Kincardine Offshore Windfarm

Environmental Statement
Appendix C: Navigation Risk Assessment

February 2016

Plan Design Enable

Kincardine Offshore Wind Farm Navigation Risk Assessment

Prepared by:	Anatec Limited
Presented to:	Kincardine Offshore Wind Limited
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Revision Number	Date	Summary of Change
00	17 September 2015	Initial Draft

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Abbreviations

AfL	-	Area for Lease
AIS	-	Automatic Identification System
ALARP	-	As low as is reasonably practical
ALB	-	All-Weather Lifeboat
ARPA	-	Automatic Radar Plotting Aid
BTA	-	British Tug Owners Association
CA	-	Cruising Association
CAST	-	Coastguard Agreement on Salvage and Towage
CGOC	-	Coastguard Operations Centre
CIA	-	Cumulative Impact Assessment
DECC	-	Department of Energy and Climate Change
DfT	-	Department for Transport
DSC	-	Digital Selective Calling
DWT	-	Dead Weight Tonnage
EIA	-	Environmental Impact Assessment
EOWDC	-	European Offshore Wind Deployment Centre
ERCoP	-	Emergency Response Cooperation Plan
ES	-	Environmental Statement
EU	-	European Union
FLOWW	-	Fishing Liaison with Offshore Wind and Wet Renewables Group
FSA	-	Formal Safety Assessment
GIS	-	Geographic Information System
GPS	-	Global Positioning System
GRP	-	Glass Reinforced Plastic
GT	-	Gross Tonnage
HMCG	-	Her Majesty's Coastguard
HSE	-	Health and Safety Executive
IALA	-	International Association of Lighthouse Authorities
ICES	-	International Council for the Exploration of the Sea
ILB	-	Inshore Lifeboat
IMO	-	International Maritime Organisation
kHz	-	Kilo Hertz
KOWL	-	Kincardine Offshore Wind Limited
MAIB	-	Marine Accident Investigation Branch
MCA	-	Maritime and Coastguard Agency
MDA	-	Managed Defence Area
MEHRA	-	Marine Environmental High Risk Area
MGN	-	Marine Guidance Notice
MOD	-	Ministry of Defence
MW	-	Mega Watts
NLB	-	National Lighthouse Board
nm	-	Nautical Mile
NMOC	-	National Maritime Operations Centre
NRA	-	Navigation Risk Assessment

NUC	-	Not Under Command
OREI	-	Offshore Renewable Energy Installations
PLA	-	Port of London Authority
PLL	-	Potential Loss of Life
PLN	-	Port Letter Number
REZ	-	Renewable Energy Zones
RNLI	-	Royal National Lifeboat Institution
RORO	-	Roll On Roll Off
RYA	-	Royal Yachting Association
SAR	-	Search and Rescue
SMS	-	Safety Management System
SRYA	-	Scottish Royal Yachting Association
THLS	-	Trinity House Lighthouse Service
UKCS	-	United Kingdom Continental Shelf
UKHO	-	United Kingdom Hydrographic Office
VHF	-	Very High Frequency
VMS	-	Vessel Monitoring System
VTS	-	Vessel Traffic Service
WTG	-	Wind Turbine Generator

1. Introduction

1.1. Background

Anatec Ltd was commissioned by Kincardine Offshore Wind Ltd (KOWL) to undertake a Navigation Risk Assessment (NRA) of the Kincardine Offshore Wind Farm (hereafter referred to as the KOWL Development) located on the east coast of Aberdeenshire.

The assessment presents detailed information on the proposed development relative to the current baseline activity and navigational features in the area. The NRA forms part of the Environmental Impact Assessment (EIA).

1.2. Navigational Risk Assessment Purpose

An EIA is a process which identifies the environmental effects, both negative and positive, in accordance with EU Directives. A key requirement of the EIA is the Navigational Risk Assessment (NRA). Following the Department of Energy and Climate Change (DECC) Methodology and Marine Guidance Notice (MGN 371), an NRA for the Project has been undertaken and includes:

- Overview of base case environment;
- Maritime traffic survey;
- Implications of Offshore Renewable Energy Installations (OREIs);
- Assessment of navigational risk pre and post development of the KOWL Development;
- Formal Safety Assessment (FSA);
- Implications on marine navigation and communication equipment;
- Identification of mitigation measures;
- Search and Rescue (SAR) planning; and
- Through life safety management.

The assessment reviews the following phases:

- Construction;
- Operation and maintenance; and
- Decommissioning.

2. Guidance and Legislation

2.1. *Primary Guidance*

The primary guidance documents used during the assessment are listed below:

- Maritime and Coastguard Agency (MCA) Marine Guidance Notice 371 (MGN 371 Merchant + Fishing) Offshore Renewable Energy Installations (OREIs) Guidance on UK Navigational Practice, Safety and Emergency Response Issues (MCA, 2008a):
- Department of Energy and Climate Change (DECC) in Association with MCA Guidance on the Assessment of Offshore Wind Farms - Methodology for Assessing Marine Navigational Safety Risks of Offshore Wind Farms (DECC, 2014); and
- International Maritime Organisation (IMO) Guidelines for Formal Safety Assessment (FSA) – MSC/Circ. 1023 (IMO, 2002).

MGN 371 highlights issues to be taken into consideration when assessing the effect on navigational safety from offshore renewable energy developments proposed within United Kingdom internal waters, territorial sea or Renewable Energy Zones (REZ).

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

The MCA require that the DECC methodology is used as an overview template for preparing navigation risk assessments. It is centered on risk management and requires a submission that shows that sufficient controls are, or will be, in place for the assessed risk (base case and future case) to be judged as broadly acceptable or tolerable. It is noted that the Methodology was developed in 2005 and the structure of NRAs has developed to allow comparison and integration with EIAs.

2.2. *Formal Safety Assessment Process*

The IMO Formal Safety Assessment process (IMO, 2002) 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 analysis (if applicable).

The impact assessment uses information within the baseline assessment to assess impacts as per the Formal Safety Assessment process.

- Hazard log and risk ranking;
- Quantified navigational risk assessment for selected hazards;
- Base case and future case risk levels assessed for selected hazards;
- Emergency response review; and
- Assessment of mitigation measures.

The main part of the impact assessment covers the potential impacts to commercial vessels, fishing vessels and recreational vessels from the construction / installation and presence of the proposed offshore wind farm and associated infrastructure including the offshore export cable. The impacts on emergency response, marine radar systems and navigational equipment are assessed for the operational phase only.

2.3. Secondary Guidance

Other guidance documents used during the assessment are listed below:

- MCA Marine Guidance Notice 372 (MGN 372 M+F) Offshore Renewable Energy Installations (OREIs) Guidance to Mariners Operating in the Vicinity of UK OREIs (MCA, 2008b);
- International Association of Marine Aids to Navigation and Lighthouse Authorities (IALA) – 0-139 the Marking of Man-Made Offshore Structures, Edition 2 IALA (2013);
- Royal Yachting Association (RYA) – The RYA's Position on Offshore Renewable Energy Developments: Paper 1 – Wind Energy (RYA, 2014);
- DECC Standard Marking Schedule for Offshore Installations (DECC, 2011); and
- The Recreational Craft Directives 94/25/EC and 2003/44/EC - implemented into UK law by the Recreational Craft Regulations 2004 (SI No. 2004/1464), apply to recreational craft and are intended to ensure the free movement of goods on the EEA market.

3. NRA Methodology

A shipping and navigation receptor can only be sensitive if there is a pathway through which an impact can be transmitted between the source activity and the receptor. When a receptor is exposed to an impact, the overall severity of consequence to the receptor is determined and the process incorporates a degree of subjectivity. Consequence assessments for shipping and navigation receptors used the following criteria, in line with baseline data and expert opinion, to assess;

- Outputs of the hazard workshop;
- Level of stakeholder concern;
- Time and/or distance of deviation;
- Number of transits of specific vessel and/or vessel type; and
- Lessons learnt from existing developments.

Rankings for severity of consequence are shown in Table 3.1.

Table 3.1 Severity of Consequence

Description	Definition
Negligible	• No injury to persons • No significant damage to infrastructure or vessel • No environmental impacts (marine pollution) • No significant operational impacts
Minor	• Slight injury(s) to person • Minor damage to infrastructure or vessel • Tier 1 pollution assistance (marine pollution) • Minor operation impacts
Moderate	• Multiple moderate or single serious injury to persons • Moderate damage to infrastructure or vessel • Tier 2 pollution assistance (marine pollution) • Considerable operational impacts
Serious	• Serious injury or single fatality • Major damage to infrastructure or vessel • Tier 2 pollution assistance (marine pollution) Major national business, operation or reputation impacts
Major	• More than one fatality • Extensive damage to infrastructure or vessel • Tier 3 pollution assistance (marine pollution) • Major international business, operation or reputation impacts

Consequence has then been assessed against frequency to identify overall tolerability of the impact. Ranking for frequency of occurrence are shown in Table 3.2.

Table 3.2 Frequency of Occurrence

Description	Definition
Negligible	Only likely to happen in exceptional circumstances.
Extremely Unlikely	Unlikely to happen but not exceptional throughout all phases of the project.
Remote	Likely to happen throughout phases of the project.
Reasonably Probable	Extremely likely to happen throughout phases of the project.
Frequent	Would occur daily throughout phases of the project.

The following tables show the overall tolerability rankings (Table 3.4) impacts according to their severity of consequence and frequency of occurrence (Table 3.3).

Table 3.3 Shipping and Navigation Risk Matrix

Frequency	Frequent	Tolerable	Tolerable	Unacceptable	Unacceptable	Unacceptable
	Reasonably Probable	Broadly Acceptable	Tolerable	Tolerable	Unacceptable	Unacceptable
	Remote	Broadly Acceptable	Broadly Acceptable	Tolerable	Tolerable	Unacceptable
	Extremely Unlikely	Broadly Acceptable	Broadly Acceptable	Broadly Acceptable	Tolerable	Tolerable
	Negligible	Broadly Acceptable	Broadly Acceptable	Broadly Acceptable	Broadly Acceptable	Tolerable
		Negligible	Minor	Moderate	Serious	Major
		Consequence				

Table 3.4 Tolerability Matrix

	Broadly Acceptable	Risk ALARP with no additional mitigations or monitoring required above embedded mitigations.
	Tolerable	Risk acceptable but may require additional mitigation measures and monitoring in place to control and reduce to ALARP.
	Unacceptable	Significant risk mitigation or design modification required to reduce to ALARP.

3.1. Methodology for Assessing Cumulative Effects

The assessment of cumulative impacts within this NRA will include in-combination effects, including consideration of the impacts arising from multiple offshore renewable energy developments and other offshore developments along the east coast of Scotland.

This subsection reviews the methodology used for assessing the cumulative effects of the proposed KOWL development with other offshore installations and activities. The Cumulative Impact Assessment (CIA) will attempt to analyse and evaluate the impacts of the project on the environment in a systematic way.

The following sources have been used to assess the effects identified as part of the baseline study:

- Stakeholder consultation and expert opinion;
- Lessons learnt;
- Desktop study; and
- Regular operator feedback.

Projects considered will include offshore developments and navigational based activities that have the potential to produce cumulative or in-combinations effects with the proposed KOWL development.

3.2. Assumptions

The shipping and navigation baseline and impact assessment has been carried out based on the information available and responses received at the time of preparation. It is assumed that any notable changes will be re-assessed and re-modelled if required.

4. Consultation Process

In order to ensure that all stakeholders and their relevant equities were included within the NRA process, a review of the stakeholders' types was undertaken in line with the baseline study. Stakeholders have been represented by organisations which have different roles including:

4.1. Stakeholders consulted as part of the NRA process

Key marine navigational stakeholders have been consulted as part of the navigational risk assessment. The following stakeholders have been consulted for assessment within this technical document; this list does not show the entire stakeholder consultation list for the project, i.e. those not relevant to the NRA.

National Stakeholders:

- Maritime Coastguard Agency (MCA)
- National Lighthouse Board (NLB)
- Royal Yachting Association

Key local and regional stakeholders:

- Aberdeen Harbour Board
- Scottish Royal Yachting Association
- Scottish Fishermen's Federation

4.2. Regular Operators Consulted as part of the NRA process

Regular operators transiting through and in proximity to the proposed KOWL development were identified, as listed below:

- Bibby Offshore
- BP Shipping
- Fisher and Sons PLC
- GulfMark UK
- North Star Shipping
- Marine Safety Forum (operator forum)

Vessel owners and operators of the vessels were initially contacted in July 2015 providing information about the development. This was followed up with invitations to the hazard workshop in August 2015 as well as communication through the Chamber of Shipping

Details of the responses to the consultation process are documented within Section 12.

5. Data Sources

The following data sources have been used in the baseline KOWL Navigation Risk Assessment:

- Fourteen days AIS and radar (31st July – 14th August 2014) marine traffic survey data;
- Fourteen days AIS only (17th January – 31s January 2015) marine traffic survey data;
- Maritime incident data from the Marine Accident Investigation Branch (2004 – 2013) and the Royal National Lifeboat Institute (2001 – 2010);
- Fishing Vessel Satellite Data (2009) provided by Marine Scotland;
- Fishing Vessel Sightings Data (2005 -2009) provided by Marine Scotland;
- Ministry of Defence (MOD) exercise areas and explosives dumping grounds (charted information);
- Locations of existing oil and gas platforms and other associated infrastructure such as pipelines and drilling wells from UK Deal (2014);
- Oil and gas fields and 28th Round license blocks from UK Deal (2014);
- Royal Yachting Association (RYA) UK Coastal Atlas of Recreational Boating (RYA, 2009).
- Designated anchorage areas (charted information);
- Marine Environmental High Risk Areas (MEHRAs) from MCA;
- Admiralty Sailing Directions (NP 54) (UKHO, 2009);
- UK Admiralty Charts issued by United Kingdom Hydrographic Office (UKHO); and
- UK Coastal Atlas of Recreational Boating (2009) and associated GIS data.

6. Marine Traffic Survey Methodology

6.1. AIS and Radar Survey Overview

In order to provide assessment of the shipping activity within the vicinity of the KOWL Development, two sets of marine traffic data were collected during 2014 and 2015. The first data set was recorded via a shore-based AIS receiver and radar scanner located in Portlethen, approximately 8nm from the western boundary of the AfL area. A total of 14 days were collected between the 31st July and the 14th August 2014.

In order to account for seasonal variations in shipping within the KOWL area, a second data set from January 2015 was collected. This second survey consisted of AIS data only, and was recorded from shore-based AIS receivers located in Aberdeen (8nm from the AfL area) and Inverbervie (14nm from the AfL area). A total of 14 days were recorded between the 17th and 31st January, giving a combined survey period of 28 days. The receiver locations, relative to the AfL area, are presented in Figure 6.1.

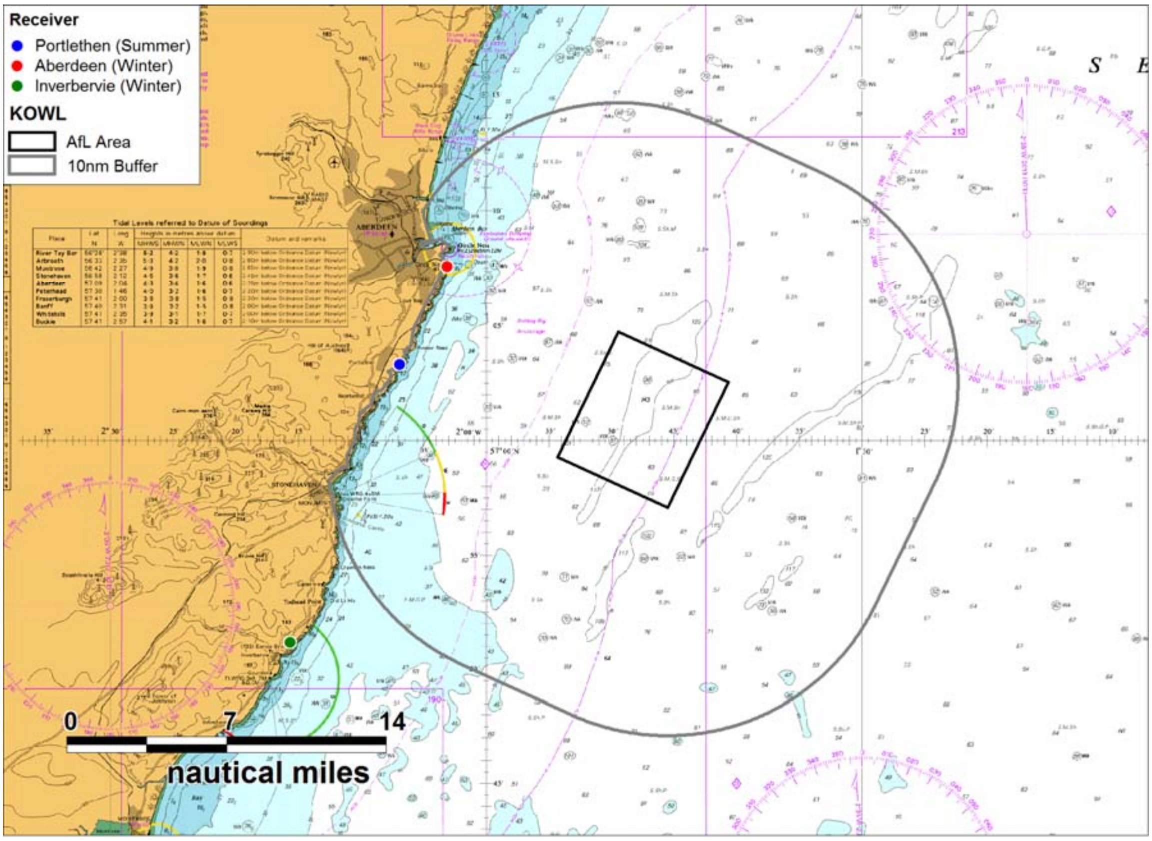

Figure 6.1 Marine Traffic Survey Receiver Locations

6.2. AIS and Radar Coverage

AIS is required on board all vessels of more than 300 gross tonnage (GT) engaged on international voyages, cargo vessels of more than 500 GT not engaged on international voyages, passenger vessels irrespective of size built on or after 1st July 2002, and fishing vessels greater than or equal to 15m in length. It is noted that some smaller fishing vessels not obliged to broadcast via AIS (<15m in length) still choose to do so voluntarily.

Therefore larger vessels were recorded on AIS, while smaller vessels without AIS installed (i.e. fishing vessels under 15m in length and recreational vessels not carrying AIS voluntarily) were recorded where possible on the Automatic Radar Plotting Aid (ARPA) of the radar system. This was supplemented by observations of vessels within visual range, to obtain information on type and size, where this information was not available from AIS. Manual logs of locations for vessels were taken when the ARPA radar was unable to acquire the vessel as a target, generally for smaller vessels such as yachts or small fishing vessels without radar reflectors.

It should be taken into consideration when viewing the Marine Traffic Survey analysis (Section) 11 that radar data was only recorded during the summer period. It is noted that small craft (fishing vessels <15m in length and recreational vessels) activity is likely to be less during winter due to weather conditions.

6.3. Commercial Vessel Activity

The marine traffic surveys carried out between August 2014 (14 days summer) and January 2015 (14 days winter) comprise the data set used to assess the potential impact upon commercial vessel activity.

6.4. Recreational Activity

The RYA and the Cruising Association (CA) represent the interests of recreational users including yachting and motor cruising. In 2005 the RYA , supported by THLS and the CA, compiled and presented a comprehensive set of charts which defined the cruising routes, general sailing and racing areas used by recreational craft around the UK coast. This information was published as the UK Coastal Atlas of Recreational Boating and has been subsequently updated (RYA, 2009). The latest addition of GIS Shape files from 2010 showing cruising routes, sailing and racing areas has been used in this assessment.

The RYA has also developed a detailed position statement (RYA, 2013) based on analysed data for common recreational craft. In addition to RYA data, the tracks of recreational vessels recorded during the summer marine traffic survey were extracted for further analysis (no recreational vessels were recorded during the winter survey).

6.5. Fishing Activity

The tracks of fishing vessels were extracted from the summer and winter marine traffic survey data for use in the fishing vessel activity analysis.

In addition, fishing vessel sightings and satellite vessel monitoring data were obtained from Marine Scotland to validate the survey data presented in the baseline assessment.

Sightings data were analysed for the five year period between 2005 to 2009 (full annual analyses). These data have been collected through the deployment of patrol vessels and surveillance aircraft. Each patrol logs the positions and details of fishing vessels within the area being patrolled. All vessels are logged, irrespective of size, provided they can be identified by their Port Letter Number (PLN).

Satellites record the positions of fishing vessels of above 15m in length a minimum of every two hours. Data have been analysed on a full annual basis for 2009 (all nationalities), which is the latest available which provides detailed positional information.

7. Project Description Details

The scope of this NRA reflects a project design statement defined by KOWL. The following section details the projected maximum extents of the project. Further information on the envelope used for the KOWL development is detailed within Chapter 10 (Shipping and Navigation) of the ES. For the collision and allision risk modelling, a worst case approach has been adopted. The worst case layout, for shipping and navigation, assessed is summarised in Section 7.4.

7.1. KOWL Development Overview

The AfL site boundary considered by KOWL is presented in Figure 7.1. The proposed turbine layout is included in the figure.

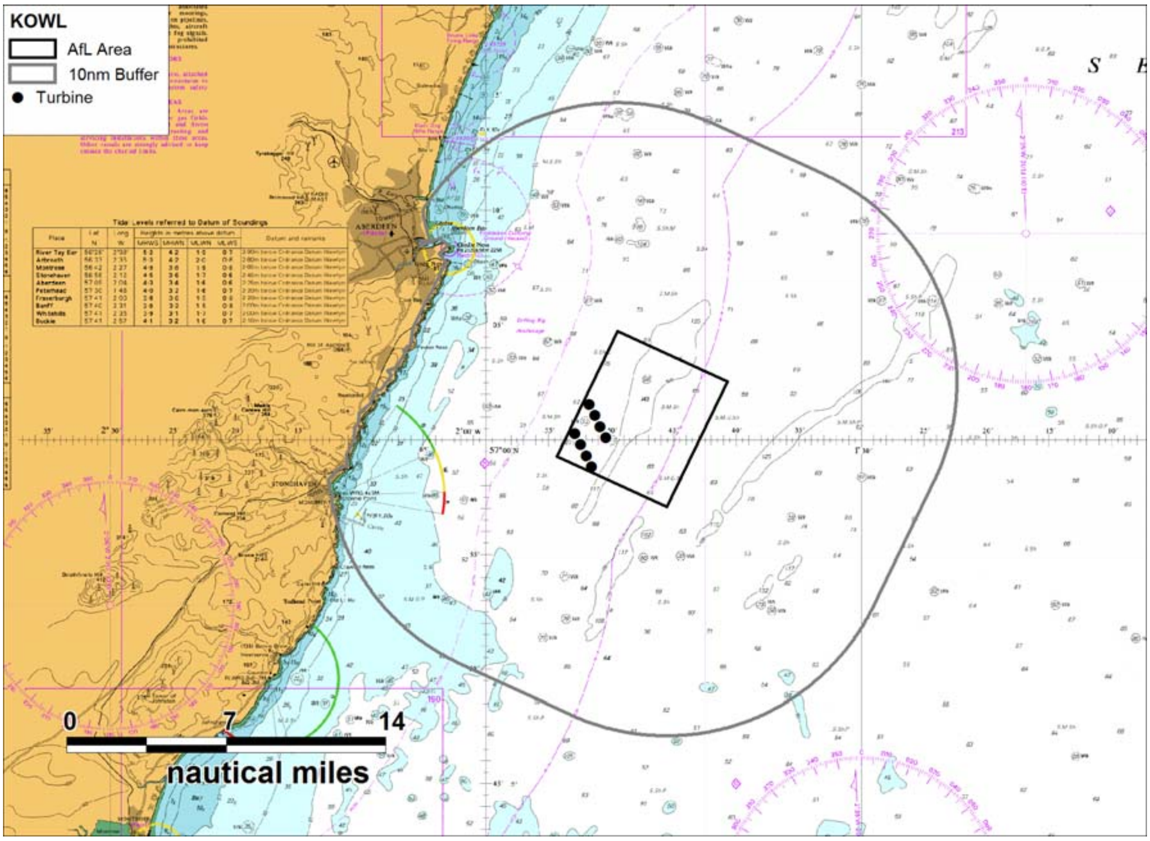

Figure 7.1 KOWL Development Location

A total of eight turbine locations have been proposed, each to be installed on a floating Windfloat structure as a base. The operational life of the KOWL development is anticipated to be 20 years. Where appropriate, analysis in this assessment has been performed within a 10nm buffer of the AfL area, shown in the above figure. The 10nm study area was deemed suitable to comprehensively assess nearby shipping, with both passing traffic to the east, inshore transits and port traffic accounted for.

7.2. WindFloat Structure

As the depth of the waters within the AfL site exceed that recommended for fixed substructures (< 50m), floating bases were considered a more viable option. Windfloat semi-submersible bases have been suggested due to success of prototype models. The structure consists of three floating columns with diameters up to 12m, joined by horizontal faces with a maximum length of 67m (between the column centre points). A turbine would be placed on a column of each floating base. The WindFloat structure will have a maximum elevation of 12m above the waterline. Access is permitted to the structures via two small craft landings. A mooring system will anchor each structure to the seabed, further details of which are provided in Section 7.4.

Due to the nature of the WindFloat structure a maximum excursion area of 25m has been assumed throughout the NRA.

An installed Windfloat structure prototype is presented in Figure 7.2.

Figure 7.2 Windfloat Structure

It is intended that the WindFloat structure shall be constructed at Nigg (Cromarty Firth) and towed to the KOWL development for installation.

7.3. Wind Turbine Generators

The eight proposed turbine location coordinates are presented in Table 7.1. Inter-array cable will connect the structures within the development. It is noted that there will be no Offshore Substation Platform (OSP) at the site, with power exported at 33KV via single or twin transmission line(s). The WTG design parameters are summarised in Table 7.2.

Table 7.1 Turbine Locations

Turbine	Longitude	Latitude
1	001° 52’ 52.1” W	57° 00’ 19.1” N
2	001° 52’ 25.7” W	56° 59’ 50.2” N
3	001° 51’ 59.1” W	56° 59’ 21.3” N
4	001° 51’ 32.7” W	56° 58’ 52.3” N
5	001° 51’ 44.6” W	57° 01’ 35.8” N
6	001° 51’ 18.1” W	57° 01’ 06.9” N
7	001° 50’ 51.6” W	57° 00’ 37.9” N
8	001° 50’ 25.1” W	57° 00’ 09.0” N

Table 7.2 Summary of WTG Design Parameters

Type / Option	Possible Requirements
WTG Capacity	6MW (assessed)
Development Size	Under 50 MW
WTG Hub Height (to centerline of hub)	LAT + 107 m
WTG Blade Length (to centerline of hub)	85 m
Effective Tip Height	LAT + 192 m
Blade Clearance	22m at all tidal states
Colour	- Surface structure traffic yellow up to 22m above water surface - Turbine tower and blades light grey.
Navigation Lighting	As required by NLB, CAA, MCA etc.

7.4. *Mooring System*

Each Windfloat structure will be moored to the seabed. The types of anchors and moorings will depend on factors that will be closely evaluated in the FEED engineering phase of the project. The current mooring system options are presented in Table 7.3. It should be noted that the anchor and mooring system shall be installed up to 18 months prior to turbine installation. Throughout this period of construction a guard vessel shall be on site at all times.

Table 7.3 Summary of Mooring System Options

Type / Option	Possible Requirements
Sub-structure type	Semi-submersible
Number of Mooring lines	4
Mooring type	Catenary Anchor

Type / Option	Possible Requirements
Anchor Type	Drag embedment anchors, Torpedo Anchors, Gravity Based Anchors
Clump Weights	Steel or reinforced concrete circa 25 tonnes in weight
Mooring lines	Anchor chain, Mooring cables, polyester mooring lines
Pennant Wires/Buoys	Temporary surface buoys during construction
Pennant Wires/Buoys	Permanent submersible buoys at seabed for ROV recovery
Installation	Anchors and mooring system present on the seabed for up to 18 months prior to turbine installation
Mooring Line Radius	Max Approx. 9 x Water Depth (dependent upon configuration and Engineering Analysis)

7.5. *Worst Case Layout*

The NRA has assumed a worst case layout of eight WTGs, presented in Figure 7.1. All eight turbine locations have been considered in the worst case layout and used as an input for the collision and allision risk modelling. The minimum spacing between turbines is 1,000m in the NNW/SSE orientation, and 2,200m in the north/south orientation.

7.6. *Export Cable Corridor*

The proposed export cable corridor is presented in Figure 7.3, relative to the AfL area. The final cable route will lie in this corridor.

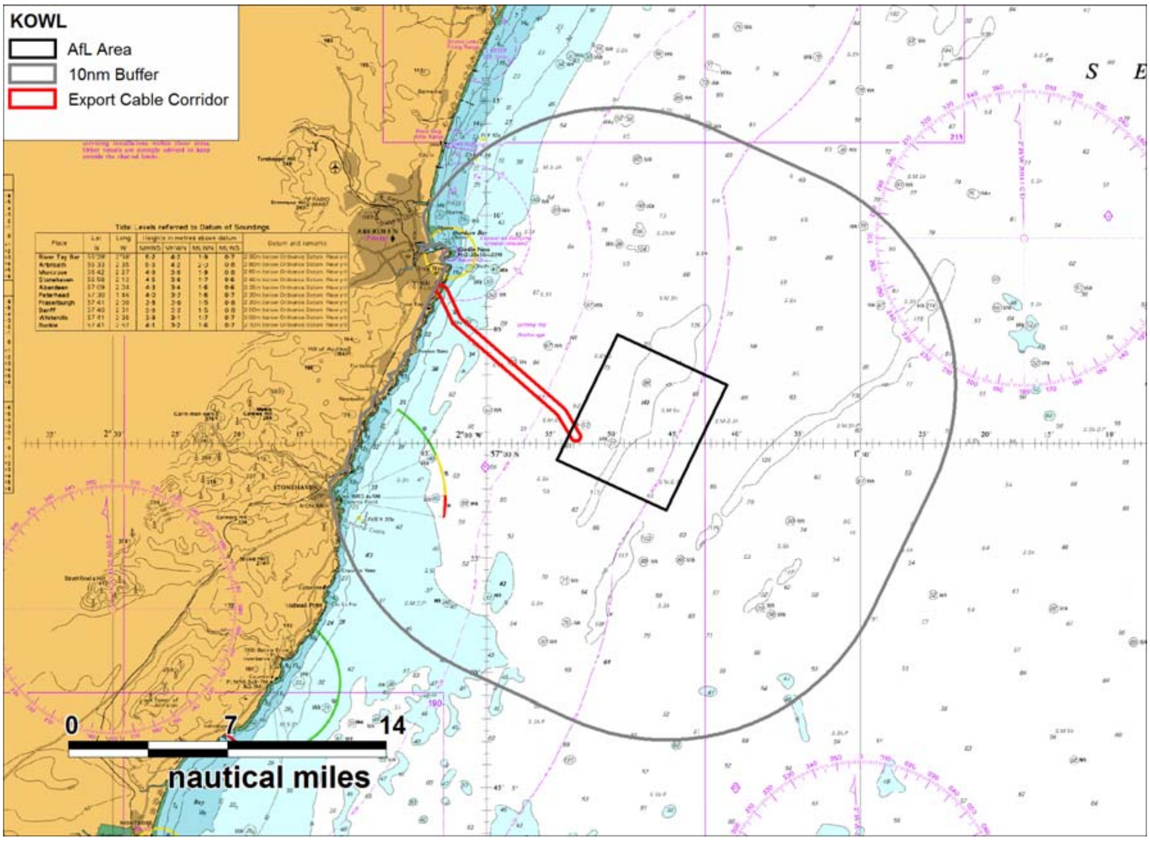

Figure 7.3 Export Cable Corridor

The export cable will run directly from the turbines to the shore via directionally drilled conduits for connection to the onshore transmission system and onshore substation. Export cable options are summarised in Table 7.4. At present KOWL would like to retain the option to install two export cables within the corridor.

Table 7.4 Summary of Export Cable Options

Type / Option	Possible Requirements
Export Cable No.	Max 2
Export Cable Length	Max 19 km each
Cable Burial	Target depth 1.5 m
Inter Array Cable	Max 12
Cable Protection (if required)	Localised burial, rock dumping or mattressing
Bend restrictors	Localised as required

8. Metocean Data

8.1. Wind

Wind data for the area, in terms of annual average direction, is presented in Figure 8.1.

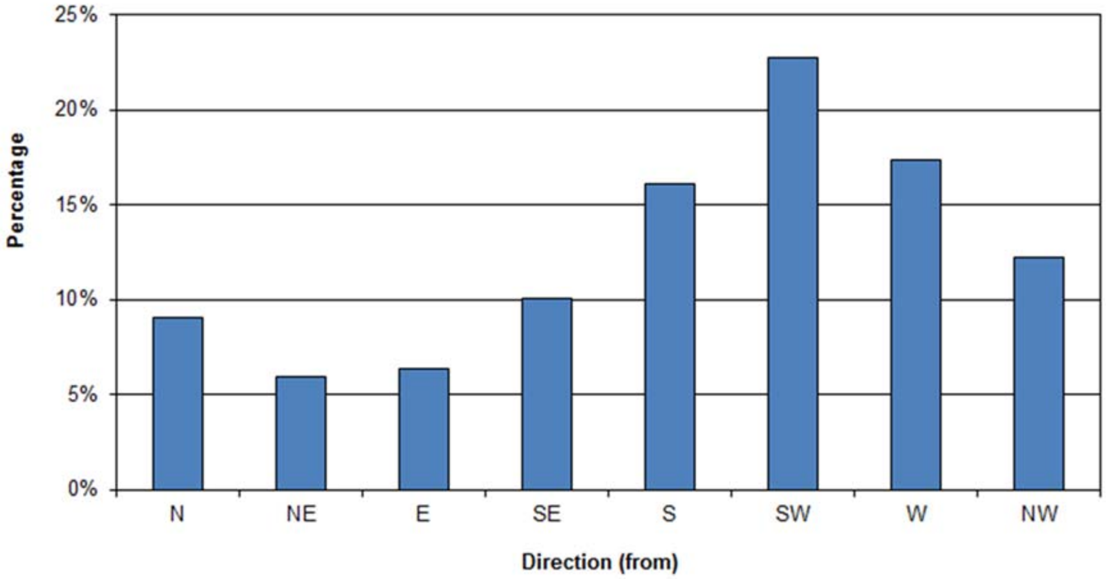

Figure 8.1 Annual Wind Direction Distribution

The predominant wind direction was from the south west (23%), west (17%), and south (16%), representing a combined total of 56%.

8.2. Wave

Significant wave height data for the area is presented below.

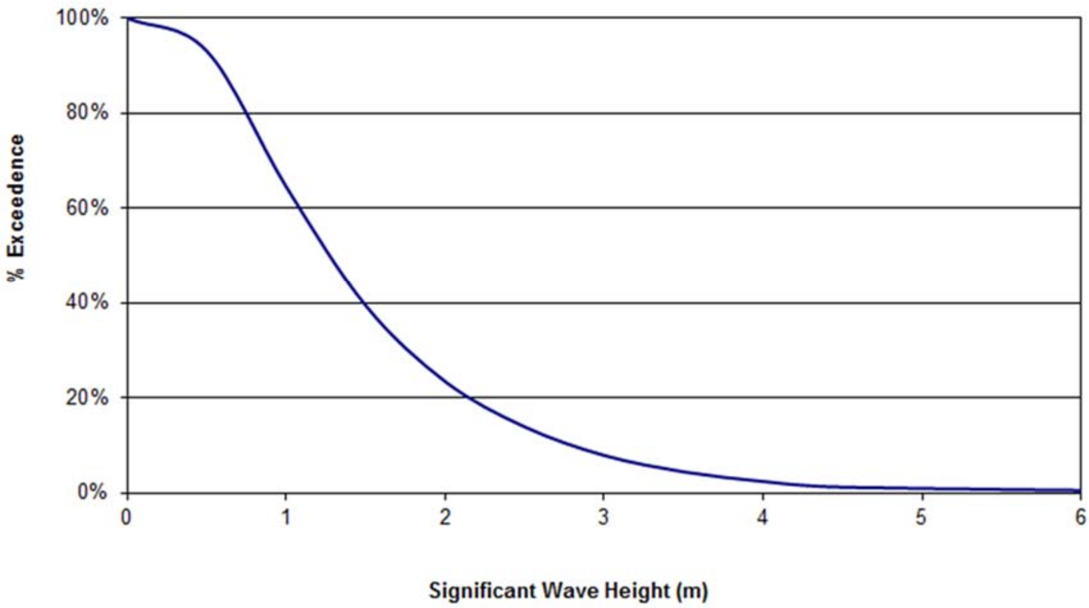

Figure 8.2 Significant Wave Height Exceedance Curve

The probability of wave height exceeding 3m throughout the year is approximately 8%. It can therefore be concluded that wave height is of calm to moderate sea state for the majority of the year.

8.3. Visibility

Historically, visibility has been shown to have a major influence on the risk of ship collision. The annual average probability of bad visibility (defined as less than 1km) has been extracted from the North Sea (West) (NP54) Admiralty Sailing Directions Pilot Book. The closest source of historical visibility data is from Inverbervie (located approximately 15nm south west). Fog was recorded on an average of 13.2% of days throughout the year. The incidence of fog increases throughout the summer months (July – September) in comparison to winter months.

8.4. Tide

Tidal information has been taken from Tidal Diamond "A" on Admiralty Chart 210-0 (Newburgh to Montrose), the location of which has been plotted relative to the KOWL Development in **Error! Reference source not found.**. Tidal stream data from Tidal Diamond "A" is presented in Table 8.1.

Table 8.1 Tidal Stream Data

Hours	Direction of Streams (°)	Rates at Spring Tide (knots)	Rates at Neap Tide (knots)
-1	011	1.2	0.6

Hours	Direction of Streams (°)	Rates at Spring Tide (knots)	Rates at Neap Tide (knots)
-2	019	0.8	0.4
-3	046	0.3	0.2
-4	160	0.4	0.2
-5	174	1.0	0.5
-6	181	1.4	0.7
High Water	189	1.2	0.6
+ 1	203	0.9	0.4
+ 2	226	0.6	0.3
+ 3	314	0.4	0.2
+ 4	358	0.9	0.4
+ 5	008	1.3	0.7
+ 6	010	1.3	0.7

The highest tidal rate during flood tide was 1.4 knots when the tidal stream bearing was 181°. The highest during the ebb tide was 1.3 knots, when the tidal stream bearing was 008° to 010°.

9. Baseline Environment

9.1. Aids to Navigation/Navigational Features

The aids to navigation installed at Aberdeen and Stonehaven are presented in Figure 9.1 relative to the KOWL Development.

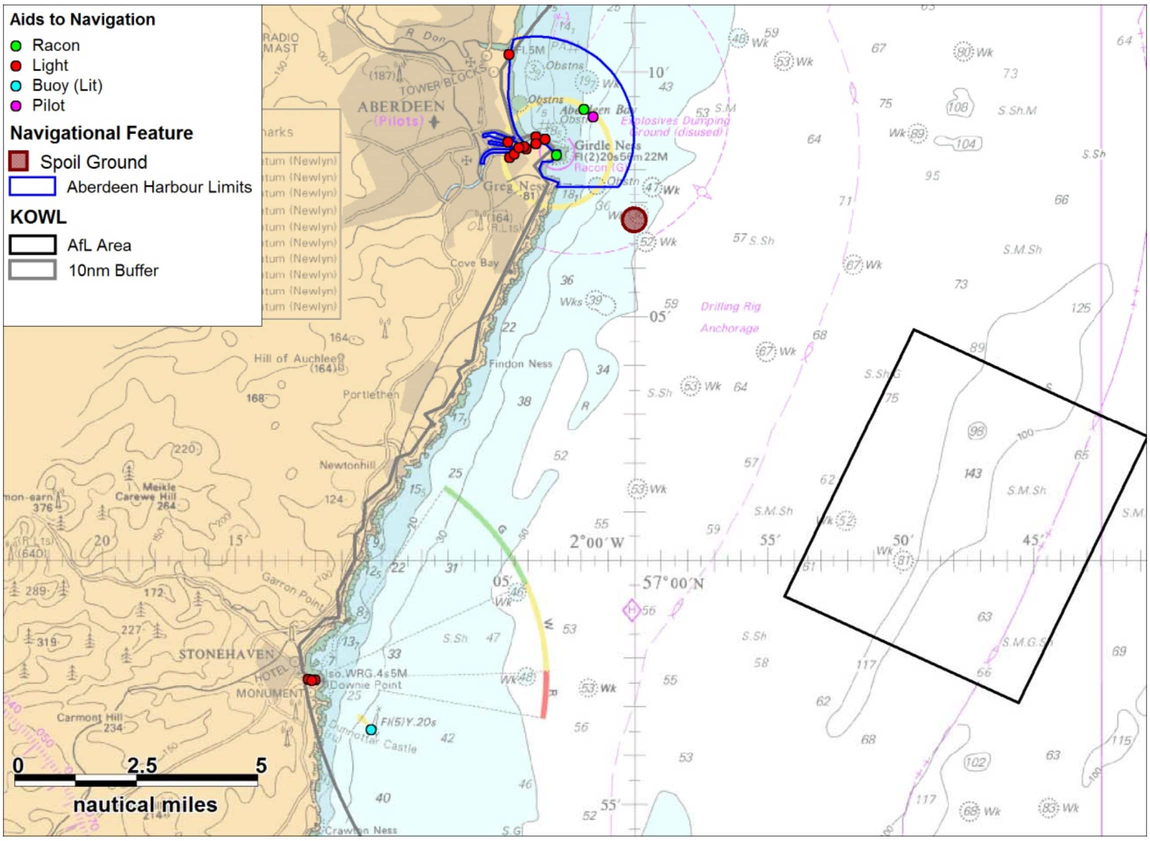

Figure 9.1 Aids to Navigation

Racons are installed at Girdle Ness lighthouse and on the Fairway Light Buoy outside of Aberdeen. Lights are also installed on the breakwater in the harbour approach. Pilot boarding takes place in the vicinity of the Fairway Buoy, approximately 8nm to the north west of the KOWL Development. The approach to Stonehaven from the south is marked by a lit buoy approximately 9nm to the south west of the KOWL Development. Further lights are installed within Stonehaven bay.

There is a spoil ground outside Aberdeen Harbour, located approximately 6nm to the north west of the KOWL Development and is used by Aberdeen Harbour Authority for disposal of spoil from in-harbour maintenance dredging.

The KOWL development is located out with all port limits, with the closest port limits (Aberdeen Harbour) located approximately 6.8nm north west of the AfL area.
There are no designated International Maritime Organisation (IMO) routeing measures in proximity to the KOWL development with all located in excess of 100nm from the KOWL development.

9.2. Main Ports

There are four significant ports in the vicinity of the KOWL Development site: Peterhead, Aberdeen, Stonehaven and Arbroath. The locations of these ports relative to the site are presented in Figure 9.2.

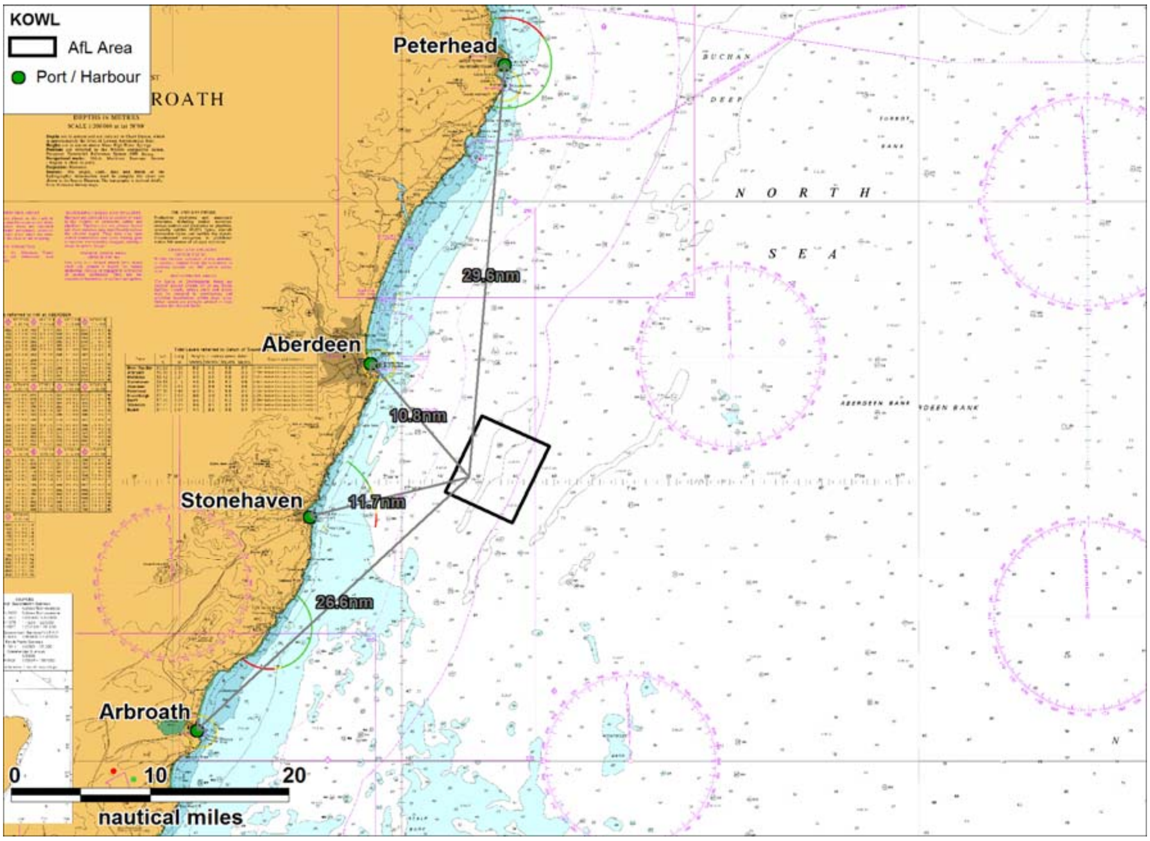

Figure 9.2 Ports in vicinity of the KOWL Development Site

The most significant port in the vicinity of the KOWL Development is Aberdeen, located approximately 10.8nm to the north west. Aberdeen handles oil and gas support traffic, cargo vessels and tankers (mainly product tankers). There are also daily ferry services to Shetland and Orkney running from Aberdeen. During 2014 Aberdeen harbour handled 7,937 vessel arrivals and 4.75 million tonnes of cargo. Aberdeen harbour controls all shipping movements within its harbour limits via VTS. All vessels must request permission to enter the VTS area when 3nm from the Fairway Light Buoy. VTS is mandatory for all vessels within the harbour limits.

Aberdeen Harbour Authority is currently with an application and consent process for proposed plans to extend the current harbour into Nigg Bay. The development would include an additional 1,700m of quay with a minimum draught of 9m meaning additional traffic would be moving to the south of the current harbour.

The port of Stonehaven, located 11.7nm to the west of the KOWL Development, is largely used by recreational vessels, however some small fishing vessels are also based here. A total of 140 regular moorings are provided for recreational vessels, with an additional 550m of berthing space on the quays.

9.3. Anchorages

The anchorage areas within the 10nm study area surrounding the KOWL Development are presented in Figure 9.3.

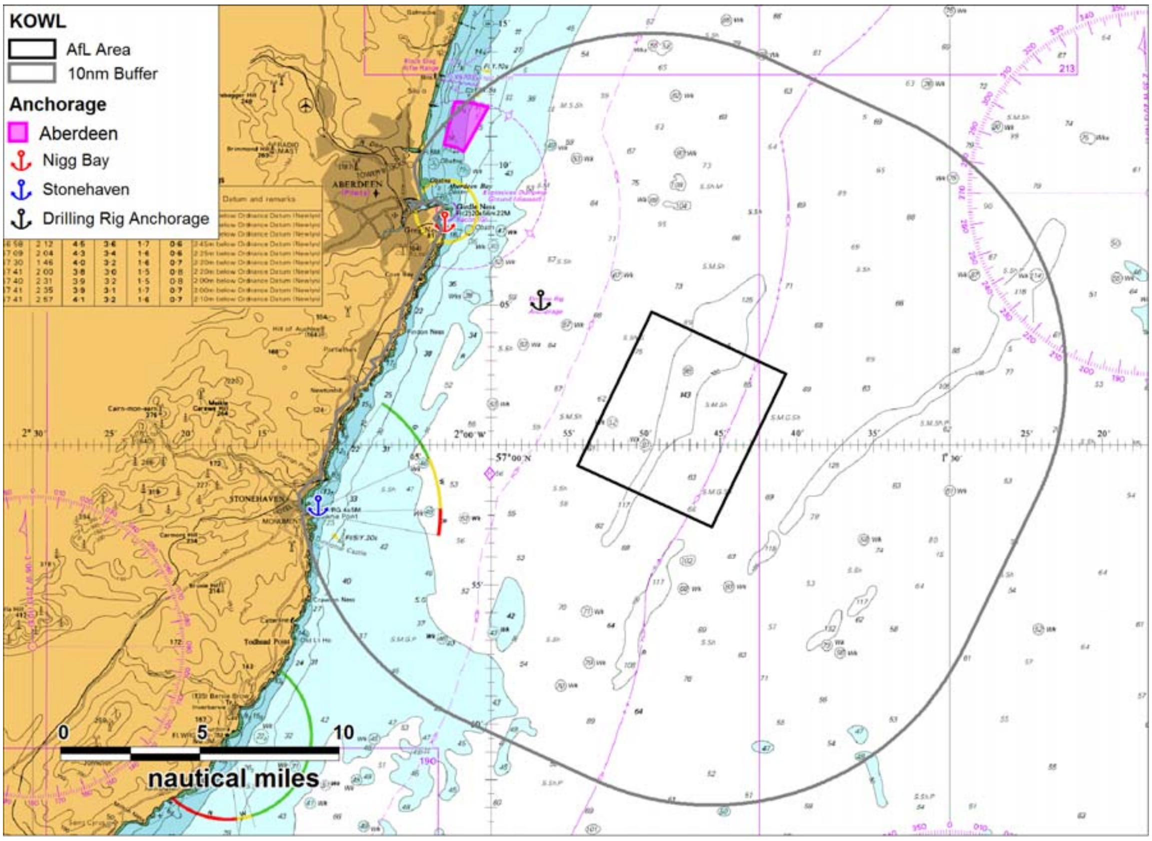

Figure 9.3 Anchorage in the vicinity of KOWL Development

The main anchorage within the study area is located approximately 9nm to the north west of the KOWL Development, outside the entrance to Aberdeen harbour. This anchorage is used as a waiting area for vessels associated with Aberdeen, and is both charted and mentioned in the Pilot Book (UKHO, 2009), which states that the bay is exposed to east winds. The pilot book also states that temporary anchorage can be made in Nigg Bay, which as noted above is still within the consenting process/

A drilling rig anchorage is located approximately 3.5nm west of the KOWL Development. This anchorage is present on Admiralty charts, and the Pilot Book lists rigs anchored here as a potential hazard to other mariners however recent traffic data shows that this site is not generally used and likely to be historic

Anchorage is also available in Stonehaven Bay at a location shown on Admiralty Charts, approximately 10nm south west of the KOWL Development. The Pilot Book states that good holding ground is available here.

9.4. *Military Practice*

The military practice and exercise areas in the vicinity of the KOWL Development are presented in Figure 9.4.

