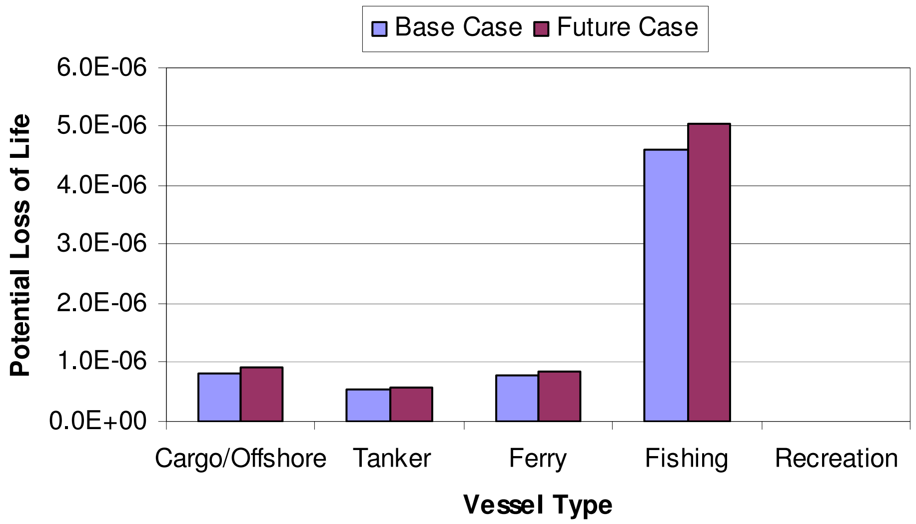


Figure 4.2 Estimated change in Annual PLL by Vessel Type due to the proposed EOWDC

Therefore, it can be seen that the fatality risk is dominated by fishing vessels, which historically have a higher fatality probability per incident than merchant vessels.

Converting the PLL to individual risk based on the average number of people exposed by vessel type, the results are presented in Figure 4.3. (This calculation assumes that the risk is shared between 10 vessels of each type, which is considered to be conservative based on the number of different vessels operating in the vicinity of the site.)

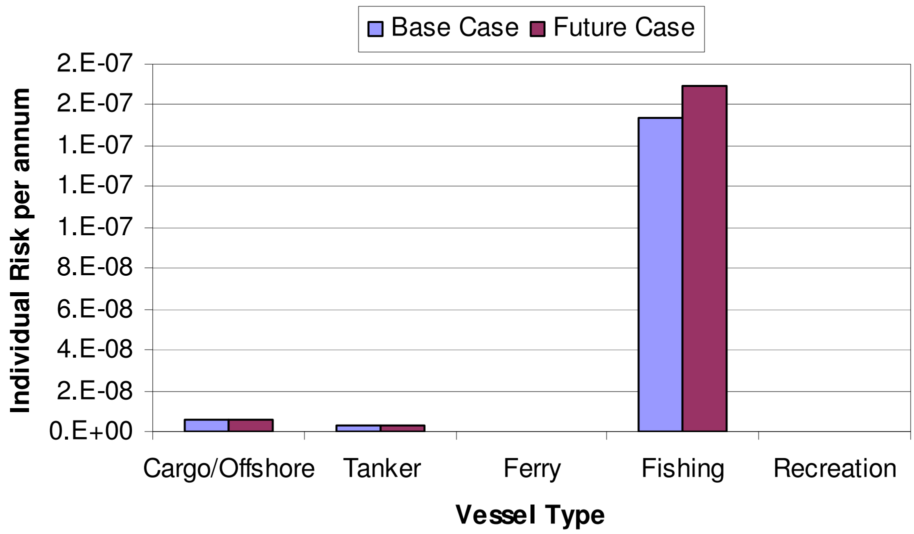


Figure 4.3 Estimated change in Individual Risk by Vessel Type due to the proposed EOWDC

Therefore, individual risk is highest for people on fishing vessels, which is related to the higher probability of fatalities occurring in the event of an incident.

4.4 Significance of Increase in Fatality Risk – Proposed EOWDC

The overall increase in PLL estimated due to the development is 6.8 x 10^{-6} fatalities per year (base case), which equates to one additional fatality in 148,000 years. This is a small change compared to the MAIB statistics which indicate an average of 29 fatalities per year in UK territorial waters.

In terms of individual risk to people, the incremental increase for commercial ships (in the region of 10^{-8}) is very low compared to the background risk level for the UK sea transport industry of 2.9 x 10^{-4} per year.

Similarly, for fishing vessels, whilst the change in individual risk attributed to the development is higher than for commercial vessels (in the region of 10^{-7}), it is very low compared to the background risk level for the UK sea fishing industry of 1.2 x 10^{-3} per year.