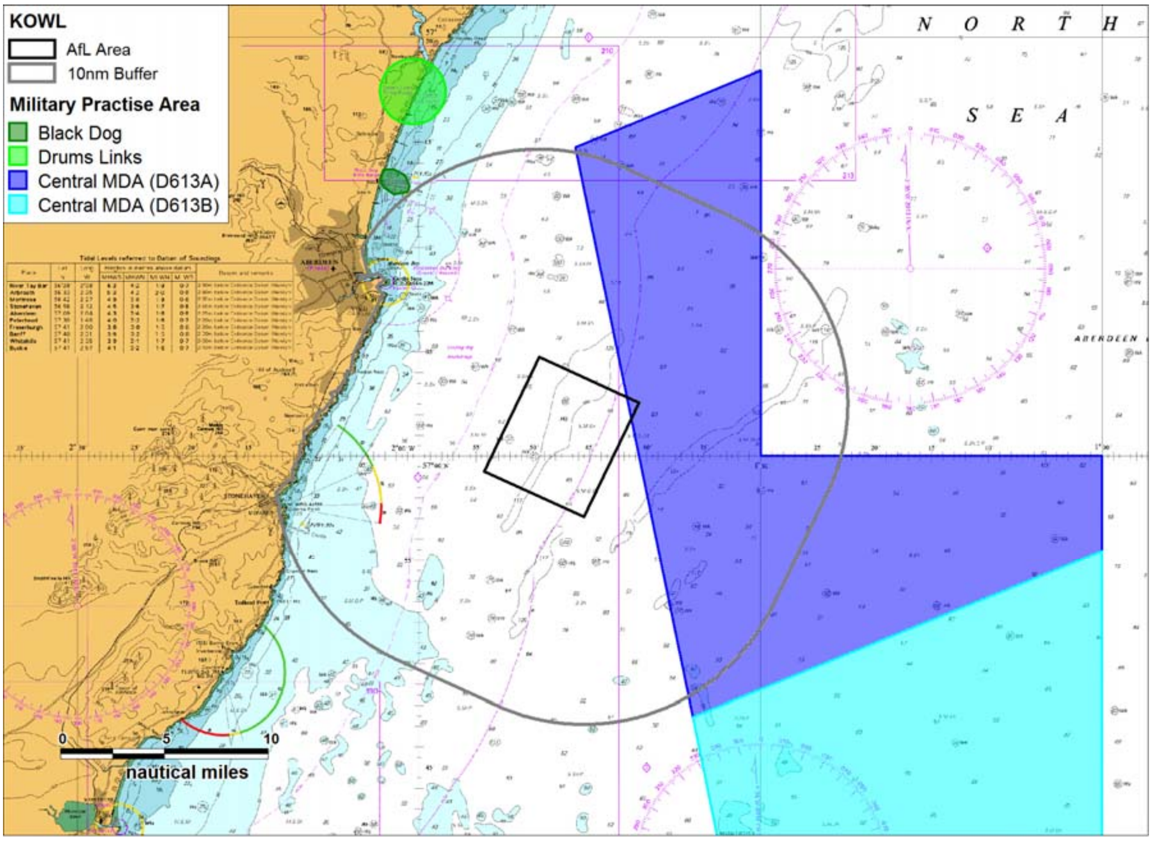

Figure 9.4 Military Practise Areas

The Central Managed Defence Area (MDA) D613A used by the Royal Air Force intersects the north eastern corner of the KOWL Development, while the Central MDA D613B area is located approximately 11nm to the south east. The Black Dog rifle range and Drums Link firing practise area are located 10.1nm and 12.5nm to the north west respectively.

A note on Admiralty Charts states that "No restrictions are placed on the right to transit the firing practise areas at any time. The firing practise areas are operated using a clear range procedure; exercises and firing only take place when the areas are considered clear of all shipping."

9.5. *Other Wind Farm Developments*

The wind farm developments in the vicinity of the KOWL Development are presented in Figure 9.5.

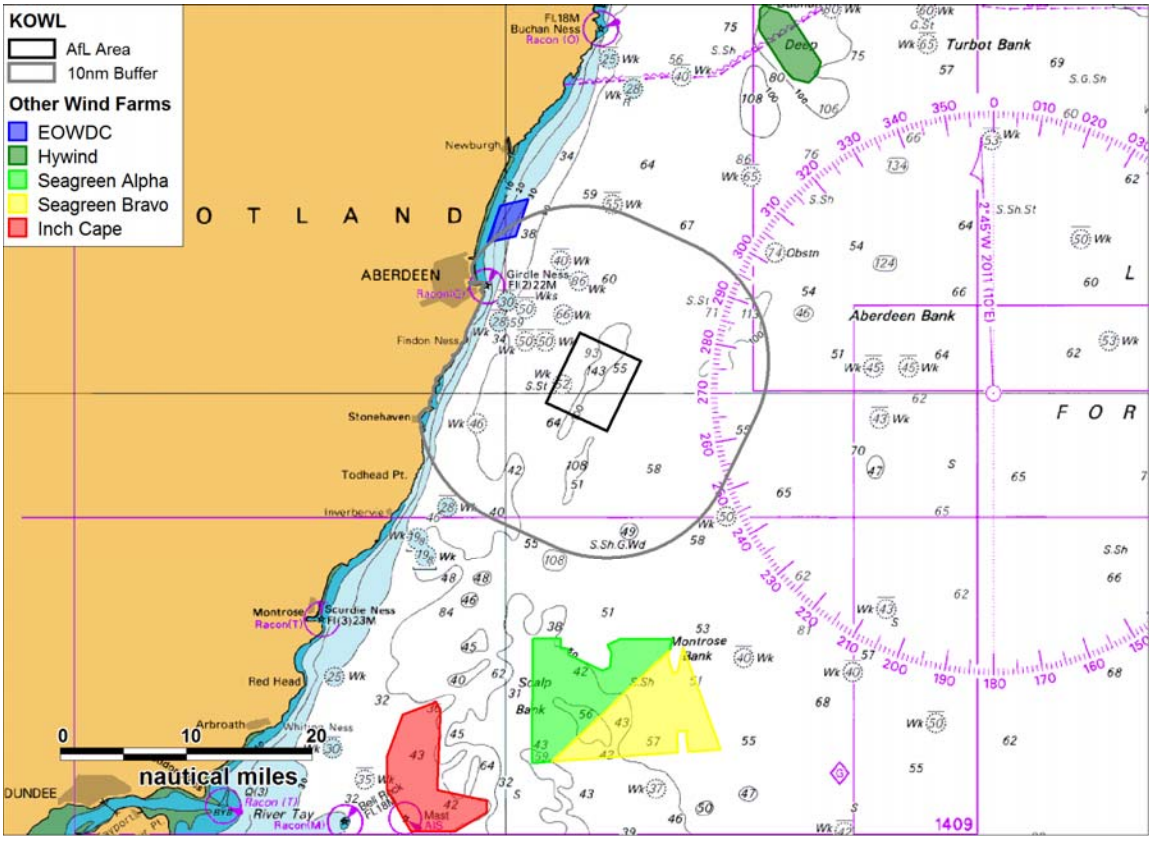

Figure 9.5 Other Wind Farm Developments

The European Offshore Wind Deployment Centre (EOWDC), situated in Aberdeen Bay, is located approximately 9.1nm north west of the KOWL Development. The EOWDC occupies a total area of approximately 5.8nm^2 (20km^2). It is planed that a total of 11 turbines of varying size (maximum anticipated size of 10MW) will be installed, giving a total output of 84MW to a maximum of 100MW. Consent for the EOWDC was authorised on the 26th March 2013 with a date for construction to commence still to be confirmed.

The consented Seagreen Firth of Forth Phase 1 Alpha and Bravo offshore wind farms are located approximately 16.5nm south of the KOWL Development. The Firth of Forth Phase 1 Alpha and Bravo offshore wind farms occupy a total area of approximately 113.5nm^2 (389.2km^2). A maximum of 150 turbines will be installed, giving a total output of approximately 1,050MW. Consent was authorised on the 10th October 2014. Details on the construction schedule are currently not available at time of writing.

The consented Inch Cape offshore wind farm is located approximately 25.1nm south west of the KOWL Development. The Inch Cape offshore wind farm occupies a total area of approximately 43.7nm^2 (149.8km^2). A maximum of 110 turbines will be installed, giving a total output of approximately 784MW. Consent was authorised on the 10th October 2014 with construction scheduled due to start in 2016 (dependant on financial close) for a period of approximately four years.

Hywind Scotland Limited is developing a floating wind farm called Hywind Scotland Pilot Park Project in Buchan Deep off Peterhead. The Project will consist of five, 6 megawatt floating Wind Turbine Generator (WTG) Units with a total capacity of up to 30MW. The WTG Units will be attached to the seabed by a three-point mooring spread and will be connected by inter-array cables; this site is located approximately 25nm from the KOWL Development.

9.6. Marine Wrecks

Admiralty Charts were used to identify the marine wrecks within the study area. The identified locations are presented relative to the KOWL Development in Figure 9.6.

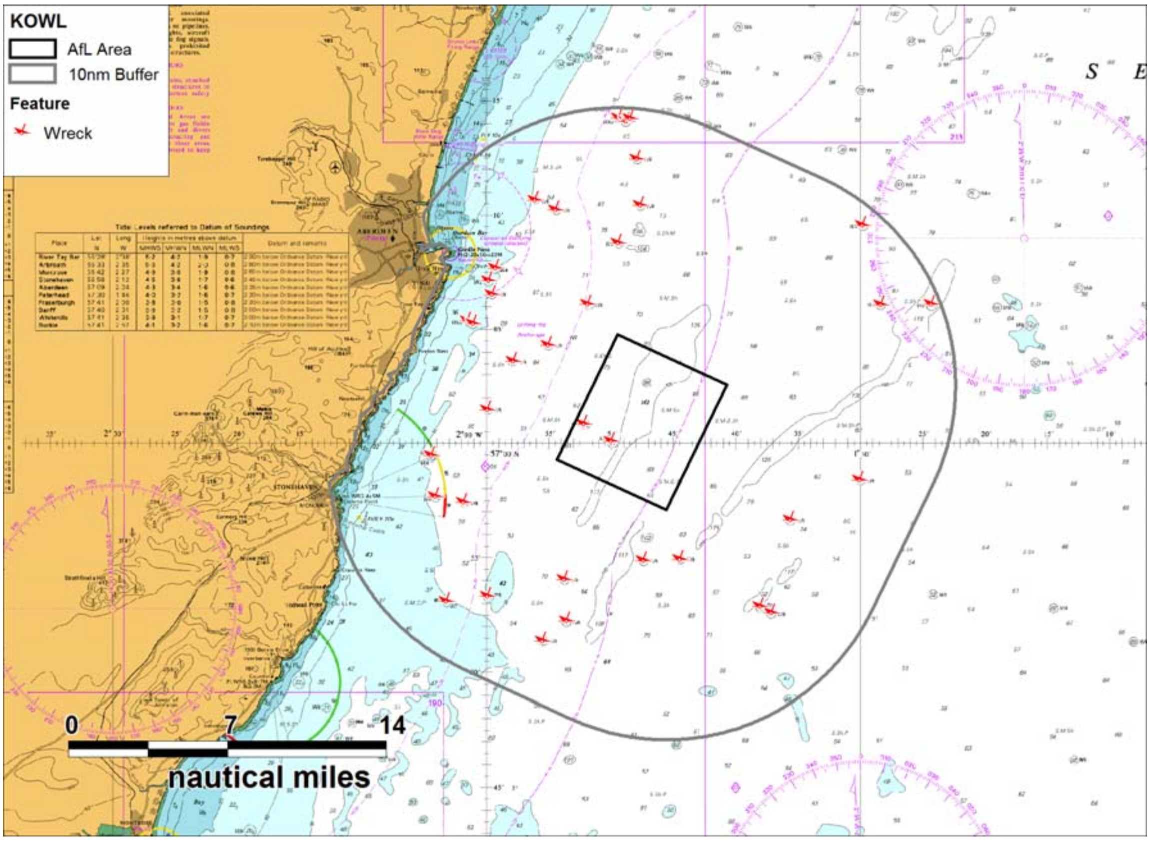

Figure 9.6 Marine Wrecks

Two wrecks were charted within the KOWL Development boundary, the western most at a depth of 52m, and the eastern most at a depth of 81m.

9.7. Marine Environmental High Risk Areas

The nearest Marine Environmental High Risk Area (MEHRA) to the KOWL Development is located 14nm to the north, and covers the coastline between Newburgh and Cruden Bay, and the River Ythan from a point approximately 3nm inland to its mouth at Newburgh. This is presented in Figure 9.7.

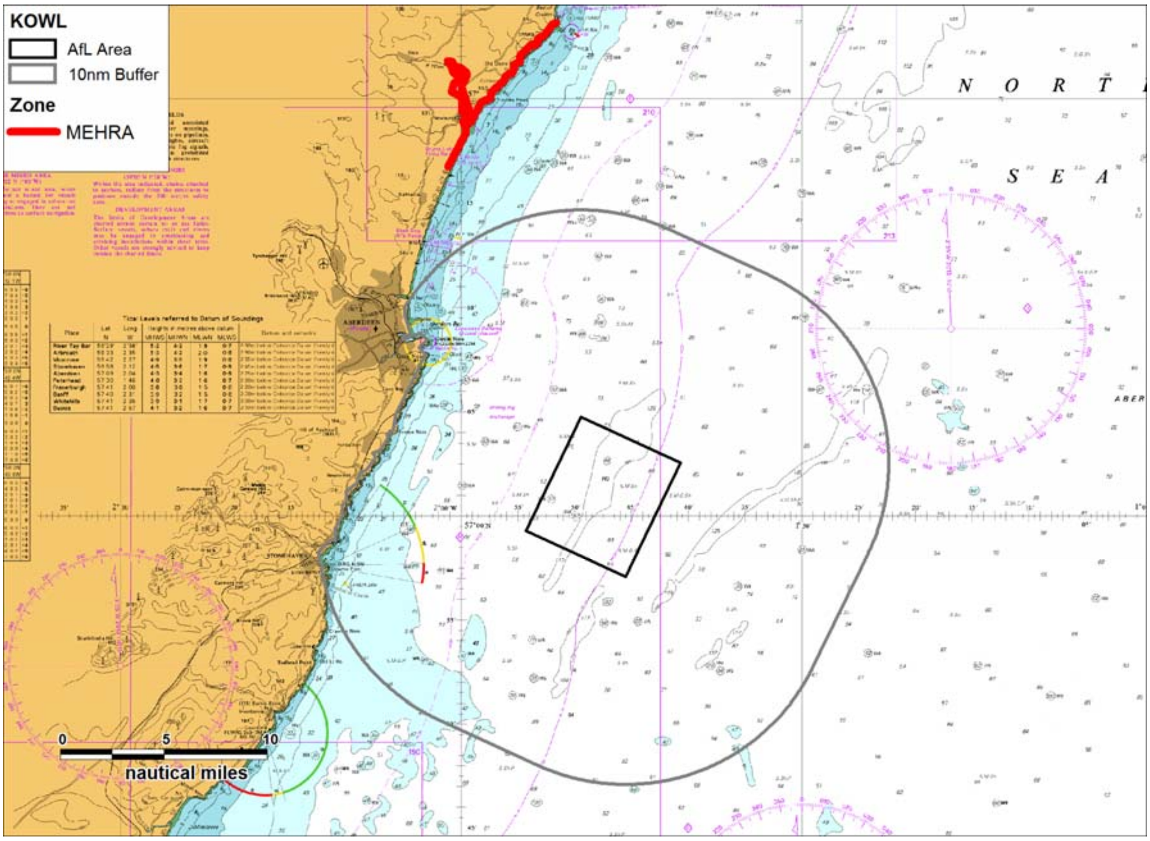

Figure 9.7 MEHRA relative to KOWL Development

9.8. Oil and Gas Infrastructure

There is no existing oil and gas infrastructure within the KOWL Development or study area. The surrounding infrastructure is presented in Figure 9.8.

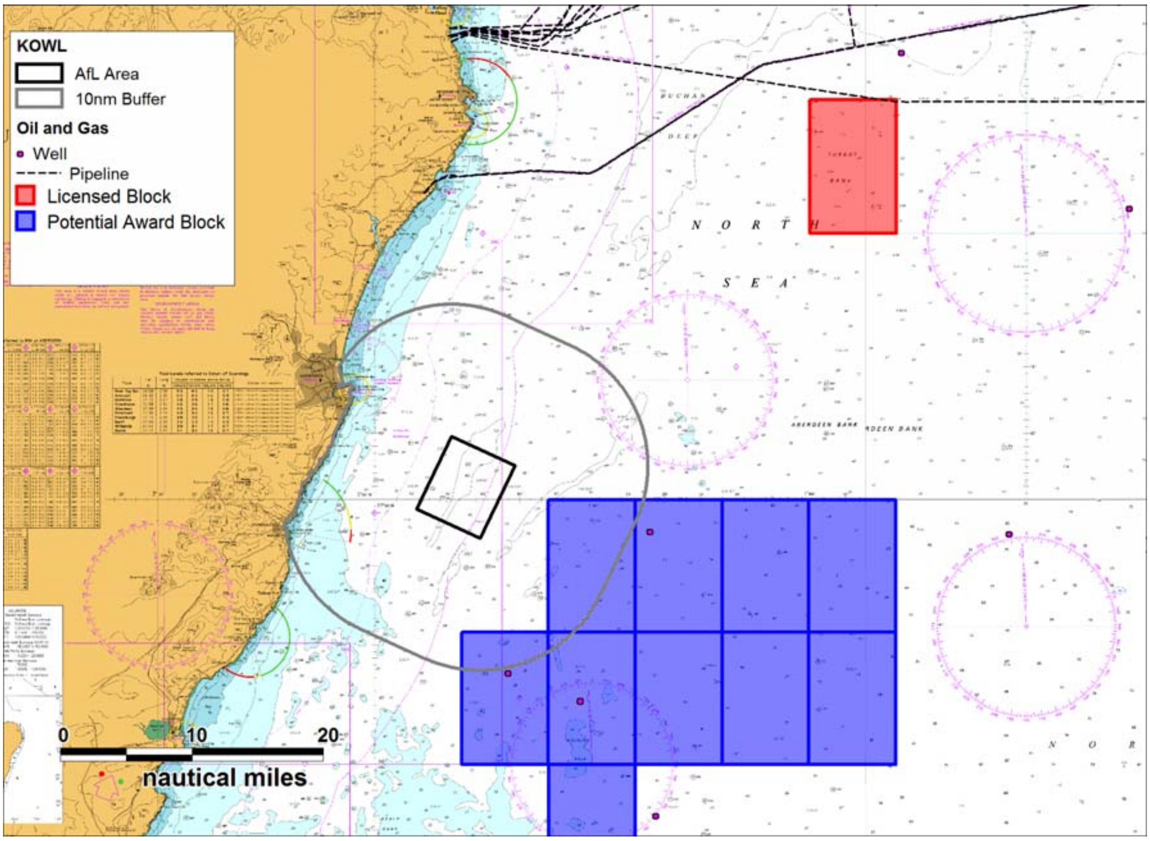

Figure 9.8 Oil and Gas Infrastructure

The existing oil and gas drilling wells in the vicinity of the KOWL development are plugged and abandoned with the closest well located approximately 11.3nm south east of the site. The closest piece of existing oil and gas infrastructure, located approximately 19.5nm north of the KOWL development, is the Forties oil pipeline which stretches from Cruden Bay to the Forties Oil Field.

The closest existing oil and gas surface platform is the Buzzard quarters and utilities platform, located approximately 51.5nm north. Licenses block 20/16 is located approximately 28.1nm north east of the KOWL development, and is the closest currently licensed oil and gas block. License block 20/16 is licensed to Sendero Petroleum Ltd. with the license currently set to expire in 2039. Throughout the 28th licensing round, a number of blocks (26/3 (part), 26/4, 26/5, 26/7, 26.8, 26/9, 26/10, 26/13 (part), 27/1 (part), and 27/6 (part)) in close proximity to the KOWL development were granted potential awards to “TGS”. The closest of these is license block 26/3, located approximately 3.3nm east of the KOWL development.

10. Emergency Response Overview and Assessment

This section assesses the current emergency response resources and facilities relevant to the KOWL Development.

10.1. Her Majesty's Coastguard

Her Majesty's Coastguard (HMGC) is undergoing a modernisation process (at time of writing) involving the closure of a number of Marine Rescue Coordination Centres, with the remaining stations being converted to Coastguard Operations Centres (CGOC). The process is due to be completed by the end of 2015, and will coordinate search and rescue (SAR) through the National Marine Operations Centre (NMOC) at Fareham (operational since September 2014), supported by a network of CGOCs at the following locations:

- Aberdeen
- Belfast
- Dover
- Falmouth
- Holyhead
- Humber
- Milford Haven
- Shetland
- Stornoway

There will be no reduction in SAR resources as part of the modernisation process, the purpose of the new system is to streamline the communication and control aspect of HMGC. The nearest CGOC to the KOWL site is located in Aberdeen Harbour, approximately 9nm to the northwest.

10.2. SAR Helicopters

Bristow Helicopters Ltd. was awarded a ten year UK SAR contract by the Department for Transport in March 2013. A total of ten helicopter bases are to be utilised by Bristow, with seven being purpose built, and the remaining three being pre-existing MCA facilities. Of the ten bases, four are in range of the KOWL Development. The nearest is Inverness, located approximately 82nm WNW. The other three with a radius of action covering the KOWL Development are Prestwick (128nm), Stornoway (161nm WNW), and Sumburgh (168nm N). All bases will become operational by July 2017 in a phased approach as presented in Table 10.1.

Table 10.1 SAR Base Timeline

UK SAR Base	Operational Date	Details
Humberside	Now Operational	New Purpose Built Base
Inverness	Now Operational	New Purpose Built Base
Caernarfon	Now Operational	New Purpose Built Base
Lydd	Now Operational	New Purpose Built Base
St Athan	1st October 2015	New Purpose Built Base

UK SAR Base	Operational Date	Details
Prestwick	1st January 2016	New Purpose Built Base
Newquay	1st January 2016	New Purpose Built Base
Lee-on-Solent	1st April 2017	Existing MCA Facility
Sumburgh	1st April 2017	Existing MCA Facility
Stornoway	1st July 2017	Refurbished MCA Facility

It is noted that Bristow have been delivering services from the Sumburgh and Stornoway bases under the Gap SAR contract since 2013. Both bases will transition to the UK SAR contract in 2017.

The Inverness and Prestwick bases will be equipped with AgustaWestland AW189 helicopters. These have a range of 200nm, and air speeds of 145 knots. The Stornoway and Sumburgh bases will be equipped with Sikorsky S92 helicopters, with radius of action of 250nm, and air speeds of 145 knots. Bristow state that both types of helicopter are able to launch within 15 minutes between the hours of 08:00 and 22:00, and within 45 minutes between the hours of 22:00 and 08:00.

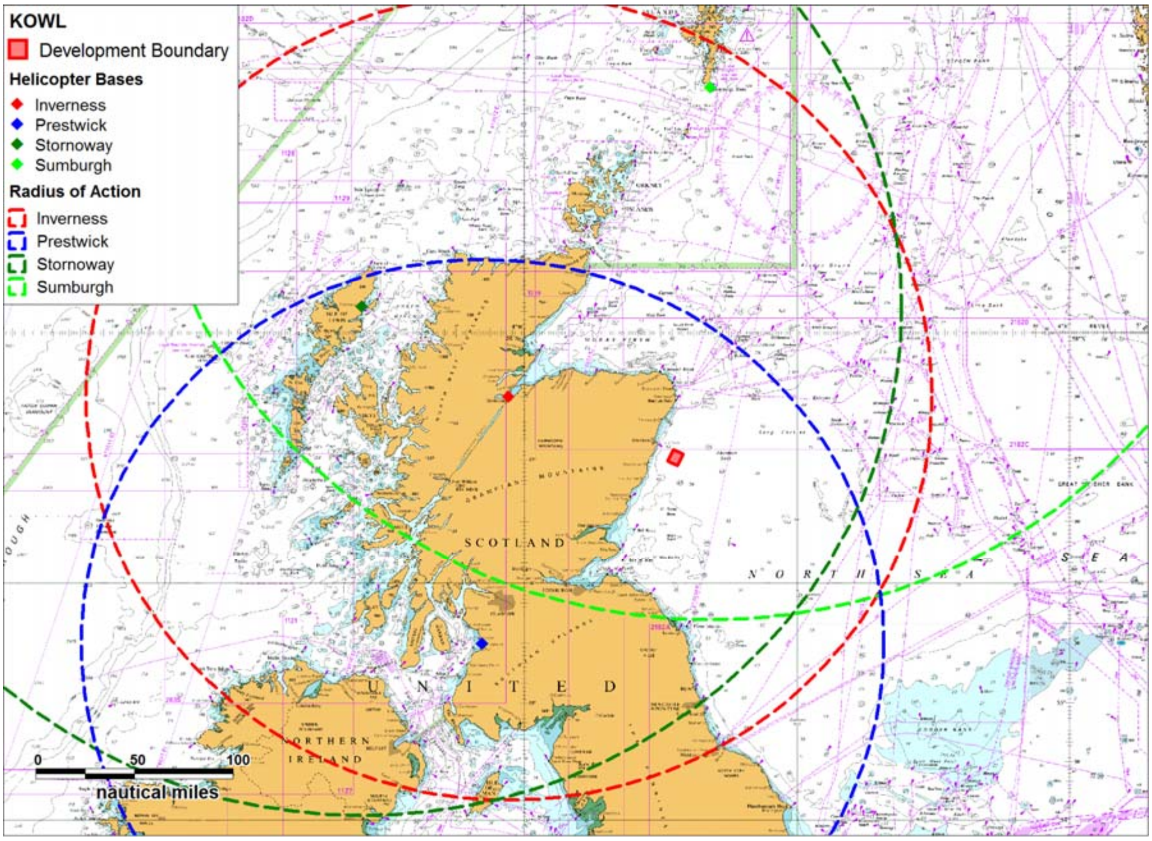

Figure 10.1 Bristow SAR Helicopter Bases

10.3. Emergency Towing Vessels

The MCA has no dedicated emergency towing vessels in the sea area in proximity to the KOWL development.

10.4. Coastguard Agreement on Salvage and Towage (CAST)

Where there is a serious risk of harm to persons or property, or a significant risk of pollution, it may be necessary to initiate emergency towing arrangements. Such arrangements should be unambiguous, agreed by all parties where possible, and activated as swiftly as practicable.

The MCA has a framework agreement with the British Tugowners Association (BTA) for emergency chartering arrangements for harbour tugs. The agreement covers activation, contractual arrangements, liabilities and operational procedures, should the MCA request assistance from any local harbour tug as part of the response to an incident. Modern harbour tugs are often capable of providing an effective emergency service in all but the worst weather conditions, and to the largest vessels.

10.5. Pollution Control and Clean-up

Any incident of marine pollution or the possibility of pollution must be reported to the nearest HMCG station which will inform the duty counter pollution and salvage officer which determines the level of response - local, regional or national. A local response is a situation that can be dealt with by one authority not requiring assistance from any other authorities. Regional and national responses are required when a significant pollution spill occurs requiring a salvage operation, a spill that requires the deployment of vessels or aircraft to assist in dispersal or during a spill that the local authority does not have the capability to respond to adequately and requires assistance from the MCA.

The initial goal if possible is to prevent pollution, the second step is to stop any further pollution through containment and the third is to minimise environmental hazards.

The MCA may deploy air borne or sea borne equipment to disperse or neutralise the pollution if the installation or the vessel does not have the capability to do so. Commercial salvers can be tasked to perform suitable salvage operations with the goal of minimising pollution.

10.6. RNLI

At the time of writing, the Royal National Lifeboat Institution (RNLI) operates 236 lifeboat stations on the UK coast, with a fleet of over 340 lifeboats. The stations in the vicinity of the KOWL Development are presented in Figure 10.2.

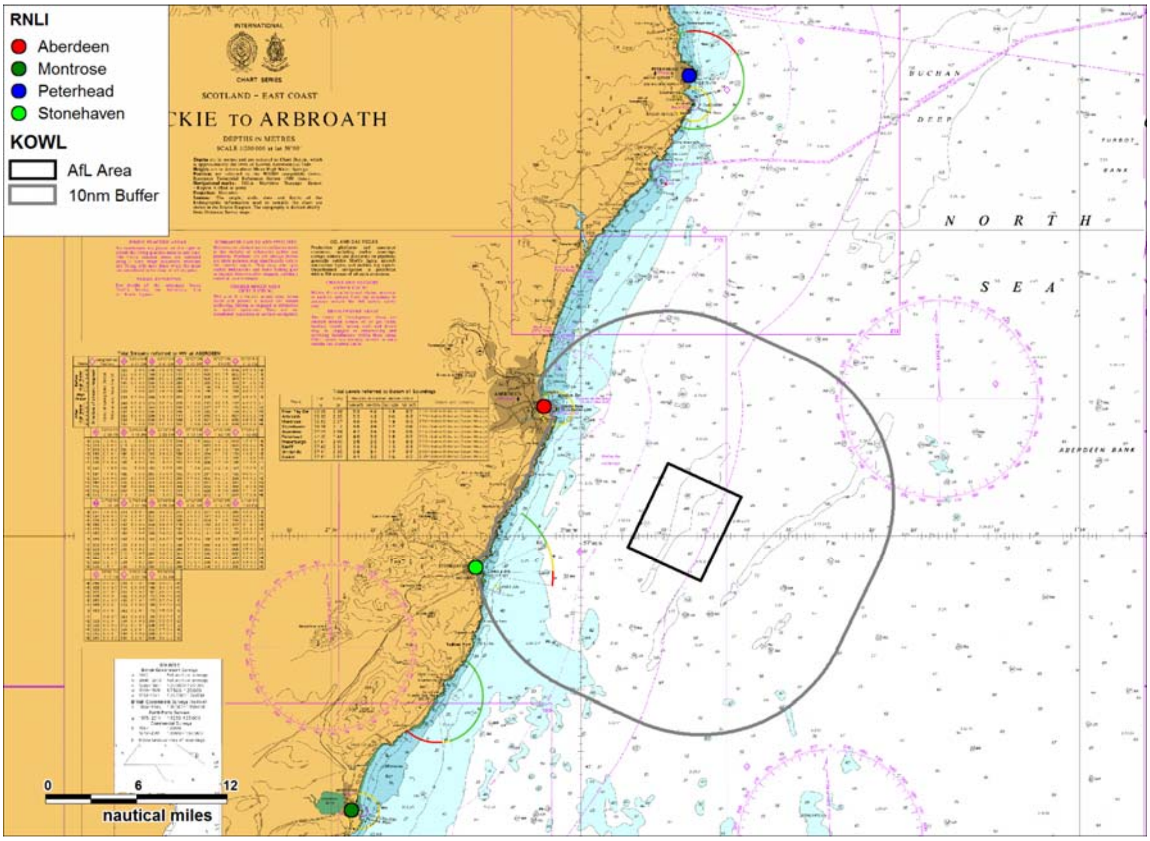

Figure 10.2 RNLI Stations near KOWL Development

The RNLI station based in Aberdeen Harbour is located approximately 9nm to the north west of the KOWL Development. The Stonehaven station is located approximately 10nm to the west of the Development. The station at Montrose is 25nm to the south west, and the station at Peterhead is 25nm to the north. Details of the all-weather (ALB) and inshore (ILB) lifeboats available at these stations are presented in Table 10.2.

Table 10.2 RNLI Lifeboats

Station	ALB		ILB	
	Class	Top Speed (knots)	Class	Top Speed (knots)
Aberdeen	Severn	25	D Class	25
Montrose	Tyne	18	D Class	25
Peterhead	Tamar	25	-	-
Stonehaven	-	-	B Class	32

It is noted that the RNLI historical incident data set (Section 10.6) used as input to the NRA showed that 98% of incidents within the 10nm study area were responded to by lifeboats from Aberdeen.

11. Maritime Incidents

11.1. MAIB

All UK-flagged commercial vessels are required to report accidents to the MAIB. Non-UK flagged vessels do not have to report unless they are within a UK port/harbour or within UK 12 mile 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 Maritime and Coastguard Agency (MCA), harbour authorities and inland waterway authorities also have a duty to report accidents to MAIB.

The locations of accidents, injuries and hazardous incidents reported to the MAIB within 10nm of the KOWL Development between 1 January 2003 and 31 December 2012 are presented in Figure 11.1, colour-coded by incident type. It should be noted that the MAIB aim for 97% accuracy in reporting the locations of incidents.

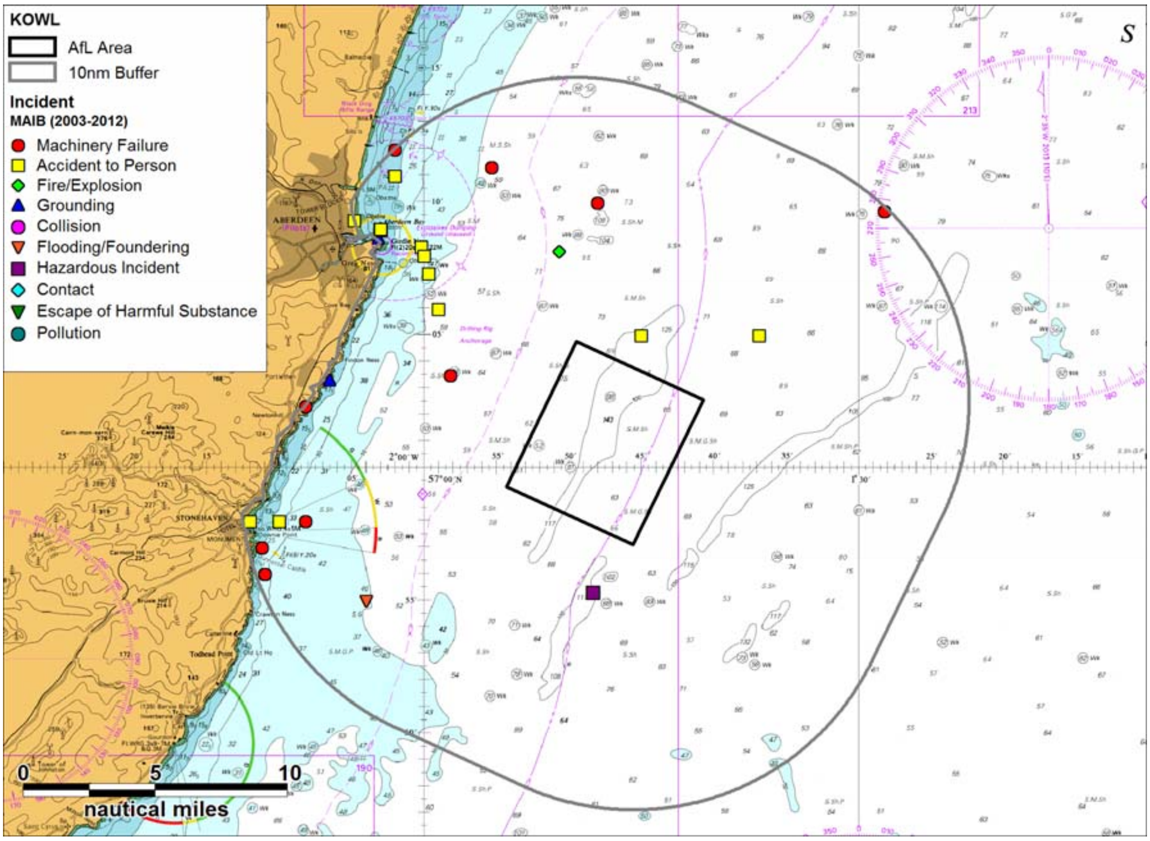

Figure 11.1 MAIB incident locations colour-coded by type within 10nm

A total of 96 incidents were reported within 10nm of the KOWL Development, corresponding to an average of approximately 10 incidents per year. It should be noted that 67 (84.4%) of these incidents were reported to have occurred within Aberdeen harbour limits. There were no incidents reported within the KOWL Development.

The distribution of incident types is summarised in Figure 11.2. The most common incident type was accident to person (43.7%), followed by machinery failure (16.7%) and contact (15.6%).

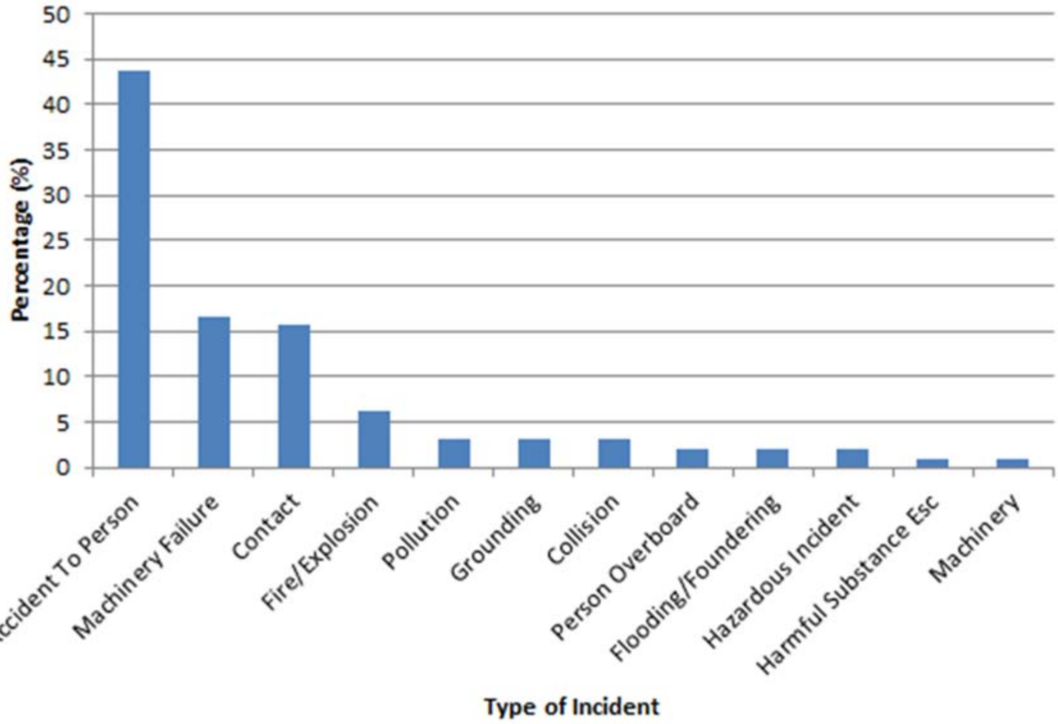

Figure 11.2 MAIB incident type in 10nm (2003-12)

11.2. RNLI

Data on RNLI lifeboat responses within 10nm of the KOWL Development in the ten-year period between 2001 and 2010 has been analysed (the most recent available). A total of 130 launches to 113 unique incidents were recorded by the RNLI (excluding hoaxes and false alarms).

Figure 11.3 presents the geographical location of incidents colour-coded by casualty type.

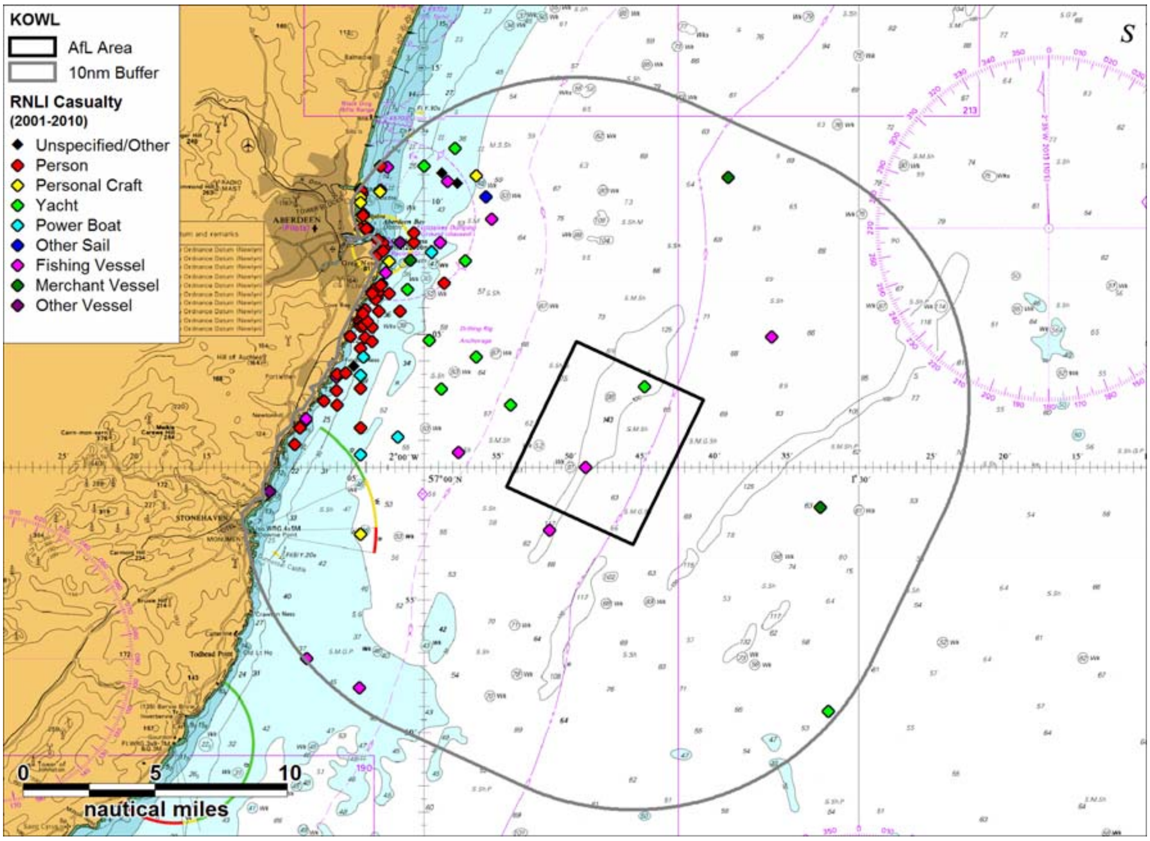

Figure 11.3 RNLI incident locations colour-coded by casualty type within 10nm

There were two incidents within the KOWL Development over the 10 year period analysed: A large fishing vessel suffered a machinery failure on 18th April 2001 and a yacht, which required assistance during adverse weather conditions on 1st April 2003. Both incidents were responded to by the Aberdeen all-weather lifeboat.

The casualty type distribution of RNLI incidents within 10nm of the KOWL Development site is illustrated in Figure 11.4. The most common casualty type responded to by the RNLI was ‘Person’ representing 49.6% of all RNLI incidents within 10nm of the KOWL Development.

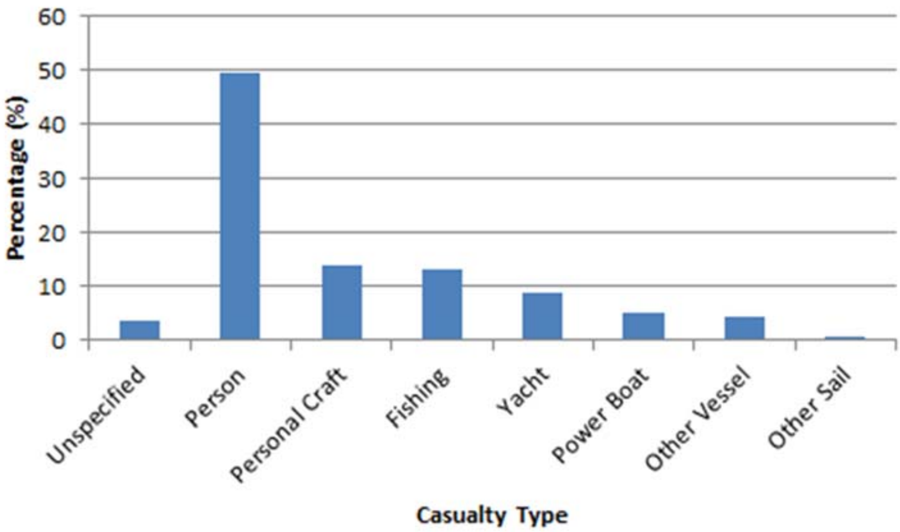

Figure 11.4 Distribution of RNLI incidents by casualty type within 10nm

Figure 11.5 presents the location of the incidents colour coded by cause.

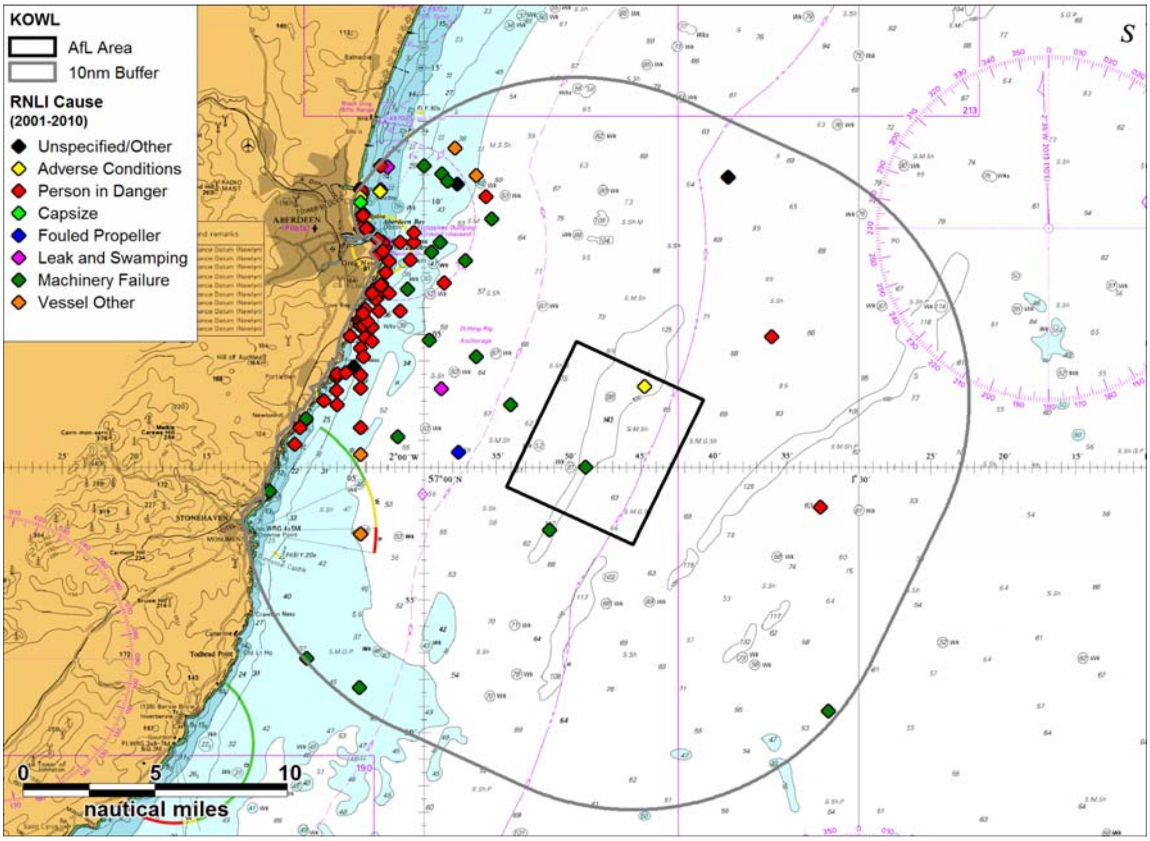

Figure 11.5 RNLI incident locations colour-coded by cause within 10nm

Overall, the most common vessel types involved were fishing vessels, pleasure craft and yachts. The main cause of incidents was person in danger, representing 64.6% of all incidents responded to by the RNLI. The distribution of incident causes is illustrated in Figure 11.6.

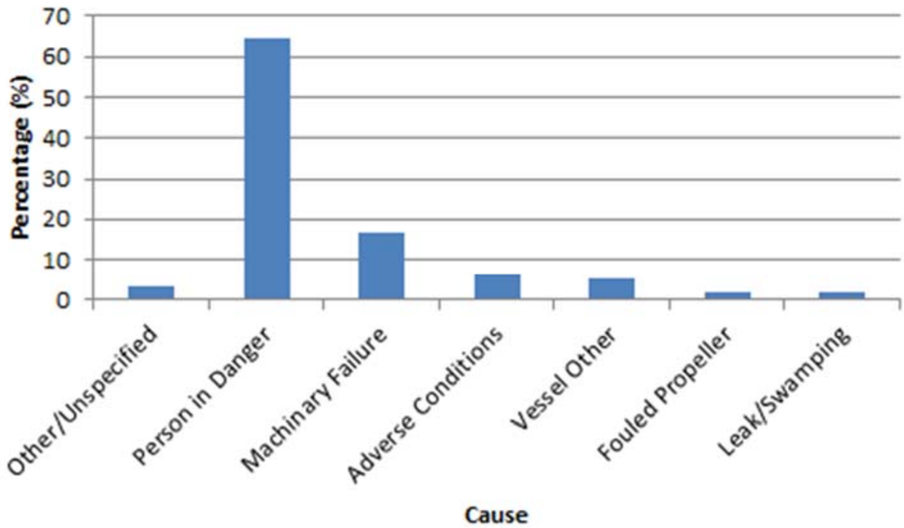

Figure 11.6 Distribution of RNLI incidents by cause within 10nm

The Aberdeen all-weather lifeboat responded to 110 of the 113 incidents recorded within 10nm of the KOWL Development. The RNLI station at Montrose responded to two incidents and one was responded to by a vessel on passage.

12. Consultation

Consultation for navigational issues has been carried out with stakeholders throughout the EIA process full details of the consultation response can be found in ES Chapter 10 (Shipping and Navigation).

13. Marine Traffic Survey

13.1. Introduction

This section presents marine traffic survey data recorded within 10nm of the KOWL Development site. In order to account for seasonal variations in shipping, two weeks of summer data and two weeks of winter AIS data has been assessed. In addition, two weeks of summer radar data was recorded in tandem with the AIS data. The two effective 14 day survey periods were as follows:

- Summer: 31st July to 14th August 2014 (AIS and radar)
- Winter: 17th to 22nd and 24th to 31st January 2015 (AIS only)

The data was collected via shore based AIS and radar receivers. Detailed information of the marine traffic survey methodology, including limitations associated with AIS and radar data is provided in Section 1. It should be taken into account when viewing the following assessment that small vessels not obliged to carry AIS may be underrepresented in the winter analysis.

13.2. Survey Analysis

13.2.1. Vessel Type

The AIS and Radar data recorded during the summer period (31st July to 14th August 2014) colour coded by vessel type is presented in Figure 13.1. A zoomed in plot showing the summer data intersecting the AfL area is then presented in Figure 13.2. Following this, the AIS data recorded during the winter period (17th to 31st January 2015) is presented in Figure 13.3. A zoomed in plot of the winter data relative to the AfL is then presented in Figure 13.4.

The "Other" category mainly consisted of local port tender vessels, lifeboats, research vessels, and pilot boats.

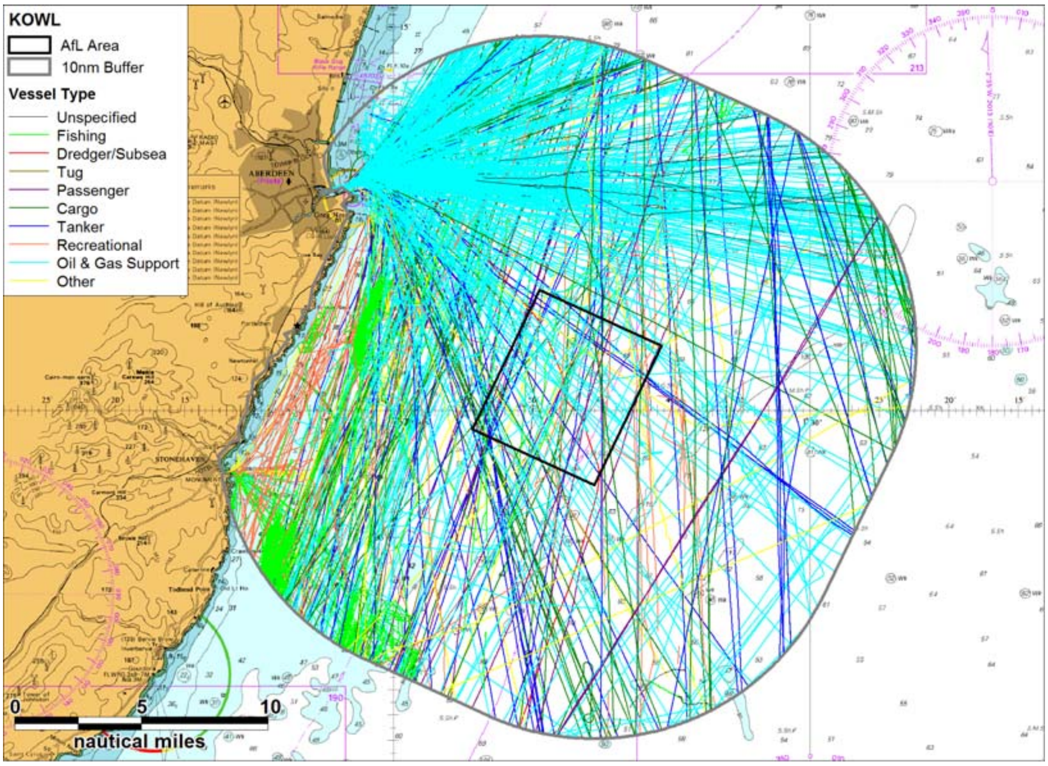

Figure 13.1 AIS and Radar Data by Vessel Type – Summer (31st July to 14th August 2014)

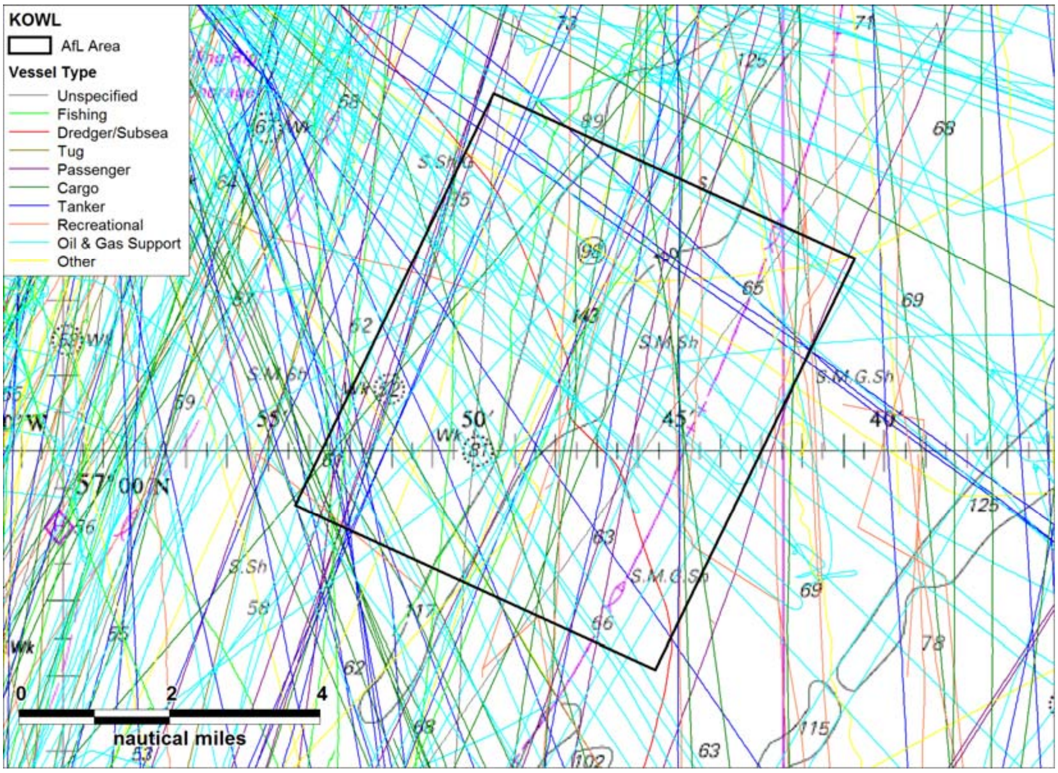

Figure 13.2 AIS and Radar Data by Vessel Type – Summer (31st July to 14th August 2014) – Detailed View of AfL

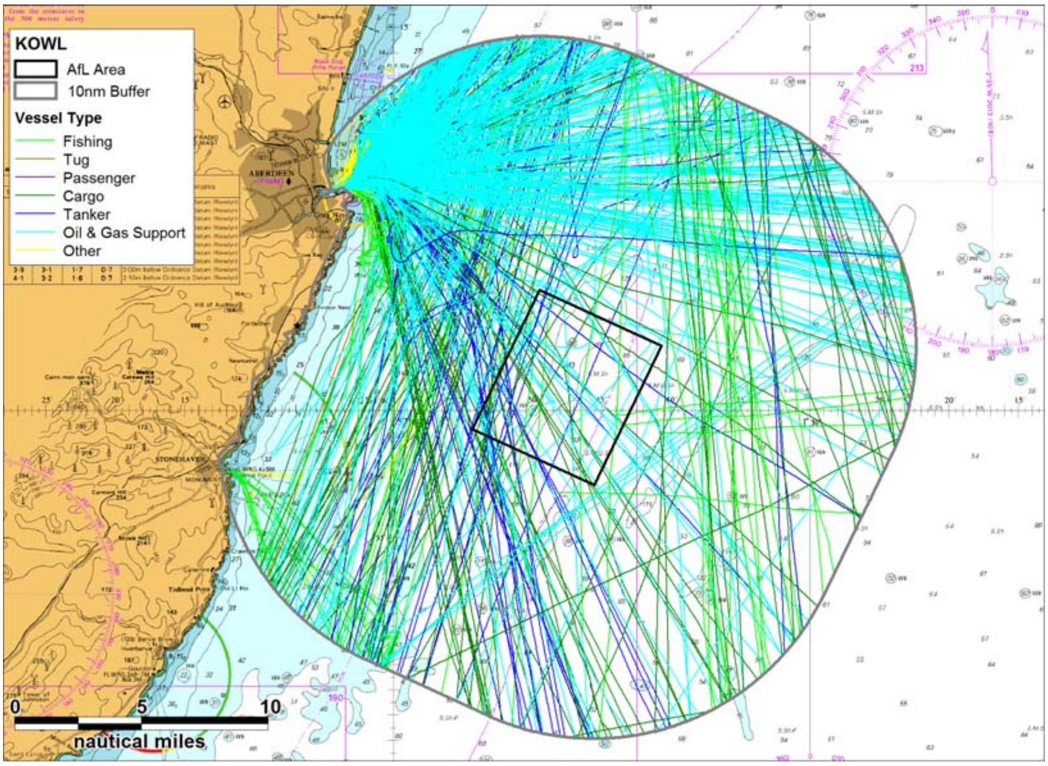

Figure 13.3 AIS Data by Vessel Type – Winter (17th to 31st January 2015)

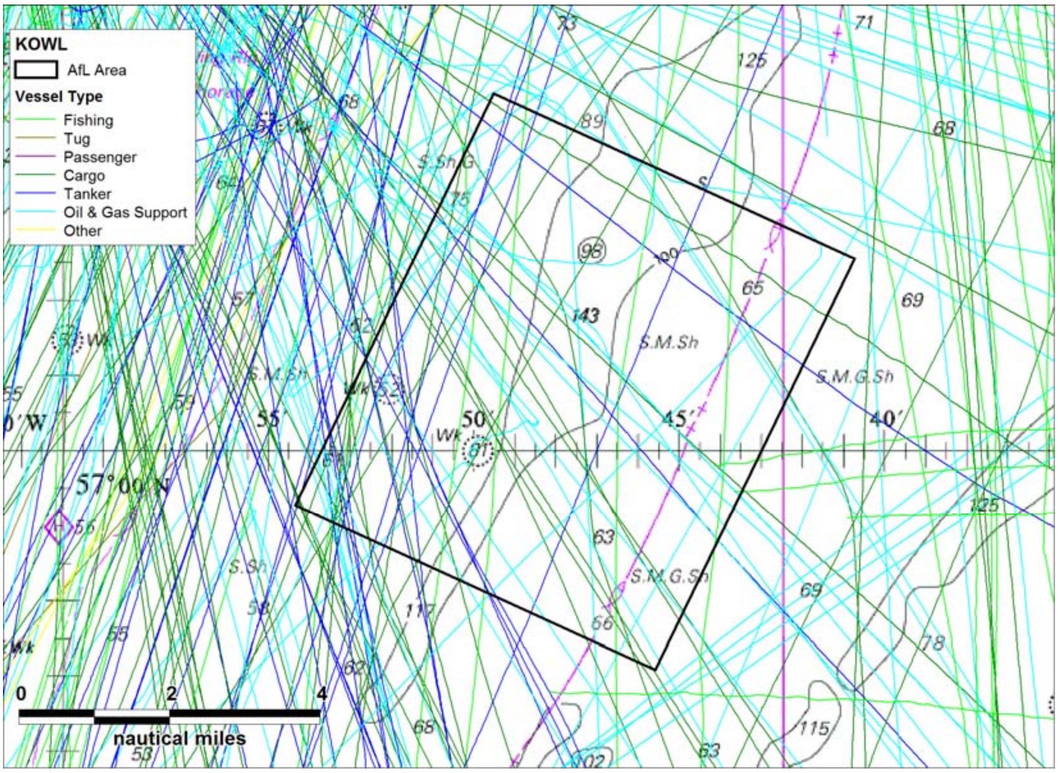

Figure 13.4 AIS Data by Vessel Type – Winter (17th to 31st January 2015) – Detailed View of AfL

The distribution of vessel type with the summer (AIS and radar) and winter (AIS only) data is presented in Figure 13.5. It should be taken into consideration when comparing the seasonal type distributions that activity from smaller non-AIS vessels will be underrepresented in the winter survey period.

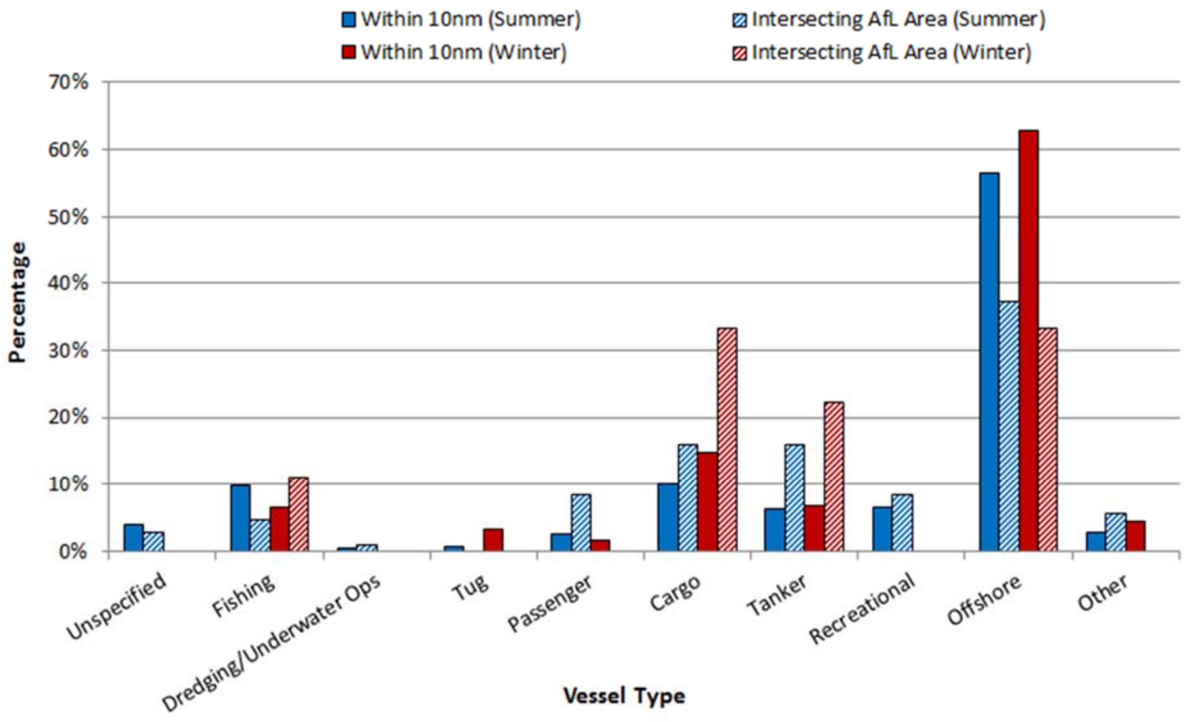

Figure 13.5 Marine Traffic Data - Vessel Type Distribution

The majority of traffic within the 10nm study area was composed of oil and gas support vessels, which accounted for 56.6% of the summer traffic, and 62.8% of the winter traffic. Commercial traffic was the next most significant vessel type during both summer and winter. Cargo vessels accounted for 10.0% of the summer traffic, and 14.8% of the winter traffic, while tankers accounted for 6.3% during summer and 6.8% during winter.

Fishing vessels represented 9.9% of the summer traffic and 6.5% of the winter traffic, however it should be noted that non-AIS fishing vessels may have been present during the winter period. No recreational vessels were recorded during the winter period compared to 6.5% recreational activity during summer. This is likely to be due to seasonal variations in appropriate sailing weather, however it should be noted that AIS is not compulsory for small recreational vessels, and approximately half of the summer recreational activity was tracked via radar.

Oil and gas support vessels represented 37.4% of shipping intersecting the KOWL Development site during the summer survey period, and 33.3% during the winter survey period. The majority of oil and gas vessel activity within the study area did not intersect the development site, as the busiest oil and gas routes were bound north east and east of Aberdeen. Moderate levels of cargo and tanker traffic associated with Aberdeen harbour intersected the site, in addition to further commercial traffic on north and south bound transits to other UK ports. During summer, approximately 15.9% of vessels intersecting the KOWL

Development site were cargo vessels, and 15.9% were tankers. During the winter survey period, this rose to 33.3% cargo and 22.2% tanker.

13.2.2. Daily Volumes

The number of unique vessels per day recorded in the summer and winter survey periods are presented in Figure 13.6.

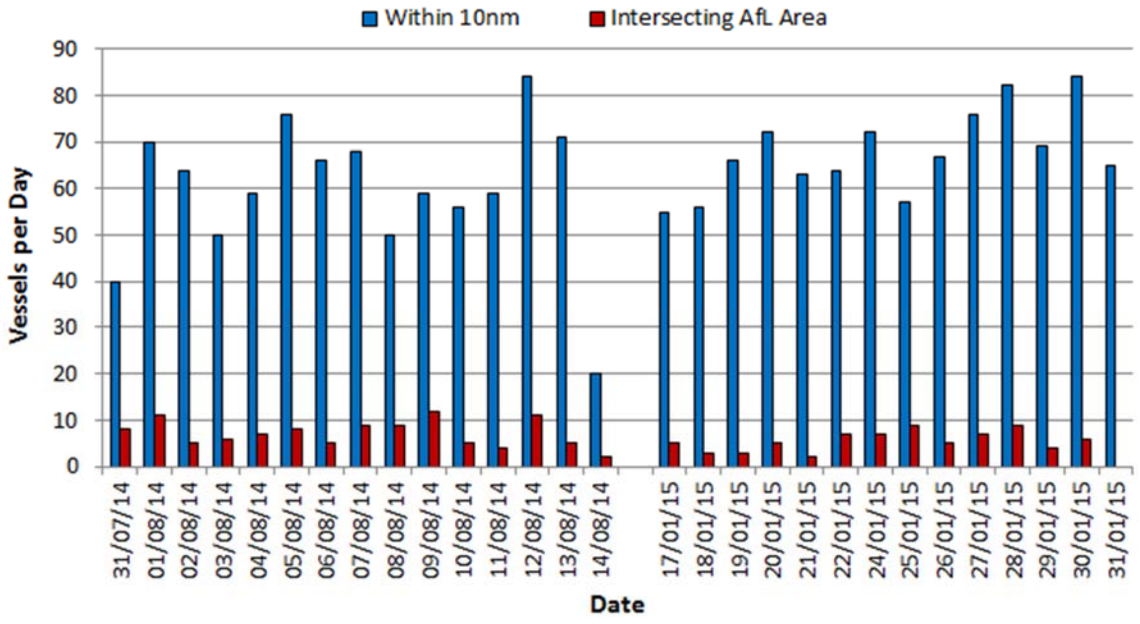

Figure 13.6 Marine Traffic Surveys Daily Vessel Volumes

An average of 64 unique vessels per day was recorded within the 10nm study area during the summer period, rising to 68 unique vessels per day in the winter period. An average of seven unique vessels a day intersected the KOWL Development during summer, falling to five during winter. These counts exclude the first and last days of the summer survey period where survey equipment setup and demobilisation resulted in only partial coverage. Over the combined summer and winter survey period, 9.7% of all recorded marine traffic intersected the KOWL Development site.

The busiest day during the summer period was the 12th August 2014, when 84 unique vessels were recorded. The quietest summer day with full coverage was the 3rd August 2014, when 50 unique vessels were recorded. The busiest day during winter was the 30th January 2015, when 84 unique vessels were recorded. The quietest day was the 17th January when 55 unique vessels were recorded.

Plots of the busiest day during the summer and winter periods are presented in Figure 13.7 and Figure 13.8 respectively.

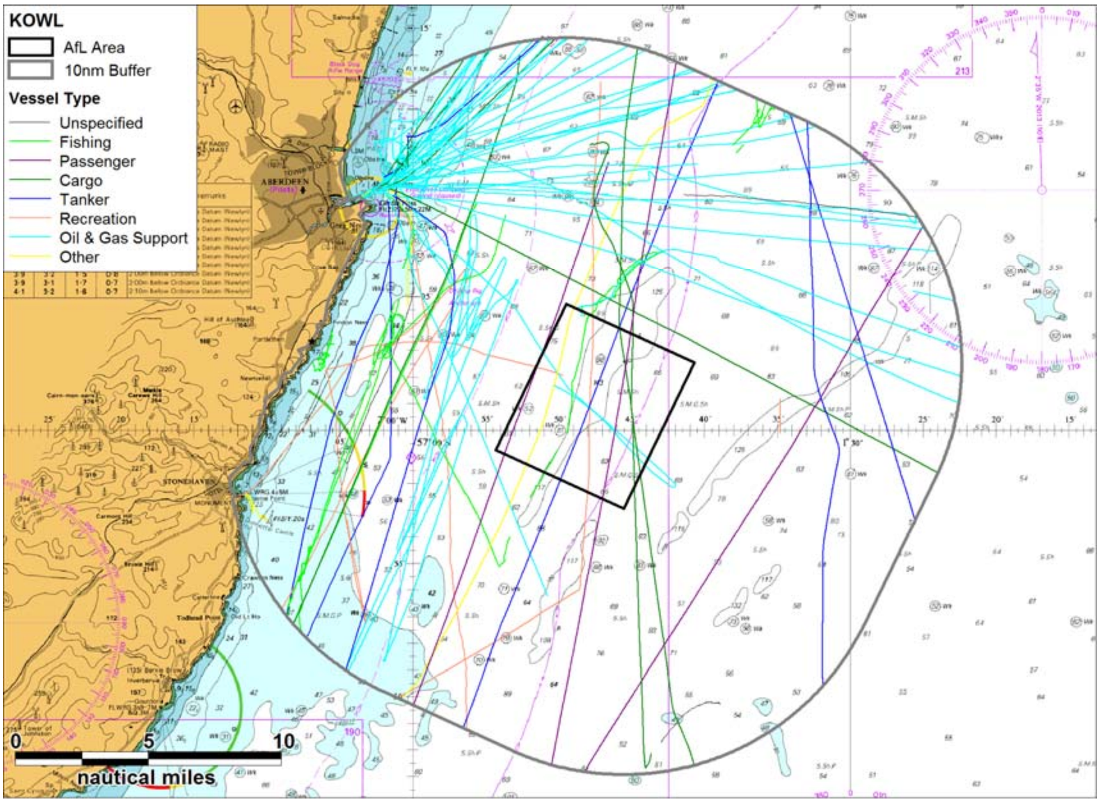

Figure 13.7 Busiest Day during Summer Period – 12/08/2014 (AIS and Radar)

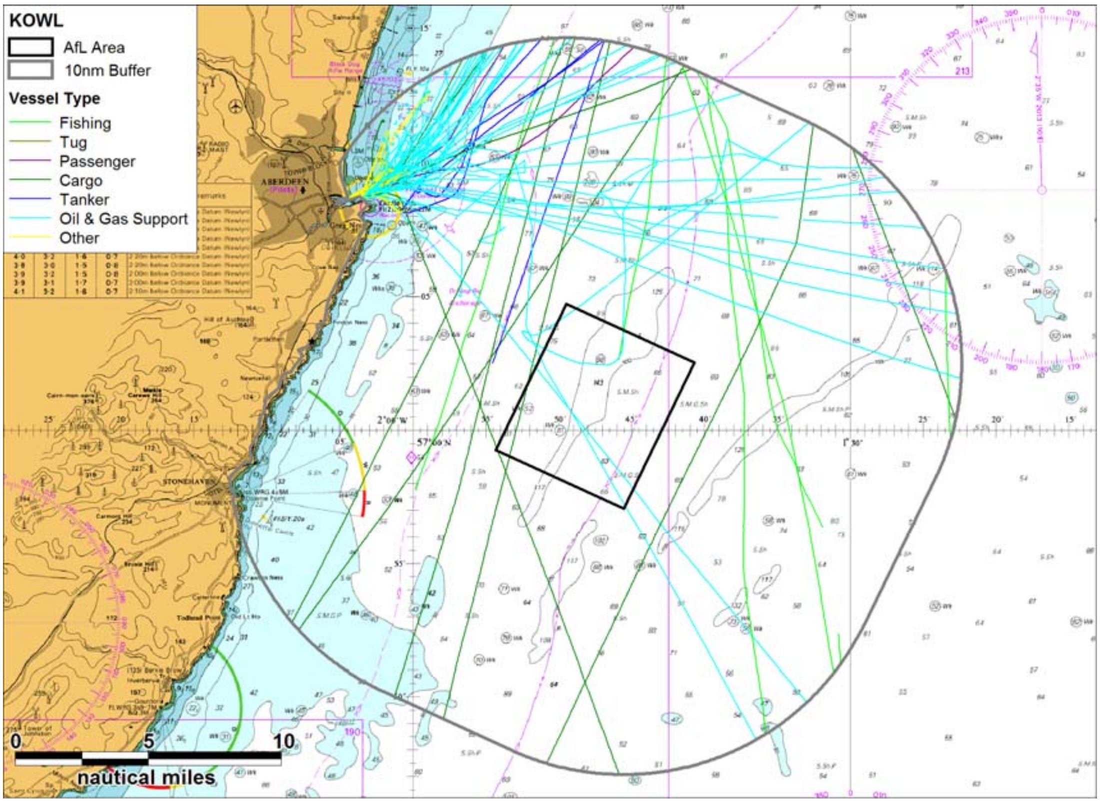

Figure 13.8 Busiest Day during Winter Period – 30/01/2015 (AIS)

13.2.3. Vessel Size

Plots of the marine traffic data recorded during the summer and winter survey periods, colour coded by vessel length, are presented in Figure 13.9 and Figure 13.10 respectively.

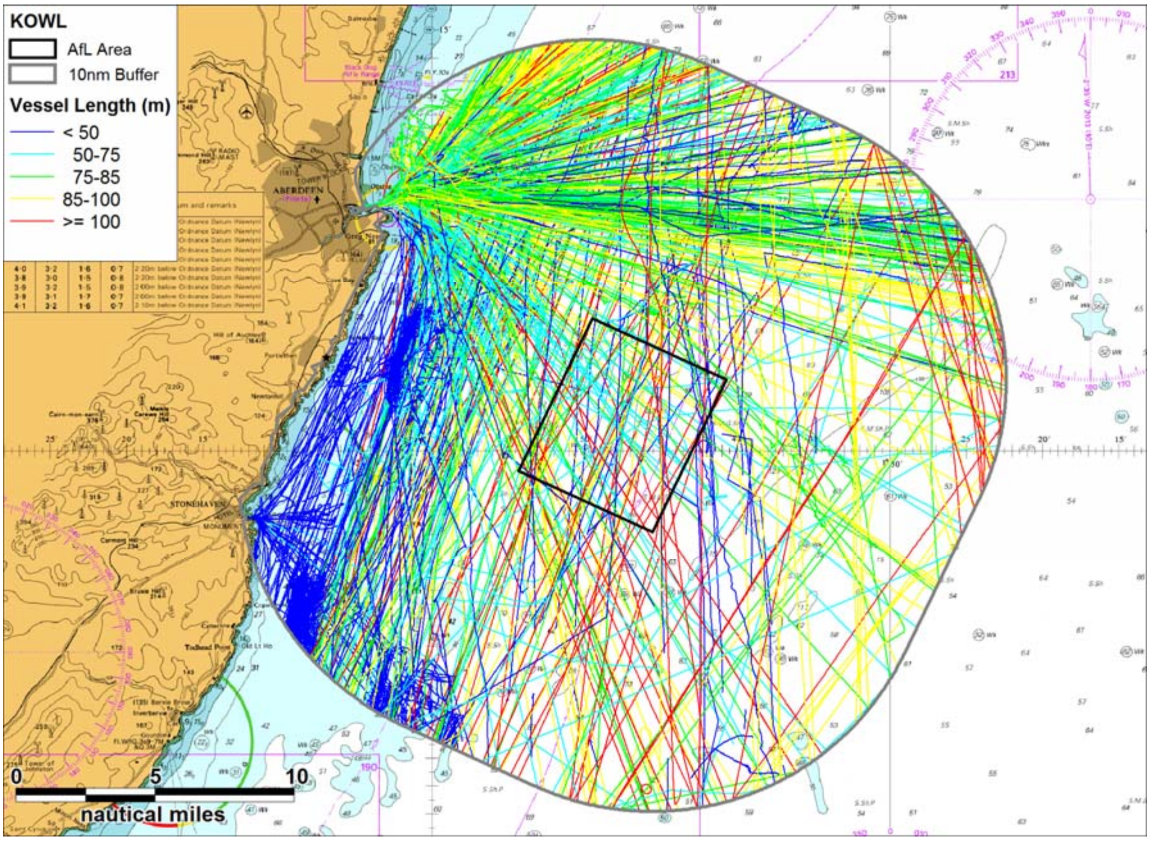

Figure 13.9 AIS and Radar Data by Vessel Length – Summer (31st July to 14th August 2014) – Detailed View of AfL

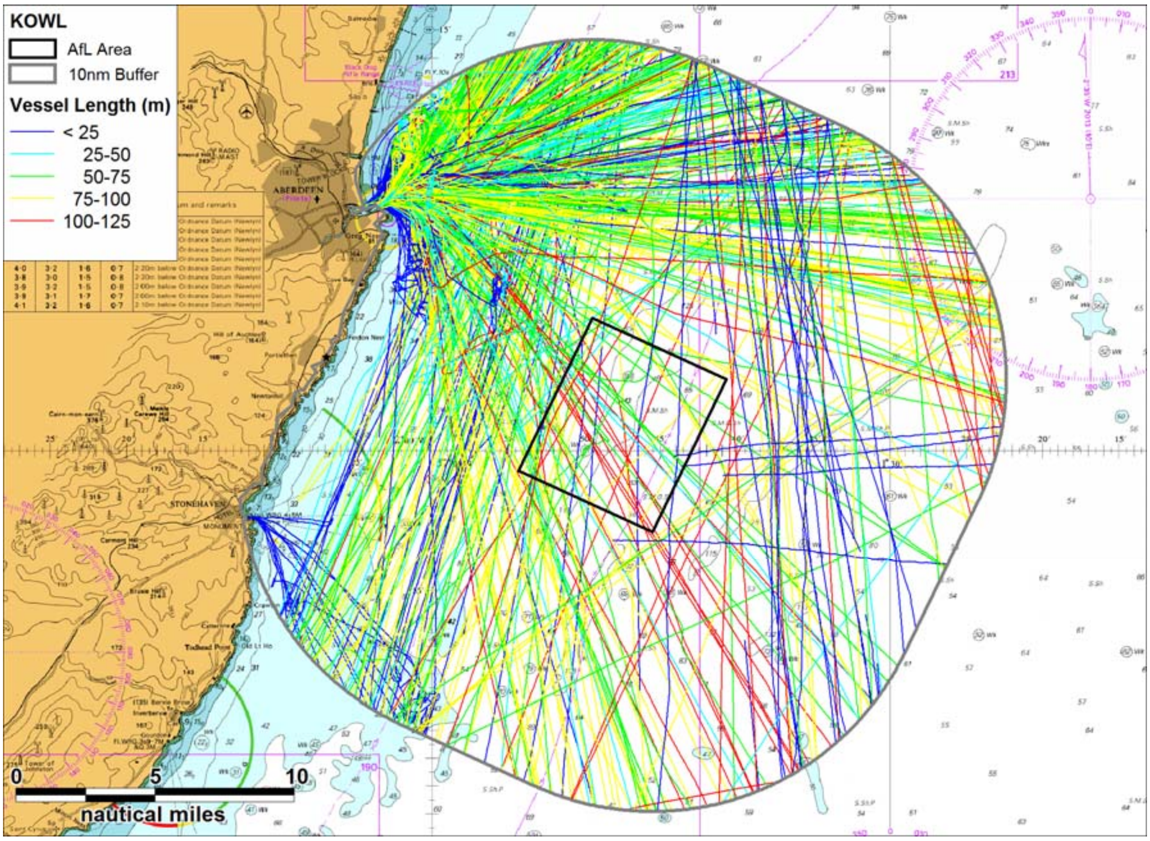

Figure 13.10 AIS Data by Vessel Length – Winter (17th to 31st January 2015)

The distributions of vessel length observed during the summer and winter survey periods are presented in Figure 13.11.

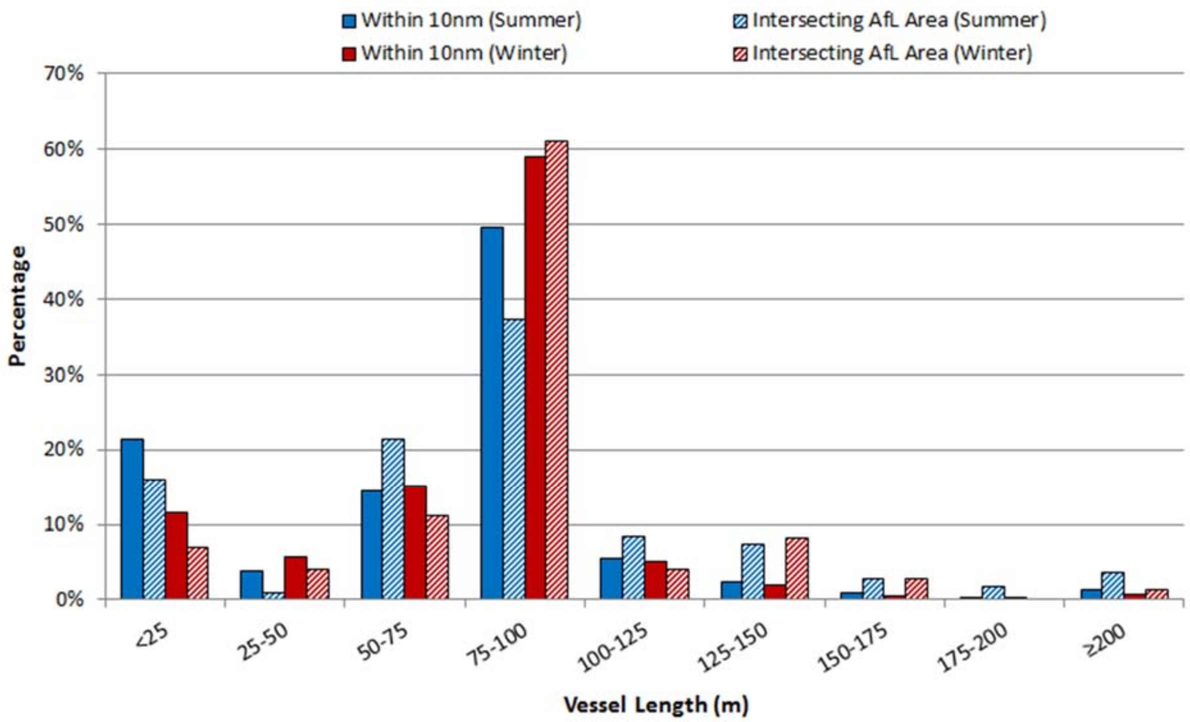

Figure 13.11 Marine Traffic Data - Vessel Length Distribution

Approximately half of the vessels recorded during the summer survey period were between 75 and 100m in length. The same category accounted for 59.1% of the winter data (it should be noted however that smaller vessel activity is likely to be underrepresented in the winter period due to the absence of radar data, which could exaggerate the proportions of the larger size categories). The prominence of the 75 to 100m category was a result of the prevalence of moderately sized offshore supply vessels associated with Aberdeen within both the summer and winter marine survey data.

The average vessel length recorded during the summer survey was 73m, rising to 77m in the winter data. This increase could be as a result of non-AIS vessels, which tend to have small lengths, not being accounted for in the winter analysis. The average length of vessels intersecting the KOWL Development was 85m during summer, and 87m in winter. This increase over the averages of the entire 10nm study area was a result of the larger oil and gas, cargo, and tankers intersecting the site, and the tendency of the smallest vessels to remain coastal.

The longest vessel recorded within the 10nm study area during summer was the *Scott Spirit*, an oil products tanker with a length of 248m. This vessel also intersected the KOWL Development site. The longest vessel recorded during winter was the *Elisabeth Knutsen*, a 265m oil products tanker. The longest vessel intersecting the KOWL Development during winter was the *Petronordic*, an oil products tanker with a length of 234m.

Plots of the marine traffic data recorded during the summer and winter survey periods are presented by vessel draught in Figure 13.12 and Figure 13.13 respectively.

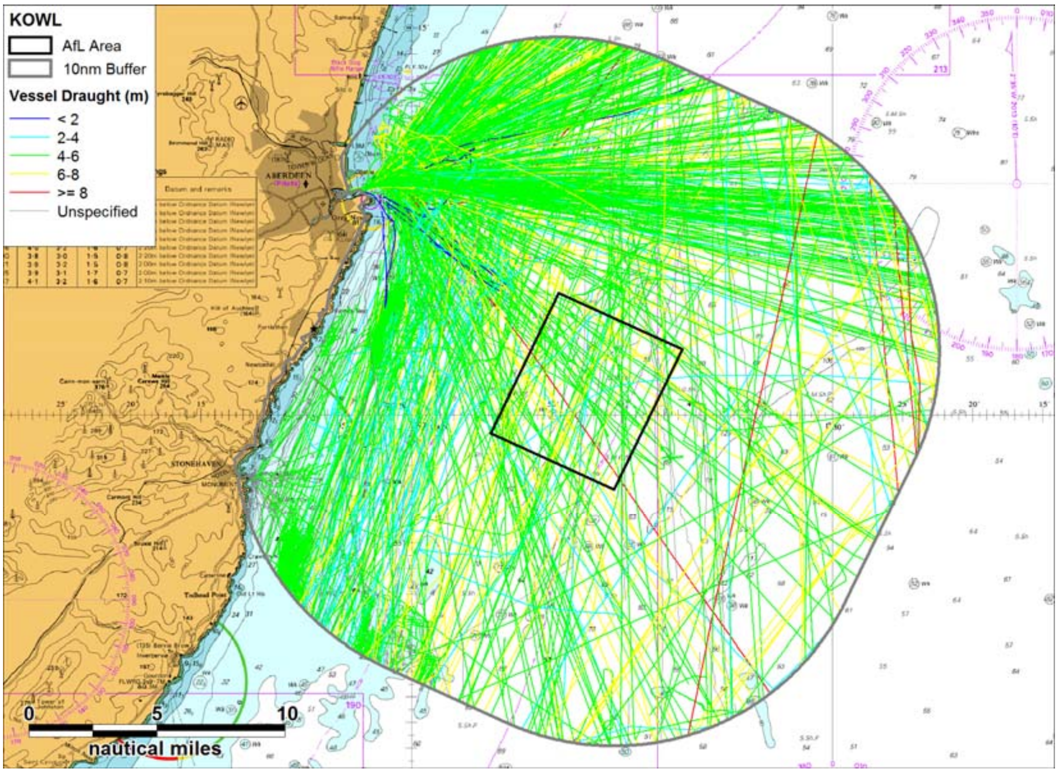

Figure 13.12 AIS and Radar Data by Vessel Draught – Summer (31st July to 14th August 2014) – Detailed View of AfL

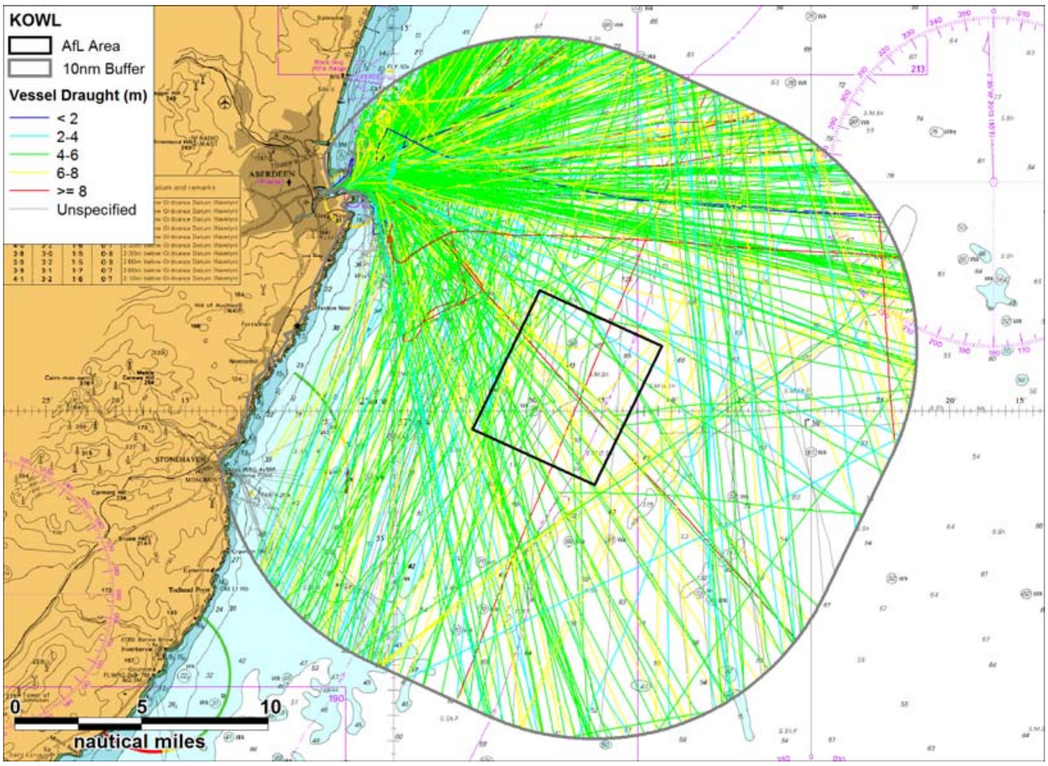

Figure 13.13 AIS Data by Vessel Draught – Winter (17th to 31st January 2015)

The distribution of vessel draught within the data is presented in Figure 13.14. It is noted that vessels with unspecified draughts (7% in summer and 10% in winter) have been excluded from the distribution analysis. Based on the lengths of the excluded vessels, the majority of their draughts were likely to be small.

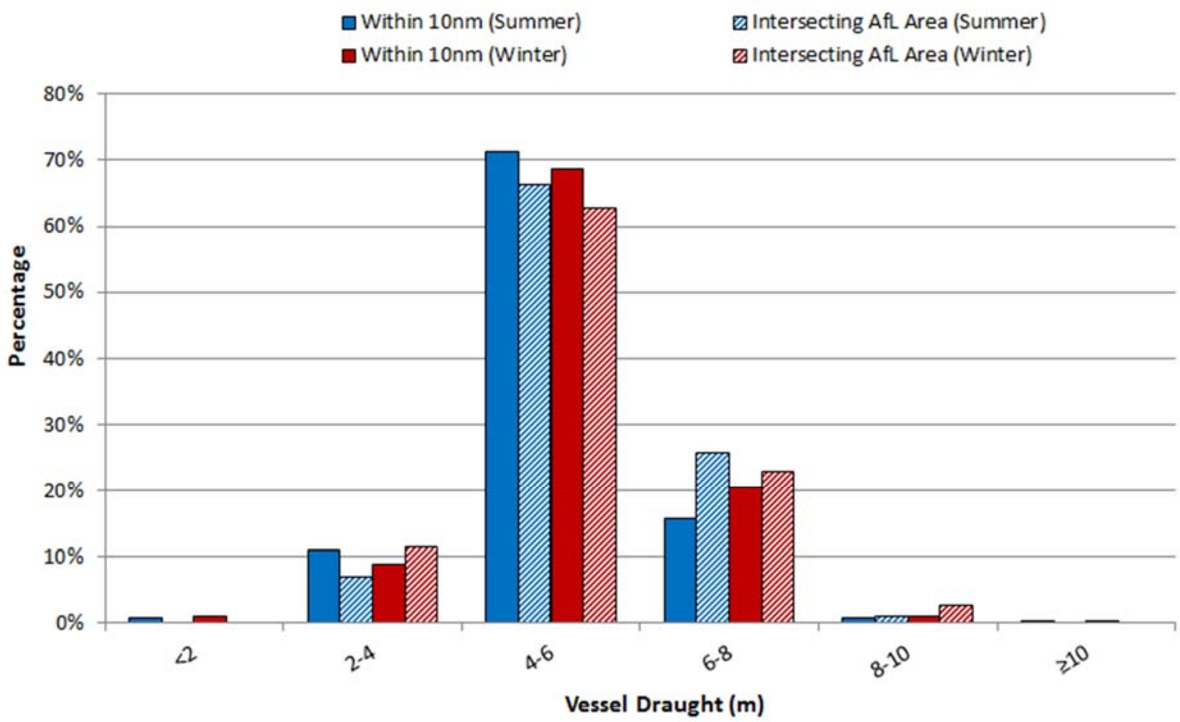

Figure 13.14 Marine Traffic Data - Vessel Draught Distribution

The majority of vessels recorded in the 10nm study area (71.3% in summer and 68.6% in winter) had draughts of between 4 and 6m. As with the prominence of the 75 to 100m length category, this was as a result of the offshore supply ships associated with Aberdeen. Less than 1% of vessels had draughts of more than 10m. It is noted that traffic associated with Aberdeen harbour is dominant in the study area, and the harbour cannot currently accommodate vessels with draughts deeper than 10m.

The average vessel draughts recorded during the summer and winter survey periods in the 10nm study area were 5.2m and 5.3m respectively. The average draughts of vessels intersecting the KOWL Development was 5.5m during summer and 5.3m during winter.

The deepest draught recorded within the 10nm study area during summer was 14.8m, from the *Trans Nanjing*, a bulk carrier with a length of 230m. This vessel was recorded approximately 20nm from the coast (and 8nm east of the KOWL Development), bound south. The deepest draught vessel intersecting the KOWL Development during summer was the *Scott Spirit* (248m oil products tanker). In winter, the deepest draught recorded was 12.1m, from the *Star Georgia*, a 229m bulk carrier, recorded on a similar route to the *Trans Nanjing* mentioned above. The vessel with the deepest draught intersecting the KOWL Development during winter was the *Petronordic* with a draught of 9.3m. This was also the longest vessel intersecting the site during winter.

13.2.4. Vessel Density

The marine traffic data was used as input to Anatec's Ship Density Calculator software. The program determines the number of times each cell of a grid is intersected by an AIS or radar track to produce an overview of the shipping density in an area. The summer and winter survey density results are presented in Figure 13.15 and Figure 13.16 respectively. The same density brackets have been used in both figures to allow direct comparison.

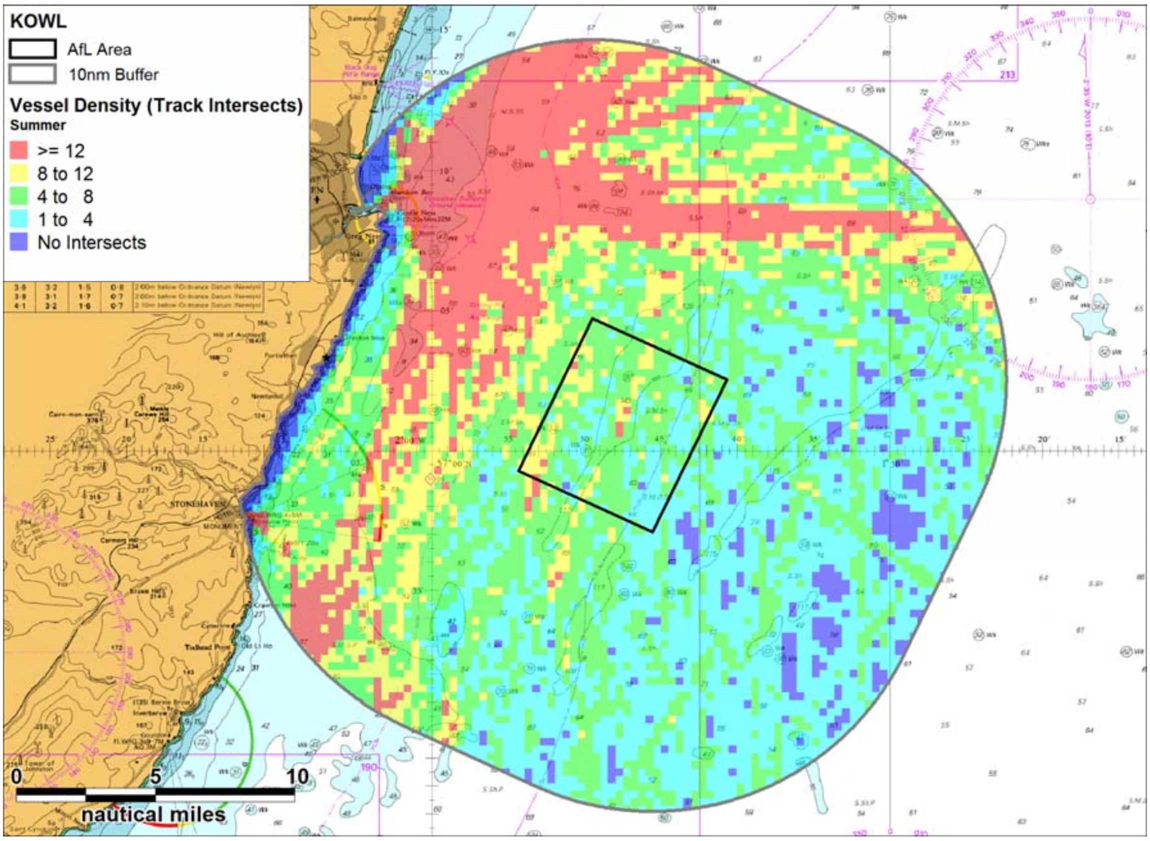

Figure 13.15 Summer Vessel Density (31st July to 14th August 2014)

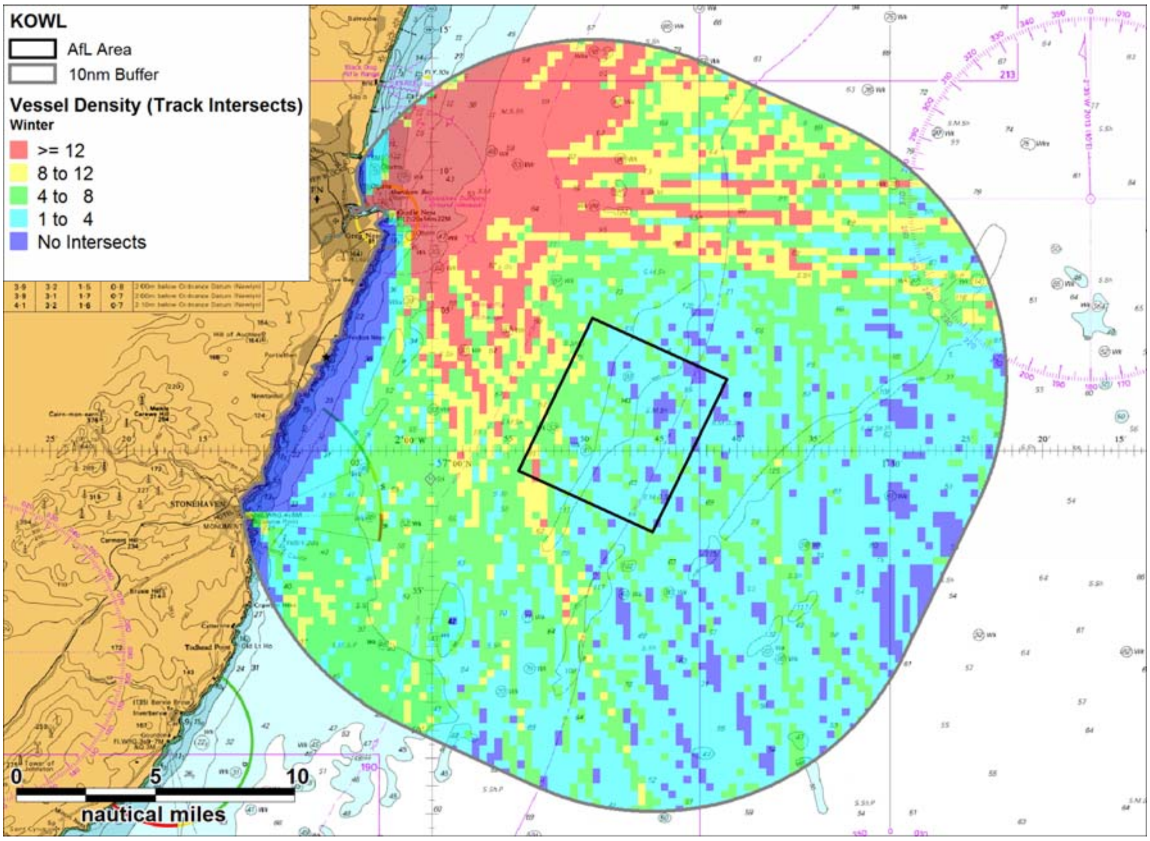

Figure 13.16 Winter Vessel Density (17th to 31st January 2015)

The most significant area of density in both summer and winter was the approach to Aberdeen harbour, including the anchorage. This was largely as a result of the oil and gas support traffic within the study area. Coastal density was higher in summer than winter, however it should be taken into consideration that smaller vessel activity is underrepresented in the winter data. Within the KOWL Development, shipping density was higher in summer than winter; however the busiest oil and gas routes did not intersect the site boundaries.

13.3. Oil and Gas Support Vessels

The tracks recorded from oil and gas support vessels during the summer and winter survey periods are presented in Figure **13**.17. As seen in Figure 13.5, oil and gas traffic accounted for 57% of the summer traffic, and 63% of the winter traffic, and was the most significant vessel type during both periods. The tracks have been colour-coded by offshore vessel type.