D5. Pollution Risk

5.1 Historical Analysis

The pollution consequences of a collision in terms of oil spill depend on the following:

- Spill probability (i.e., likelihood of outflow following an accident)
- Spill size (amount of oil)

Two types of oil spill are considered:

- Fuel oil spills from bunkers (all vessel types)
- Cargo oil spills (laden tankers)

The research undertaken as part of the DfT's MEHRAs project (Ref. v) has been used as it was comprehensive and based on worldwide marine spill data analysis.

From this research, the overall probability of a spill per accident was calculated based on historical accident data for each accident type as presented in Figure 5.1.

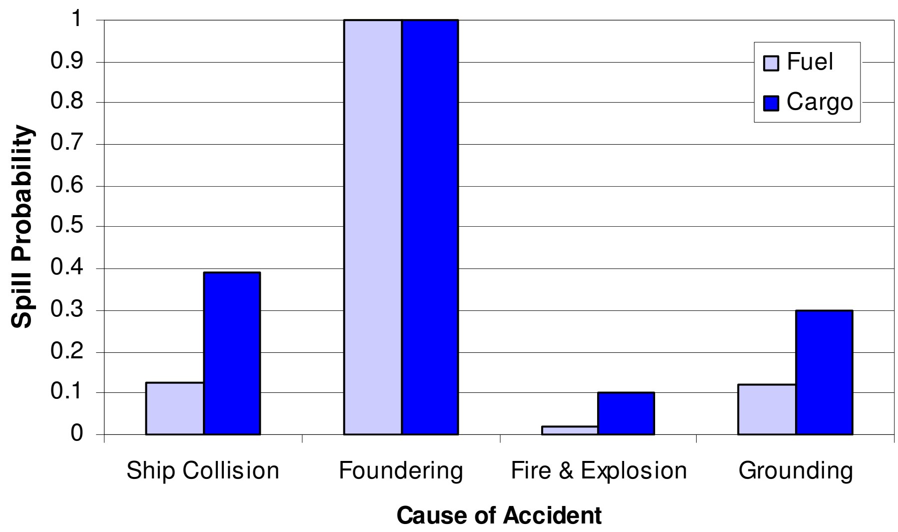


Figure 5.1 Probability of an Oil Spill resulting from an Accident

Therefore, it was estimated that 13% of ship collisions result in a fuel oil spill and 39% of collisions involving a laden tanker result in a cargo oil spill.

In the event of a bunker spill, the potential outflow of oil depends on the bunker capacity of the vessel. Historical bunker spills from ships have generally been limited to a size below 50% of the bunker capacity, and in most incidents much lower. For the types and sizes of ships exposed to the site, an average spill size of 100 tonnes of fuel oil is considered to be a conservative assumption.

For cargo spills from laden tankers, the spill size can vary significantly. ITOPF report the following spill size distribution for tanker collisions between 1974 and 2004.

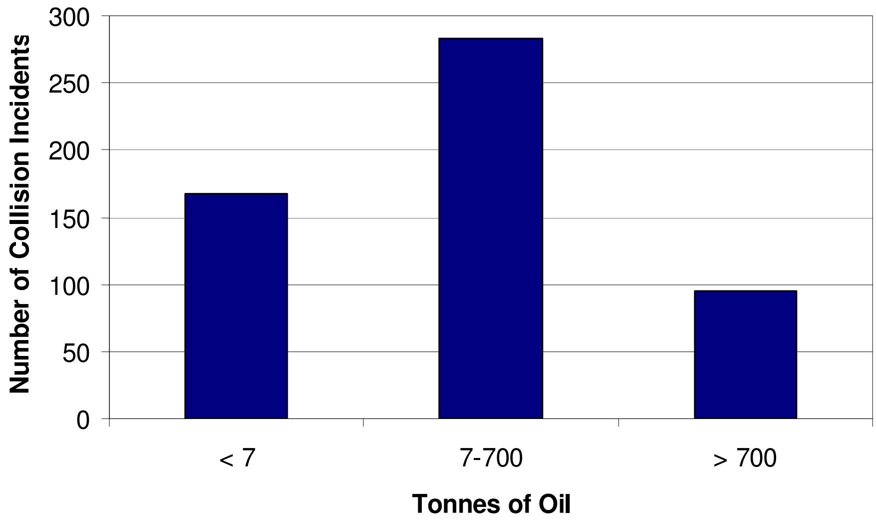


Figure 5.2 Spill Size Distribution in Tanker Collision Incident (ITOPF 1974-2004)

31% of spills are below 7 tonnes, 52% are between 7 and 700 tonnes and 17% are greater than 700 tonnes. Based on this data and the tankers transiting the area in proximity to the proposed EOWDC site, an average spill size of 400 tonnes is considered conservative.