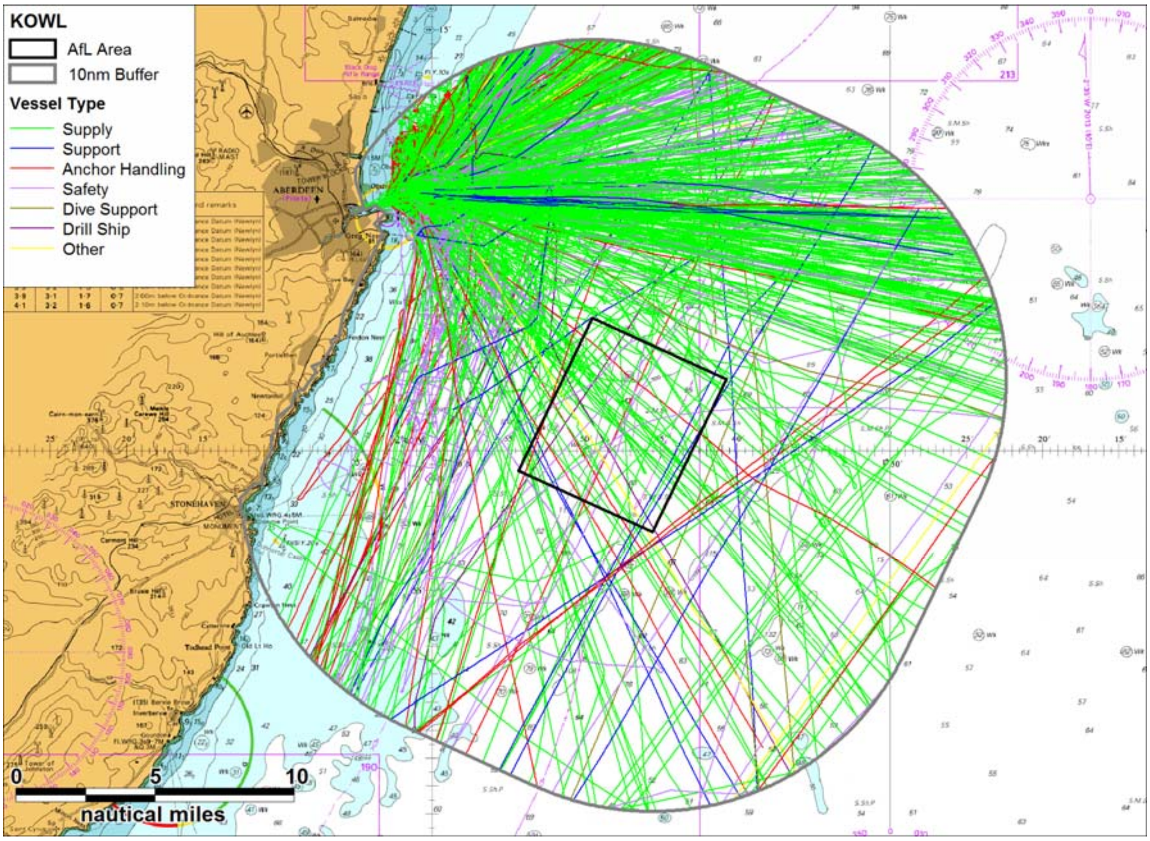

Figure 13.17 Oil & Gas Support Vessels

An average of 34 unique oil and gas support vessels per day were recorded within the study area during summer, rising to 43 during the winter period. It should be taken into consideration that the location of the AIS receiver during the summer survey meant coverage was not comprehensive for vessels in the approach to Aberdeen (see Section 6.2 for more information), which may explain the rise in vessel numbers between the two surveys. An average of three oil and gas support vessels per day intersected the KOWL Development site during summer, falling to two unique vessels per day in winter. As observed in the vessel density figures (Figure 13.15 and Figure 13.16) the vast majority of oil and gas support vessels are associated with routes bound east and north east from Aberdeen, and therefore miss the KOWL Development.

The majority of oil and gas vessels were offshore supply ships, with 70.7% falling into this category during summer and 77.0% during winter.

13.4. Commercial Vessels

The commercial vessel activity recorded during the summer and winter marine traffic surveys is presented in Figure 13.18.

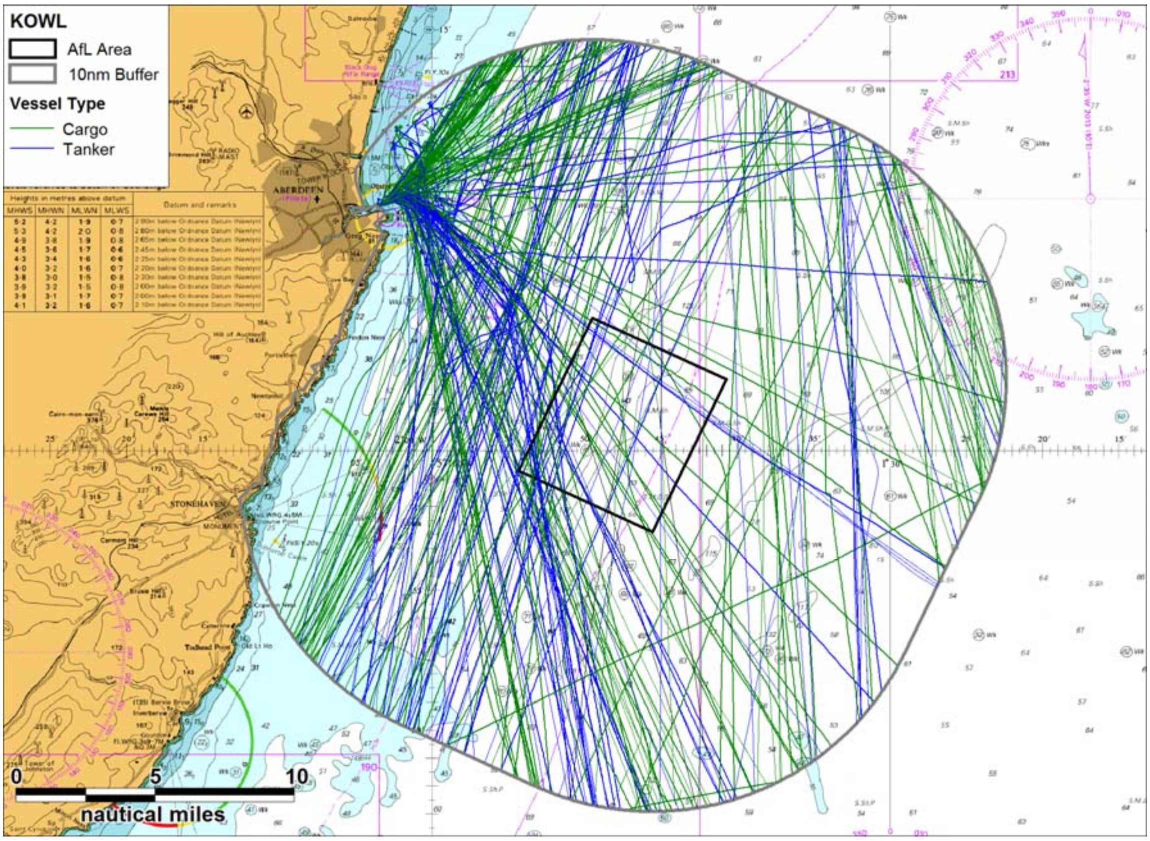

Figure 13.18 Commercial Marine Traffic Survey Data

An average of six unique cargo vessels and four unique tankers per day were recorded during the summer survey, rising to ten cargo vessels and five tankers during winter. As with the oil and gas support traffic, it is possible that there is an underrepresentation of commercial traffic during summer due to coverage issues in the approach to the harbour. An average of two unique cargo vessels and one unique tanker per day intersected the KOWL Development during both the summer and winter surveys.

13.5. Passenger Vessels

The tracks recorded from passenger vessels during the summer and winter marine traffic surveys are presented in Figure 13.19 and Figure 13.20 respectively. During winter, only passenger vessels on a route bound north from Aberdeen were recorded. For this reason the winter figure has been presented as a zoomed in plot of Aberdeen for clarity.

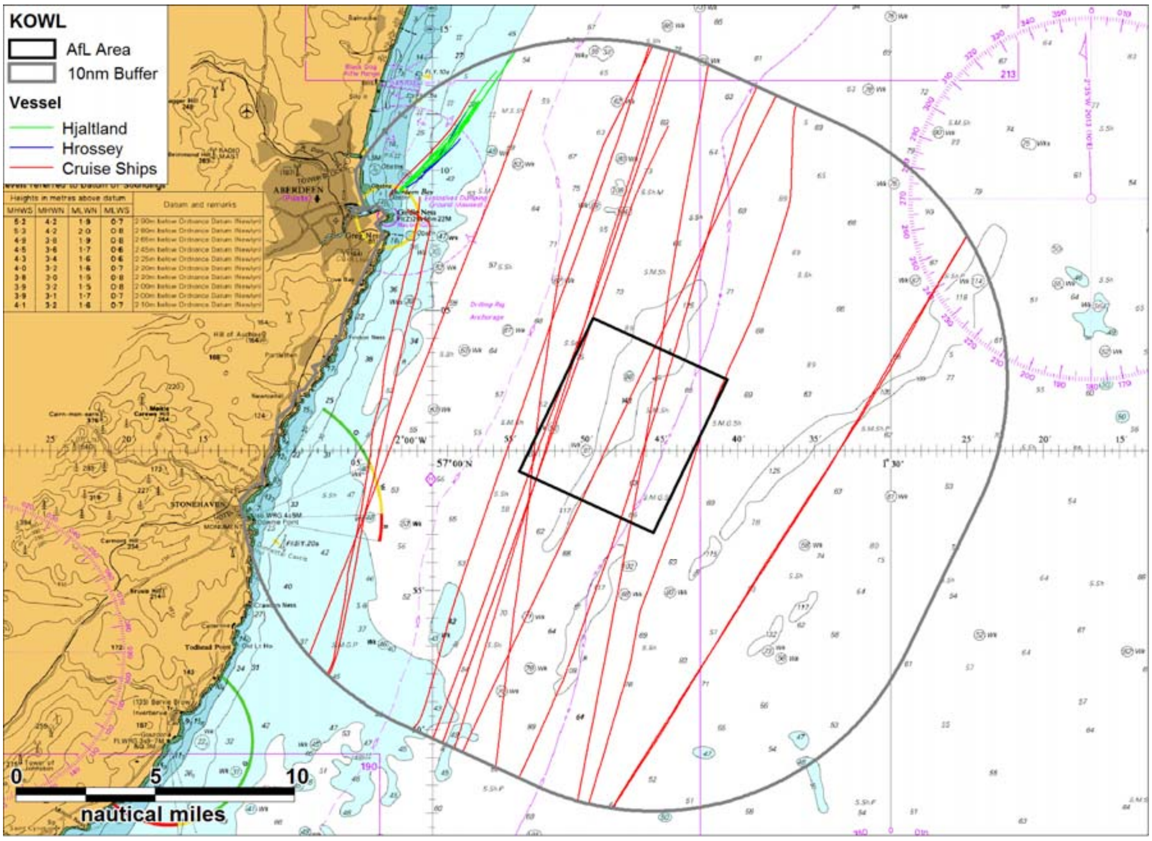

Figure 13.19 Summer Passenger Marine Traffic Survey Data

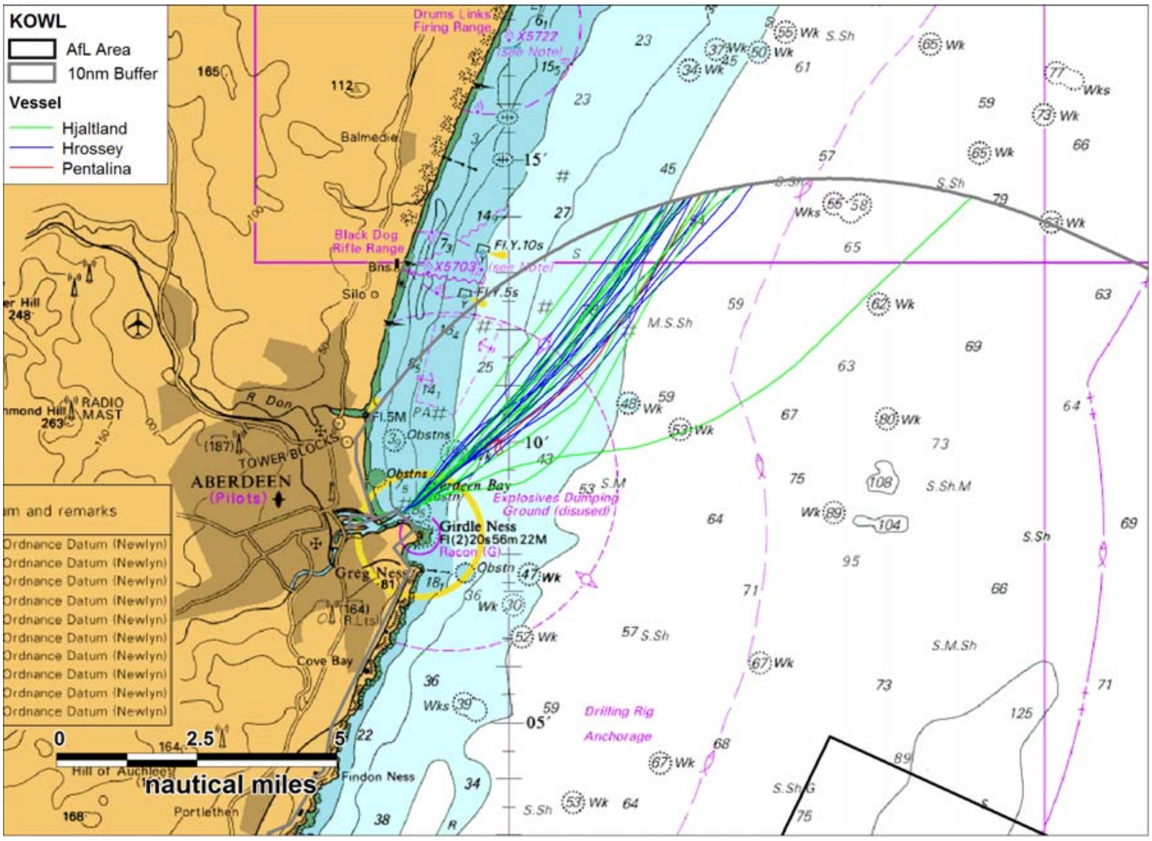

Figure 13.20 Winter Passenger Marine Traffic Survey Data

The regular passenger traffic during both summer and winter comprised of the daily Aberdeen NorthLink ferries, the Hjaltland and the Hrossey. The ferries run on routes between Aberdeen and Kirkwall, and Aberdeen and Lerwick. During summer, in addition to the NorthLink ferries, an average of one cruise ship per day was also recorded within the study area. During winter, the *Pentalina*, a 70m RORO passenger vessel was recorded en route to Aberdeen dry dock and does not normally serve Aberdeen as a commercial ferry service. No further passenger vessels were recorded during the winter period.

A total of eight unique passenger vessels intersected the KOWL Development during summer. No passenger vessels intersected the site during winter.

13.6. Recreational Vessels

The tracks from recreational vessels recorded during summer are presented in Figure 13.21. No tracks from recreational vessels were recorded during the winter survey.

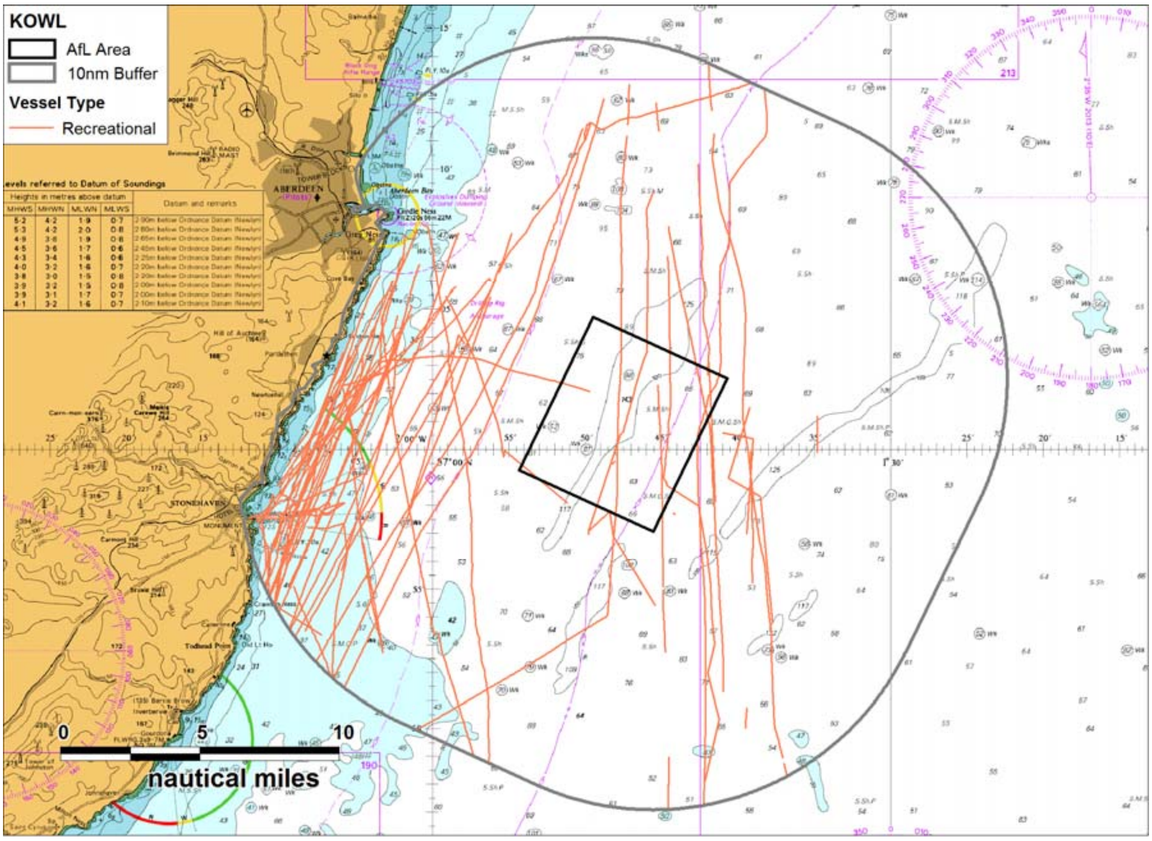

Figure 13.21 Summer Recreational Marine Traffic Survey Data

An average of four unique recreational vessels per day were recorded during the summer survey period. The majority of these vessels remained coastal, however an average of one a day intersected the KOWL Development.

The recreational cruising routes (assigned by the RYA) intersecting the study area are presented in Figure 13.22. The RYA classifies each of its assigned cruising routes into one of three categories:

- *Heavy Recreational Routes*: - Very popular routes on which a minimum of six or more recreational vessels will probably be seen at all times during summer daylight hours. These also include the entrances to harbours, anchorages and places of refuge.
- *Medium Recreational Routes*: - Popular routes on which some recreational craft will be seen at most times during summer daylight hours.
- *Light Recreational Routes*: - Routes known to be in common use but which do not qualify for medium or heavy classification.

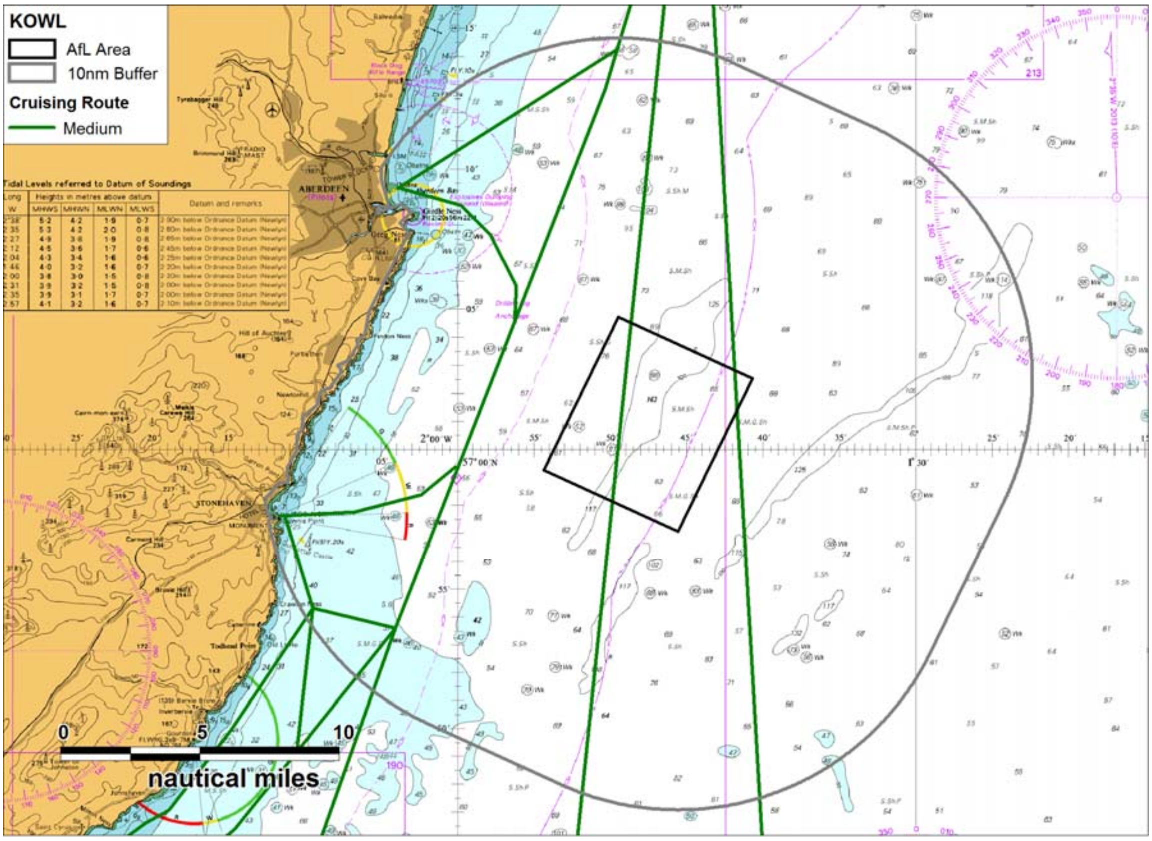

Figure 13.22 RYA Recreational Cruising Routes

A total of ten recreational cruising routes intersected the 10nm study area, two of which intersected the KOWL Development. All ten routes were classified as "medium" use.

13.7. Fishing Vessels

13.7.1. Introduction

This section of the Marine Traffic Survey analysis presents assessment of the AIS and radar tracks recorded from fishing vessels during the summer period, and the AIS data from the winter survey period. In addition, VMS (satellite) data from 2009 and long term sightings surveillance data from between 2005 and 2009 has been assessed for comparison with the AIS data. It should be taken into consideration when viewing the AIS analysis that smaller non-AIS fishing vessels are accounted for in the summer survey period but not the winter survey period. Further information on the data sources is available in Section 0.

13.7.2. AIS Analysis

The number of unique fishing vessels recorded per day in both the summer and winter survey periods is presented in Figure 13.23.

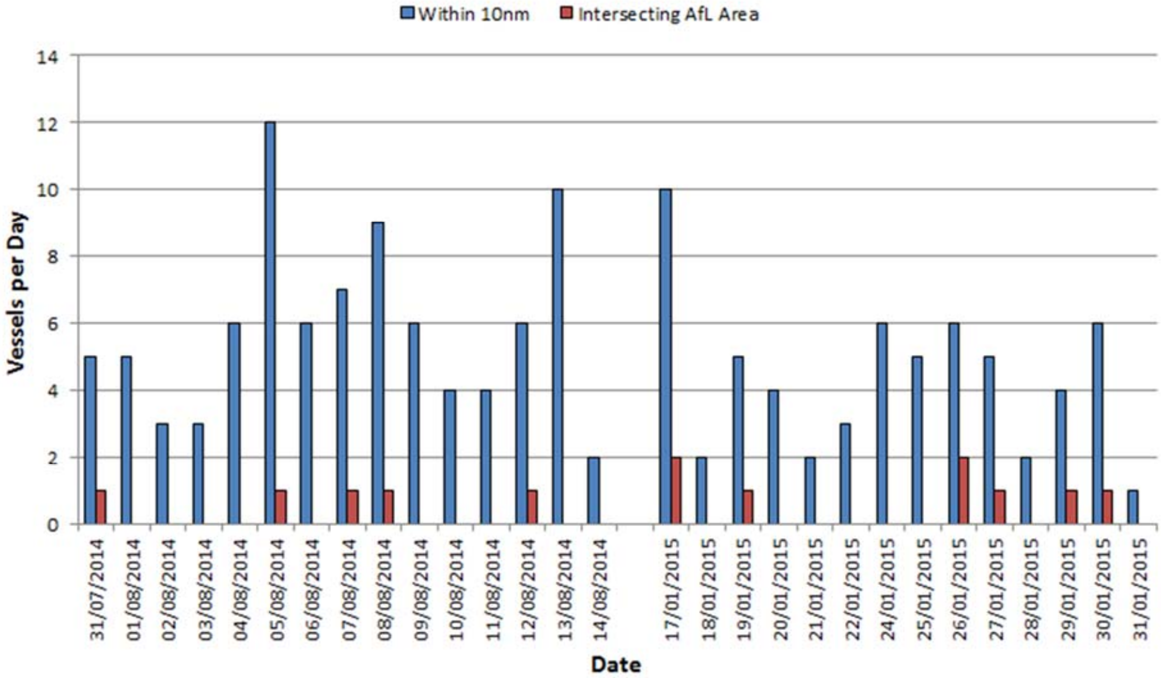

Figure 13.23 AIS and Radar Fishing Vessel Daily Counts

The busiest day during the summer survey period was the 5th August 2014, when 12 unique fishing vessels were recorded. The quietest days of full coverage were the 2nd and 3rd of August 2014, when three vessels were recorded. No more than one fishing vessel per day was recorded entering the KOWL Development during the summer period. The average during summer was six unique fishing vessels per day.

The busiest day during winter was the 17th January 2015 when 10 unique fishing vessels were recorded in the study area. The quietest day was the 31st January 2015 when one fishing vessel was recorded. Two fishing vessels were recorded within the KOWL Development site on the 17th and 26th of January 2015. The average during winter was 4 vessels a day.

The tracks recorded from fishing vessels via AIS are presented colour coded by gear type in Figure 13.24 for the combined summer and winter survey period. It is noted that not all fishing vessels tracked via the radar and visual survey could be identified.

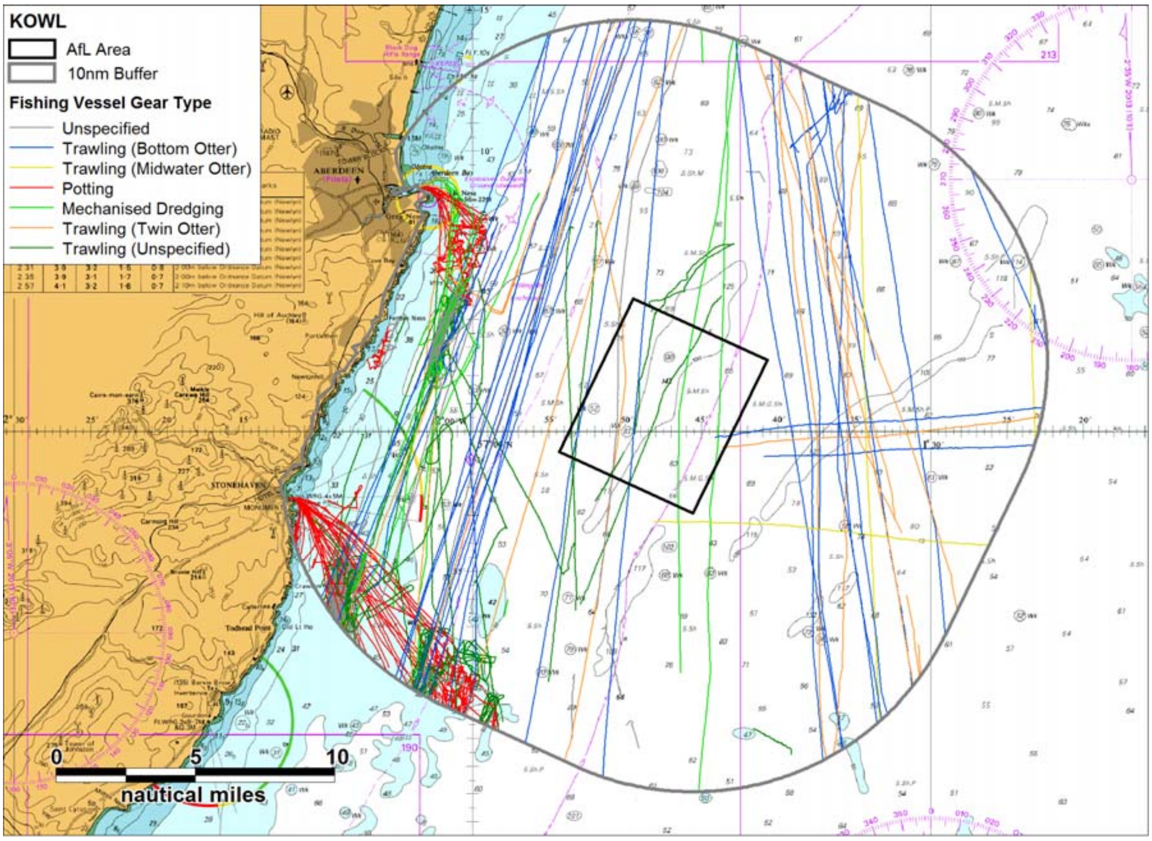

Figure 13.24 AIS/Radar Fishing Data – Combined Survey Period

It is seen that significant fishing occurred approximately 1nm from the coast between Aberdeen and Portlethen from potters, dredgers, and demersal trawlers. Potting activity was noted in the summer survey off the Portlethen coast. Dredging and trawling also occurred east of Stonehaven. One trawler whose behaviour suggested it was engaged in fishing was recorded within the KOWL Development site boundary during the summer survey. Fishing vessels whose behaviour suggested they were in transit rather than fishing were also recorded within the study area. Eleven such tracks intersected the KOWL Development site.

The gear type distribution recorded within the marine traffic surveys is presented in Figure 13.25, excluding 21% of vessels whose gear type could not be determined.

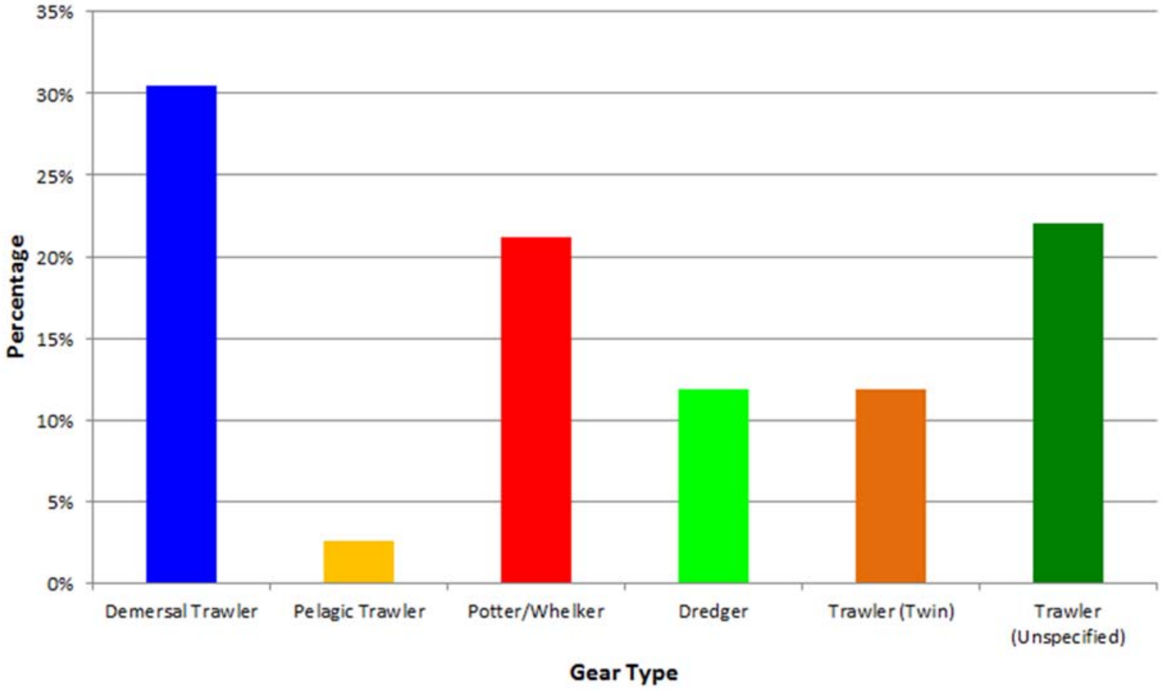

Figure 13.25 Marine Traffic Data – Fishing Gear Type Distribution

The majority of fishing vessels within the study area were trawlers, including demersal (31%), unspecified (22%), twin (12%), and pelagic (3%). Potting activity accounted for 21% of the total, and dredging a further 12%.

13.7.3. VMS (Satellite) Surveillance Data Analysis

The number of VMS points recorded per month during 2009 is presented in Figure 13.26.

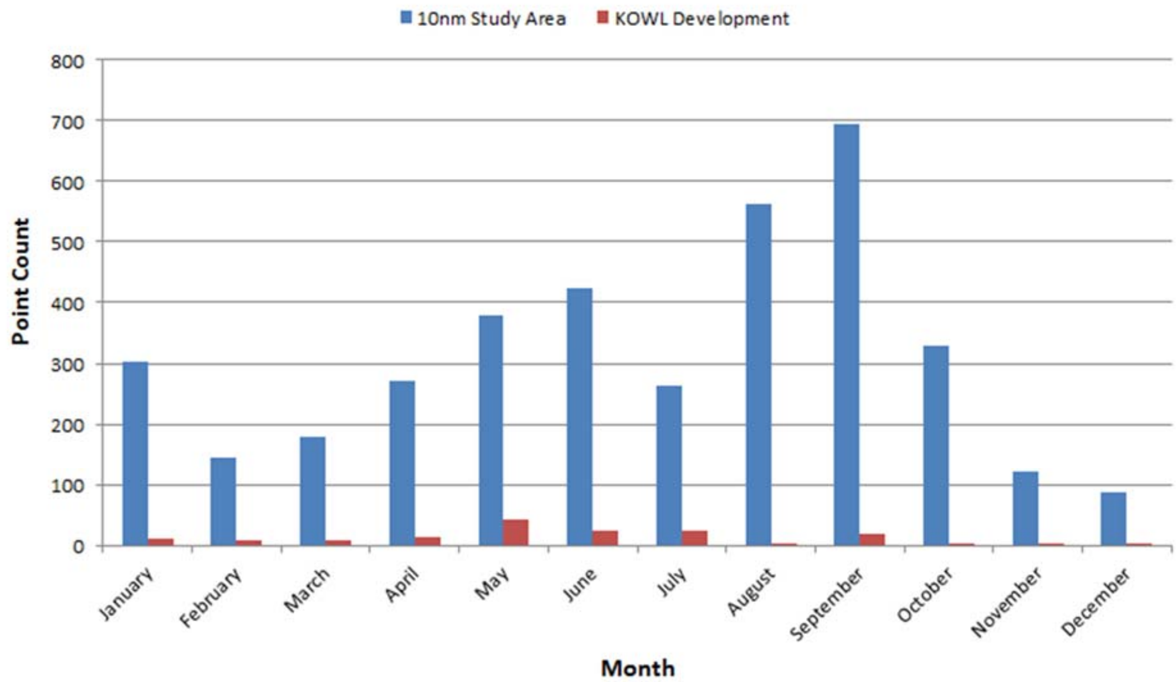

Figure 13.26 VMS Surveillance Point Monthly Count

The busiest period in 2009 in terms of VMS activity within the 10nm study area was in August and September, while the quietest months were November and December. The busiest month within the KOWL Development site boundaries was May.

Excluding 78% unspecified, the majority of recorded VMS points were from dredgers, approximately 74%. A further 18% were from demersal trawlers, and 8% were from unspecified trawlers. Within the KOWL Development, excluding 70% unspecified, approximately 81% of points were from dredgers, with the remaining points coming from demersal trawlers. It is noted that these distributions need to be viewed in the context of the large subset of points from vessels with unspecified gear types, however it can be concluded that significant dredging occurred.

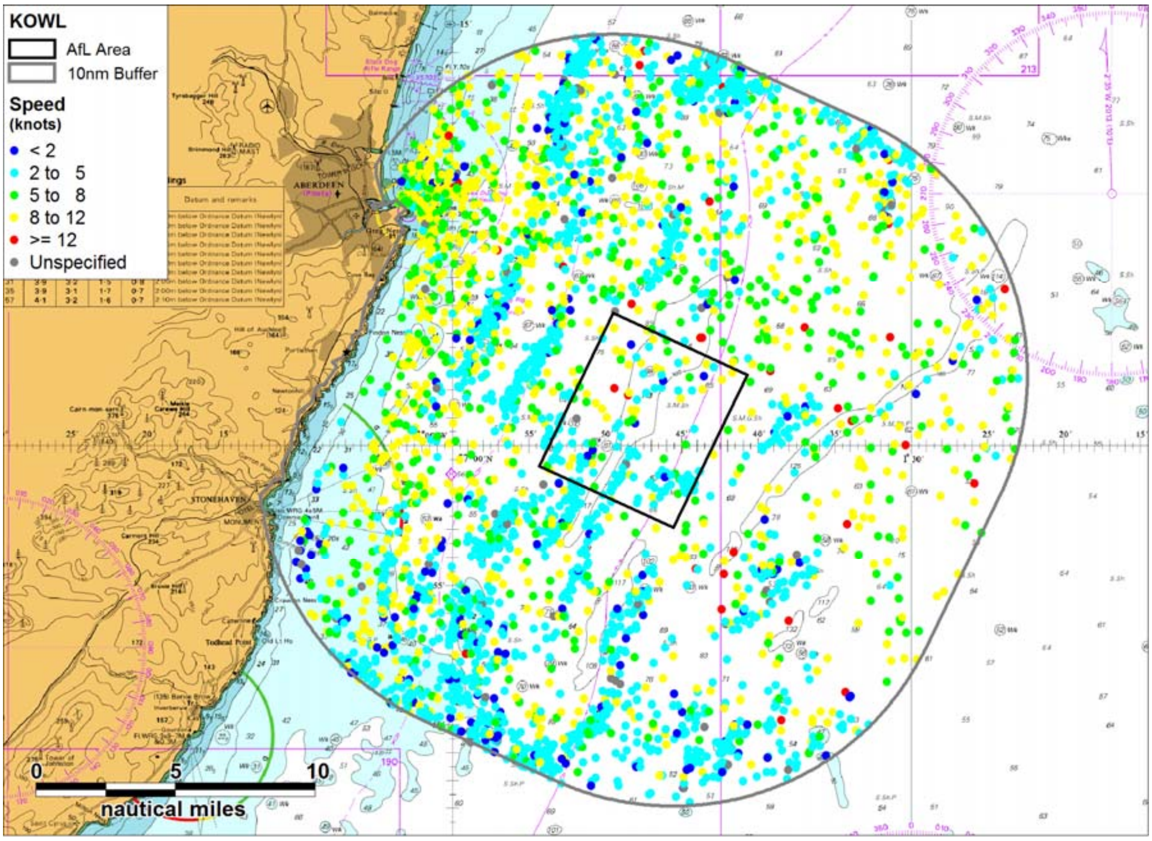

Figure 13.27 VMS Surveillance Data by Speed – 2009

The VMS points recorded from vessels travelling at less than 5 knots are presented in Figure 13.28 colour coded by gear type.

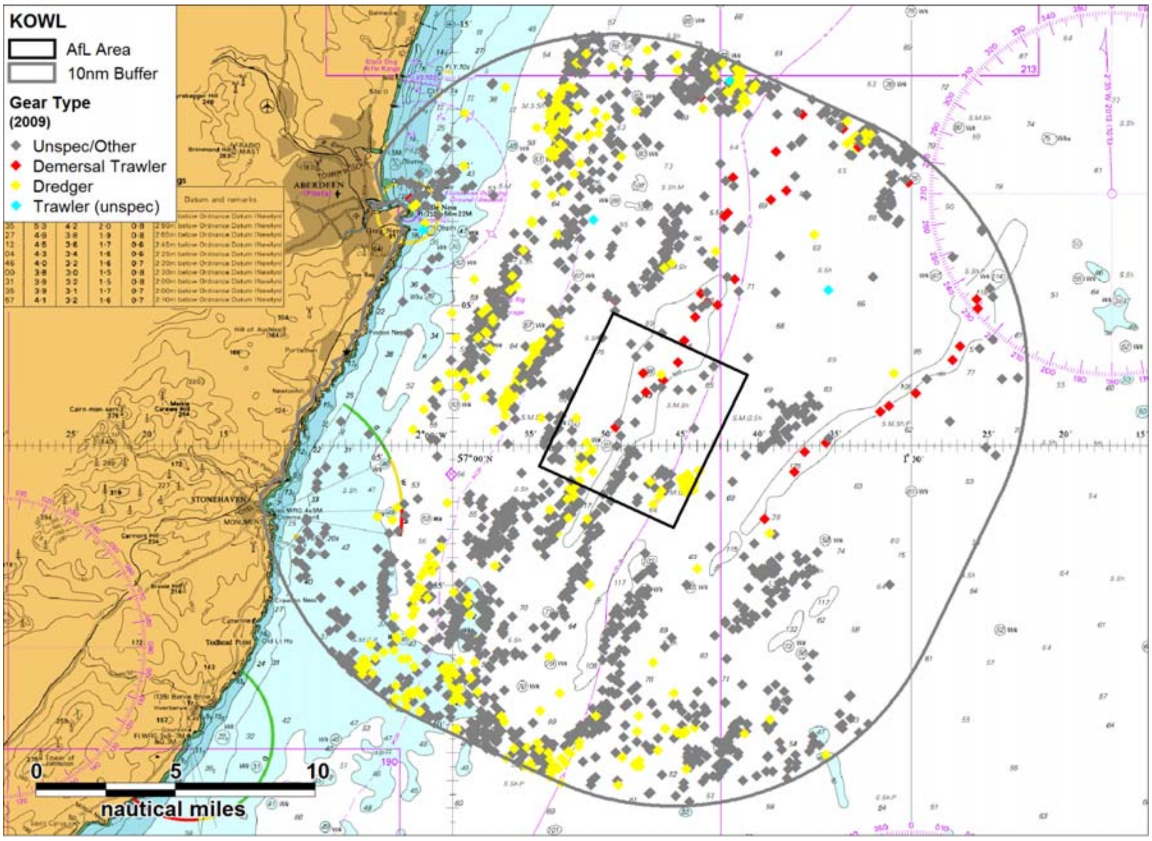

Figure 13.28 VMS Surveillance Data by Gear Type (Speeds less than 5 knots) - 2009

Approximately 96% of the VMS points recorded within the 10nm study area were from UK based vessels. A further 3% were from vessels from the Netherlands, and 1% were associated with vessels from France. A small number of points from Danish, Norwegian, and Faroe Island vessels were also recorded. Of the points recorded within the KOWL Development, 97% were from UK vessels, and 3% were from vessels from Netherlands. One point was recorded in the site from a French vessel.

13.7.4. Sightings Surveillance Analysis

The sighted vessels within the ICES Subsquares intersecting the KOWL Development site are presented in Figure 13.29 colour coded by gear type.

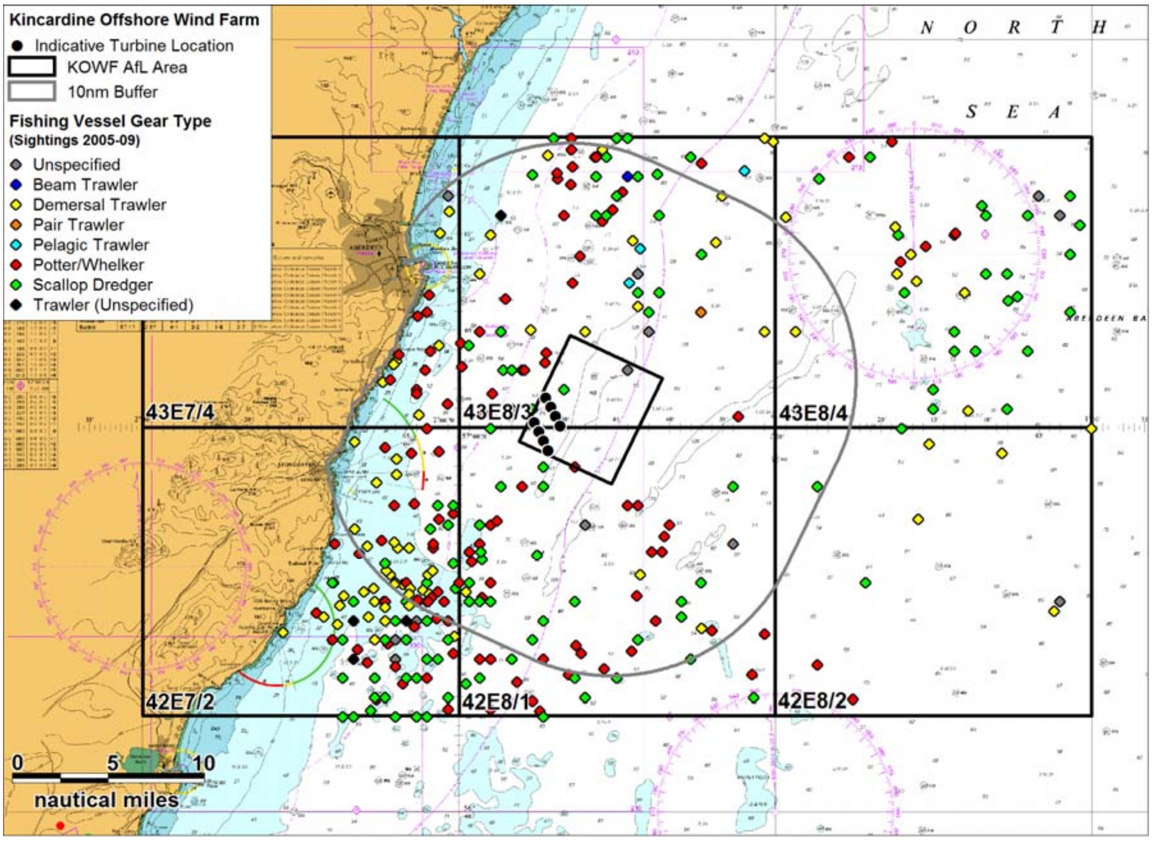

Figure 13.29 Sightings Surveillance Data by Gear Type – 2005 to 2009

Scallop dredgers and potters/whelkers were the most frequently sighted fishing vessel gear type, representing 35.3% and 34.4% of all fishing vessel sightings respectively. Demersal stern trawlers also represented a significant proportion (23.2%) of fishing vessel gear types sighted. Of the three fishing vessels sighted within the KOWL Development one was a potter/whelker, one was a scallop dredger and one was unspecified.

The sightings data colour coded by vessel activity is presented in Figure 13.30.

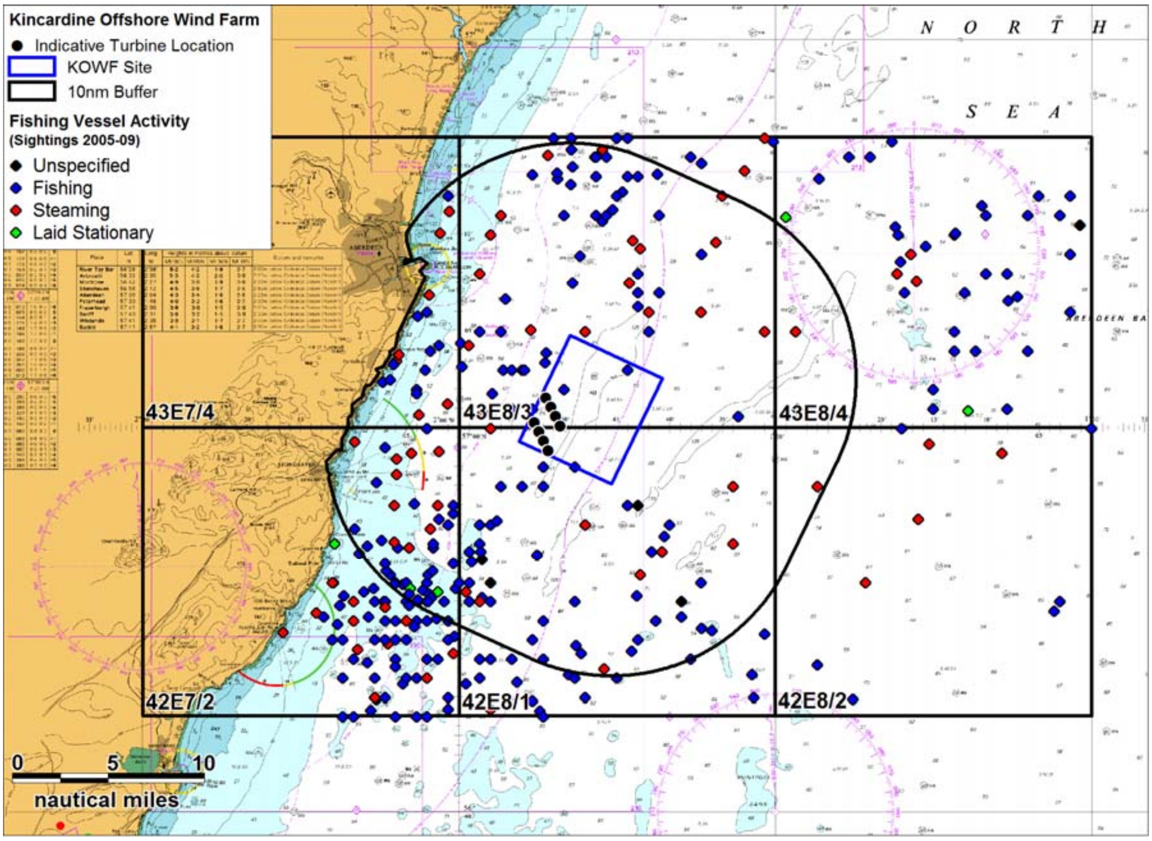

Figure 13.30 Sightings Surveillance Data by Activity – 2005 to 2009

Approximately 77% of vessels were engaged in fishing at the time they were sighted. A further 22% were logged as being on passage. The remaining vessels were laid stationary. The three vessels sighted within the KOWL Development boundaries were all engaged in fishing.

The vast majority (96%) of vessels sighted were UK registered. Vessels from the Netherlands, Norway, and France were also recorded. All three vessels sighted within the KOWL Development were UK registered.

13.8. Anchored Vessels

The vessels observed to be at anchor within the combined summer and winter survey periods are presented in Figure 13.31.

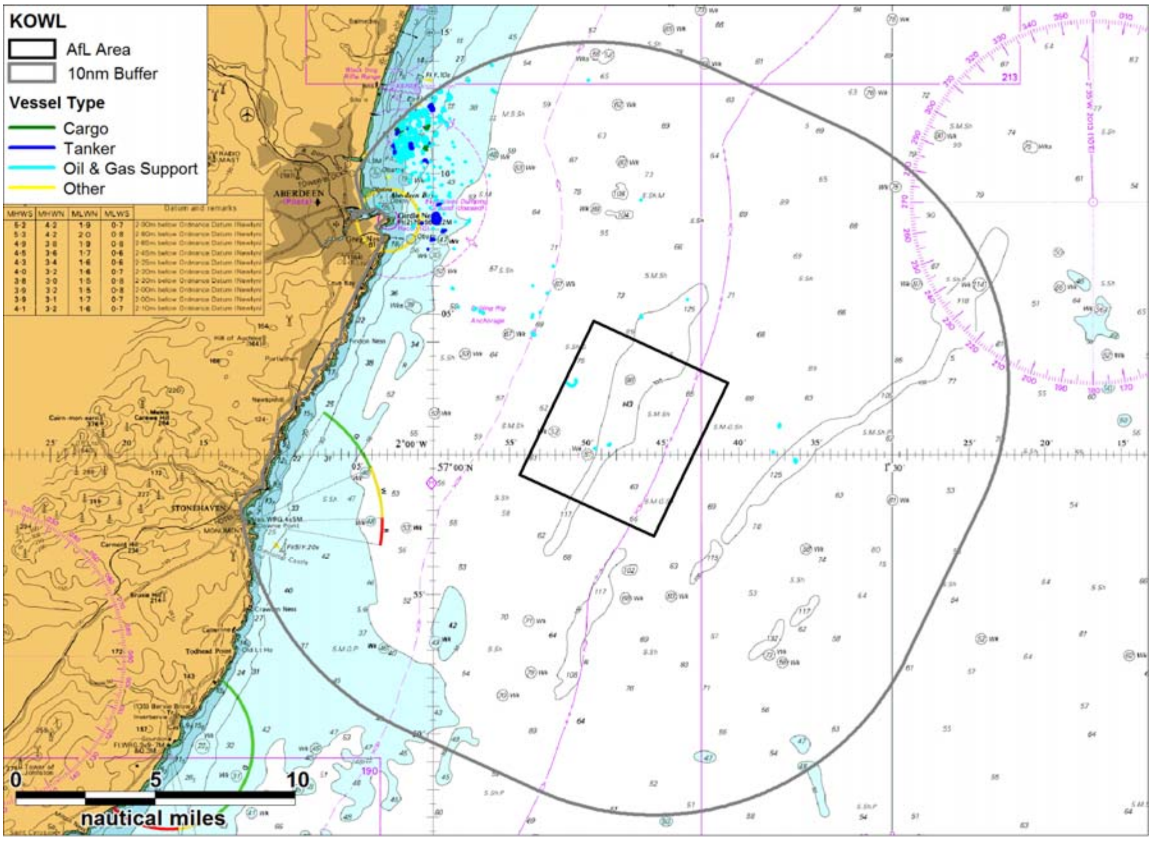

Figure 13.31 Marine Traffic Survey Data - Anchored Vessels within Study Area

The most significant area in terms of anchoring was outside of Aberdeen harbour. In addition to the vessels using the designated Aberdeen anchorage (see Section 9.1), shuttle tankers too large for the harbour anchored approximately 2nm east of its entrance. Oil and gas support vessels were also seen anchoring further east, including within the KOWL Development boundaries. Zoomed in plots of the anchoring at Aberdeen and further afield are presented in Figure 13.32 and Figure 13.33 respectively.

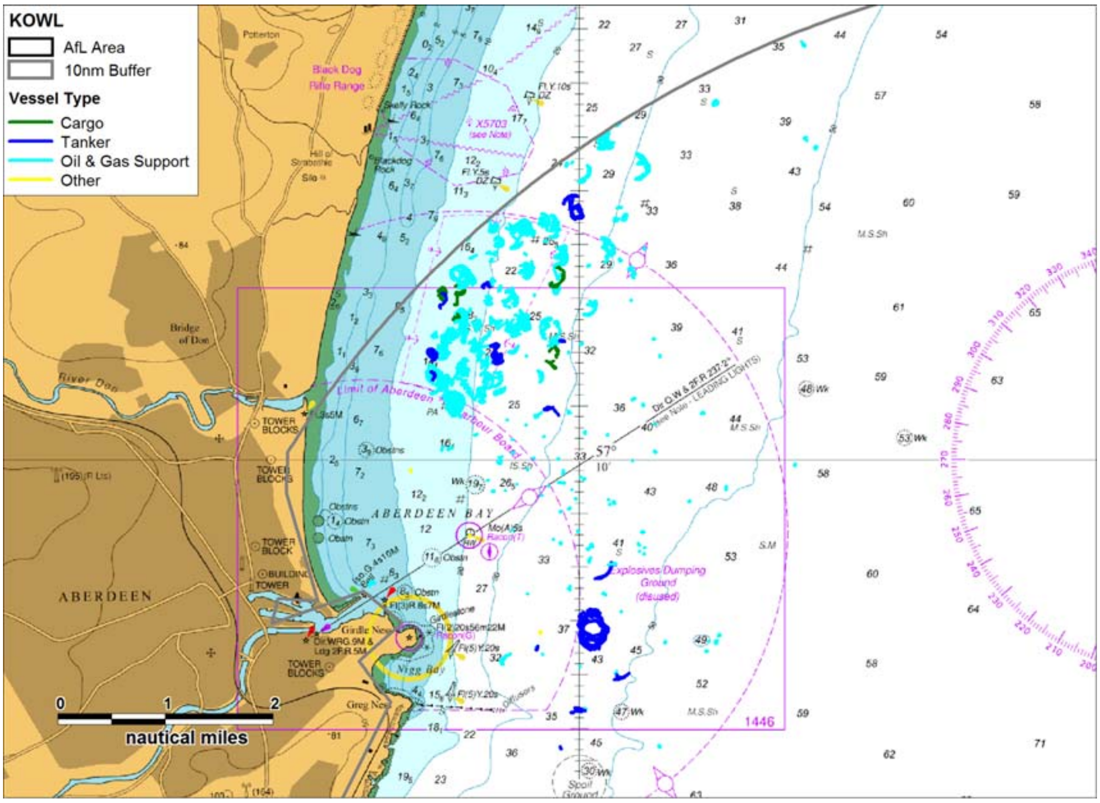

Figure 13.32 Marine Traffic Survey Data - Anchored Vessels at Aberdeen

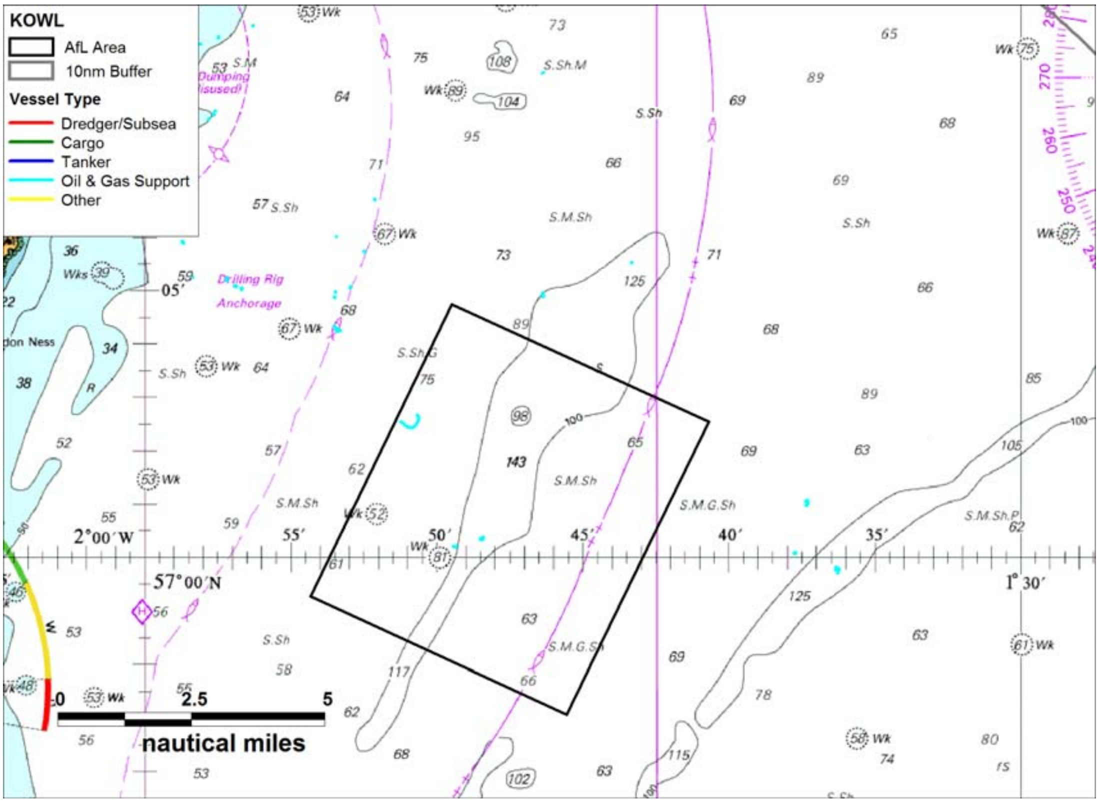

Figure 13.33 Marine Traffic Survey Data - Anchored Vessels Offshore

The vast majority (91%) of vessels at anchor were oil and gas related. Tankers accounted for 5%, cargo vessels a further 2%, and the remaining 1% was from "other" vessels. The majority of oil and gas vessels anchored within the designated Aberdeen anchorage, awaiting entrance to Aberdeen harbour, however they were also observed at anchor further offshore. In particular, three vessels displayed possible anchoring behaviour within the KOWL Development. Details of the three vessels are presented in Table 13.1.

Table 13.1 Vessels Anchored within KOWL Development Boundaries

Name	Date	Length (m)	DWT	Type
Sentinel Ranger	01/08/2014	65	1,400	Supply Vessel
Deep Cygnus	03/08/2014	123	7,877	Multi-Purpose Offshore Vessel
Skandi Foula	27/01/2015	84	4,100	Supply Vessel

It is noted that the physical and charted presence of offshore installations should dissuade anchoring from occurring in their vicinity during and following construction.

13.9. Vessel Routing

The 28 day marine traffic survey data was used to identify the main shipping routes utilised by vessels in the vicinity of the KOWL Development. The identified routes are presented in Figure 13.4.

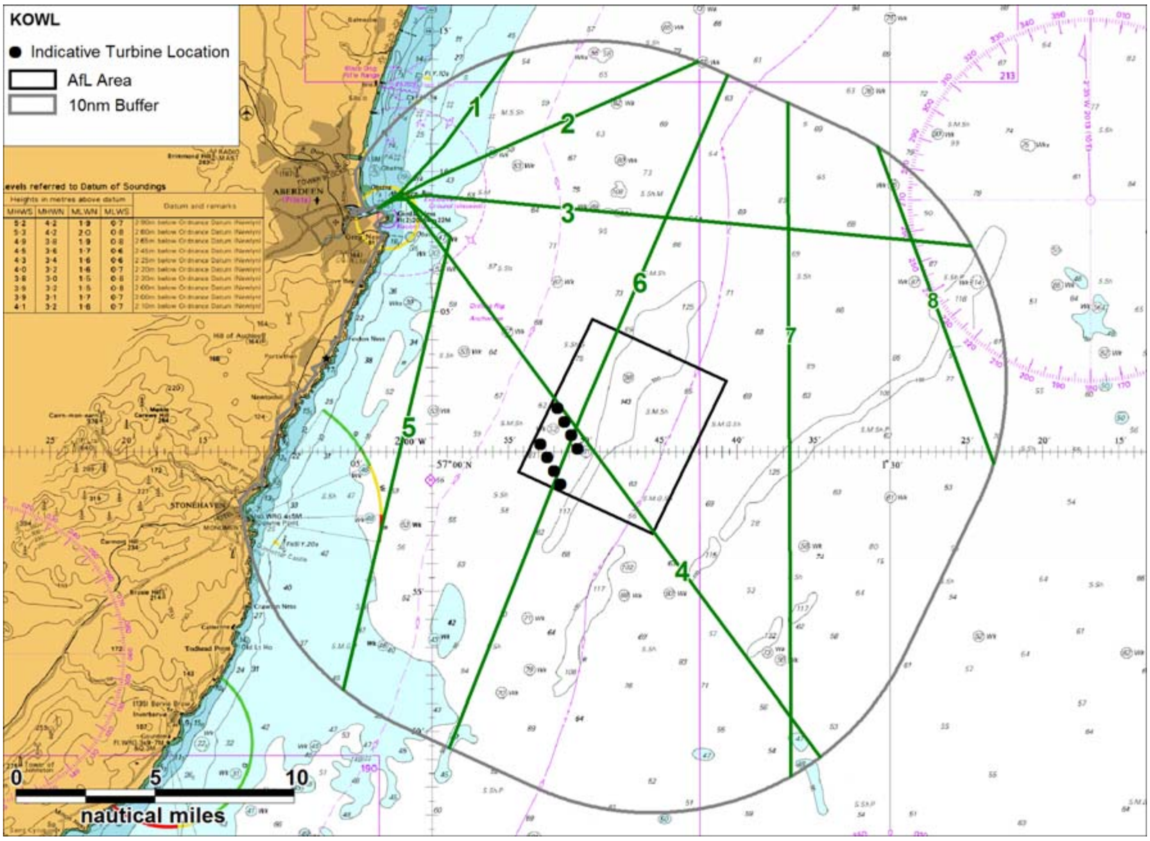

Figure 13.34 Base Case Shipping Routes

Details of the routes are provided in Table 13.2.

Table 13.2 Main Shipping Routes

Route Number	Destination	Vessel Type	Number of Vessels per day
1	Aberdeen – Orkney waters / northern oil and gas installations (e.g. Captain, Ninian and Athena fields). Including Northlink Aberdeen to Kirkwall/Lerwick.	75% offshore oil and gas affiliated. 15% cargo. 10% passenger.	8
2	Aberdeen – Norway and north eastern oil and gas installations (e.g. Kittiwake, Andrew and Brent fields)	90% offshore oil and gas affiliated. 10% cargo.	10

Route Number	Destination	Vessel Type	Number of Vessels per day
3	Aberdeen – eastern oil and gas installations (e.g. Elgin, Curlew, Pierce North and Janice fields)	100% offshore oil and gas affiliated.	8
4	Aberdeen – southern UK / mainland Europe.	40% offshore oil and gas affiliated. 35% cargo. 25% tanker.	4
5	Aberdeen – east coast Scottish ports (e.g. Montrose, Dundee and Leith).	60% offshore oil and gas affiliated. 25% tanker. 10% cargo. 5% other.	2
6	Northern ports (e.g. Invergordon, Inverness and Lerwick) – Firth of Forth ports (e.g. Leith, Rosyth and Grangemouth) / Montrose.	30% offshore oil and gas affiliated. 30% cargo. 20% tanker. 10% passenger.	5
7	Transient traffic between northern ports (e.g. Peterhead, Scrabster, Lerwick and Wick) – southern ports (e.g. Rotterdam, Immingham and Blyth).	50% cargo. 30% tanker. 20% offshore.	1
8	Northern ports (e.g. Peterhead, Inverness and Reykjavik) to Tees / Humber.	80% cargo. 20% tanker.	1

Routes 4 and 6 in the above table intersected the KOWL Development. Route 4 is transited by approximately four vessels a day between Aberdeen and other UK and mainland Europe ports. Offshore vessels, cargo vessels, and tankers were all observed using Route 4 within the marine traffic survey data. Approximately five vessels per day transit Route 6 between ports on the north coast of Scotland and ports in the Firth of Forth. Offshore vessels, cargo vessels, passenger vessels, and tankers were all observed using Route 6 within the marine traffic survey data.

14. Future Case Marine Traffic

This section presents the anticipated future case level of activity in the vicinity of the proposed development site, which has been input into the collision risk modelling.

14.1. Increases in Traffic Associated with Ports

Data published by the Department for Transport (DfT, 1984 – 2013), as illustrated in Figure 14.1 and Figure 14.2, summarises the total tonnage and number of arrivals per annum at each main port in proximity to the KOWL development. It should be noted that the following DfT data used throughout this analysis is not inclusive of all vessel arrivals however it is considered representative of overall trends in vessel arrivals and total tonnage.

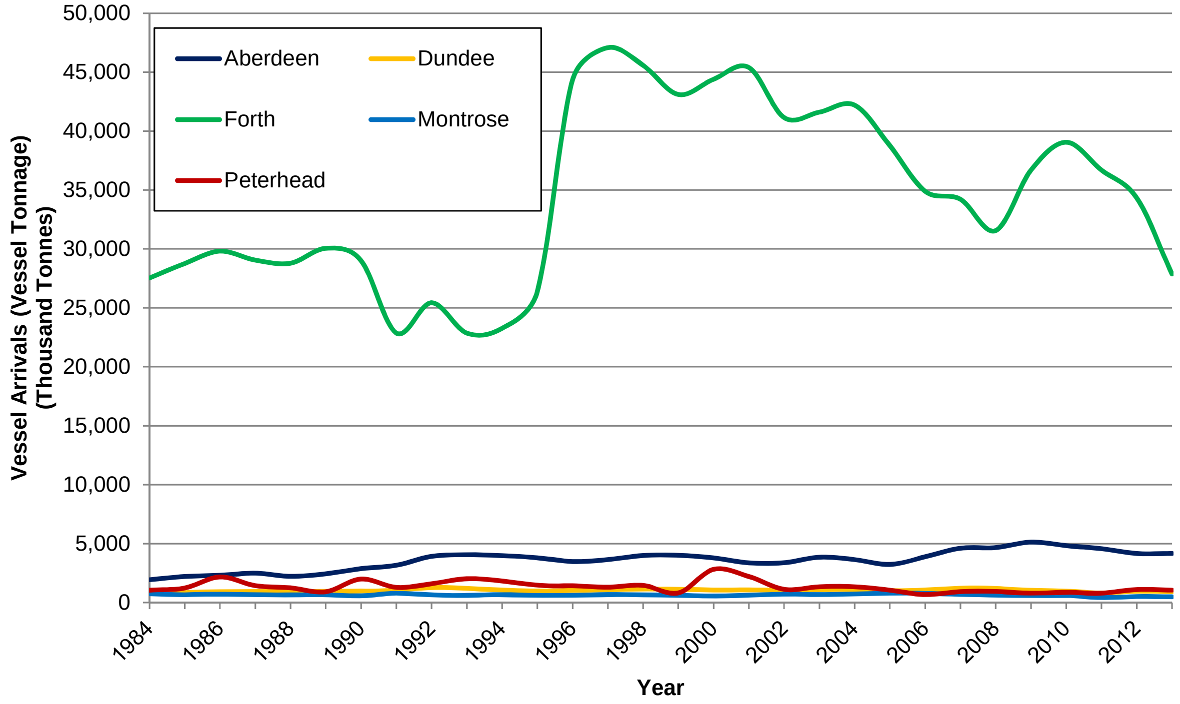

Figure 14.1 Total Tonnage through Main Ports

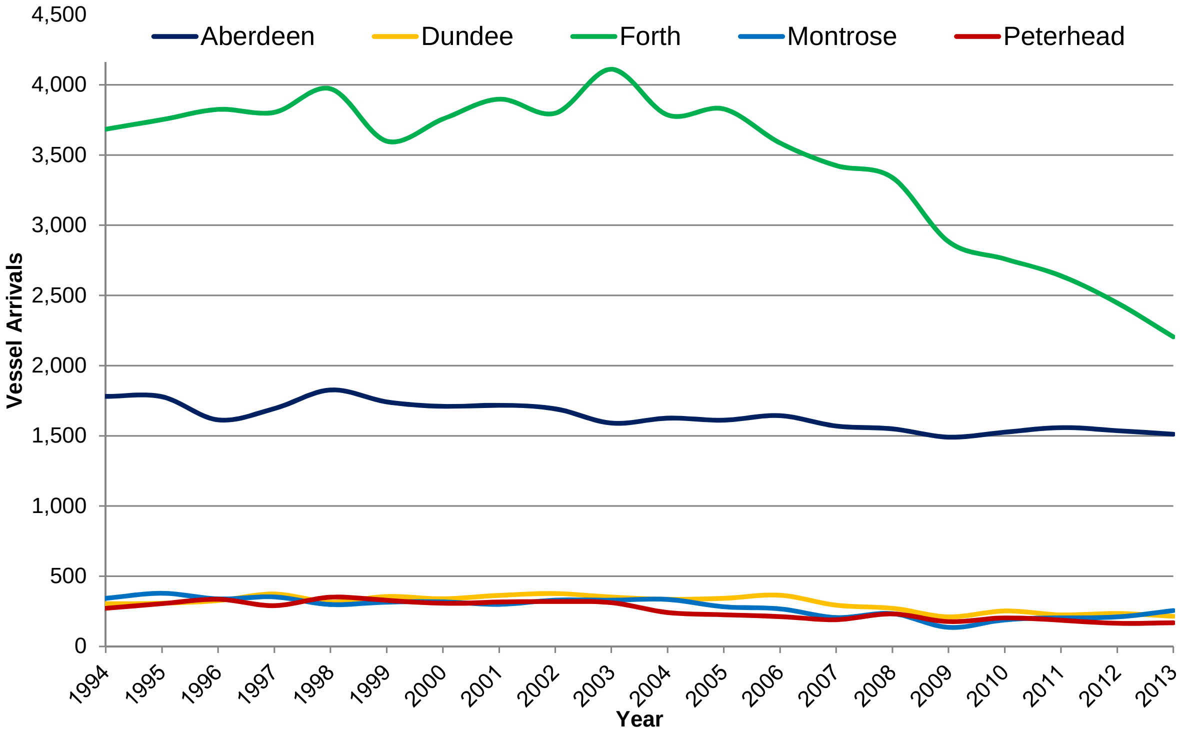

Figure 14.2 Vessel Arrivals at Main Ports

Vessel arrivals at Forth Ports are greatest with an average of 3,454 vessel arrivals and a total tonnage of approximately 34.4 million tonnes per annum throughout the time period analysed. However, in recent years (2006 onwards), the number of vessel arrivals has decreased by approximately 6.6% per annum. Throughout 2013, there was a total of 2,204 vessel arrivals and a total tonnage of 27.8 million tonnes at Forth Ports.

Vessel arrivals and total tonnage at Aberdeen Harbour, the closest principal port to the KOWL development, have remained stable throughout the time period analysed with an average of 1,638 vessel arrivals and a total tonnage of approximately 3.5 million tonnes.

Vessel arrivals and total tonnages at other nearby main ports (Dundee, Montrose and Peterhead) are frequented far less often than both Aberdeen and Forth Ports, with an average of less than 500 vessel arrivals and total tonnages of less than 1.5 million tonnes.

Due to the potential for future growth at Aberdeen Harbour, including the development of Nigg Bay, and adopting a worst case scenario, a future growth in vessel movements of 10% has been estimated over the life of the KOWL development.

14.2. Increases in Fishing Vessel Activity

For commercial fishing vessel activity, a 10% future increase in fishing vessel activity has been used to demonstrate potential impacts.

14.3. Recreational Vessel Activity

In terms of recreational vessel activity, a 10% future increase in recreational vessel activity has been used to demonstrate potential impacts.

14.4. Increase in Traffic Associated with KOWL

It has been estimated that during the construction of the KOWL development there will be an increase in vessel movements, over the total construction and the maintenance period – however given the size of the site these numbers are expected to be low. Construction vessel movements have not been included in the collision risk modelling. However the vessels are ultimately under the control of the KOWL marine coordination centre, where the safe passage planning and operation within a Safety Management System will be ensured.

14.5. Collision Probabilities

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

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 KOWL development, the potential increased congestion caused by the development and potential displacement of traffic in the area may have an influence. Again, a 10% overall increase was assumed on base case with development risk.

14.6. Commercial Traffic Re-Routeing

The following sub-section analyses the potential alternative routeing options for routes where displacement may occur. It is not possible to consider all options so the shortest and therefore most likely alternatives have been considered. Assumptions for re-routes include:

- All alternative routes maintain a minimum of 1nm from wind turbine generators in line with the MCA shipping template;
- Time increases are calculated using the average speed of vessels operating on each individual route whilst within 10nm of the AfL area; and
- All mean routes take into account areas of shallow water and known routeing preferences.

It should be noted that alternatives do not consider adverse weather routeing.

Following construction of the KOWL development, deviations would be required for Route 4 and Route 6. An illustration of the anticipated shift in main route positions is presented in Figure 14.3. Information on the route deviations and associated time increases are presented in Table 14.1. Time increases have been calculated using the average speed of vessels operating on each individual route within 10nm of the development site.

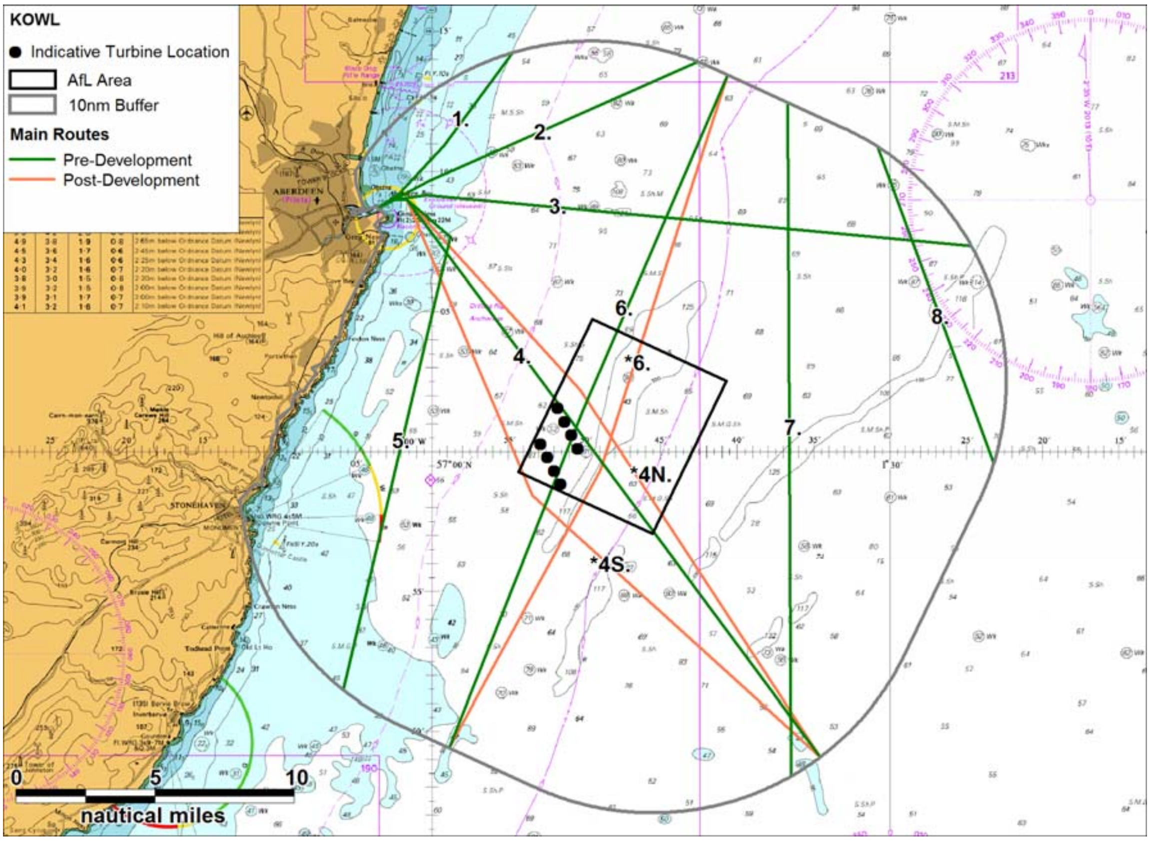

Figure 14.3 Deviated Main Commercial Routes

Table 14.1 Summary of Main Commercial Main Route Deviations

Route Number	Vessels per Day	Deviation (nm)	% Increase	Time Increase based on average vessel speed
4 (North)	4	0.1	0.3%	<1 minute
4 (South)		0.6	2.3%	<4 minute
6	5	0.1	0.4%	<1 minute

15. Industry Standard (Embedded) Mitigation Measures

The following embedded mitigation measures were assumed present during the Formal Safety Assessment, presented in Table 15.1.

Table 15.1 Embedded Mitigation

Description	Definition
24hrs emergency coordination centre	KOWL are committed to the development, including integration into existing oil and gas facilities located within Aberdeen, of a 24 hrs monitoring and emergency contact facility. This will ensure that the turbines are monitored and any mooring issues are noted immediately.
AIS carriage on support vessels	All support craft associated with the development will carry AIS.
Application and use of rolling safety zones of up to 500m during construction, operations & maintenance and decommissioning	Where required 500m rolling safety zones would be used around current areas of constructions, major maintenance and decommissioning.
Operational safety zones	A minimum of 50m operational safety zones will also be applied for given the subsea mooring of the structures and potential excursion of the WTGs.
Cable protection	Export cables would be protected appropriately taking into account fishing and anchoring practices and an appropriate burial protection index study. Positions of cables would be promulgated and charted by appropriate means As per the requirements of MGN 371 any cable protection used will be risk assessed to ensure it does not present an under keel clearance risk to vessels transiting over the top. This in particular is required in shallow waters areas where deep keeled recreational craft may transit.
Cardinal marker buoys deployed during construction / decommissioning.	Cardinal markers buoys will be deployed around the site to mark the construction (and decommissioning area) of the turbine development. It is assumed that these cardinal buoys will remain in situ for the approximate 18 month period when the cables and mooring installation will be in place without the surface structures.
Compliance with MCA's MGN 371 including Annex 5	Annex Five 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 around an Offshore Renewable Energy Installations (OREI)'.

Description	Definition
Development and implementation of an Emergency Response Cooperation Plan (ERCoP)	An Emergency Response Cooperation Plan (ERCoP) would be developed and implemented for the construction, operational & maintenance and decommissioning phases. The ERCoP would be based on the standard MCA template and would consider the potential for self-help capability as part of the ongoing process.
Fisheries Liaison	The FLOWW (Fishing Liaison with Offshore Wind and Wet Renewables Group) best practice guidance for fisheries liaison will be followed, including the establishment of a fishing liaison plan. An FLO has been appointed for the Project and will continue in this role during construction.
Guard vessels during construction	Guard vessels would be used during construction, and significant maintenance to both protect the installations and workers on the wind turbines, particularly in areas in proximity to main traffic routes. Their role would be to both alert vessels to the development activity and provide support in the event of an emergency situation. A guard vessel will be present for the approximate 18 month period when the export cables, inter array cables and mooring structures will be in situ.
Marked on admiralty charts	The windfarm would be charted by the UK Hydrographic Office (UKHO). This would include wind turbines, offshore cable corridor (specific location of export cables) and inter-array cables for the appropriate scale charts. Discussions will also be held with the UKHO in collaboration with the MCA regarding the charting of subsea mooring lines and anchors.
Minimum blade clearance	Wind turbines would be constructed to ensure that a constant rotor blade clearance (air draught) of 22m above all tidal states is maintained; due to the floating nature of the turbines.
Monitoring	Active monitoring of development to ensure that the structures and / or cables would not become a hazard to navigation over time, for example, export cables becoming exposed.

Description	Definition
Navigational marking and lighting	Structures within the windfarm would be marked and lit in accordance with International Association of Lighthouse Authorities (IALA) Recommendation O-139 on the Marking of Man-Made Offshore Structures (IALA, 2013), but may also include the use of other visual and sounds aids (e.g. Fog horns and AIS aids to navigation) to navigation as agreed with the Northern Lighthouse Board (NLB). This includes use of standard marine colours. Aviation lighting and marking will be defined by the Civil Aviation Authority in conjunction with SAR requirements. An Aids to Navigation Management Plan will also be developed to effectively manage all lights and marks associated with the site.
Promulgation of information	Appropriate liaison and dissemination of information and warnings through Notices to Mariners and other appropriate media, (e.g., Admiralty Charts, fishermen's awareness charts and Pilot Books) would enable vessels too effectively and safely passage plan around the KOWL (including inter-array cables) and the offshore cable corridor. It is noted that this will include international promulgation of information.
Safety Management System (SMS)	The developer/operator of KOWL will have a SMS in place throughout all phases of the project. This would include procedures such as adverse weather protocols.
Towing risk management plan	A management plan for the towing operation will be developed by the towage company; this will follow standard and international marine procedures.
Works vessel coordination	All on site traffic associated with the construction and decommissioning will be controlled through a Works Vessel Coordination/Control centre.
Single line of orientation within final agreed layout.	Recent changes to marine guidance (MGN 371) require all offshore wind farm sites to maintain at least one direction of orientation to assist surface craft navigation and to be used as search and rescue corridors.
ID numbering	Individual OREI marking should conform to a spreadsheet layout, i.e. lettered on the horizontal axis and numbered on the vertical axis. The detail of this will depend on the shape and geographical orientation of the final layout. Each WTG shall be marked with a unique ID number.

16. Formal Safety Assessment

16.1. Introduction

The impact assessment is based on the IMO Formal Safety Assessment process (IMO, 2002) approved by the IMO in 2002 under SC/ Circ.1023/MEPC/Circ392, and referred to in Section 3.

As indicated within the IMO FSA guidelines and the DECC guidance on risk assessment methodology (DECC, 2005) 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.

16.2. Hazard Identification

The Kincardine Offshore Wind Farm Hazard Workshop was held on the 20th August 2015 at Anatec's Aberdeen office. The purpose of the workshop was to provide an opportunity to consult with both statutory and local stakeholders in order to identify potential hazards to shipping and navigational safety associated with the Kincardine project. Table 16.1 summarises attendees at the hazard workshop and the organisation they represent.

Table 16.1 Hazard Workshop Attendees

Attendee	Organisation
Allan MacAskill	Pilot Offshore Renewables
Sam Westwood	Anatec
Sandy Bendall	
Stuart Carruthers	Royal Yachting Association
Craig Wilson	DOF Group
John Watt	Scottish Fisherman's Federation
Peter West	
Ian Balgowan	
Pete Lowson*	Maritime and Coastguard Agency

* Via telephone.

The following subsection summarises the hazards that were discussed for each receptor and phase during the hazard workshop.

16.2.1. Construction and Decommissioning:

- Increased powered collision risk with construction / decommissioning vessels;
- Increased drifting collision risk with construction / decommissioning vessels;
- Vessel to vessel collision due to avoidance of construction / decommissioning safety zones or areas;
- Vessel anchoring on or dragging over subsea equipment (installed cable and mooring system) prior to commissioning;

- Snagging risk to fishing vessels associated with subsea equipment (installed cable and mooring system) prior to commissioning;
- Increased encounter and collision risk during towing operations; and
- Increased vessel deviations due to avoidance of construction safety zones / areas.

16.2.2. Operation and Maintenance:

- Increased powered allision risk with turbines (operational);
- Increased drifting allision risk with turbines (operational);
- Increased allision risk (both powered and drifting) with turbines (off-station), i.e. turbine has become floating hazard;
- Increased vessel to vessel collision due to avoidance of operational site;
- Potential de-masting (vertical gear allision);
- Potential UKC interaction with subsea infrastructure;
- Impacts on adverse weather routeing and anchoring;
- Vessel anchoring on or dragging over subsea equipment (installed export cable and turbine mooring system);
- Snagging risk to fishing vessels associated with the subsea mooring equipment and export cable route; and
- Increased vessel deviations due to avoidance of operational site.

16.2.3. All Phases:

- Restricted search and rescue capability in an emergency situation; and
- Restricted oil spill response in a pollution incident.

16.3. Hazard Discussions

During the hazard workshop, assuming a worst case scenario, 23 of the 28 discussed hazards were judged to be **broadly acceptable**, with the remaining five falling into the **tolerable** category. In terms of the most likely scenarios, only two out of the 28 were considered to be in the **tolerable** category. This is presented in Figure 16.1.

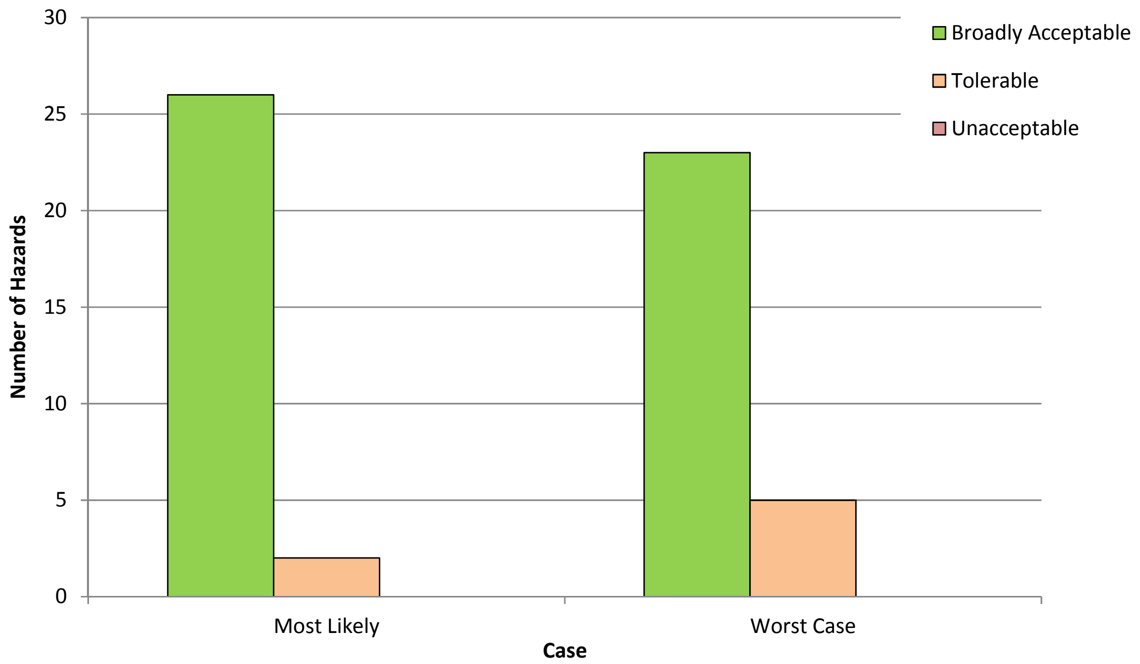

Figure 16.1 Hazard Workshop Results

The five hazards considered **tolerable** in the worst case scenarios were:

- Snagging risk to fishing vessels associated with subsea equipment prior to commissioning;
- Increased allision risk between recreational vessels (both powered and drifting) and turbines;
- Increased allision risk between fishing vessels (both powered and drifting) and turbines;
- Potential de-masting of a recreational vessel; and
- Snagging risk to fishing vessels associated with subsea mooring equipment and export cable route.

The hazards considered **tolerable** assuming most likely scenarios were:

- Increased vessel deviations due to avoidance of construction safety zones/areas; and
- Increased vessel deviations due to avoidance of operational site.

16.4. Risk Assessment

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

(Base case uses current traffic levels and future case uses future traffic levels based on predicted change over the life of the KOWL site.)

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)

17. Allision and Collision Risk Modelling

17.1. Introduction

This section assesses the major hazards associated with the development of the KOWL Development. This is divided into without development (pre-installation) and with development (post-installation) risks and includes major hazards associated with:

- Increased vessel to vessel collision risk;
- Additional vessel to structure allision risk;
- Additional risk associated with vessels Not Under Command (NUC); and

The base case assessment uses the present day vessel activity level identified from the maritime traffic surveys, consultation and other data sources. The future case assessment made conservative assumptions on shipping traffic growth over the life time of the KOWL Development.

All vessel types including commercial, oil and gas, fishing and recreational vessels have been considered in the assessments.

The modelling was undertaken using the worst case layout as summarised in Section 7.5

17.2. Base Case without KOWL Development

17.2.1. Vessel Encounters

An assessment of current ship-to-ship encounters was undertaken to determine the base case levels of vessel interaction prior to construction of the KOWL development. An encounter was defined as the paths of two or more vessels coming within 1nm of each other within 60 seconds. Any encounter involving a vessel passing within 5nm of the KOWL Development at any time during the encounter has been included in the analysis.

The daily counts of encounters recorded during the summer and winter marine traffic survey periods are presented in Figure 17.1.

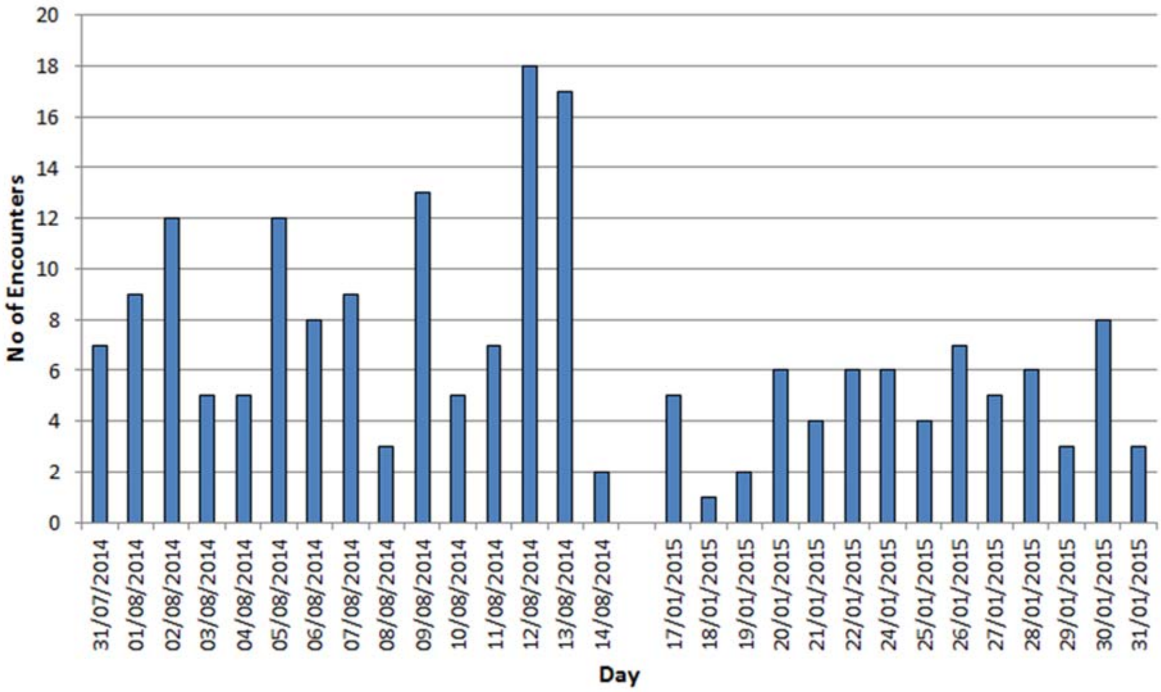

Figure 17.1 Daily Vessel Encounter Numbers

There were an average of nine encounters per day recorded during summer, and an average of five per day during winter. The busiest day during summer was the 12th of August 2014, when 18 encounters were recorded (13 of which involved non-AIS vessels). The busiest day during winter was the 30th January 2015 when eight encounters were recorded.

The overall encounter density is presented in Figure 17.2.

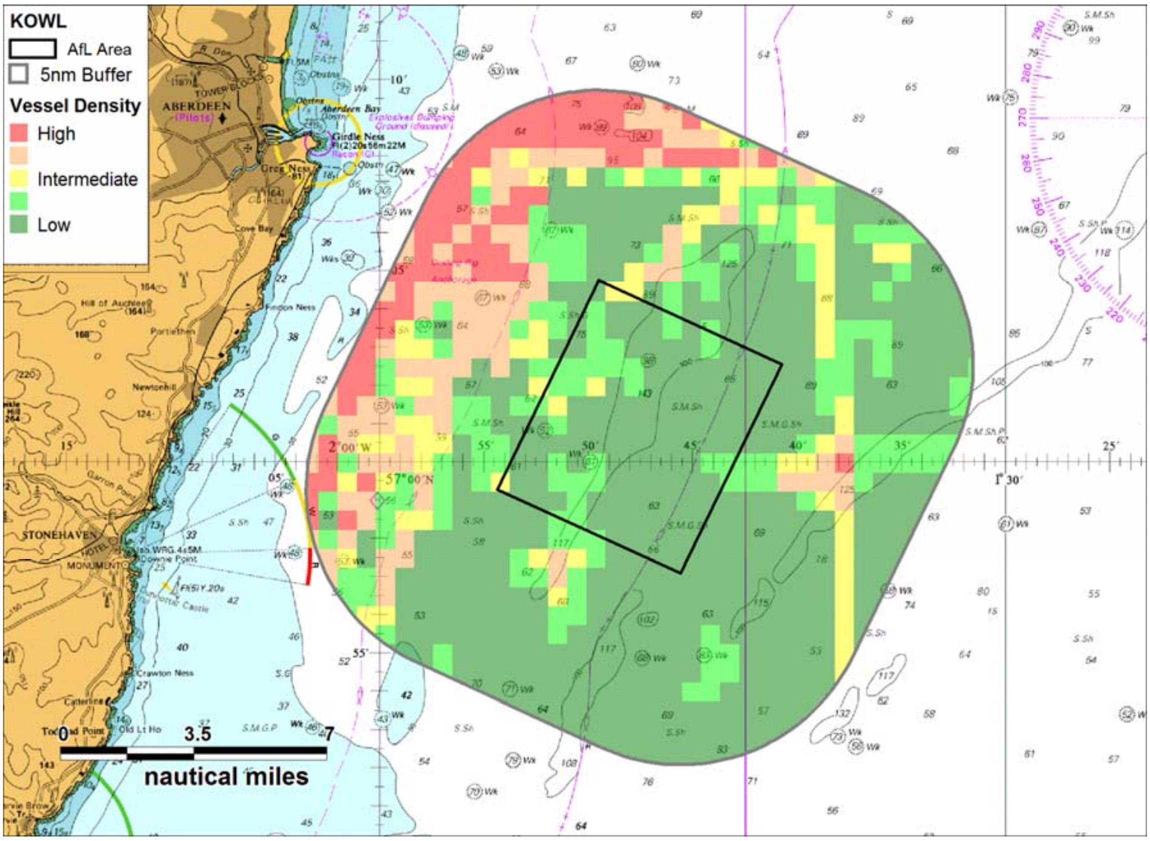

Figure 17.2 Encounter Density

The tracks from the identified encounters during summer and winter are presented in Figure 17.3 colour coded by vessel type. It is noted that potential pair trawling activity was observed during the winter period to the east of the KOWL Development from the following vessels:

- The *Aubretia* and the *Mystical Rose*
- The *Lynden* and the *Virtuous*

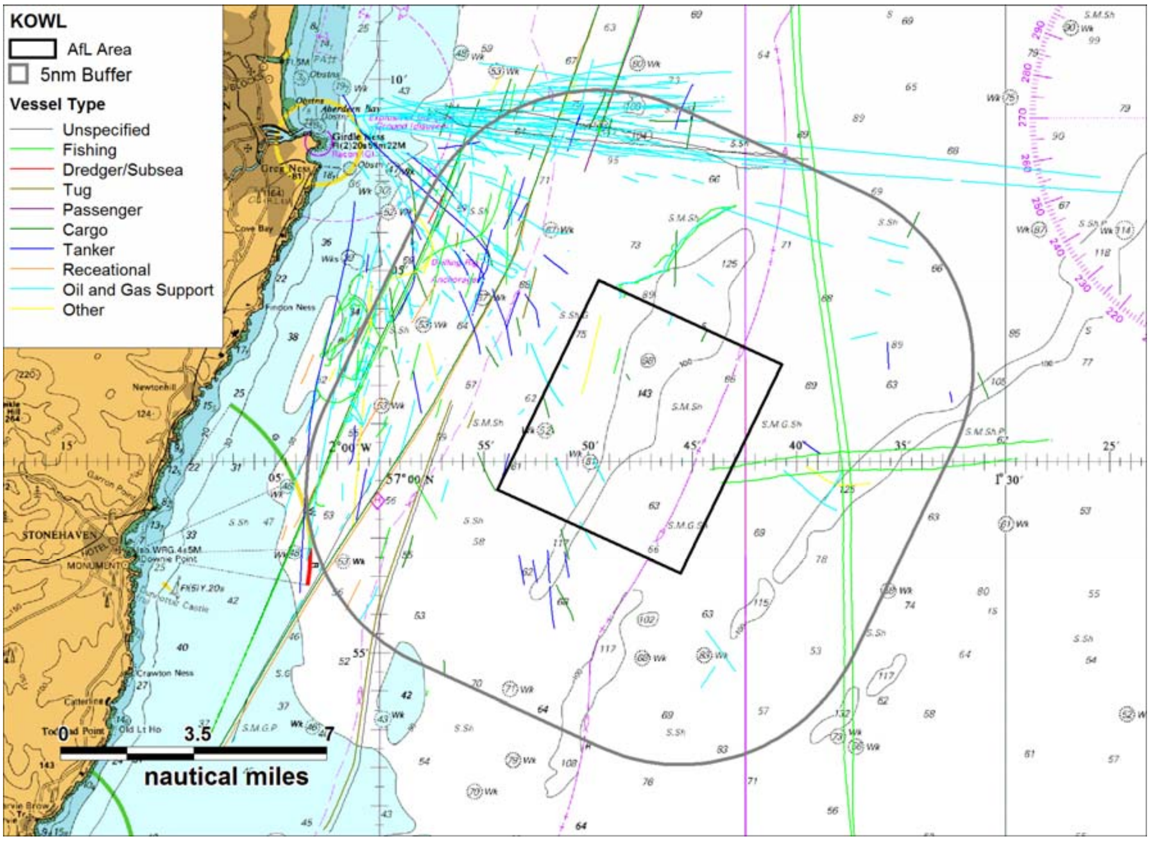

Figure 17.3 AIS and Radar Encounters

The distribution of vessel types involved in the recorded encounters is presented in Figure 17.4.

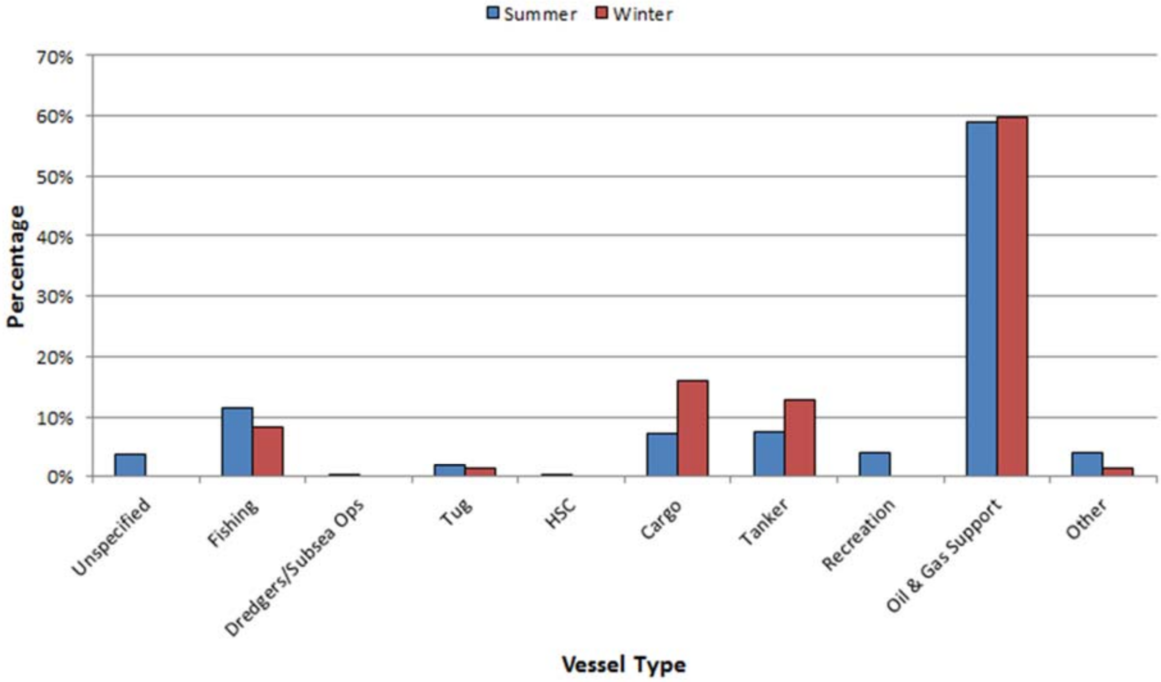

Figure 17.4 AIS and Radar Encounters – Vessel Type Distribution

The majority of vessels involved in encounter situations were related to oil and gas support during both summer (59%) and winter (60%). During winter, cargo vessels and tankers accounted for 16% and 13% respectively, falling to 7% and 8% respectively in summer. Fishing vessels accounted for 11% of vessels involved in summer encounters, and 8% of those in winter.

17.2.2. Vessel to Vessel Collision

Based on the current routing and encounter levels in the area, Anatec's CollRisk model was run to estimate the base case vessel-to-vessel collision risk in the vicinity of the KOWL development area. The marine traffic survey data was used to validate route positions, widths, and traffic levels in the area. The model has been calibrated using 20 years of historical incident data, however it should be noted that minor collisions and incidents in port were not included.

It was estimated that the annual frequency of a vessel being involved in a collision was 1.23×10^{-2} based on the current traffic levels and routing. This corresponds to a vessel being involved in a collision once every 81 years.