For fishing and recreational vessel collisions, comprehensive statistical data is not available so it is conservatively assumed that 50% of all collisions involving these vessels will lead to oil spill with the quantity spilled being an average of 5 tonnes for fishing vessels and 1 tonne for recreational vessels.

5.2 Pollution Risk – Proposed EOWDC

Applying the above probabilities to the collision frequency by vessel type presented in Figure 4.1 and the average spill size per vessel, the amount of oil spilled per year due to the impact of the development is estimated to be as follows:

- Base Case: 0.07 tonnes of oil per year
- Future Case: 0.08 tonnes of oil per year

The predicted increases in tonnes of oil spilled distributed by vessel type for the base and future cases are presented in Figure 5.3.

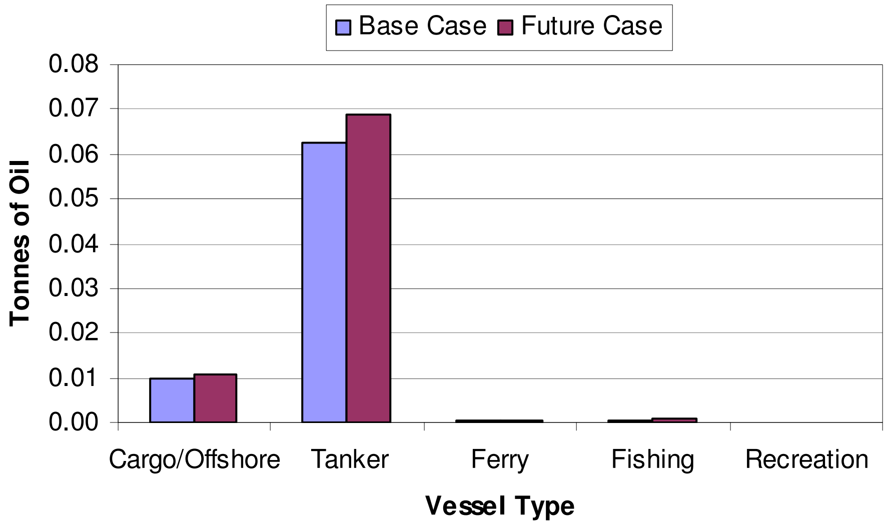


Figure 5.3 Estimated change in Pollution by Vessel Type due to Site

It can be seen that tankers, which can spill both fuel and cargo oils, pose the largest oil spill threat.

5.3 Significance of Increase in Pollution Risk – Proposed EOWDC

To assess the significance of the increased pollution risk from marine vessels caused by the proposed EOWDC, historical oil spill data for the UK has been used as a benchmark.

From the MEHRAs research (Ref. v), the average annual tonnes of oil spilled in the waters around the British Isles due to marine accidents in the 10-year period from 1989-98 1998 was 16,111. This is based on a total of 146 reported oil pollution incidents of greater than 1 tonne (smaller spills are excluded as are incidents which occurred within port and harbour areas or as a result of operational errors or equipment failure). Merchant vessel spills accounted for approximately 99% of the total while fishing vessel incidents accounted for less than 1%.

The overall increase in pollution estimated due to the development is very low compared to the historical average pollution quantities from marine accidents in UK waters (approximately 0.0005%).

D6. Conclusions

The quantitative risk assessment indicates that the impact of the proposed EOWDC on people and the environment is relatively low compared to background risk levels in UK waters.

However, it is recognised that there is a degree of uncertainty associated with numerical modelling. For example, the model does not consider the potential radar interference from turbines which may have an influence on the risk of vessel-to-vessel collisions, especially in reduced visibility where one or both of the vessels involved is not carrying AIS. Therefore, conservative assumptions have been applied in this analysis and the overall project is being carried out based on the principle of ALARP to ensure the risks to people and the environment are managed to a level that is as low as reasonably practicable.

It should also be noted that this is the localised impact of a single project and there will be additional maritime risks associated with other offshore wind farm projects in Scotland and the UK as a whole.

D7. References

i IMO Maritime Safety Committee, 74th Edition, Agenda Item 5 (MSC 74/5/X), Bulk Carrier Safety – Formal Safety Assessment, 2001.

ii MCA "Safety Information – FSA, Statistical Data" web page.

iii International Labour Organisation, The Impact on Seafarers' Living and Working Conditions of Changes in the Structure of the Shipping Industry, Geneva 2001, JMC/29/2001/3.

iv Department for Transport Maritime Statistics 2004.

v Department for Transport, Identification of Marine Environmental High Risk Areas (MEHRA's) in the UK, 2001.