17.3. Base Case with KOWL Development

17.3.1. Potential for Increased Vessel to Vessel Collision Risk

The revised routeing pattern following construction of the KOWL Development has been estimated based on the future commercial traffic re-routeing analysis (see section 14.6). It is assumed that vessels would be able to pre-plan their revised passage in advance of encountering the development site as per MGN 372 and effective mitigation will be in place in the form of information distribution about the development through Notices to Mariners, updated charts and Aids to Navigation.

Anatec's CollRisk model was run based on the estimated changes to vessel routing following the installation of the KOWL turbines. This resulted in an increase in frequency of 8.42 x 10^{-5} from the base case. This corresponds to an additional collision every 11,883 years. The results are presented graphically in Figure 17.5.

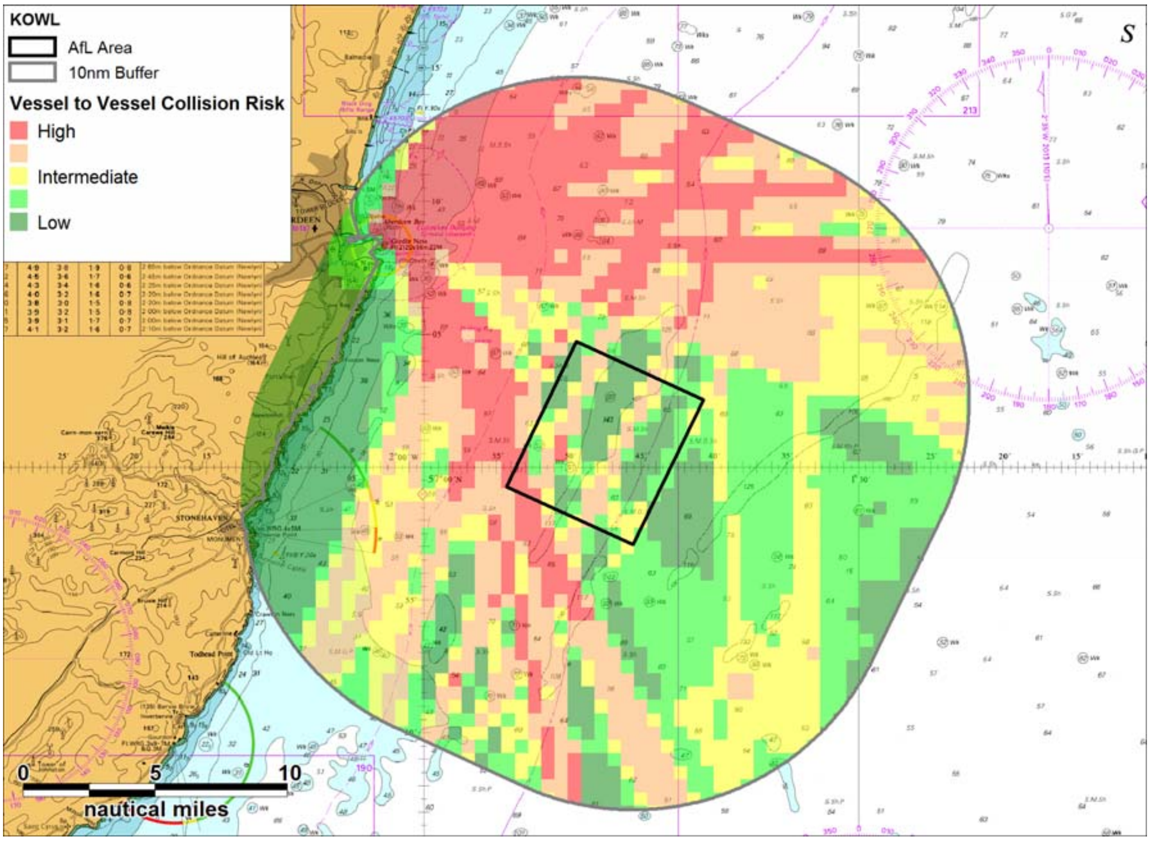

Figure 17.5 Vessel to Vessel Collision Risk

As previously mentioned, the model is calibrated on major incidents occurring at sea, which allows for benchmarking but does not cover all incidents, such as those with minor effects.

17.3.2. Potential for Additional Vessel Allision with Structure Allision Risk

There are two main scenarios that could lead to passing vessels alliding with offshore structures such as wind turbines:

- Powered Allision: Vessel is under power but errant;
- Drifting Allision: Vessel on a passing route suffers propulsion failure and subsequently drifts under the influence of the prevailing weather/tidal conditions.

These scenarios are assessed below.

17.3.2.1. Powered Vessel to Structure Allision

Anatec's CollRisk model was run to determine the frequency of a vessel under power alliding with a KOWL turbine. Assuming current traffic vessels and the anticipated change in routeing following the construction of the KOWL Development, a vessel to turbine allision is not considered a likely event. It is noted that this is based on the assumption that effective mitigation measures are put in place to ensure mariners are aware of the presence of the turbines, such as Notices to Mariners, updated charts, and clear lights and markings.

It was estimated that the annual frequency of a vessel colliding with one of the KOWL turbines whilst under power was 3.99×10^{-4}, which corresponds to an incident once every 2,505 years. This is based on the predicted routeing of vessels following the turbine installation and local metocean data. This is lower than the historical UKCS average of 5.3×10^{-4} per installation-year (1 in 1,900 years).

17.3.2.2. Drifting Vessel to Structure Allision

The risk of a vessel losing power and subsequently drifting into a turbine was estimated using Anatec's CollRisk model. The model assumes a vessel suffers engine breakdown before it drifts, and takes into account the type and size of vessel, number of engines and average time needed to repair in different conditions.

The predicted route alterations following KOWL Development construction and current traffic levels were used to estimate the vessel exposure profile within 10nm of the KOWL site. The exposure times were divided by vessel type and size, allowing the model to assign appropriate factors based on analysis of historical accident data to the exposure profile.

The following drift scenarios have been modelled:

- Weather;
- Peak Spring Flood Tide;
- Peak Spring Ebb Tide.

The worst case result was seen to be the wind rose scenario. 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.

It was estimated that the annual frequency of a vessel drifting into a KOWL turbine was 5.52×10^{-5}, which corresponds to an allision once every 18,107 years. The low frequency is in line with historical data, as there are no recorded incidents of a passing vessel drifting into an offshore installation on the UKCS in over 6,000 operational-years. It is noted that there are recorded incidents of vessels drifting within UK waters, however this has never led to a collision as drifting vessels have always recovered by anchoring, successfully repairing the engines, or receiving help from a towing vessel. It should be taken into consideration that there have been a small number of "near-misses".

17.3.3. 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 and the experience of collisions between fishing vessels and UK Continental Shelf (UKCS) offshore installations (published by Health and Safety Executive (HSE)).

The fishing model takes into account fishing density in the area of interest. As seen in Section 6.5, the majority of fishing activity occurred east of Stonehaven and Aberdeen, out with the AfL. For this reason, fishing densities were estimated for both the AfL site alone and the entire 10nm study area.

It was estimated that the frequency of a fishing vessel colliding with a turbine, assuming the density level for the whole study, was 1.15×10^{-1}, or once every 9 years. This fell to once every 205 years if the risk was modelled using the density seen within the AfL alone. It is noted that vessels are likely to avoid turbines once they are installed, which is not accounted for in the model.

17.3.4. 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

17.3.4.1. 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 22m above all tidal states, given that the turbines float. This matches the MCA and RYA guidance.

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 17.6 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.

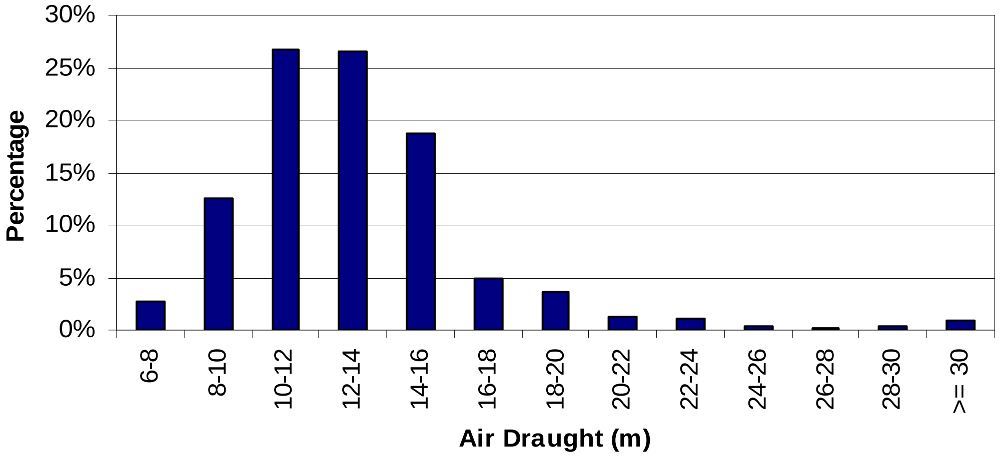

Figure 17.6 Air Draught Data – IRC Fleet (2002)

From this data, just under 4% 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 further noted that the wind farm 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 MGN 371 (MCA, 2008a).

17.4. Future Case with KOWL Development

. The potential increase in traffic levels, as discussed in Section 14, which looks at the historical trend, will increase the probability of vessel-to-structure allisions (both powered and drifting). Whilst in reality the risk would vary by type, size and route, it is roughly estimated that this would lead to a linear 10% increase in ship movements and hence in the base case collision risks.

The increased shipping would also increase the probability of vessel-to-vessel encounters and hence collisions. Whilst this is not a direct result of the KOWL development, the increased congestion caused by the site and potential displacement of fishing / recreation activity in the area may have an influence. In this case, the predicted collision frequency increase has been modelled with and without the KOWL development based on the forecast traffic increases.

It is recognised that such future predictions have a degree of uncertainty. Monitoring will take place to identify any significant changes in navigational usage of the area over the life of the development.

17.5. Risk Results Summary

The base case and future case results annual levels of risk are presented in Table 17.1. The change in risk is also shown, i.e., the estimated collision risk with the wind farm minus the baseline collision risk without the wind farm (which is zero except for vessel-to-vessel collisions). Following this, the annual collision risk for all scenarios is illustrated in Figure 17.7.

Table 17.1 Summary of Results

Collision Scenario	Base Case			Future Case		
	Without	With	Change	Without	With	Change
Passing Powered	--	3.99×10^{-4}	3.99×10^{-4}	--	4.39×10^{-4}	4.39×10^{-4}
Passing Drifting	--	5.52×10^{-5}	5.52×10^{-5}	--	6.07×10^{-5}	6.07×10^{-5}
Vessel-to-Vessel	1.23×10^{-2}	1.24×10^{-2}	8.42×10^{-5}	1.36×10^{-2}	1.37×10^{-2}	9.26×10^{-5}
Fishing	--	4.87×10^{-3}	4.87×10^{-3}	--	5.36×10^{-3}	5.36×10^{-3}
Total	8.66×10^{-3}	1.40×10^{-2}	5.38×10^{-3}	9.53×10^{-3}	1.54×10^{-2}	5.92×10^{-3}

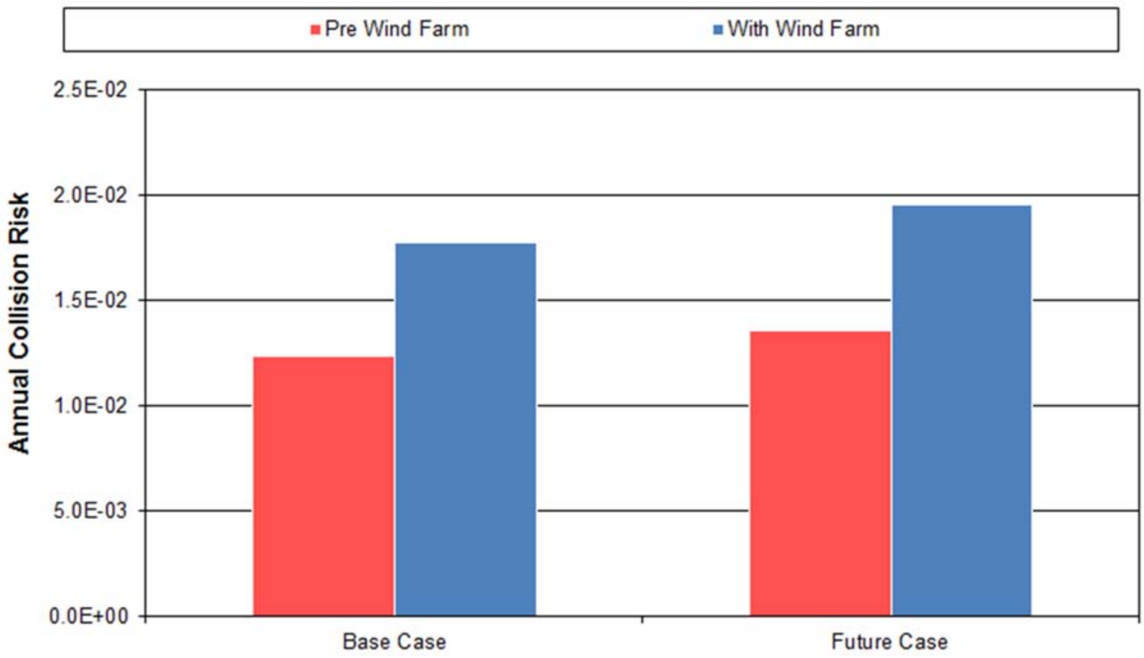

Figure 17.7 Summary of Results

It is estimated that the annual collision risk will rise from one in 186 years to one in 169 years based on a conservative traffic increase.

18. Additional Mitigation Measures

In addition to the industry standard mitigations described in Section 15, the following additional mitigation measures were identified during the Formal Safety Assessment process.

Table 18.1 Additional Mitigation Measures

Additional Mitigation	Summary
Agreement for towage provision	To ensure towing assistance is readily available when needed, for example in the event of a vessel breaking down and drifting towards the KOWL development, and to promulgate information to any third party users.
Operational safety zones	Operational safety zones of up to 500 metres given the excursion of the WTGs from a central point and the risks associated with subsea cables and mooring lines. This will be charted to ensure that the mariner is away of the risk and advised by law not to enter the area due to the risk of air draft and under keel clearance issues.
Warning Signage	Warning signs noting air clearance risk should also be placed on the cross bars between the floatation chambers.
Fisheries Liaison	Extensive information promulgation of information to the fishing community to ensure that the subsea hazards are clear; including liaison with the United Kingdom Hydrographic Office and Kingfisher. Including early liaison with KIS-Orca to ensure relevant information is available for incorporation into fishing vessel plotters. This will ensure fishing vessels are aware of the developments work and allow them to plan accordingly.
Consideration for different fisheries operational over length of export cable regarding protection.	This will ensure all possible types of fishing activity are taken into consideration when cable protection measures are decided.
Fishing awareness course for all KOWL work boat operatives	This will ensure that work boats are aware of the expected fishing activity in the area and are aware of the relevant safety procedures in the event of an incident associated with a fishing vessel.
Advanced auditing of work boat operatives	This will ensure all marine personnel are suitably trained in navigation safety. Suggested inclusion of a KOWL specific navigation safety exam.
Inspection & Maintenance Regime and independent verification of mooring lines/chains.	Inspection and maintenance regime to ensure that the cables and mooring lines (including anchor spread) do not quickly deteriorate over time and pose a hazard including snagging or underwater allision. This should also include 3rd party verification of the mooring systems as requested by the MCA.
Tracking of wind turbines.	Tracking device (design to be confirmed) to be installed on the turbine structure, so that if it float free it can be located again quickly. This may include an excursion alarm to notify an

	extreme excursion (value to be defined) from its central point.
Redundancy in guard vessel provision agreement and inclusion of emergency towing equipment.	Redundancy in guard vessel provision agreement to ensure a guard vessel is on site at all times, including during periods of adverse weather. Emergency towing equipment to be included on guard vessel to allow primary response in the event of an emergency.
Support vessel to accompany towage operation.	A support vessel to provide assistance (if required) in event of an emergency and to liaise with third party vessels (when necessary) during towage.
Pick-up Point/Helicopter Access Point	Use of buoyancy chamber of Windfloat structure as pick-up/helicopter access point.

19. Communication and Position Fixing

19.1. Introduction

The following section summarises the potential impacts of the different communications and position fixing devices used in and around offshore windfarms from the potential effects of the KOWL Development on the physical environment. This section includes a literature review of the industry assessments.

19.2. Impact of Marine Radar

In 2004 the MCA conducted trials within and close to the North Hoyle windfarm off North Wales to determine any impact of wind turbines on marine communications and navigations systems (MCA and QinetiQ, 2004).

The trials indicated that there is minimal impact on VHF radio, 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 vessel 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 Windfarm in the Thames Estuary and by Trinity House in other locations. Based on the results of the North Hoyle trial, the MCA produced the shipping route template (MCA 2004) a non-prescriptive tool used to give guidance on the distances which should be established between shipping routes and offshore windfarms.

A second trial was conducted at Kentish Flats on behalf of BWEA (BWEA 2008). 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 at distances of one nautical mile and more from the windfarm. 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 windfarms could be produced by other strong echoes close to the observing vessel although not necessarily to the same extent;
- Reflections and distortions by conventional ships structures and fittings created many of the effects and that the effects vary from vessel to vessel and radar to radar;
- VTS scanners static radars could 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; and

- Small vessels operating near the windfarm were usually detectable by radar on ships' operating near the array but were less detectable when the small vessel was operating within the array.

The potential radar interference is mainly a problem during periods of bad visibility when ARPA may not detect and track smaller vessels in the vicinity mariners may not be able to visually confirm their presence (i.e. those without AIS installed which are usually fishing and recreational craft).

Based on the trials carried out to date the onset range from the turbines of false returns is about 1.5nm, with progressive deterioration in the radar display as the range closes.

It should be noted that MCA and MoD trials show that problems are also produced on the radars of SAR helicopters, restricting the detection of small vessels and casualties within windfarms.

19.3. KOWL Radar Impact

Figure **19**.1 presents the turbine locations surrounded by 500m, 1.5nm, and 2nm buffers relative to the future case main routes.

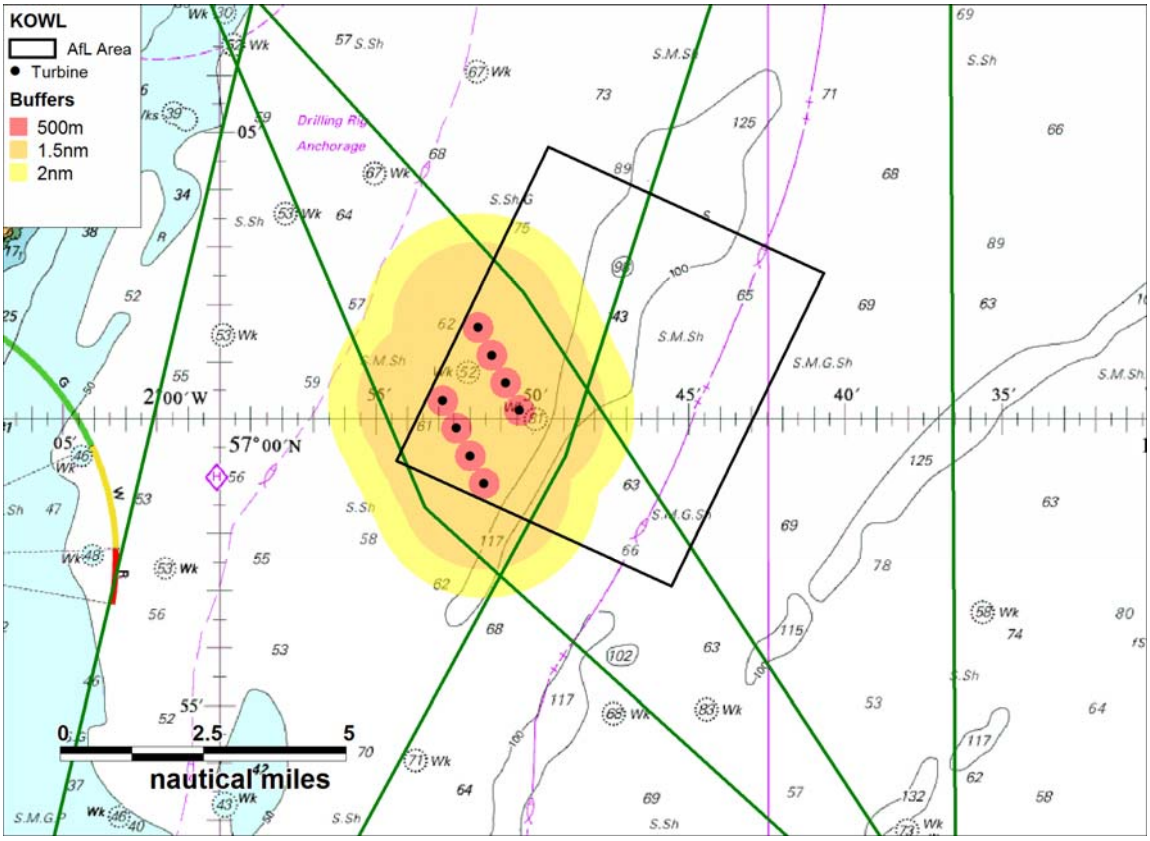

Figure 19**.1 KOWL Turbine Radar Interference Buffers**

The radar effects described are only likely to be experienced within 1.5nm of the WTGs.

The effects will be less severe than other offshore wind farms in the UK due to there being only eight structures.

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. AIS will also help to determine if a target is valid, as most vessels in this area mandatorily carry AIS.

Experienced mariners should be able to suppress the observed problems to an extent and for short periods 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 glass reinforced plastic (GRP) constructed craft, therefore due care is needed in making such adjustments (MCA, 2008b).

The Kentish Flats 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 KOWL site. However, although greater vigilance is required, it appears that during the Kentish Flats 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 learn to work with and around the effects, there is potential for radar impacts to increase 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 OREIs off the UK coast (MCA, 2008b).

Due to there being only eight structures present at the KOWL Development, and given the high standard of the majority of the passing shipping, it is not anticipated that radar effects will be significant.

19.4. Very High Frequency (VHF) Communications (including Digital Selective Calling (DSC))

Vessels operating in and around offshore windfarms have not noted any noticeable effects on VHF (including voice and DSC communications). No significant impact is anticipated at the KOWL Development and therefore has been scoped out of the EIA assessment.

19.5. VHF Direction Finding

No significant impact has been noted at other sites and none are expected at the KOWL Development and therefore has been scoped out of the EIA assessment.

19.6. Navtex Systems

No significant impact has been noted at other sites and none are expected at the KOWL Development and therefore has been scoped out of the EIA assessment.

19.7. AIS

No significant impact is anticipated for AIS signals being transmitted and received at the KOWL Development and therefore has been scoped out of the EIA assessment.

19.8. GPS

No significant impact has been noted at other sites and none are expected at the KOWL Development and therefore has been scoped out of the EIA assessment.

19.9. Structures and Generators affecting Sonar Systems in Area

No evidence has been found to date with regard to existing windfarms 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 KOWL Development and therefore has been scoped out of the EIA assessment.

19.10. Electromagnetic Interference on Navigation Equipment

A compass, magnetic compass or mariner's compass is a navigational instrument for determining direction relative to the earth's magnetic poles. It consists of a magnetised pointer (usually marked on the North end) free to align itself with Earth's magnetic field. A compass could be used to calculate heading, used with a sextant to calculate latitude, and with a marine chronometer to calculate longitude.

Like any magnetic device, compasses are affected by nearby ferrous materials as well as by strong local electromagnetic forces, such as magnetic fields emitted from power cables. As the compass still serves as an essential means of navigation in the advent of power loss or a secondary source, it should not be allowed to be affected to the extent that safe navigation is prohibited.

19.10.1. Wind Turbines

No problems with respect to magnetic compasses were reported. However, small vessels with simple magnetic steering and hand bearing compasses should be wary of using these close to wind turbines as with any structure in which there is a large amount of ferrous material (MCA and QinetiQ 2004).

19.10.2. Export and Inter Array Cables

Previous consultation with the MCA has indicated that cables should not result in more than five degrees of compass deviation for marine vessels. The important factors that affect the resultant deviation are:

- Water and burial depth;
- Current (alternating or direct) running through the cables;
- Spacing or separation of the two cables in a pair (Balanced Monopole and Bipolar designs); and/or
- Cable route alignment relative to earth's magnetic field.

It is noted that all equipment and cables would be rated and in compliance with design codes. In addition the cables associated with the windfarm would be buried and any generated fields would be very weak and would have no impact on navigation or electronic equipment. No impact is anticipated for the KOWL Development.

19.11. Noise Impact

19.11.1. Acoustic Noise Masking Sound Signals

Therefore, there is no indication that the sound level of the KOWL Development would have any significant influence on marine safety.

19.11.2. Noise Impacting Sonar

Once in operation it is not believed that the subsea acoustic noise generated by the windfarm would have any significant impact on sonar systems. It is noted that these systems are already designed to work in noisy environments.

19.12. Effects on Visual Collision / Allision Avoidance

19.12.1. Visual Impact (Other Vessels)

The spacing (minimum of 1,00m) and alignment of the proposed turbine locations is not expected to create visual “blind spots” between vessels. A small vessel emerging from the turbines should be visible to other vessels for the vast majority of time.

19.12.2. Visual Impact (Navigational Aids and/or Landmarks)

As the KOWL Development is to be suitably marked and lit, it is not expected to affect a vessel’s ability to safely navigate in the area through visual impairment. In particular, it is noted that the Development does not impact on any pre-existing navigational aids.

20. Cumulative and In-Combination Effects

20.1. Introduction

A number of projects and marine activities were scoped out of the assessment with regards to vessel movement as these were considered to be part of the baseline marine environment for vessel traffic. This includes traffic associated with fishing activity and recreational craft transits. The following table (Table 20.1) notes developments in proximity to the KOWL development and indicates if they have been considered throughout the cumulative impact assessment.

Table 20.1 Cumulative Screening

Development	Distance from KOWL development (nm)	Status	Data Confidence	Screened In
MOD Marine Activities: Drum Links Firing Range (X5722), Black Dog Rifle Range (X5703), Central Managed Defence Area (D613A)	Various	On Going	Medium	No- No cumulative impact anticipated.
28th Round Oil and Gas Potential Award License Blocks: 26/3 (part), 26/4, 26/5, 26/7, 26.8, 26/9, 26/10, 26/13 (part), 27/1 (part), and 27/6 (part).	3.3 (closest)	Early Planning	Medium	No- No cumulative impact anticipated.
Nigg Bay (Aberdeen) port development.	8.1	Early Planning	High	Yes- Potential for cumulative impact on port operations and vessel routeing. Potential overlaps in construction activity
European Offshore Wind Development Centre (Aberdeen)	9.1	Consent Authorised	High	Yes- Potential for cumulative impact during towage of WTGs from Nigg (Cromarty

Development	Distance from KOWL development (nm)	Status	Data Confidence	Screened In
				Firth).
Seagreen – Alpha and Bravo Offshore Wind Farms	16.5	Consent Authorised	High	Yes- Potential for cumulative impact upon vessel routeing.
Forties – Cruden Bay Oil Pipeline	19.5	Fully Commissioned	High	No- No cumulative impact anticipated.
Hywind Floating Offshore Wind Farm	24.6	Consent Application Submitted	High	Yes- Potential for cumulative impact upon vessel routeing and during towage of WTGs from Nigg (Cromarty Firth).
Inch Cape Offshore Wind Farm	25.1	Consent Authorised	High	Yes- Potential for cumulative impact upon vessel routeing.
27th Round Oil and Gas Current License Blocks: 20/16	28.1	Early Planning	Medium	No- No cumulative impact anticipated.
Neart na Gaoithe Offshore Wind Farm	40.5	Consent Authorised	High	Yes- Potential for cumulative impact upon vessel routeing.
Fife Energy Park Offshore Demonstration Wind Turbine	60.9	Fully Commissioned	High	No- No cumulative impact anticipated.

Development	Distance from KOWL development (nm)	Status	Data Confidence	Screened In
2B Energy Demonstrator	61.3	Early Planning	High	No- No cumulative impact anticipated.
Moray Offshore Wind Farm	67.7	Consent Authorised	High	Yes- Potential for cumulative impact during towage of WTGs from Nigg (Cromarty Firth).
Beatrice Offshore Wind Farm	68.9	Consent Authorised	High	Yes- Potential for cumulative impact during towage of WTGs from Nigg (Cromarty Firth).
Dounreay Floating Offshore Wind Development Centre	115.3	Early Planning	Low	No- No cumulative impact anticipated.

20.2. Screened In Cumulative Developments

The cumulative developments that have been screened in are presented relative to the KOWL Development in **Error! Reference source not found.**. The cumulative impact of the screened in developments is presented in ES Chapter 10 (Shipping and Navigation).

21. Cost Benefit Analysis

The FSA guidelines includes a process of Cost Benefit Assessment (CBA) to rank the proposed risk control options in terms of risk benefit related to life cycle costs. This will be considered in terms of gross cost of averting a fatality (GCAF). This is a cost effectiveness measure in terms of ratio of marginal (additional) cost of the risk control option to the reduction in risk to personnel in terms of the fatalities averted. GCAF can be calculated as:

$$\frac{\textbf{COST}}{\textbf{RISK}}$$

Until final specifications of mitigation measures are defined a review of cost benefit analysis cannot be undertaken, however, KOWL is committed to implementing mitigation measures to ensure risks are As Low As Reasonably Practicable (ALARP).

22. Through Life Safety Management

22.1. Safety Policy and Safety Management System

QHSE documentation including a policy statement and Safety Management Systems (SMS) will be continually updated throughout the development process. The following sections provide an overview of documentation and how it will be maintained and reviewed with reference where required to specific marine documentation.

Monitoring, reviewing and auditing will be carried out on all procedures and activities and feedback actively sought. The designated person (identified in QHSE documentation), managers and supervisors are to maintain continuous monitoring of all marine operations and determine if all required procedures and processes are being correctly implemented.

22.2. Future Monitoring

The operator has a commitment to manage the risks associated with the activities undertaken at the proposed development site and associated works. It will establish an integrated management system which ensures that the safety and environmental impacts of those activities are tolerable. This includes the use of remote monitoring and switching for Aids to Navigation to ensure that if a light is faulty a quick fix can be instigated from the marine control centre.

22.3. Future Monitoring of Marine Traffic

The necessity of this will be decided in consultation with the MCA and an approach and duration determined post-consent.

22.4. Decommissioning Plan

A decommissioning plan will be developed. With regard to impacts on shipping and navigation this will also include consideration of the scenario where, on decommissioning and on completion of removal operations, an obstruction is left on site (attributable to the development) which is considered to be a danger to navigation and which has not proved possible to remove. Such an obstruction may require to be marked until such time as it is either removed or no longer considered a danger to navigation, the continuing cost of which would need to be met by the developer/operator.

23. Summary

23.1. Introduction

A Navigational Risk Assessment for the proposed Kincardine Offshore Wind Farm has been undertaken in line with the MCA and DECC guidance for such assessments. Extensive relevant baseline data was collected comprising seasonal marine traffic survey data (AIS, Radar, and visual surveys), desk-based studies, and consultation with local stakeholders and experts for use in the assessment.

23.2. Consultation

As part of the Formal Safety Assessment process, statutory and local stakeholders, and local regular operators were consulted regarding the KOWL Development. All relevant comments received were mentioned and addressed within the NRA and ES Chapter 10 (Shipping and Navigation).

23.3. Marine Traffic Surveys

Two marine traffic surveys were performed for use in this assessment, a summer survey consisting of AIS, radar, and visual vessel recording from Portlethen, and a winter survey consisting of AIS data collection from coastal AIS receivers. Both surveys showed that oil and gas support vessels accounted for the majority of traffic in the area (approximately 60%).

The significant fishing in the area was recorded to the east of Stonehaven, and east of Aberdeen harbour. The majority of other fishing vessels appeared to be on passage rather than actively engaged in fishing.

The vast majority of anchoring activity occurred in the designated anchorage to the north of Aberdeen, however three vessels were recorded at anchor within the KOWL AfL, all related to oil and gas.

The majority of recreational activity was coastal, however an average of one recreational vessel per day interested the AfL boundary.

23.4. Collision Risk Modelling

Anatec's CollRisk models were used to quantitatively assess the collision risks associated with the KOWL development. Vessel-to-vessel, powered vessel-to-structure, drifting vessel-to-structure, and fishing vessel collision risks were all modelled. The most significant risk was seen to be from vessel-to-vessel collisions, with one incident estimated to occur per 81 years, however the rise in risk from the base case associated with KOWL was not significant, corresponding to an additional collision once every 11,883 years.

Based on current traffic levels a drifting collision was estimated to occur once every 18,107 years, and a powered collision once every 2,505 years. A fishing vessel collision was estimated to occur once every 205 years, however this assumed the turbines would have no effect on current fishing patterns and locations.

23.5. Formal Safety Assessment

A Formal Safety Assessment was carried out, combining expert opinion, local knowledge, and a hazard workshop. The hazard workshop was hosted by Anatec Ltd on the 20th August 2015, the purpose of which was to consult with both statutory and local stakeholders to identify potential hazards relating to shipping and navigation safety relating to the KOWL project.

The majority of identified hazards were considered to be "broadly acceptable", however the following were considered "tolerable":

- Snagging risk to fishing vessels from subsea equipment prior to or after commissioning (worst case scenario);
- Increased allision risk to fishing and recreational vessels (powered and drifting) with turbines (worst case scenario);
- De-masting of a recreational vessel (worst case scenario);
- Increased vessel deviations due to avoidance of construction safety zones/areas (most likely scenario); and
- Increased vessel deviations due to avoidance of site (most likely scenario).

23.6. Impact Assessment for EIA

Following identification of both future case impacts and the outcomes of the Formal Safety Assessment, an impact assessment in line with EIA guidance has been undertaken. This impact assessment screens the baselines data from the NRA and makes a necessart. The impact assessment can be found in ES Chapter 10 (Shipping and Navigation). The following sections provide more information about the methodology and inputs for the impact assessment.

24. References

- BWEA (2008). *Investigation of Technical and Operational Effects on Marine Radar Close to Kentish Flats Offshore Wind Farm*. London: BWEA (now RUK), DECC, MCA & PLA.

- DECC (2005): *Guidance on the Assessment of the Impact of Offshore Wind Farms: Methodology for Assessing the Marine Navigational Safety Risks of Offshore Wind Farms*. London: Department of Energy & Climate Change.

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Kincardine Offshore Wind Farm Navigation Risk Assessment (Annex 2 - Hazard Log)

Prepared by:	Anatec Limited
Presented to:	Kincardine Offshore Wind Ltd.
Date:	17 September 2015
Revision No.:	00
Reference:	A3414-KOWL-NRA-3

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1. Introduction

This report presents the Hazard Log for the navigational risks associated with the proposed KOWL development.

The workshop was held in Aberdeen on 20th August 2015 and was attended by local maritime stakeholders, as outlined in Table 1.1.

Table 1.1 Hazard Review Workshop Attendees

Attendee	Organisation
Allan MacAskill	Pilot Offshore Renewables
Sam Westwood	Anatec
Sandy Bendall	
Stuart Carruthers	Royal Yachting Association
Craig Wilson	DOF Group
John Watt	Scottish Fisherman's Federation
Peter West	
Ian Balgowan	
Pete Lowson*	Maritime and Coastguard Agency

The following sections define the methodology to be used when undertaking the Hazard Workshop for identifying navigational risks associated with the KOWL development. The methodology outlines the purpose of the workshop, the outline of day and the process of identifying and assessing the hazards.

When assessing the risks associated with siting a new offshore wind farm development, as per the requirements of the Maritime and Coastguard Agency (MCA) Marine Guidance Note (MGN) 371 and the Department of Energy and Climate Change (DECC) 'Methodology for Assessing Marine Navigation Risk's', a Hazard Log must be produced to identify hazards that are introduced or altered by the development.

The level of risk associated with these hazards must be assessed and suitable risk reduction measures put in place when the risk level is too high, in order to bring it down to acceptable levels. It is essential that this is undertaken at this stage in the process so that hazards can be identified, risks can be assessed and risk reduction measures can be put in place, thus ensuring that the only risks remaining are those which have been defined as 'broadly acceptable' or those which are tolerable and being controlled to keep them 'As Low As Reasonably Practicable' (ALARP).

During the hazard workshop, vessel types were considered separately to ensure the risk levels are assessed for each type and that the risk reduction measures were identified on a type-specific basis, e.g., specific risk reduction measures for fishing vessels differ to those for commercial vessels. Different phases of a project (i.e. construction, operation & maintenance and decommissioning) were taken into account as some hazards may only be relevant within certain phases. The inclusion of hazards such as dropped objects and man overboard will help to create a more comprehensive, preliminary hazard log for the project.

In addition to creating the hazard log, another important element of the day was gaining input and gathering information from stakeholders who have local and site specific knowledge about the area surrounding the proposed development.

2. Objectives

The objectives of the hazard workshop were to:

- Identify the navigational risks associated with the KOWL development.
- Discuss possible causes;
- Assess the consequences of the scenario (most likely and worst case);
- Discuss mitigation measures; and
- Agree level of residual risk.

3. Consequence and Frequency Bands

Rankings for severity of consequence are shown in Table 3.1.

Table 3.1 Severity of Consequence

Description	Definition
Negligible	• No injury to persons • No significant damage to infrastructure or vessel • No environmental impacts (marine pollution) • No significant operational impacts
Minor	• Slight injury(s) to person • Minor damage to infrastructure or vessel • Tier 1 pollution assistance (marine pollution) • Minor operation impacts
Moderate	• Multiple moderate or single serious injury to persons • Moderate damage to infrastructure or vessel • Tier 2 pollution assistance (marine pollution) • Considerable operational impacts
Serious	• Serious injury or single fatality • Major damage to infrastructure or vessel • Tier 2 pollution assistance (marine pollution) Major national business, operation or reputation impacts
Major	• More than one fatality • Extensive damage to infrastructure or vessel • Tier 3 pollution assistance (marine pollution) • Major international business, operation or reputation impacts

Consequence has then been assessed against frequency to identify overall tolerability of the impact. Ranking for frequency of occurrence are shown in
Table 3.2.

Table 3.2 Frequency of Occurrence

Description	Definition
Negligible	Only likely to happen in exceptional circumstances.
Extremely Unlikely	Unlikely to happen but not exceptional throughout all phases of the project.
Remote	Likely to happen throughout phases of the project.
Reasonably Probable	Extremely likely to happen throughout phases of the project.
Frequent	Would occur daily throughout phases of the project.

The following tables show the overall tolerability rankings (Table 3.4) impacts according to their severity of consequence and frequency of occurrence (

Table 3.3).

Table 3.3 Shipping and Navigation Risk Matrix

Frequency	Frequent	Tolerable	Tolerable	Unacceptable	Unacceptable	Unacceptable
	Reasonably Probable	Broadly Acceptable	Tolerable	Tolerable	Unacceptable	Unacceptable
	Remote	Broadly Acceptable	Broadly Acceptable	Tolerable	Tolerable	Unacceptable
	Extremely Unlikely	Broadly Acceptable	Broadly Acceptable	Broadly Acceptable	Tolerable	Tolerable
	Negligible	Broadly Acceptable	Broadly Acceptable	Broadly Acceptable	Broadly Acceptable	Tolerable
		Negligible	Minor	Moderate	Serious	Major
		Consequence				

Table 3.4 Tolerability Matrix

	Broadly Acceptable	Risk ALARP with no additional mitigations or monitoring required above embedded mitigations.
	Tolerable	Risk acceptable but may require additional mitigation measures and monitoring in place to control and reduce to ALARP.
	Unacceptable	Significant risk mitigation or design modification required to reduce to ALARP.

4. Results

Following the workshop a Hazard Log was developed and issued for consultation with those that attended as well as those organisations that were invited and could not attended. The following impacts for the KOWL development were identified:

Construction and Decommissioning:

- Increased powered collision risk with construction / decommissioning vessels;
- Increased drifting collision risk with construction / decommissioning vessels;
- Vessel to vessel collision due to avoidance of construction / decommissioning safety zones or areas;
- Vessel anchoring on or dragging over subsea equipment (installed cable and mooring system) prior to commissioning;
- Snagging risk to fishing vessels associated with subsea equipment (installed cable and mooring system) prior to commissioning;
- Increased encounter and collision risk during towing operations; and
- Increased vessel deviations due to avoidance of construction safety zones / areas.

Operation and Maintenance:

- Increased powered allision risk with turbines (operational);
- Increased drifting allision risk with turbines (operational);
- Increased allision risk (both powered and drifting) with turbines (off-station), i.e. turbine has become floating hazard;
- Increased vessel to vessel collision due to avoidance of operational site;
- Potential de-masting (vertical gear allision);
- Potential UKC interaction with subsea infrastructure;
- Impacts on adverse weather routeing and anchoring;
- Vessel anchoring on or dragging over subsea equipment (installed export cable and turbine mooring system);
- Snagging risk to fishing vessels associated with the subsea mooring equipment and export cable route; and
- Increased vessel deviations due to avoidance of operational site.

All Phases:

- Restricted search and rescue capability in an emergency situation; and
- Restricted oil spill response in a pollution incident.

During the hazard workshop, assuming a worst case scenario, 23 of the 28 discussed hazards were judged to be **broadly acceptable**, with the remaining five falling into the **tolerable** category. In terms of the most likely scenarios, only two out of the 28 were considered to be in the **tolerable** category. This is presented in Figure 4.1.

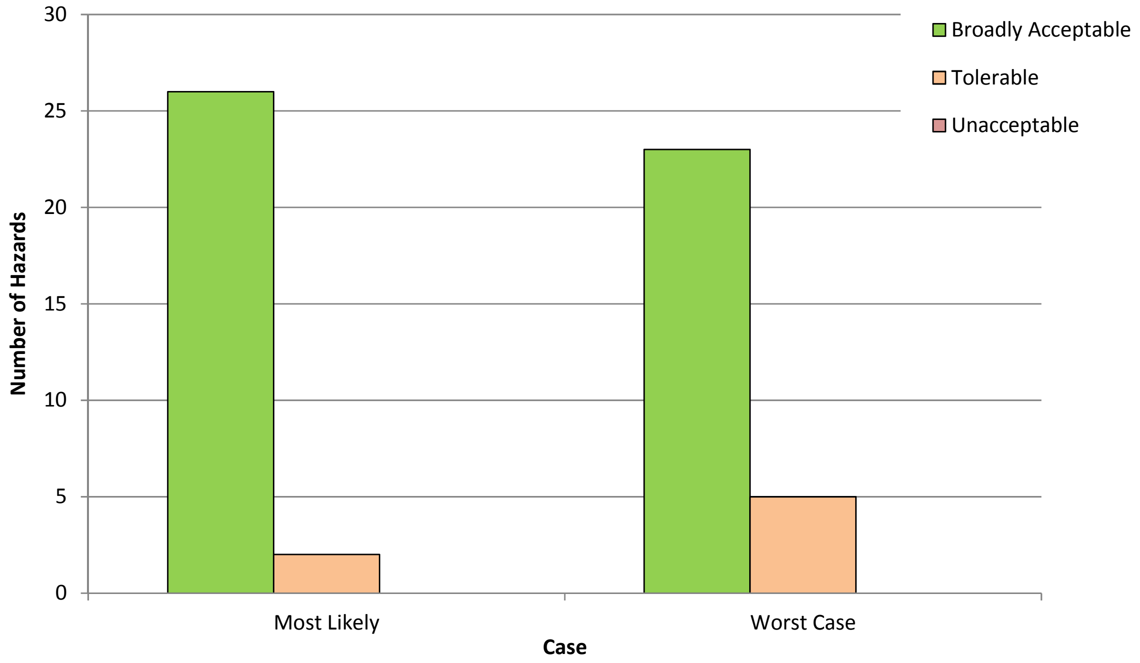

Figure 4.1 Hazard Workshop Results

The five hazards considered **tolerable** in the worst case scenarios were:

- Snagging risk to fishing vessels associated with subsea equipment prior to commissioning;
- Increased allision risk between recreational vessels (both powered and drifting) and turbines;
- Increased allision risk between fishing vessels (both powered and drifting) and turbines;
- Potential de-masting of a recreational vessel; and
- Snagging risk to fishing vessels associated with subsea mooring equipment and export cable route.

The hazards considered **tolerable** assuming most likely scenarios were:

- Increased vessel deviations due to avoidance of construction safety zones/areas; and
- Increased vessel deviations due to avoidance of operational site.

Full details of the logged and ranked hazards are summarised in

Table 4.1 KOWL Development Hazard Ranking Results

Phase (C, O, D)	Category	Hazard Title	Hazard Detail	Possible Causes	Embedded Mitigation	Most Likely Consequence	Realistic Worst Case Consequence	Most Likely: People	Most Likely: Environment	Most Likely: Property (Vessel)	Most Likely: Business	Most Likely: Consequence	Most Likely: Frequency	
C & D	Commercial Vessels (e.g. cargo, tanker, passenger)	Increased **powered** collision risk with construction / decommissioning vessels.	Increased works vessel to third party vessel **powered** collision risk due to the presence of construction / decommissioning vessels (both on site and on route to / from site).	Adverse weather Equipment failure Fatigue Human error Lack of awareness Lack of experience Lack of passage planning Manoeuvring error Navigational aid failure Poor visibility Watch keeper failure	Active monitoring of marine traffic (e.g. AIS, radar and CCTV) AIS fitted on all workboats working within site Charting of site ERCoP Guard Vessel Issue Notice to Mariners / Navtex Marking and lighting Passage planning by vessels Radio reporting with Aberdeen Harbour Ships ARPA radar & watchkeeping Up-to-date charts 24hr Marine coordination centre	Minor damage to vessels. Minor injuries to crew members. Minor environmental impact. Negligible disruption to KOWL operations.	Penetration damage to vessel resulting in severe damage. Possible resulting in fatality. Serious environmental impact. Serious disruption to KOWL operations.	3	3	2	2	3	2	Ac
	Recreational							3	2	1	1	2	3	Ac
	Fishing							3	2	1	1	2	3	Ac
C & D	Commercial Vessels (e.g. cargo, tanker, passenger)	Increased **drifting** collision risk with construction / decommissioning vessels.	Increased works vessel to third party vessel **drifting** collision risk due to the presence of construction / decommissioning vessels (both on site and on route to / from site).	Adverse weather Dragged anchor Equipment failure Human error Lack of awareness Lack of experience Poor holding ground Poor visibility	Active monitoring of marine traffic (e.g. AIS, radar and CCTV) AIS fitted on all workboats working within site Charting of site ERCoP Guard Vessel Issue Notice to Mariners / Navtex Marking and lighting Watchkeeping 24hr Marine coordination centre	Minor damage to vessels. Minor injuries to crew members. Minor environmental impact. Negligible disruption to KOWL operations.	Penetration damage to vessel resulting in severe damage. Possible resulting in fatality. Serious environmental impact. Serious disruption to KOWL operations.	3	3	2	2	3	1	Ac
	Recreational							3	2	1	1	2	2	Ac
	Fishing							3	2	1	1	2	2	Ac

C & D	All Vessels	Vessel to vessel collision due to avoidance of construction / decommissioning safety zones or areas.	Increased third party vessel to third party vessel collision risk due to avoidance of construction / decommissioning safety zones or areas.	Communication failure Failure to comply with Colregs Fatigue Human Error Increased vessel density Lack of awareness Lack of experience Lack of passage planning Poor visibility Watchkeeper failure.	Active monitoring of marine traffic (e.g. AIS, radar and CCTV) AIS fitted on all workboats working within site Compliance with Colregs Continuous watch by multi-channel VHF, including DSC Control of working traffic ERCoP Fisheries Liaison Guard Vessel Issue Notices to Mariners/NAVTEX Kingfisher publications Liaison with Recreational Sailors Passage planning by vessels Ships ARPA radar & watchkeeping Watchkeeping 24hr Marine coordination centre	Minor damage to vessels. Minor injuries to crew members. Minor environmental impact. Negligible disruption to KOWL operations.	Penetration damage to vessel resulting in severe damage. Possible resulting in fatality. Serious environmental impact. Serious disruption to KOWL operations.	3	2	2	1	2	2	I Ac
C & D	All Vessels	Vessel anchoring on or dragging over subsea equipment (installed cable and mooring system) prior to commissioning.	Vessel may anchor over subsea equipment (mooring system and export cable) or a nearby vessel may drag it's anchor prior to commissioning of the wind farm.	Adverse weather Equipment failure Failure to promulgate information Human error Incident in proximity to site Lack of awareness Navigation aid failure Poor holding ground	Active monitoring of marine traffic (e.g. AIS, radar and CCTV) Anchor watch / guard zone Contingency planning for weather Charting of site ERCoP Guard Vessel Kingfisher publications Marker post (onshore) for export cable Notice to Mariners Up-to-date charts 24hr Marine coordination centre	Anchor causes no damage to export cable or mooring system: minor impact on KOWL operations. No impact on vessel. Negligible environmental impact.	Anchor causes major damage to export cable or mooring system: major impact on KOWL operations. Vessel becomes snagged on export cable: potential for serious injury. Minor environmental impact.	2	1	3	3	2	3	I Ac
C & D	Fishing	Snagging risk to fishing vessels associated with subsea equipment (installed cable and mooring system) prior to commissioning.	Fishing vessel drags gear and snags with subsea equipment (mooring system and export cable) prior to commissioning of the wind farm.	Failure to promulgate information Equipment failure Fishing vessels attracted to site Human error Lack of awareness Lack of experience	Abandon gear Charting of site ERCoP Fisheries liaison Guard Vessel Issue to Notices to Mariners / Navtex Kingfisher publications Marking and lighting Notices to Fishermen Up-to-date charts	Fishing vessel loses gear and suffers disruption to fishing operations. No injuries to crew members. Negligible environmental impact. Minor disruption to KOWL operations.	Fishing vessel snags and loses stability resulting in the vessel foundering. Loss of life. Moderate environmental impact. Major disruption to KOWL operations.	1	1	2	2	2	3	I Ac

C & D	All Vessels	Increased encounter and collision risk during towing operations.	Increased vessel to vessel encounter and collision risk during towing of the wind turbine structure from Nigg (Moray Firth) to the Kincardine site.	Communication failure Failure to comply with Colregs Fatigue Human Error Increased vessel density Lack of awareness Lack of experience Lack of passage planning Poor visibility Watchkeeper failure.	AIS fitted on all workboats working within site Compliance with Colregs Continuous watch by multi-channel VHF, including DSC; Control of working traffic ERCoP Fisheries Liaison Issue Notices to Mariners/NAVTEX Kingfisher publications Liaison with Recreational Sailors Marine coordination Passage planning by vessels Ships ARPA radar & watchkeeping Watchkeeping	Vessel encounters towage operation and takes avoiding action. No injuries. No environmental impact. Minor impact on KOWL operations.	Vessel collides with towing vessel / tow, resulting in serious damage to vessels and potential for loss of life. Serious environmental impact. Serious disruption to KOWL operations.	1	1	1	2	1	4	I Ac
C & D	All Vessels	Increased vessel deviations due to avoidance of construction safety zones / areas.	Increased steaming time and deviations for transiting vessels due to avoidance of construction safety zones / areas.	Failure to promulgate information Increased vessel density Lack of passage planning Safety Zones (up to 500m)	Charting of site Issue Notice to Mariners / Navtex Kingfisher publications Marking and lighting Passage planning by vessels Ships ARPA radar & watchkeeping Up-to-date charts	Vessel well informed of KOWL development and is considered throughout passage planning. Early course alteration implemented resulting in minor deviation.	Vessel unaware of KOWL development and therefore is not considered throughout passage planning. Resultant 'dog-leg' style deviation resulting in moderate deviation.	1	1	1	1	1	5	T
O	Commercial Vessels (e.g. cargo, tanker, passenger)	Increased **powered** allision risk with turbines (fully operational).	Due to the physical presence of the wind turbines (fully operational) there could be an increased risk of **powered** vessel allisions with the structures.	Adverse weather Equipment failure Fatigue Human error Lack of awareness Lack of experience Lack of passage planning Manoeuvring error Navigational aid failure Poor visibility Watchkeeper failure	Active monitoring of marine traffic (e.g. AIS, radar and CCTV) Charting of site ERCoP Issue Notice to Mariners / Navtex Kingfisher publications Marking and lighting Passage planning by vessels Ships ARPA radar & watchkeeping Up-to-date charts 24hr marine coordination centre	Minor damage to vessel / structure. Minor injuries to crew members. Minor environmental impact. Negligible disruption to KOWL operations.	Penetration damage to vessel resulting in severe damage. Possible resulting in fatality. Serious environmental impact. Serious disruption to KOWL operations.	3	3	2	2	3	2	I Ac
	Recreational							3	2	1	1	2	3	I Ac
	Fishing							3	2	1	1	2	3	I Ac
O	Commercial Vessels (e.g. cargo, tanker, passenger)	Increased **drifting** allision risk with turbines (fully operational).	Due to the physical presence of the wind turbines (fully operational) there could be an increased risk of **drifting** vessel allisions with the structures.	Adverse weather Dragged anchor Equipment failure Human error Lack of awareness Lack of experience Poor holding ground Poor visibility	Charting of site ERCOP Issue Notice to Mariners / Navtex Marine coordination Marking and lighting Watchkeeping	Minor damage to vessel / structure. Minor injuries to crew members. Minor environmental impact. Negligible disruption to KOWL operations.	Penetration damage to vessel resulting in severe damage. Possible resulting in fatality. Serious environmental impact. Serious disruption to KOWL operations.	3	3	2	2	3	1	I Ac
	Recreational							3	2	1	1	2	2	I Ac
	Fishing							3	2	1	1	2	2	I Ac
O	Commercial Vessels (e.g. cargo, tanker, passenger)	Increased allision risk (both **powered** and **drifting**) with turbines (off-station), i.e. turbine has become floating	Following an equipment failure, the turbine may become a floating hazard and drift off station thus	Adverse weather Equipment failure	Design & testing ERCoP Onsite assistance from workboats in area	Equipment failure and loss of station detected quickly, emergency protocol initiated and	Equipment failure and loss of station not detected and turbine becomes drifting hazard.	2	1	2	4	2	2	I Ac

	Recreational	hazard.	presenting an increased allision risk (both **powered** and **drifting** vessels) for third party vessels.			emergency mitigation measures implemented, e.g. navigational safety broadcasts, guard vessel etc. Minor collision risk. Negligible environmental impact. Serious impact on KOWL operations.	Serious collision risk with potential for fatalities. Serious environmental impact. Major disruption to KOWL operations.	2	1	2	4	2	2	I Ac
	Fishing							2	1	2	4	2	2	I Ac
O	Recreational	Potential de-masting (vertical gear allision).	Potential de-masting (vertical gear allision) of recreational craft due to allision with blades (recreational vessel with mast greater than 22m in height) or supporting cross beam of floating structure.	Adverse weather Equipment failure Fatigue Human error Insufficient air clearance Lack of awareness Lack of experience Lack of passage planning	Charting of site ERCoP Issue Notices to Mariners / Navtex Liaison with recreational sailors Marine coordination Marking and lighting Up-to-date charts	Minor damage to vessel / structure. Minor injuries to crew members. Minor environmental impact. Negligible disruption to KOWL operations.	Loss of mast. Serious injuries to crew members. Minor environmental impact. Serious impact on KOWL operations.	1	2	2	1	2	2	I Ac
O	Recreational	Potential UKC interaction with subsea infrastructure.	Potential under keel clearance interaction with subsea infrastructure (e.g. mooring lines and subsea supporting cross beam).	Adverse weather Equipment failure Fatigue Human error Insufficient under keel clearance Lack of awareness Lack of experience Lack of passage planning	Charting of site ERCoP Issue Notices to Mariners / Navtex Liaison with recreational sailors Marine coordination Marking and lighting Up-to-date charts	Minor damage to vessel / structure. Minor injuries to crew members. Minor environmental impact. Negligible disruption to KOWL operations.	Loss of keel / damage to hull. Serious injuries to crew members. Minor environmental impact. Serious impact on KOWL operations.	1	2	2	1	2	1	I Ac
O	All Vessels	Impacts on adverse weather routeing and anchoring.	Due to the physical presence of the turbines and export cable the overall ability to adverse weather route and anchor may be reduced.	Failure to promulgate information Increased vessel density Lack of passage planning Operational Safety Zones	Charting of site Issue Notice to Mariners / Navtex Kingfisher publications Marking and lighting Passage planning by vessels Ships ARPA radar & watch keeping Up-to-date charts	Minor impact on adverse weather routeing and anchoring due to limited size of development.	Moderate impact on adverse weather routeing and anchoring due to limited size of development. Potential for reduced passenger / crew comfort and minor injury.	1	1	1	2	1	3	I Ac
O	All Vessels	Vessel anchoring on or dragging over subsea equipment (installed export cable and turbine mooring system).	Vessel may anchor over subsea equipment (mooring system and export cable) or a nearby vessel may drag it's anchor.	Adverse weather Equipment failure Failure to promulgate information Human error Incident in proximity to site Lack of awareness Navigation aid failure Poor holding ground	Anchor watch / guard zone Contingency planning for weather Charting of site ERCoP Kingfisher publications Notice to Mariners Up-to-date charts	Anchor causes no damage to export cable or mooring system: minor impact on KOWL operations. No impact on vessel. Negligible environmental impact.	Anchor causes major damage to export cable or mooring system: major impact on KOWL operations. Vessel becomes snagged on export cable: potential for serious injury. Minor environmental impact.	2	1	3	3	2	2	I Ac

O	Fishing	Snagging risk to fishing vessels associated with the subsea mooring equipment and export cable route.	Fishing vessel drags gear and snags with subsea equipment (mooring system and export cable) prior to commissioning of the wind farm.	Failure to promulgate information Equipment failure Fishing vessels attracted to site Human error Lack of awareness Lack of experience	Abandon gear Charting of site ERCoP Fisheries liaison Issue to Notices to Mariners / Navtex Kingfisher publications Marking and lighting Notices to Fishermen Up-to-date charts	Fishing vessel loses gear and suffers disruption to fishing operations. No injuries to crew members. Negligible environmental impact. Minor disruption to KOWL operations.	Fishing vessel snags and loses stability resulting in the vessel foundering. Loss of life. Moderate environmental impact. Major disruption to KOWL operations.	1	1	2	2	2	3	Ac
O	All Vessels	Increased vessel deviations due to avoidance of operational site.	Increased steaming time and deviations for transiting vessels due to avoidance of operational site.	Failure to promulgate information Increased vessel density Lack of passage planning Operational Safety Zones (noting application requirements)	Charting of site Issue Notice to Mariners / Navtex Kingfisher publications Marking and lighting Passage planning by vessels Ships ARPA radar & watchkeeping Up-to-date charts	Vessel well informed of KOWL development and is considered throughout passage planning. Early course alteration implemented resulting in minor deviation.	Vessel unaware of KOWL development and therefore is not considered throughout passage planning. Resultant 'dog-leg' style deviation resulting in moderate deviation.	1	1	1	2	1	5	T
C, O, D	Emergency Response	Restricted search and rescue capability in an emergency situation.	Restricted search and rescue capability in an emergency situation due to the presence of the KOWL development.	Incident in proximity to development	ERCoP Onsite assistance from workboats in area Personal Protective Equipment Site personnel suitably trained	Minor impact on SAR capability (e.g. vessels may have to navigate at reduced speed) but overall provision not impacted.	Serious impact on SAR capability (e.g. impacts overall probability of detection). Potential for fatalities and major impact on KOWL operations.	2	2	2	2	2	3	Ac
C, O, D	Emergency Response	Restricted oil spill response in a pollution incident.	Restricted oil spill response in an emergency situation due to the presence of the KOWL development.	Incident in proximity to development	ERCoP	Minor impact on oil spill response (e.g. vessels may have to navigate at reduced speed) but overall provision not impacted.	Serious impact on oil spill response y (e.g. ability to contain spill / spray dispersant). Potential for serious environmental impact and major impact on KOWL operations.	1	3	1	3	2	2	Ac

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Table 4.1 KOWL Development Hazard Ranking Results

Phase (C, O, D)	Category	Hazard Title	Hazard Detail	Possible Causes	Embedded Mitigation	Most Likely Consequence	Realistic Worst Case Consequence	Most Likely: People	Most Likely: Environment	Most Likely: Property (Vessel)	Most Likely: Business	Most Likely: Consequence	Most Likely: Frequency	Most Likely: Risk	Worst Case: People	Worst Case: Environment	Worst Case: Property (Vessel)	Worst Case: Business	Worst Case: Consequence	Worst Case: Frequency	Worst Case: Risk	Potential Risk Reduction
C & D	Commercial Vessels (e.g. cargo, tanker, passenger)	Increased **powered** collision risk with construction / decommissioning vessels.	Increased works vessel to third party vessel **powered** collision risk due to the presence of construction / decommissioning vessels (both on site and on route to / from site).	Adverse weather Equipment failure Fatigue Human error Lack of awareness Lack of experience Lack of passage planning Manoeuvring error Navigational aid failure Poor visibility Watch keeper failure	Active monitoring of marine traffic (e.g. AIS, radar and CCTV) AIS fitted on all workboats working within site Charting of site ERCoP Guard Vessel Issue Notice to Mariners / Navtex Marking and lighting Passage planning by vessels Radio reporting with Aberdeen Harbour Ships ARPA radar & watchkeeping Up-to-date charts 24hr Marine coordination centre	Minor damage to vessels. Minor injuries to crew members. Minor environmental impact. Negligible disruption to KOWL operations.	Penetration damage to vessel resulting in severe damage. Possible resulting in fatality. Serious environmental impact. Serious disruption to KOWL operations.	3	3	2	2	3	2	Broadly Acceptable	4	4	3	3	4	1	Broadly Acceptable	Advanced auditing of work boat operatives, including a project specific navigational safety exam. Fishing awareness course for all Kincardine work boat operatives. Redundancy in guard vessel provision to ensure onsite permanently.
	Recreational							3	2	1	1	2	3	Broadly Acceptable	4	3	2	2	3	2	Broadly Acceptable	
	Fishing							3	2	1	1	2	3	Broadly Acceptable	4	3	2	2	3	2	Broadly Acceptable	

C & D	Commercial Vessels (e.g. cargo, tanker, passenger)	Increased **drifting** collision risk with construction / decommissioning vessels.	Increased works vessel to third party vessel **drifting** collision risk due to the presence of construction / decommissioning vessels (both on site and on route to / from site).	Adverse weather Dragged anchor Equipment failure Human error Lack of awareness Lack of experience Poor holding ground Poor visibility	Active monitoring of marine traffic (e.g. AIS, radar and CCTV) AIS fitted on all workboats working within site Charting of site ERCoP Guard Vessel Issue Notice to Mariners / Navtex Marking and lighting Watchkeeping 24hr Marine coordination centre	Minor damage to vessels. Minor injuries to crew members. Minor environmental impact. Negligible disruption to KOWL operations.	Penetration damage to vessel resulting in severe damage. Possible resulting in fatality. Serious environmental impact. Serious disruption to KOWL operations.	3	3	2	2	3	1	Broadly Acceptable	4	4	3	3	4	1	Broadly Acceptable	Advanced auditing of work boat operatives, including a project specific navigational safety exam. Agreement for towage provision. Fishing awareness course for all Kincardine work boat operatives. Inclusion of emergency towing equipment on-board guard vessel. Redundancy in guard vessel provision to ensure onsite permanently.
	Recreational							3	2	1	1	2	2	Broadly Acceptable	4	3	2	2	3	1	Broadly Acceptable	
	Fishing							3	2	1	1	2	2	Broadly Acceptable	4	3	2	2	3	1	Broadly Acceptable	

C & D	All Vessels	Vessel to vessel collision due to avoidance of construction / decommissioning safety zones or areas.	Increased third party vessel to third party vessel collision risk due to avoidance of construction / decommissioning safety zones or areas.	Communication failure Failure to comply with Colregs Fatigue Human Error Increased vessel density Lack of awareness Lack of experience Lack of passage planning Poor visibility Watchkeeper failure.	Active monitoring of marine traffic (e.g. AIS, radar and CCTV) AIS fitted on all workboats working within site Compliance with Colregs Continuous watch by multi-channel VHF, including DSC Control of working traffic ERCoP Fisheries Liaison Guard Vessel Issue Notices to Mariners/NAVTEX Kingfisher publications Liaison with Recreational Sailors Passage planning by vessels Ships ARPA radar & watchkeeping Watchkeeping 24hr Marine coordination centre	Minor damage to vessels. Minor injuries to crew members. Minor environmental impact. Negligible disruption to KOWL operations.	Penetration damage to vessel resulting in severe damage. Possible resulting in fatality. Serious environmental impact. Serious disruption to KOWL operations.	3	2	2	1	2	2	Broadly Acceptable	4	4	3	2	3	1	Broadly Acceptable	Redundancy in guard vessel provision to ensure onsite permanently.
C & D	All Vessels	Vessel anchoring on or dragging over subsea equipment (installed cable and mooring system) prior to commissioning.	Vessel may anchor over subsea equipment (mooring system and export cable) or a nearby vessel may drag it's anchor prior to commissioning of the wind farm.	Adverse weather Equipment failure Failure to promulgate information Human error Incident in proximity to site Lack of awareness Navigation aid failure Poor holding ground	Active monitoring of marine traffic (e.g. AIS, radar and CCTV) Anchor watch / guard zone Contingency planning for weather Charting of site ERCoP Guard Vessel Kingfisher publications Marker post (onshore) for export cable Notice to Mariners Up-to-date charts 24hr Marine coordination centre	Anchor causes no damage to export cable or mooring system: minor impact on KOWL operations. No impact on vessel. Negligible environmental impact.	Anchor causes major damage to export cable or mooring system: major impact on KOWL operations. Vessel becomes snagged on export cable: potential for serious injury. Minor environmental impact.	2	1	3	3	2	3	Broadly Acceptable	3	1	4	5	3	2	Broadly Acceptable	Agreement for towage provision. Inclusion of emergency towing equipment on-board guard vessel. Redundancy in guard vessel provision to ensure onsite permanently.

C & D	Fishing	Snagging risk to fishing vessels associated with subsea equipment (installed cable and mooring system) prior to commissioning.	Fishing vessel drags gear and snags with subsea equipment (mooring system and export cable) prior to commissioning of the wind farm.	Failure to promulgate information Equipment failure Fishing vessels attracted to site Human error Lack of awareness Lack of experience	Abandon gear Charting of site ERCoP Fisheries liaison Guard Vessel Issue to Notices to Mariners / Navtex Kingfisher publications Marking and lighting Notices to Fishermen Up-to-date charts	Fishing vessel loses gear and suffers disruption to fishing operations. No injuries to crew members. Negligible environmental impact. Minor disruption to KOWL operations.	Fishing vessel snags and loses stability resulting in the vessel foundering. Loss of life. Moderate environmental impact. Major disruption to KOWL operations.	1	1	2	2	2	3	Broadly Acceptable	4	3	4	5	4	2	Tolerable	Consideration for different fisheries operational over length of export cable regarding protection (if required). Early liaison with KIS-Orca to ensure relevant information is available for incorporation into fishing vessel plotters.
C & D	All Vessels	Increased encounter and collision risk during towing operations.	Increased vessel to vessel encounter and collision risk during towing of the wind turbine structure from Nigg (Moray Firth) to the Kincardine site.	Communication failure Failure to comply with Colregs Fatigue Human Error Increased vessel density Lack of awareness Lack of experience Lack of passage planning Poor visibility Watchkeeper failure.	AIS fitted on all workboats working within site Compliance with Colregs Continuous watch by multi-channel VHF, including DSC; Control of working traffic ERCoP Fisheries Liaison Issue Notices to Mariners/NAVTEX Kingfisher publications Liaison with Recreational Sailors Marine coordination Passage planning by vessels Ships ARPA radar & watchkeeping Watchkeeping	Vessel encounters towage operation and takes avoiding action. No injuries. No environmental impact. Minor impact on KOWL operations.	Vessel collides with towing vessel / tow, resulting in serious damage to vessels and potential for loss of life. Serious environmental impact. Serious disruption to KOWL operations.	1	1	1	2	1	4	Broadly Acceptable	4	4	3	3	4	1	Broadly Acceptable	Support vessel to accompany towage operation.

C & D	All Vessels	Increased vessel deviations due to avoidance of construction safety zones / areas.	Increased steaming time and deviations for transiting vessels due to avoidance of construction safety zones / areas.	Failure to promulgate information Increased vessel density Lack of passage planning Safety Zones (up to 500m)	Charting of site Issue Notice to Mariners / Navtex Kingfisher publications Marking and lighting Passage planning by vessels Ships ARPA radar & watchkeeping Up-to-date charts	Vessel well informed of KOWL development and is considered throughout passage planning. Early course alteration implemented resulting in minor deviation.	Vessel unaware of KOWL development and therefore is not considered throughout passage planning. Resultant 'dog-leg' style deviation resulting in moderate deviation.	1	1	1	1	1	5	Tolerable	1	1	1	3	2	2	Broadly Acceptable	No Further Mitigation Required
O	Commercial Vessels (e.g. cargo, tanker, passenger)	Increased **powered** allision risk with turbines (fully operational).	Due to the physical presence of the wind turbines (fully operational) there could be an increased risk of **powered** vessel allisions with the structures.	Adverse weather Equipment failure Fatigue Human error Lack of awareness Lack of experience Lack of passage planning Manoeuvring error Navigational aid failure Poor visibility Watchkeeper failure	Active monitoring of marine traffic (e.g. AIS, radar and CCTV) Charting of site ERCoP Issue Notice to Mariners / Navtex Kingfisher publications Marking and lighting Passage planning by vessels Ships ARPA radar & watchkeeping Up-to-date charts 24hr marine coordination centre	Minor damage to vessel / structure. Minor injuries to crew members. Minor environmental impact. Negligible disruption to KOWL operations.	Penetration damage to vessel resulting in severe damage. Possible resulting in fatality. Serious environmental impact. Serious disruption to KOWL operations.	3	3	2	2	3	2	Broadly Acceptable	4	4	3	3	4	1	Broadly Acceptable	Application for operational safety zones
	Recreational							3	2	1	1	2	3	Broadly Acceptable	4	3	2	2	3	2	Broadly Acceptable	
	Fishing							3	2	1	1	2	3	Broadly Acceptable	4	3	2	2	3	2	Broadly Acceptable	
O	Commercial Vessels (e.g. cargo, tanker, passenger)	Increased **drifting** allision risk with turbines (fully operational).	Due to the physical presence of the wind turbines (fully operational) there could be an increased risk of **drifting** vessel allisions with the structures.	Adverse weather Dragged anchor Equipment failure Human error Lack of awareness Lack of experience Poor holding ground Poor visibility	Charting of site ERCOP Issue Notice to Mariners / Navtex Marine coordination Marking and lighting Watchkeeping	Minor damage to vessel / structure. Minor injuries to crew members. Minor environmental impact. Negligible disruption to KOWL operations.	Penetration damage to vessel resulting in severe damage. Possible resulting in fatality. Serious environmental impact. Serious disruption to KOWL operations.	3	3	2	2	3	1	Broadly Acceptable	4	4	3	3	4	1	Broadly Acceptable	Agreement for towage provision. Application for operational safety zones
	Recreational							3	2	1	1	2	2	Broadly Acceptable	4	3	2	2	3	1	Broadly Acceptable	
	Fishing							3	2	1	1	2	2	Broadly Acceptable	4	3	2	2	3	1	Broadly Acceptable	

O	Commercial Vessels (e.g. cargo, tanker, passenger)	Increased allision risk (both **powered** and **drifting**) with turbines (off-station), i.e. turbine has become floating hazard.	Following an equipment failure, the turbine may become a floating hazard and drift off station thus presenting an increased allision risk (both **powered** and **drifting** vessels) for third party vessels.	Adverse weather Equipment failure	Design & testing ERCoP Onsite assistance from workboats in area	Equipment failure and loss of station detected quickly, emergency protocol initiated and emergency mitigation measures implemented, e.g. navigational safety broadcasts, guard vessel etc. Minor collision risk. Negligible environmental impact. Serious impact on KOWL operations.	Equipment failure and loss of station not detected and turbine becomes drifting hazard. Serious collision risk with potential for fatalities. Serious environmental impact. Major disruption to KOWL operations.	2	1	2	4	2	2	Broadly Acceptable	4	4	3	3	4	1	Broadly Acceptable	Agreement for towage provision. Independent verification of mooring lines / chains. Application for operational safety zones
	Recreational							2	1	2	4	2	2	Broadly Acceptable	5	3	5	2	4	2	Tolerable	
	Fishing							2	1	2	4	2	2	Broadly Acceptable	5	5	5	2	4	2	Tolerable	
O	Recreational	Potential de-masting (vertical gear allision).	Potential de-masting (vertical gear allision) of recreational craft due to allision with blades (recreational vessel with mast greater than 22m in height) or supporting cross beam of floating structure.	Adverse weather Equipment failure Fatigue Human error Insufficient air clearance Lack of awareness Lack of experience Lack of passage planning	Charting of site ERCoP Issue Notices to Mariners / Navtex Liaison with recreational sailors Marine coordination Marking and lighting Up-to-date charts	Minor damage to vessel / structure. Minor injuries to crew members. Minor environmental impact. Negligible disruption to KOWL operations.	Loss of mast. Serious injuries to crew members. Minor environmental impact. Serious impact on KOWL operations.	1	2	2	1	2	2	Broadly Acceptable	5	3	5	2	4	2	Tolerable	High visibility (retro-reflective) warning signage Application for operational safety zones Use of maintenance lighting (which can be remotely operated) to forewarn vessels of crossbeam presence.

O	Recreational	Potential UKC interaction with subsea infrastructure.	Potential under keel clearance interaction with subsea infrastructure (e.g. mooring lines and subsea supporting cross beam).	Adverse weather Equipment failure Fatigue Human error Insufficient under keel clearance Lack of awareness Lack of experience Lack of passage planning	Charting of site ERCoP Issue Notices to Mariners / Navtex Liaison with recreational sailors Marine coordination Marking and lighting Up-to-date charts	Minor damage to vessel / structure. Minor injuries to crew members. Minor environmental impact. Negligible disruption to KOWL operations.	Loss of keel / damage to hull. Serious injuries to crew members. Minor environmental impact. Serious impact on KOWL operations.	1	2	2	1	2	1	Broadly Acceptable	3	2	2	4	3	1	Broadly Acceptable	High visibility (retro-reflective) warning signage Application for operational safety zones
O	All Vessels	Impacts on adverse weather routeing and anchoring.	Due to the physical presence of the turbines and export cable the overall ability to adverse weather route and anchor may be reduced.	Failure to promulgate information Increased vessel density Lack of passage planning Operational Safety Zones	Charting of site Issue Notice to Mariners / Navtex Kingfisher publications Marking and lighting Passage planning by vessels Ships ARPA radar & watch keeping Up-to-date charts	Minor impact on adverse weather routeing and anchoring due to limited size of development.	Moderate impact on adverse weather routeing and anchoring due to limited size of development. Potential for reduced passenger / crew comfort and minor injury.	1	1	1	2	1	3	Broadly Acceptable	3	1	1	2	2	1	Broadly Acceptable	No Further Mitigation Required
O	All Vessels	Vessel anchoring on or dragging over subsea equipment (installed export cable and turbine mooring system).	Vessel may anchor over subsea equipment (mooring system and export cable) or a nearby vessel may drag it's anchor.	Adverse weather Equipment failure Failure to promulgate information Human error Incident in proximity to site Lack of awareness Navigation aid failure Poor holding ground	Anchor watch / guard zone Contingency planning for weather Charting of site ERCoP Kingfisher publications Notice to Mariners Up-to-date charts	Anchor causes no damage to export cable or mooring system: minor impact on KOWL operations. No impact on vessel. Negligible environmental impact.	Anchor causes major damage to export cable or mooring system: major impact on KOWL operations. Vessel becomes snagged on export cable: potential for serious injury. Minor environmental impact.	2	1	3	3	2	2	Broadly Acceptable	3	1	4	5	3	1	Broadly Acceptable	Application operational safety zones

O	Fishing	Snagging risk to fishing vessels associated with the subsea mooring equipment and export cable route.	Fishing vessel drags gear and snags with subsea equipment (mooring system and export cable) prior to commissioning of the wind farm.	Failure to promulgate information Equipment failure Fishing vessels attracted to site Human error Lack of awareness Lack of experience	Abandon gear Charting of site ERCoP Fisheries liaison Issue to Notices to Mariners / Navtex Kingfisher publications Marking and lighting Notices to Fishermen Up-to-date charts	Fishing vessel loses gear and suffers disruption to fishing operations. No injuries to crew members. Negligible environmental impact. Minor disruption to KOWL operations.	Fishing vessel snags and loses stability resulting in the vessel foundering. Loss of life. Moderate environmental impact. Major disruption to KOWL operations.	1	1	2	2	2	3	Broadly Acceptable	4	3	4	5	4	2	Tolerable	Consideration for different fisheries operational over length of export cable regarding protection (if required). Exploit flexibility of KIS-Orca to include as much information as possible regarding subsea infrastructure Application for operational safety zones
O	All Vessels	Increased vessel deviations due to avoidance of operational site.	Increased steaming time and deviations for transiting vessels due to avoidance of operational site.	Failure to promulgate information Increased vessel density Lack of passage planning Operational Safety Zones (noting application requirements)	Charting of site Issue Notice to Mariners / Navtex Kingfisher publications Marking and lighting Passage planning by vessels Ships ARPA radar & watchkeeping Up-to-date charts	Vessel well informed of KOWL development and is considered throughout passage planning. Early course alteration implemented resulting in minor deviation.	Vessel unaware of KOWL development and therefore is not considered throughout passage planning. Resultant 'dog-leg' style deviation resulting in moderate deviation.	1	1	1	2	1	5	Tolerable	1	1	1	4	2	2	Broadly Acceptable	No Further Mitigation Required

C, O, D	Emergency Response	Restricted search and rescue capability in an emergency situation.	Restricted search and rescue capability in an emergency situation due to the presence of the KOWL development.	Incident in proximity to development	ERCoP Onsite assistance from workboats in area Personal Protective Equipment Site personnel suitably trained	Minor impact on SAR capability (e.g. vessels may have to navigate at reduced speed) but overall provision not impacted.	Serious impact on SAR capability (e.g. impacts overall probability of detection). Potential for fatalities and major impact on KOWL operations.	2	2	2	2	2	3	Broadly Acceptable	4	1	1	5	3	1	Broadly Acceptable	Potential use of buoyancy chamber of Windfloat structure as pick-up point / helicopter access point.
C, O, D	Emergency Response	Restricted oil spill response in a pollution incident.	Restricted oil spill response in an emergency situation due to the presence of the KOWL development.	Incident in proximity to development	ERCoP	Minor impact on oil spill response (e.g. vessels may have to navigate at reduced speed) but overall provision not impacted.	Serious impact on oil spill response y (e.g. ability to contain spill / spray dispersant). Potential for serious environmental impact and major impact on KOWL operations.	1	3	1	3	2	2	Broadly Acceptable	1	5	1	5	3	1	Broadly Acceptable	No Further Mitigation Required

Kincardine Offshore Wind Farm

Navigational Risk Assessment

Annex 1

MGN 371 Checklist

Prepared by:	Anatec Limited
Presented to:	Kincardine Offshore Wind Limited
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Revision Number	**Date**	**Summary of Change**
00	17 September 2015	Initial Draft

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
Annex 1 : Considerations on Site Position, Structures and Safety Zones			
1. Site and Installation Co-ordinates: Developers are responsible for ensuring that formally agreed variations in the co-ordinates of site perimeters and individual OREI structures are made available, on request, to interested parties at all project stages, including application for consent, development, array variation, operation and decommissioning. This should be supplied as authoritative Geographical Information System (GIS) data, preferably in Environmental Systems Research Institute (ESRI) format. Metadata should facilitate the identification of the data creator, its date and purpose, and the geodetic datum used. For mariners' use, appropriate data should also be provided in latitude/ longitude formats.			
2. Traffic Survey			
All vessel types	✓		***Section 6: Marine Traffic Survey Methodology – 6.1 AIS and Radar Survey Overview.*** *Tracking of all vessel types was achieved via a combination of AIS, Radar, and visual surveys.*
Four weeks duration, within 12 months prior to submission of the Environmental Statement	✓		***Section 6: Marine Traffic Survey Methodology – 6.1 AIS and Radar Survey Overview.*** *Data was collected for two survey periods, each with effective survey lengths of 14 days.*
Seasonal variations	✓		***Section 6: Marine Traffic Survey Methodology – 6.1 AIS and Radar Survey Overview.*** *Data from the first survey was collected during July/August 2014. Data from the second was collected during January 2015 to account for seasonal variation.*
Recreational and fishing vessel organisations	✓		***Section 6: Marine Traffic Survey Methodology – 6.4 Recreational Activity & 6.5 Fishing Activity*** *Fishing vessels and recreational vessels were accounted for with the marine traffic surveys. In addition, VMS and Sightings data was used to further assess fishing activity. Fishing and recreational organisations and stakeholders were included in the consultation process.*
Port and navigation authorities	✓		***Section 9.2 Main Port*** *Port and Navigation authorities were identified as part of the baseline.*

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
Assessment			
a. Proposed OREI site relative to areas used by any type of marine craft.	✓		***Section 13 Marine Traffic Survey: 13.2 Survey Analysis*** *Summarises the results of the survey analysis, including vessel type summary.* ***Section 13 Marine Traffic Survey: 13.3 Oil and Gas Support Vessels*** *Presents analysis of oil and gas support traffic in the area based on traffic surveys.* ***Section 13 Marine Traffic Survey: 13.4 Commercial Vessels*** *Presents analysis of commercial vessel traffic in the area based on traffic surveys.* ***Section 13 Marine Traffic Survey: 13.5 Passenger Vessels*** *Presents analysis of passenger vessel traffic in the area based on traffic surveys.* ***Section 13 Marine Traffic Survey: 13.6 Recreational Vessels*** *Presents analysis of recreational vessel traffic in the area based on traffic surveys.* ***Section 13 Marine Traffic Survey: 13.7 Fishing Vessels*** *Presents analysis of fishing vessel activity in the area based on traffic surveys and supplementary data*
b. Numbers, types and sizes of vessels presently using such areas	✓		***Section 13 Marine Traffic Survey: Section 13.2 Survey Analysis*** *Presents analysis of vessel numbers, types, and sizes within area.*
c. Non-transit uses of the areas, e.g. fishing, day cruising of leisure craft, racing, aggregate dredging, etc.	✓		***Section 13 Marine Traffic Survey: 13.6 Recreational Vessels*** *Presents analysis of recreational vessel traffic in the area based on traffic surveys.* ***Section 13 Marine Traffic Survey: 13.7 Fishing Vessels*** *Presents analysis of fishing vessel activity in the area based on traffic surveys and supplementary data*

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
d. Whether these areas contain transit routes used by coastal or deep-draught vessels on passage.	✓		***Section 13 Marine Traffic Survey: 13.2 Survey Analysis*** *Draught analysis demonstrating routing and behaviour of deep draughted vessels.*
e. Alignment and proximity of the site relative to adjacent shipping lanes	✓		***Section 13 Marine Traffic Survey: 13.9 Vessel Routing & Section 14 Future Case Marine Traffic: 14. Commercial Traffic Re-Routeing*** *Studies alignment and proximity of the site relative to adjacent shipping lanes, by analysis of Marine Traffic Survey data.*
f. Whether the nearby area contains prescribed routeing schemes or precautionary areas	✓		***Section 9: Baseline Environment – 9.1: Navigational Features*** *Summarises relevant navigational features in proximity to KOWL Development.*
g. Whether the site lies on or near a prescribed or conventionally accepted separation zone between two opposing routes	✓		***Section 9: Baseline Environment – 9.1: Navigational Features*** *Summarises relevant navigational features in proximity to KOWL Development.*
h. Proximity of the site to areas used for anchorage, safe haven, port approaches and pilot boarding or landing areas.	✓		***Section 9: Baseline Environment – 9.1: Navigational Features & 9.3 Anchorages*** *Examines proximity of KOWL Development to anchorages and pilot boarding areas.*
i. Whether the site lies within port limits, etc. jurisdiction of a port and/or navigation authority.	✓		***Section 9: Baseline Environment – 9.1: Navigational Features*** *Summarises relevant navigational features in proximity to KOWL Development.*
j. Proximity of the site to existing fishing grounds, or to routes used by fishing vessels to such grounds.	✓		***Section 13 Marine Traffic Survey: 13.7 Fishing Vessels*** *Presents analysis of fishing vessel activity in the area based on traffic surveys and supplementary data*
k. Proximity of the site to offshore firing/bombing ranges and areas used for any marine military purposes.	✓		***Section 9 Baseline Environment: 9.4 Military Practise*** *Presents military practise areas in the vicinity of KOWL Development.*

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
l. Proximity of the site to existing or proposed offshore oil / gas platform, marine aggregate dredging, marine archaeological sites or wrecks, or other exploration/exploitation sites	✓		***Section 9: Baseline Environment – 9.1: Navigational Features*** *Summarises relevant navigational features in proximity to KOWL Development.* ***Section 9: Baseline Environment – 9.6: Marine Wrecks*** *Displays locations of wrecks in proximity to KOWL Development.* ***Section 9: Baseline Environment – 9.8: Oil and Gas Infrastructure*** *Summarises oil and gas infrastructure in proximity to KOWL Development.*
m. Proximity of the site relative to any designated areas for the disposal of dredging spoil	✓		***Section 9: Baseline Environment – 9.1: Navigational Features*** *Summarises relevant navigational features in proximity to KOWL Development.*
n. Proximity of the site to aids to navigation and/or Vessel Traffic Services (VTS) in or adjacent to the area and any impact thereon.	✓		***Section 9: Baseline Environment - 9.1: Navigational Features*** *Summarises relevant navigational features in proximity to KOWL Development.* ***Section 9: Baseline Environment – 9.2 Main Ports*** *Summarises ports in proximity to KOWL Development.*
o. 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.	✓		***Section 18 Allision and Collision Risk Modelling*** *Used computer simulation techniques to assess present-day vessel activity and future-case with windfarm activity, with vessels being displaced following construction. Examined encounters, vessel-to-vessel collisions, vessel allision with structure, fishing vessel allision and recreational vessel allision.*
p. Type(s) of simulation used in analysis Limitation of system(s)	✓		***Section 18 Allision and Collision Risk Modelling*** *Discusses simulations used in the analysis. All the quantified risk assessments were carried out using*

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
			Anatec's COLLRISK software which conforms to the DECC methodology as outlined in the Guidance. 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.
3. OREI Structures			
a. 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.	✓		***Section 7: Project Description Details – 7.5: Worst Case Layout*** *Outlines the Rochdale Envelope, including the number of OREI structures and auxiliary platforms.* ***Section 7: Project Description Details – 7.6 Export Cable Corridor*** *Examines options for cabling to shore.* ***Section 14: Future Case Marine Traffic - 14. Commercial Traffic Re-Routeing*** *Considers the impact of the OREI on vessels steaming on passage.* ***Section 18 Allision and Collision Risk Modelling*** *Analyses consequence to collision and allision risk associated with KOWL Development.*
Clearances of wind turbine blades above the sea surface *not less than 22 metres*	✓		***Section 7: Project Description Details – 7.5: Worst Case Layout*** *Minimum clearances between sea level conditions and wind turbine rotors will be not less than 22m and will meet MCA guidance.*
Least depth of current turbine blades	✓		*Not applicable.*
The burial depth of cabling	✓		***Section 7: Project Description Details – 7.6 Export Cable Corridor*** *Examines options for cabling to shore including target burial depth.*
b. 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 10 Emergency Response Overview*** *Detailed review of emergency response resources and their proximity to KOWL.*
c. With respect to specific OREI devices,	✓		***Table 15.1 Embedded Mitigations***

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
how rotor blade rotation, other exposed moving mechanical parts and/or power transmission, etc., will be controlled by the designated services when this is required in an emergency.			*This will be included within ERCoP*
4. 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 or close to 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			***Section 14: Future Case Marine Traffic - 14. Commercial Traffic Re-Routeing*** *Assesses whether navigation within or close to the site would be safe for commercial vessels.*
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.	✓		***Table 15.1 Embedded Mitigations*** *Application for safety zones.*
c. Exclusion from the site could cause navigational, safety or routeing problems for vessels operating in the area. eg by causing a vessel or vessels to follow a less than optimum route	✓		***Table 15.1 Embedded Mitigations*** *Application for safety zones.*
Relevant information concerning a decision to seek a "safety zone" for a particular site during any point in its construction, operation or decommissioning should be specified in the Environmental Statement accompanying the development application	✓		***Table 15.1 Embedded Mitigations*** *Application for safety zones. Further information will be provided post consent.*
Annex 2 : Navigation, collision avoidance and communications			
1. The Effect of Tides and Tidal Streams : *It should be determined whether:*			
i. 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	✓		***Section 8 – Metocean Data*** *Overview of data relative to the site.*

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
problems at high water which do not exist at low water conditions, and vice versa.			
ii. The set and rate of the tidal stream, at any state of the tide, has a significant effect on vessels in the area of the OREI site.	✓		***Section 8 – Metocean Data*** *Overview of data relative to the site.*
iii. The maximum rate tidal stream runs parallel to the major axis of the proposed site layout, and, if so, its effect.	✓		***Section 8 – Metocean Data*** *Overview of data relative to the site.*
iv. The set is across the major axis of the layout at any time, and, if so, at what rate.	✓		***Section 8 – Metocean Data*** *Overview of data relative to the site.*
v. In general, whether engine failure or other circumstance could cause vessels to be set into danger by the tidal stream.			***Section 17 – Allision and Collision Risk Modelling*** *17.3.2 models allision risk associated with drifting vessels.*
vi. The structures themselves could cause changes in the set and rate of the tidal stream.	✓		***Section 8 – Metocean Data*** *Overview of data relative to the site.*
vii. The structures in the tidal stream could be such as to produce siltation, deposition of sediment or scouring, affecting navigable water depths in the wind farm area or adjacent to the area	✓		***Section 8 – Metocean Data*** *Overview of data relative to the site.*
2. Weather: *It should be determined whether:*			
i. 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.	✓		***Section 8 – Metocean Data*** *Overview of data relative to the site.*
ii. The structures could create problems in the area for vessels under sail, such as wind masking, turbulence or sheer.	✓		***Section 17 – Allision and Collision Risk Modelling*** *Section 17.3.4 covers recreation vessels allision.*
iii. 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 such as referred to in 2.1 (v) above	✓		***Section 8 – Metocean Data*** *Overview of data relative to the site.*
3. Visual Navigation and Collision Avoidance: *It should be determined whether:*			
i. The structures could block or hinder the view of other vessels under way on any route.	✓		***Section 19.12 Effects on visual collision and allision*** *Assesses the visual impact for vessels.*
ii. The 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 19.12 Effects on visual collision and allision*** *Assesses the visual impact for vessels on visual navigation aids.*
4. Communications, Radar and Positioning Systems : *To provide researched opinion of a generic and, where appropriate, site specific nature concerning whether:*			

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
i. The 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 19 Communication and Position Fixing*** *Section notes where impacts are or are not expected for communication and position fixing equipment including radar, AIS, VHF.*
ii. The 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 19 Communication and Position Fixing*** *Section notes where impacts are or are not expected for communication and position fixing equipment including radar, AIS, VHF.*
iii. The OREI, in general, would comply with current recommendations concerning electromagnetic interference.	✓		***Section 19.10 EMF on Navigational Equipment*** *Impacts an associated with wind turbines and cables*
iv. The structures and generators might produce sonar interference affecting fishing, industrial or military systems used in the area.			***Section 19 Communication and Position Fixing*** *Section notes where impacts are or are not expected for communication and sonar*
v. The site might produce acoustic noise which could mask prescribed sound signals.	✓		***Section 19.1 Noise Impact*** *Impacts of the WTG on vessels sound signals*
vi. Generators and the seabed cabling within the site and onshore might produce electro-magnetic fields affecting compasses and other navigation systems.	✓		***Section 19.10 EMF on Navigational Equipment*** *Impacts an associated with wind turbines and cables*
5. Marine Navigational Marking : *It should be determined:*			
i. How the overall site would be marked by day and by night taking into account that there may be an ongoing requirement for marking on completion of decommissioning, depending on individual circumstances.	✓		***Section 15 Industry Standard (Embedded)Mitigations*** *Details the guidance that will be used to define navigational marking*
ii. 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 15 Industry Standard (Embedded)Mitigations*** *Details the guidance that will be used to define navigational marking*
iii. If the specific OREI structure would be inherently radar conspicuous from all seaward directions (and for SAR and maritime surveillance aviation purposes) or	✓		*Given the size of the site there are not expected to be significant issues for Radar detection.*

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
would require passive enhancers			
iv. If the site would be marked by one or more radar beacons (Racons)	✓		*This would be defined by NLB at a later date.*
v. If the site would be marked by an Automatic Identification System (AIS) transceiver, and if so, the data it would transmit.	✓		*This would be defined by NLB at a later date.*
vi. If the site would be fitted with a sound signal, and where the signal or signals would be sited	✓		*This would be defined by NLB at a later date.*
vii. 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 and lights resolved	✓		***Section 15 Industry Standard (Embedded)Mitigations*** *Details the guidance that will be used to define navigational marking*
viii. 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 15 Industry Standard (Embedded)Mitigations*** *Details the guidance that will be used to define navigational marking*
ix. 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. Separate detailed guidance is available from the GLAs on this matter.	✓		*The site will comply with availability criteria defined by NLB.*
x. 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 15 Industry Standard (Embedded)Mitigations*** *Details the guidance that will be used to define navigational marking*
6. Hydrography: In order to establish a baseline, detailed and accurate hydrographic surveys are required to IHO Order 1a standard multibeam bathymetry with final data being supplied as a digital full density data set, and erroneous soundings flagged as deleted but include in the data set. A full report detailing survey methodology and equipment should accompany the surveys.			
Annex 3: MCA template for assessing distances between wind farm boundaries and shipping routes			
Annex 4: 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	✓		***Section 15 Industry Standard (Embedded)Mitigations and Section 18 Additional Measures*** *Details the guidance that will be used to define navigational marking*

Issue: OREI RESPONSE	**Yes**	**No**	**Reference notes/Remarks**
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:			
i. Promulgation of information and warnings through notices to mariners and other appropriate media.	✓		***Section 15 Industry Standard (Embedded)Mitigations and Section 18 Additional Measures*** *Details the guidance that will be used to define navigational marking. Final measure will be defined by the MCA and NLB.*
ii. Continuous watch by multi-channel VHF, including Digital Selective Calling (DSC).	✓		
iii. Safety zones of appropriate configuration, extent and application to specified vessels	✓		
iv. Designation of the site as an area to be avoided (ATBA).	✓		
v. Implementation of routeing measures within or near to the development.	✓		
vi. Monitoring by radar, AIS and/or closed circuit television (CCTV).	✓		
vii. Appropriate means to notify and provide evidence of the infringement of safety zones or ATBA's.	✓		
viii. Any other measures and procedures considered appropriate in consultation with other stakeholders.	✓		
ix. Creation of an Emergency Response Cooperation Plan with the relevant Maritime Rescue Coordination Centre (from construction phase onwards)	✓		
Annex 5: 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.			
1. Design Requirements: The OREI 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 or other OREI site:			
i. 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.	✓		***Table 15.1 Embedded Mitigations*** *KOWL commits to compliance with MGN 371*
ii. 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	✓		***Table 15.1 Embedded Mitigations*** *KOWL commits to compliance with MGN 371*

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
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)			
iii. 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.	✓		***Table 15.1 Embedded Mitigations*** *KOWL commits to compliance with MGN 371*
iv. 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.	✓		***Table 15.1 Embedded Mitigations*** *KOWL commits to compliance with MGN 371*
v. All OREI generators and transmission systems should be equipped with control mechanisms that can be operated from the OREI Central Control Room or through a single contact point.			
vi. Throughout the design process for an OREI, appropriate assessments and methods for safe shutdown should be established and agreed, through consultation with MCA Navigation safety Branch, Search and rescue Branch and other emergency support services.	✓		***Table 15.1 Embedded Mitigations*** *KOWL commits to compliance with MGN 371*
vii. The OREI control mechanisms should allow the Control Room Operator to fix and maintain the position of the WTG blades, nacelles and other appropriate OREI moving parts to configurations determined by the	✓		***Table 15.1 Embedded Mitigations*** *KOWL commits to compliance with MGN 371*

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
Maritime Rescue Co-ordination Centre (MRCC). This same operator must be able to immediately effect the control of offshore substations and export cables.			
viii. Nacelle hatches and other OREI enclosed spaces in which personnel are working 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.	✓		***Table 15.1 Embedded Mitigations*** *KOWL commits to compliance with MGN 371*
ix. 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.	✓		***Table 15.1 Embedded Mitigations*** *KOWL commits to compliance with MGN 371*
x. 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	✓		***Table 15.1 Embedded Mitigations*** *KOWL commits to compliance with MGN 371. This will need to be discussed further with the MCA post consent.*
2. Operational Requirements			
i. The Central Control Room, or mutually agreed single point of contact, should be manned 24 hours a day.	✓		***Table 15.1 Embedded Mitigations*** *KOWL commits to compliance with MGN 371*
ii. The Central Control Room, 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, or individual devices in other types of OREI.	✓		***Table 15.1 Embedded Mitigations*** *KOWL commits to compliance with MGN 371 and to develop and ERCOP*
iii. All MRCCs will be advised of the contact telephone number of the Central Control Room, or mutually agreed single point of contact.	✓		***Table 15.1 Embedded Mitigations*** *KOWL commits to compliance with MGN 371 and to develop and ERCOP*
iv. All MRCCs will have a chart indicating	✓		***Table 15.1 Embedded Mitigations***

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
the GPS position and unique identification number of each of the WTGs in all wind farms or all devices in other types of OREI.			*KOWL commits to compliance with MGN 371 and to develop and ERCOP*
v. All search and rescue helicopter bases will be supplied with an accurate chart of all the OREI and their GPS positions.	✓		***Table 15.1 Embedded Mitigations*** *KOWL commits to compliance with MGN 371 and to develop and ERCOP*
vi. The Civil Aviation Authority shall be supplied with accurate GPS positions of all OREI structures for civil aviation navigation charting purposes	✓		***Table 15.1 Embedded Mitigations*** *KOWL commits to compliance with MGN 371 and to develop and ERCOP*
3. Operational Procedures			
i. 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 he MRCC/SC 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.	✓		***Table 15.1 Embedded Mitigations*** *KOWL commits to compliance with MGN 371 and to develop and ERCOP*
ii. The control room operator, or single point of contact, 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.	✓		***Table 15.1 Embedded Mitigations*** *KOWL commits to compliance with MGN 371 and to develop and ERCOP*
iii. 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,	✓		***Table 15.1 Embedded Mitigations*** *KOWL commits to compliance with MGN 371 and to develop and ERCOP*

Issue: OREI RESPONSE	Yes	No	Reference notes/Remarks
during the Scoping and Environmental Impact Assessment processes			
iv. Communication 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	✓		***Table 15.1 Embedded Mitigations*** *KOWL commits to compliance with MGN 371 and to develop and ERCOP*

Offshore Renewable Energy Installations

Methodology for Assessing the Marine Navigational Safety Risks of Offshore Wind Farms (Compliance with recommended DTI Methodology)

General Comments:

Section	Yes	No	Reference notes/Remarks
A1: Overview and guidance on navigation safety issues.	✓		***Section 2: Guidance and Legislation.*** *Lists the primary guidance documents used during the assessment.*
A2: Overview of FSA.	✓		***Section 2.2: Formal Safety Assessment Process.*** *This is a structured and synthetic methodology based on risk analysis and cost benefit analysis.*
A3: Lessons learned.	✓		*Details the general considerations included in this NRA of lessons learnt and expert opinion from previous offshore wind farm developments and other sea users.*
B1: Base case traffic densities and types.	✓		***Section 13: Marine Traffic Survey.*** *Presents AIS and Radar data.*
B2: Future traffic densities and types.	✓		***Section 14: Future Case Marine Traffic.*** *Presents the future case level of activity in the vicinity of KOWL.*
B3: The marine environment :			
B3.1 Technical & operational analysis	✓		***Section 7: Project Design Statement.*** *Wind farm details defined by KOWL.*
B3.2 Generic TOA	✓		***Section 3: Navigation Risk Assessment Methodology, Section 6: Marine Traffic Survey Methodology.*** *Overview of methodologies.*
B3.3 Potential accidents	✓		***Section 17: Allision and Collision Risk Modelling and Assessment.*** *Assesses the major hazards associated with the development of the proposed KOWL.*
B3.4 Affected navigational activities	✓		***Section 13: Marine Traffic Survey.***

Section	Yes	No	Reference notes/Remarks
B3.5 Effects of wind farm structures	✓		***Section 17: Allision and Collision Risk Modelling and Assessment***
B3.6 Development phases	✓		***Section 7: Project Design Statement.*** *Wind farm details defined by KOWL.*
B3.7 Other structures & features	✓		***Section 9: Baseline Environment, Section 20: Cumulative and In-combination Effects.***
B3.8 Vessel types involved	✓		***Section 13: Marine Traffic Survey.*** *Identifies types of vessels involved from AIS, Radar and visual surveys.*
B3.9 Conditions affecting navigation	✓		***Section 8 and Section 19*** *Metocean Data and Impact on Marine Radar Systems and Navigation*
B3.10 Human actions	✓		***Contained within the ES – Chapter 10***
C1: Hazard Identification	✓		***Contained within the ES – Chapter 10***
C2: Risk Assessment	✓		***Contained within the ES – Chapter 10***
C3: Hazard log	✓		***Appendix B:*** *Hazard Log.*
C4: Level of risk	✓		***Contained within the ES – Chapter 10***
C5: Influences on level of risk	✓		***Contained within the ES – Chapter 10***
C6: Tolerability of residual risk	✓		***Contained within the ES – Chapter 10***
D1 : Appropriate risk assessment	✓		***Contained within the ES – Chapter 10***
D2 : MCA approval for assessment tools and techniques	✓		***Section 3 NRA Methodology****.*
D3: Demonstration of results	✓		***Appendix B:*** *Hazard Log.*
D4 : Area traffic assessment	✓		***Section 13: Marine Traffic Survey.*** *Presents AIS and Radar data.*
D5 : Specific traffic assessment	✓		***Section 13: Marine Traffic Survey.*** *Presents AIS and Radar data.*
E1 : Risk control log	✓		***Appendix B:*** *Hazard Log.*
E2 : Cost benefit assessment	✓		***Section 21: Cost Benefit Analysis.*** *This will be considered in terms of gross cost of averting a fatality (GCAF.)*
E3 : Assessment of equity to stakeholders	✓		***Section 12: Consultation***
F1: Tolerability of risk claim	✓		***Contained within the ES – Chapter 10***
G1 : Hazard identification checklist	✓		***Appendix B:*** *Hazard Log.*
G2 : Risk control checklist	✓		***Appendix B:*** *Hazard Log.*
G3 : MCA MGN 371 compliance checklist	✓		***Appendix C:*** *MGN 371 Checklist.*

Kincardine Offshore Wind Farm

Navigation Risk Assessment

(Annex 3 - Consequences)

Prepared by:	Anatec Limited
Presented to:	Kincardine Offshore Wind Ltd.
Date:	17 September 2015
Revision No.:	00
Reference:	A3414-KOWL-NRA-4

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1. 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 KOWL development.

The significance of the impact of the KOWL development is also assessed based on risk evaluation criteria and comparison with historical accident data in UK waters.

2. 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 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 risk. 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. In this technical note, UK waters means the UK Exclusive Economic Zone and UK territorial waters means within the 12nm limit. The figure also highlights the risk acceptance criteria as suggested in International Maritime Organisation (IMO) Marine Safety Committee (MSC) 72/16.

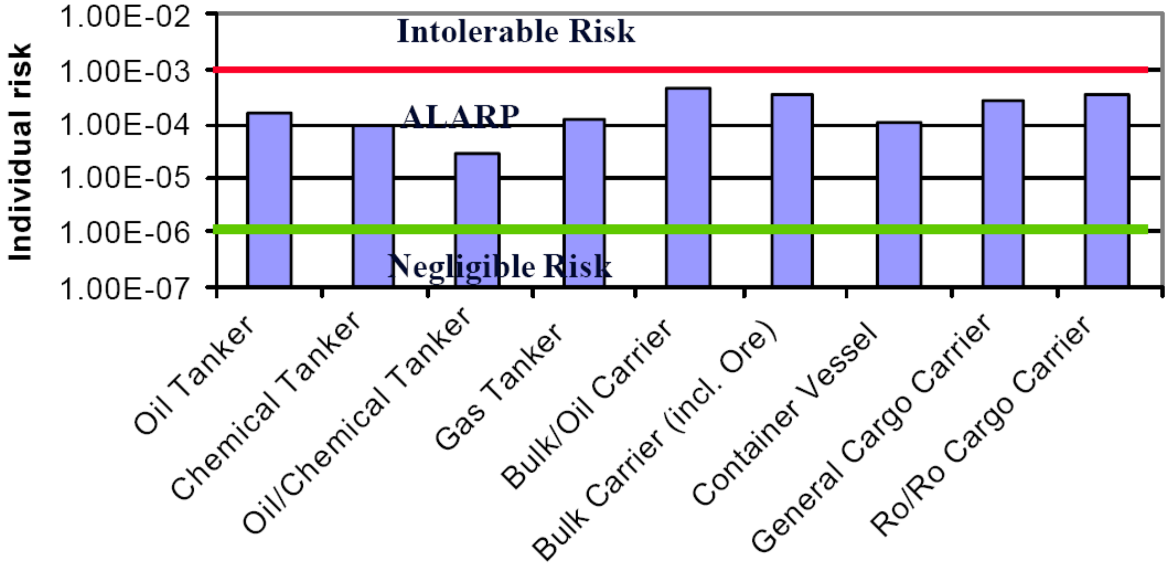

Figure 2.1 Individual Risk Levels and Acceptance Criteria per Ship Type

Typical bounds defining the As Low As Reasonably Practicable (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 Marine Coastguard Agency (MCA) website presents individual risks for various UK industries based on Health and Safety Executive (HSE) data for 1987-91. 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.

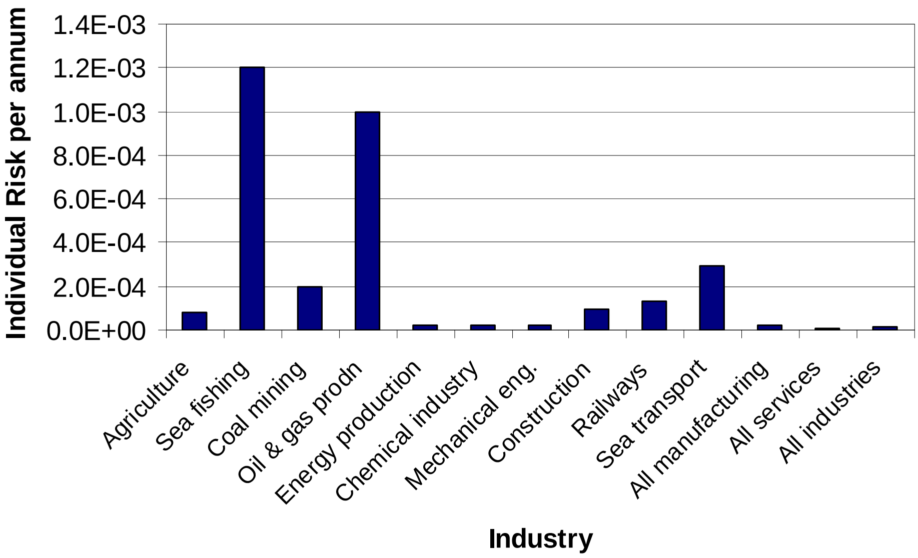

Figure 2.2 Individual Risk per Year for various UK Industries

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 KOWL development 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 KOWL development 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 KOWL development compared to background pollution risk levels for the UK.

3. MAIB Incident Analysis

3.1 All Incidents

All UK commercial vessels are required to report accidents to Marine Accident Investigation Branch (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 (MAIB aim for 97% accuracy in reporting of incidents) of incidents reported in the vicinity of the UK are presented in Figure 3.1, colour-coded by type.

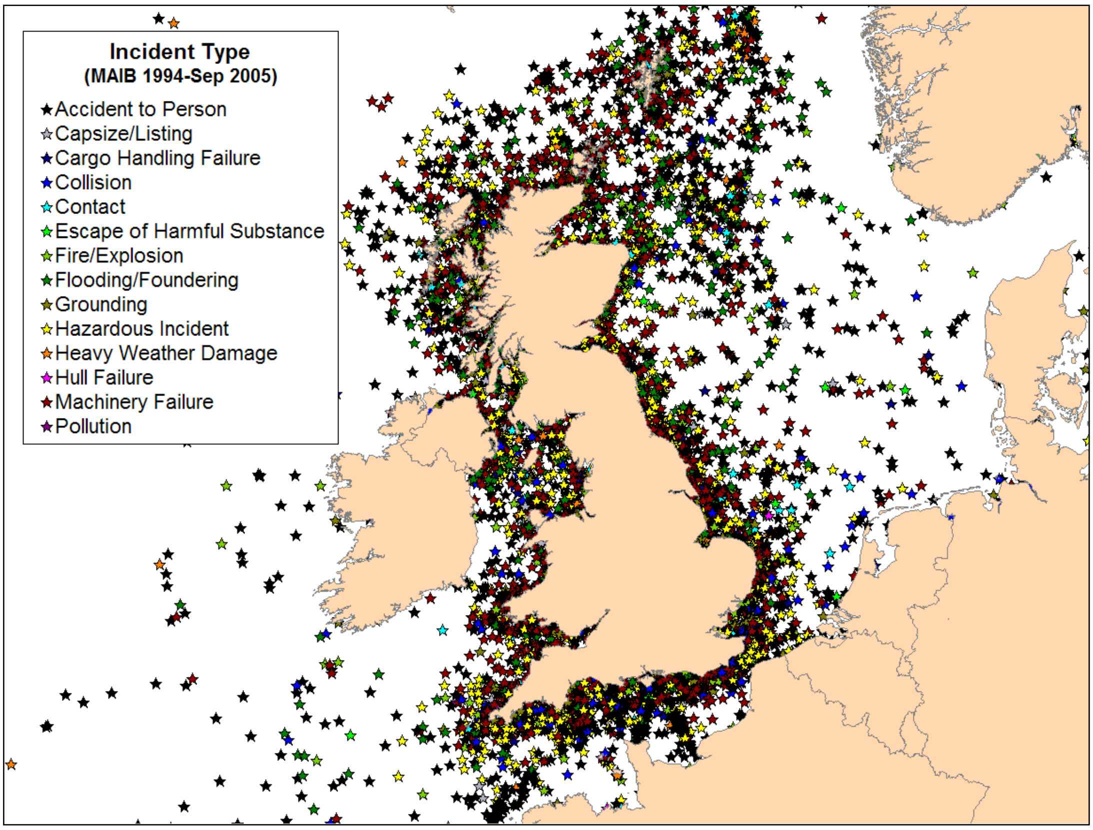

Figure 3.1 Incident Locations by Type (MAIB 1994-Sep 2005)

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

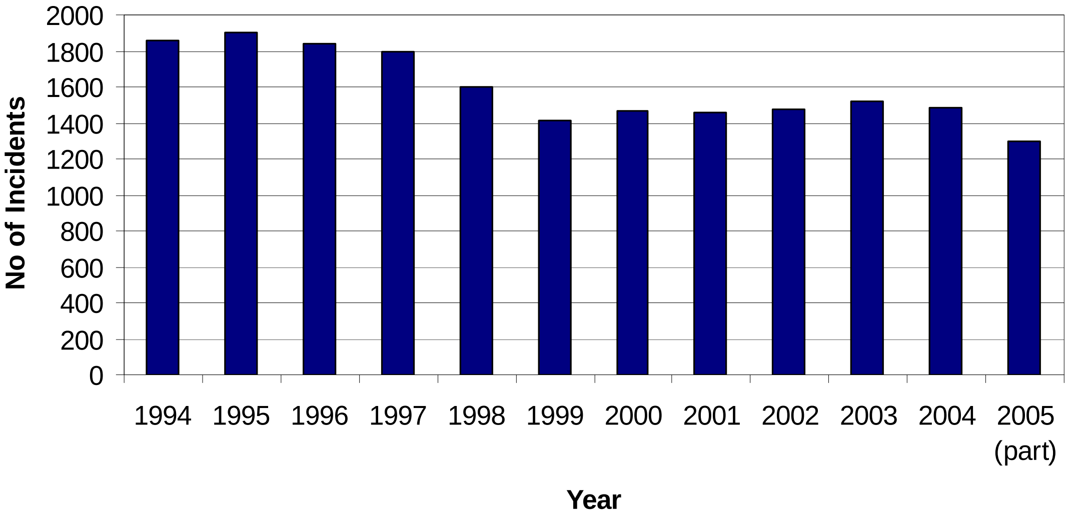

Figure 3.2 Incidents per Year (MAIB 1994-Sep 2005)

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.

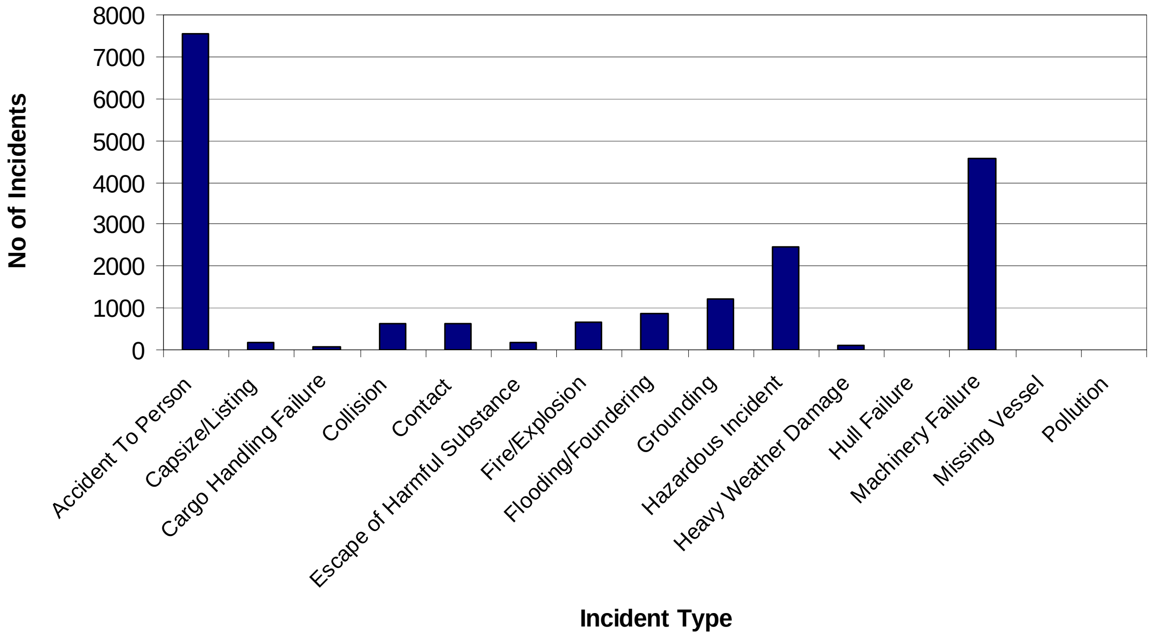

Figure 3.3 Incidents by Incident Type (MAIB 1994-Sep 2005)

Therefore, the most common incident types were Accident to Person (where the incident is an accident to a vessel, e.g., collision or machinery failure, it would be reported under this vessel accident category) (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.

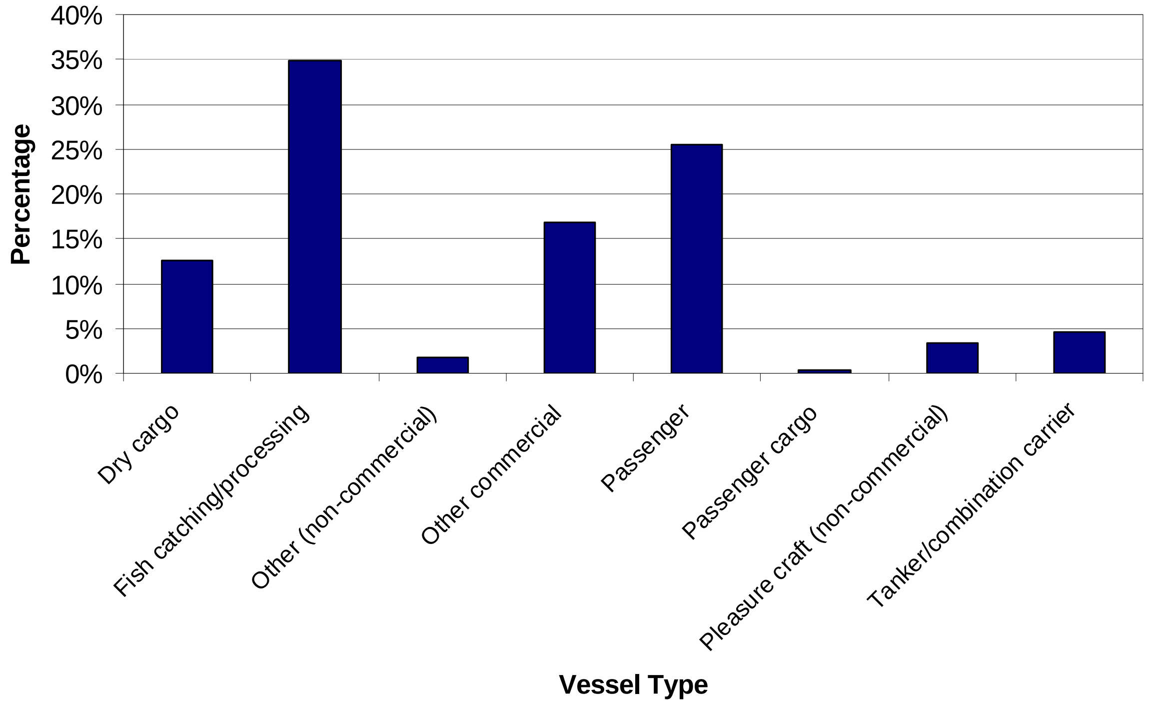

Figure 3.4 Incidents by Vessel Type (MAIB 1994-Sep 2005)

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.

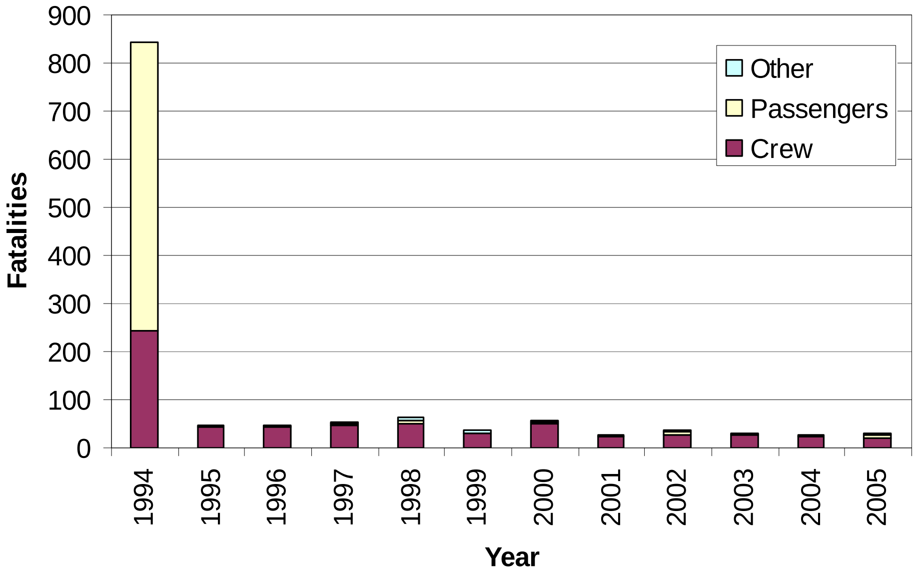

Figure 3.5 Number of Fatalities (MAIB 1994-Sep 2005)

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.

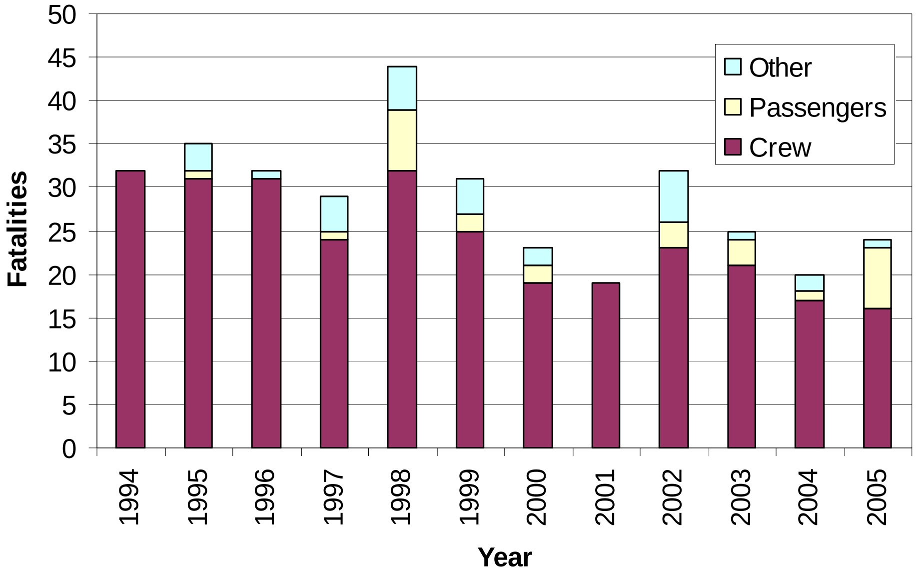

Figure 3.6 Number of Fatalities for Incidents in UK Waters (MAIB 1994-Sep 2005)

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.

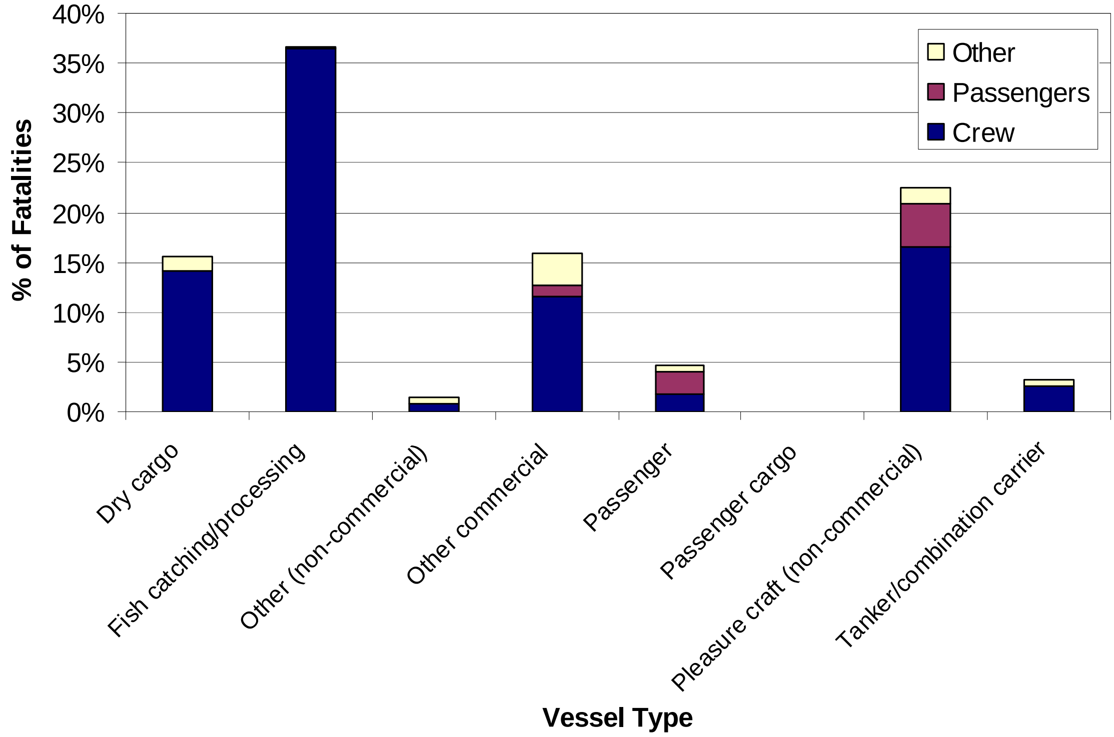

Figure 3.7 Fatalities by Vessel Type for Incidents in UK (MAIB 1994-Sep 2005)

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.

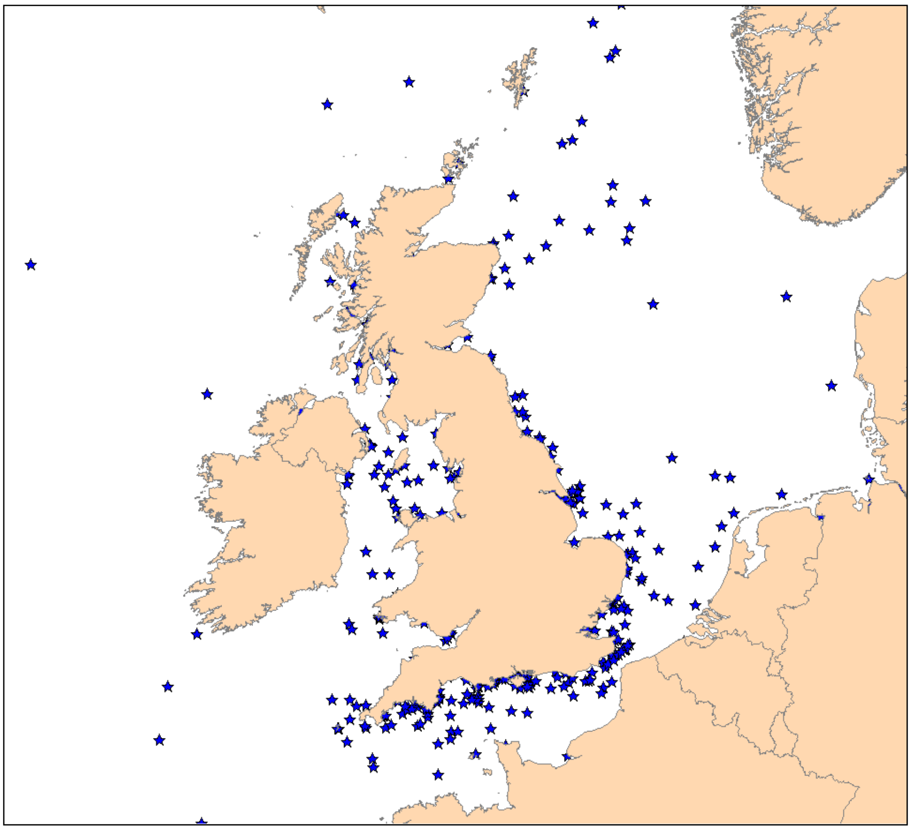

Figure 3.8 Collision Incident Locations (MAIB 1994-Sep 2005)

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

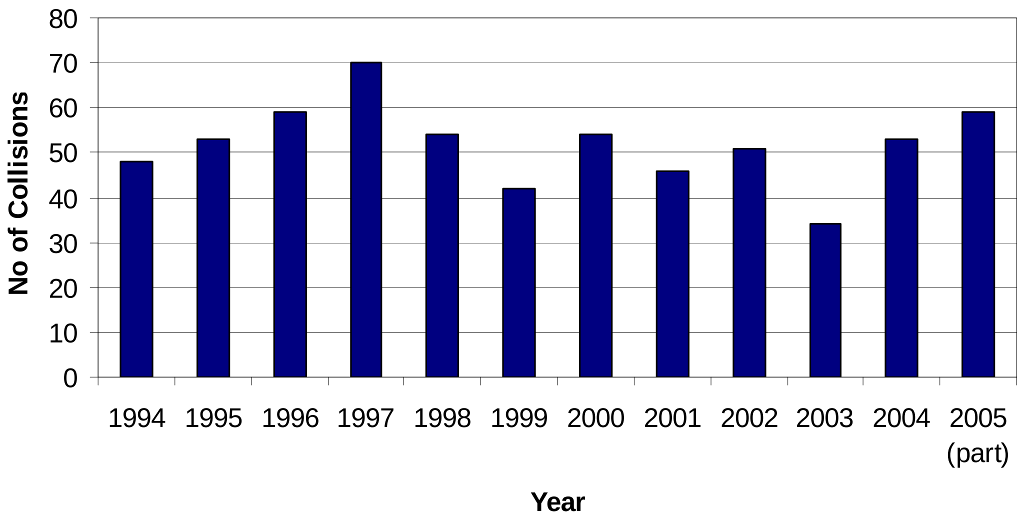

Figure 3.9 Collisions per Year (MAIB 1994-Sep 2005)

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.

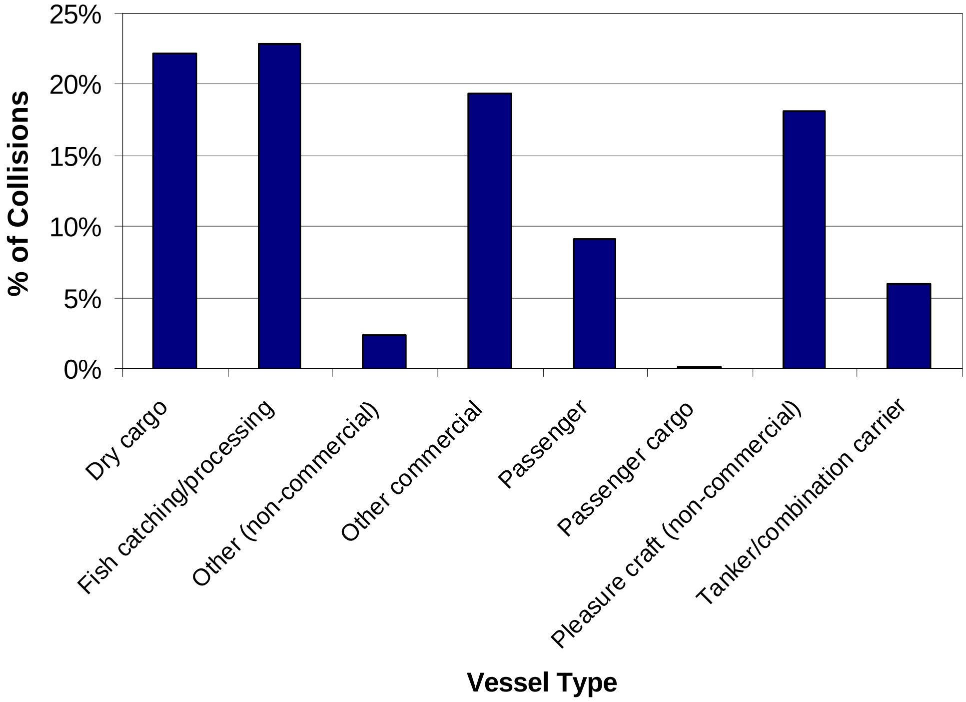

Figure 3.10 Collisions by vessel Type (MAIB 1994-Sep 2005)

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.

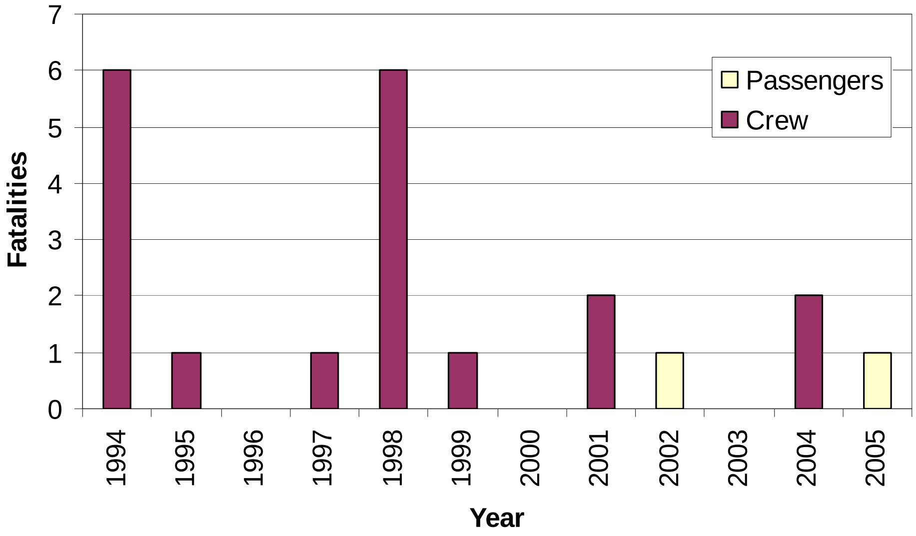

Figure 3.11 Fatalities from Collisions (MAIB 1994-Sep 2005)

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 Traffic Separation Scheme (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.

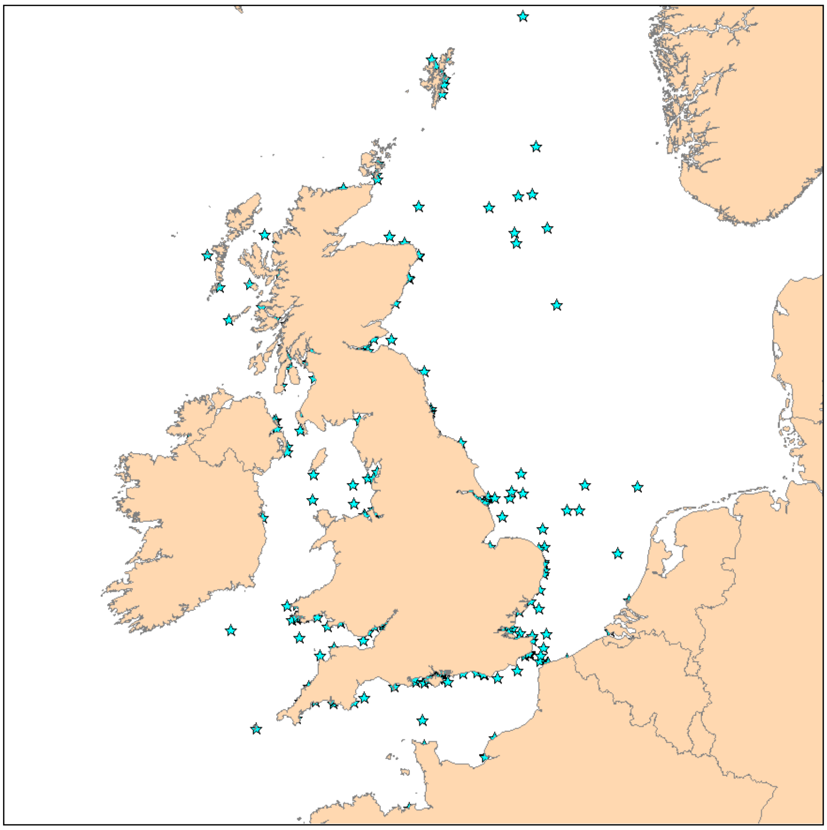

Figure 3.12 Contact Incident Locations (MAIB 1994-Sep 2005)

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

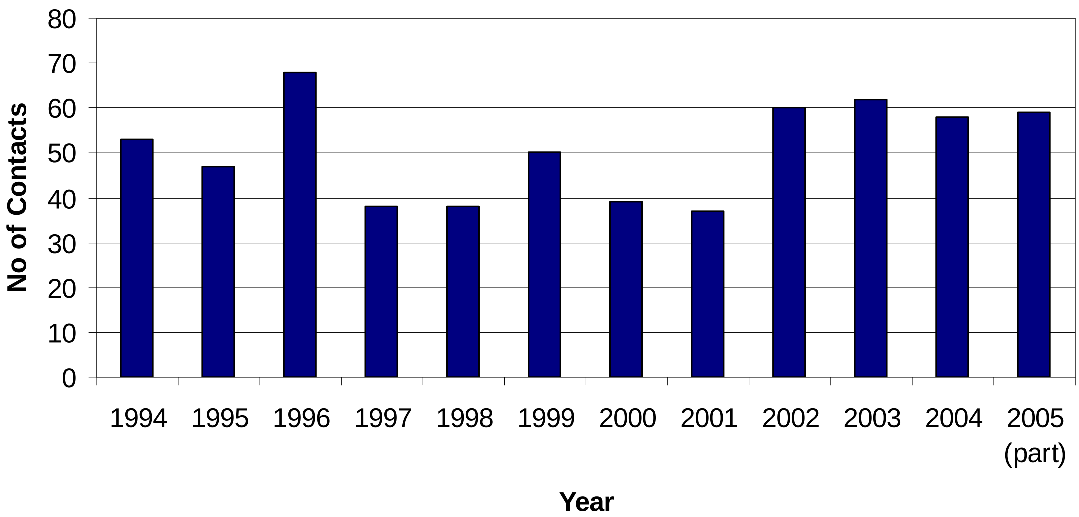

Figure 3.13 Contact Incidents per Year (MAIB 1994-Sep 2005)

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.

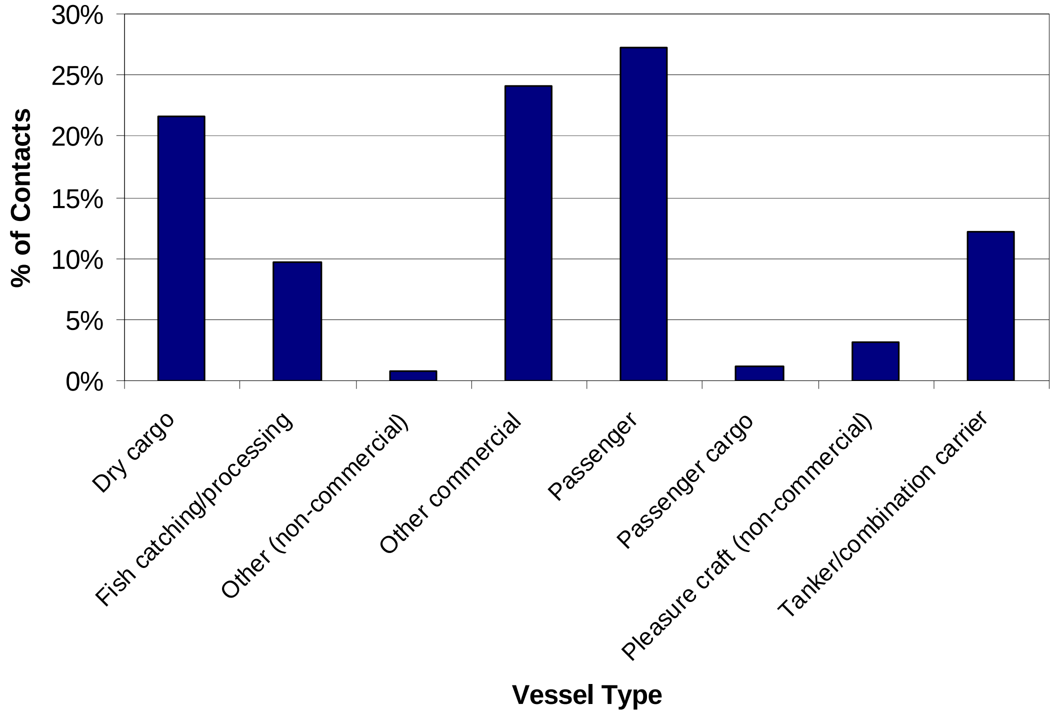

Figure 3.14 Contacts by Vessel Type (MAIB 1994-Sep 2005)

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.

4. 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 KOWL development.

The KOWL development is assessed to have the potential to affect the following incidents:

- Passing Powered Allision with Wind farm Structure;
- Passing Drifting Allision with Wind farm Structure;
- Vessel-to-Vessel Collision; and
- Fishing Vessel Allision 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 allisions 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 on-board 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 the average commercial vessel had a crew of 17. For other (non-commercial vessels) such as naval craft and Royal National Lifeboat Institute (RNLI) lifeboats the average crew has been estimated to be 20. On-board 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).

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 on-board the ships involved in the collisions.

Based on 21 fatalities, the overall fatality probability in a collision for any individual on-board is approximately 4.3×10^{-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 on-board non-commercial vessels.

4.3 Fatality Risk due to the KOWL development

The base case and future case annual collision and allision frequency levels without the KOWL development and with the proposed turbine layout are summarised below.

Table 4.2 Summary of Annual Collision and Allision Frequency Results

Scenario	Base Case			Future Case		
	Without	With	Change	Without	With	Change
Passing Powered	--	3.99×10^{-4}	3.99×10^{-4}	--	4.39×10^{-4}	4.39×10^{-4}
Passing Drifting	--	5.52×10^{-5}	5.52×10^{-5}	--	6.07×10^{-5}	6.07×10^{-5}
Vessel-to-Vessel	1.23×10^{-2}	1.24×10^{-2}	8.42×10^{-5}	1.36×10^{-2}	1.37×10^{-2}	9.26×10^{-5}
Fishing	--	4.87×10^{-3}	4.87×10^{-3}	--	5.36×10^{-3}	5.36×10^{-3}
Total	8.66×10^{-3}	1.40×10^{-2}	5.38×10^{-3}	9.53×10^{-3}	1.54×10^{-2}	5.92×10^{-3}

For the local vessels operating in the area of the site, the average manning/persons on-board (POB) has been estimated as follows.

Table 4.3 Vessel types, incidents and average persons exposed

Vessel Type	Collision/Allision Incidents	Average Manning/ POB
Cargo/Offshore	Passing powered, passing drifting, vessel-to-vessel.	25
Tanker	Passing powered, passing drifting, vessel-to-vessel.	20
Passenger Ferry	Passing powered, passing drifting, vessel-to-vessel.	600
Fishing Vessel	Vessel-to-vessel and fishing.	6
Recreational Vessel	Vessel-to-vessel.	4

From the detailed results of the collision frequency modelling, the distribution of the predicted change in collision and allision frequency by vessel type due to the KOWL development layout is presented in the following figure.

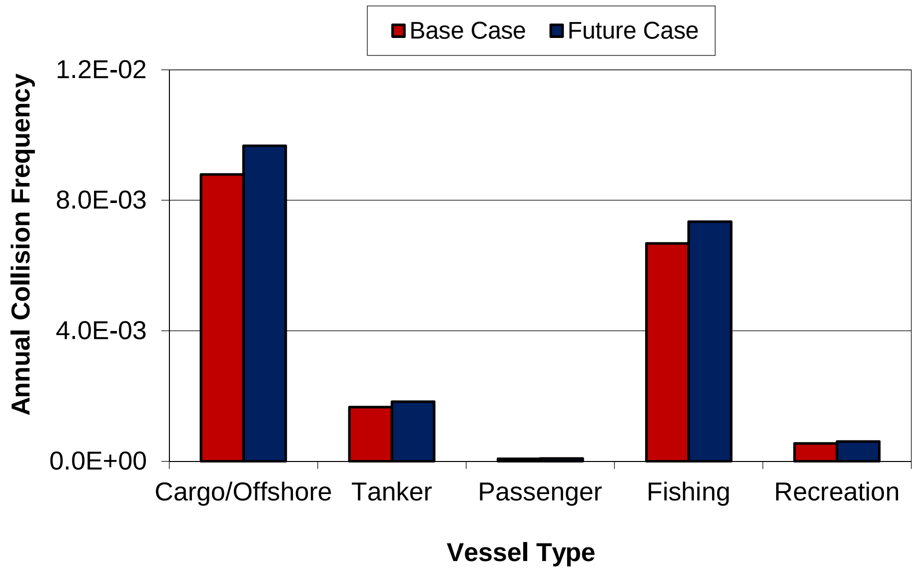

Figure 4.1 Change in Collision and Allision Frequency by Vessel Type Estimated for the KOWL development

It can be seen that for the proposed turbine layout the change in collision/allision frequency is dominated by cargo/offshore and fishing vessels. The change in frequency is lowest for other commercial vessels (tankers and ferries) and recreational vessels.

Combining the collision/allision frequency, 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 KOWL development is estimated to be as follows:

Table 4.4 Potential Loss of Life due to KOWL Development

	KOWL Development
Base Case PLL (fatalities per year)	3.57E-04
Future Case PLL (fatalities per year)	3.92E-04

For the worst case turbine layout the estimated base case PLL increase equates to an average of one additional fatality in 2,803 years, whilst the future case PLL increase corresponds to an average of one additional fatality in 2,548 years.

For the proposed turbine layout, 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.

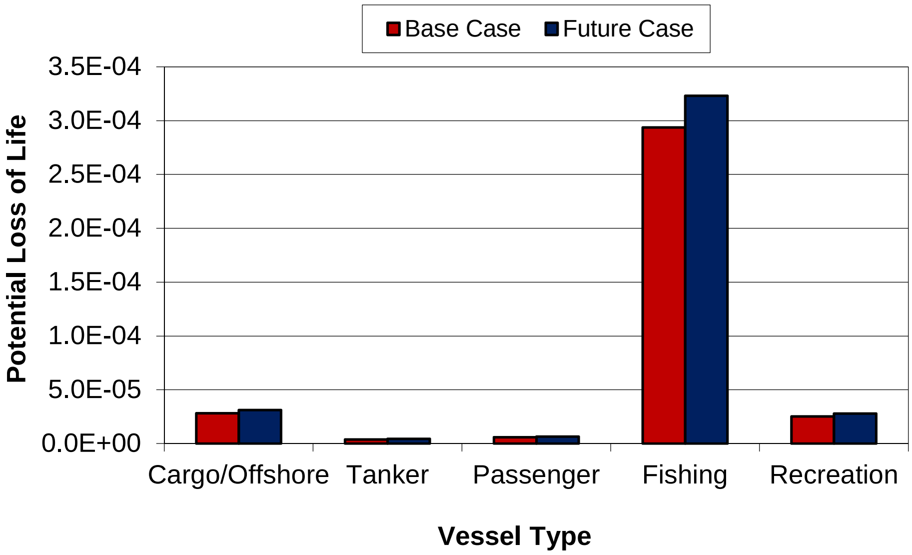

Figure 4.2 Estimated Change in Annual PLL by Vessel Type due to the KOWL development

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 for cargo/offshore vessels, tankers, fishing and recreational vessels, 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.

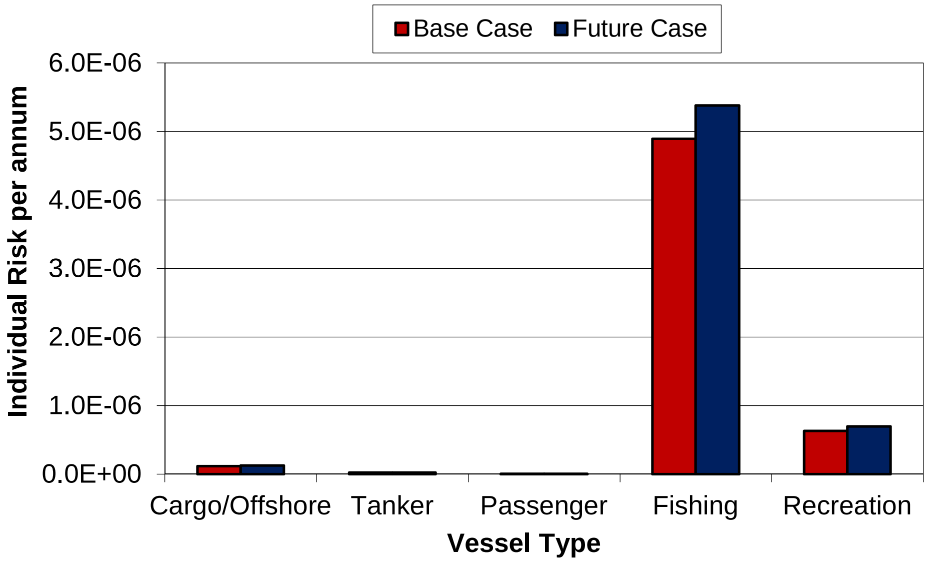

Figure 4.3 Estimated Change in Individual Risk by Vessel Type due to the KOWL development

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 as the greater change in collision frequency for fishing vessels.

4.4 Significance of Increase in Fatality Risk – KOWL Development

The worst case overall increase in PLL estimated due to the development is 3.6×10^{-4} fatalities per year, which equates to one additional fatality in 2,803 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^{-7}) is low compared to the background risk level for the UK sea transport industry of 2.9×10^{-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 4.8×10^{-3}) it is comparable to the background risk level for the UK sea fishing industry of 1.2×10^{-3} per year.

5. 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 Marine Environmental High Risk Areas (MEHRAs) project 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.

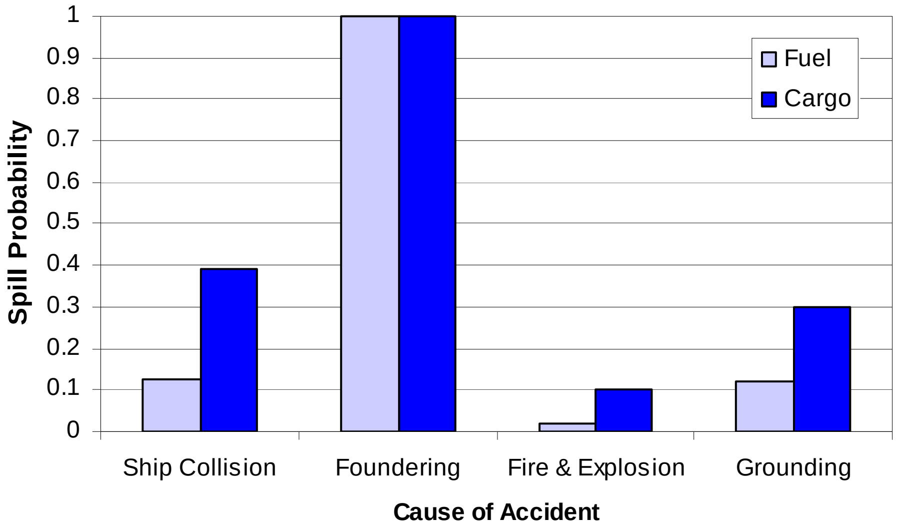

Figure 5.1 Probability of an Oil Spill Resulting from an Accident

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. International Tanker Owners Pollution Federation limited (ITOPF) report the following spill size distribution for tanker collisions between 1974 and 2004.

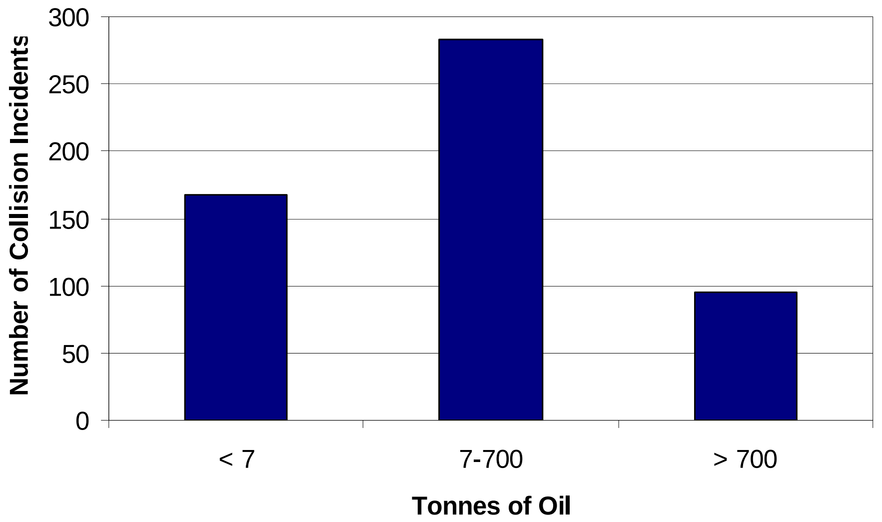

Figure 5.2 Spill Size Distribution in Tanker Collision Incidents (ITOPF 1974-2004)

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 KOWL development, an average spill size of 400 tonnes is considered conservative.

For fishing and recreational vessel collisions/allisions, 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 – KOWL development

Applying the above probabilities to the combined collision and allision 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:

Table 5.1 Annual Oil Spilled due to KOWL development

	KOWL Development
Base Case (tonnes of oil per year)	0.39
Future Case (tonnes of oil per year)	0.43

The predicted increases in tonnes of oil spilled distributed by vessel type for the two proposed turbine layouts are presented in Figure 5.3

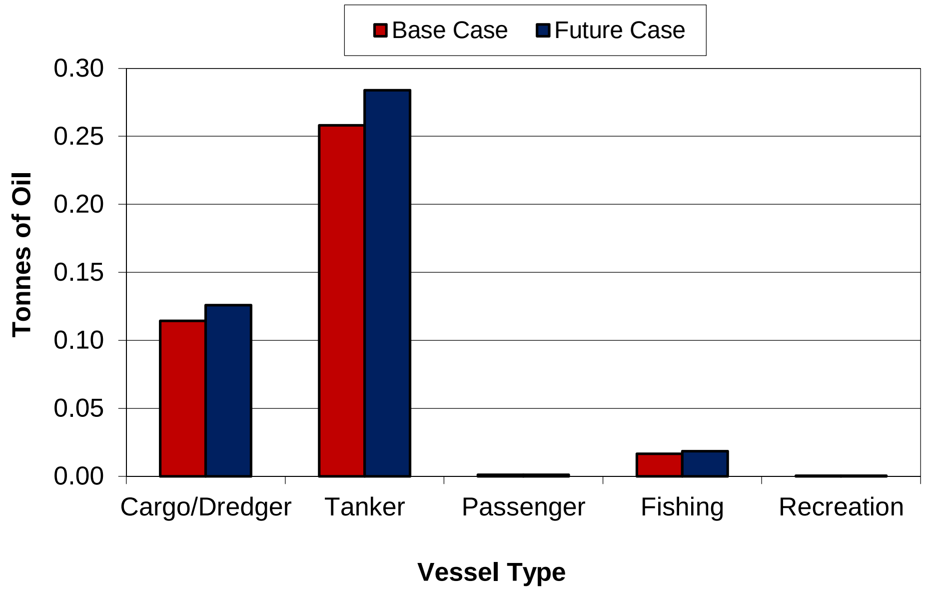

Figure 5.3 Estimated Change in Pollution by Vessel Type due to the KOWL development

It can be seen that tankers, which can spill both fuel and cargo oils, contribute the majority of the overall risk of oil spill, although cargo/offshore vessels are also a significant contributor given the high annual collision frequency for the proposed development.

5.3 Significance of Increase in Pollution Risk

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

From the MEHRAs research; 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 - 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 0.002% for the worst case).

6. Conclusions

The quantitative risk assessment indicates that the impact of the KOWL development 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 Automatic Identification System (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 the North Sea and the UK as a whole.

7. References

- IMO Maritime Safety Committee, 74th Edition, Agenda Item 5 (MSC 74/5/X), Bulk Carrier Safety – Formal Safety Assessment, 2001
- MCA "Safety Information – FSA, Statistical Data" web page.
- 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.
- Department for Transport Maritime Statistics 2004
- Department for Transport, Identification of Marine Environmental High Risk Areas (MEHRA's) in the UK, 2001.