2012 Hazard Log

(Appendix 12D)

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C1. Introduction

This appendix presents the Hazard Log for the navigational risks associated with the proposed Phase 1 offshore wind farms (Project Alpha and Project Bravo) and the Transmission Asset Project in the outer approaches to the Firth of Forth and Tay off the east coast of Scotland.

The workshop was held in Dunfermline on 18th January 2012 attended by local maritime stakeholders, as outlined in Table 1. Other marine stakeholders including representatives from the Chamber of Shipping, Cruising Association, Scottish Canoe Association, RNLI and regular operators were also invited but could not be present on the day.

Table 1 Hazard Review Workshop Attendees

Attendee	Position	Company/Organisation
Peter Douglas	Navigation Manager	Northern Lighthouse Board (NLB)
Archie Johnstone	Navigation Officer	Northern Lighthouse Board (NLB)
Pete Thomson	Offshore Energy Liaison Officer	Maritime and Coastguard Agency (MCA)
Scott Horsburgh	Marine Superintendent	Marine Scotland
Archie MacCallum	Commanding Officer, *MPV Hirta*	Marine Scotland
Bill Hughes	Manager of Fisherman's Mutual Association (FMA) (Pittenweem) Ltd	Kingdom Seafood/FMA Ltd
Sandy Ritchie	Secretary	Anglo-Scottish Fisherman's Federation
John Watt	Fishing Industry Advisor	Scottish Fisherman's Federation
Ashley Nicholson	Assistant Marine Manager	Forth Ports Plc.
Leanne Fisher	Marine Officer	Forth Ports Plc.
Graham Russell	Planning and Environment Officer	Royal Yachting Association (Scotland)
Robert Waterston	Interim Project Developer for Seagreen Wind Energy	URS Infrastructure & Environment UK Limited
Naomi Healey-Cathcart	Project Manager Offshore Development	Seagreen Wind Energy Ltd
Mike Cain	Senior Risk Analyst	Anatec Ltd

Attendee	Position	Company/Organisation
Robert Jones	Risk Analyst	Anatec Ltd

The approach taken in this assessment is in line with the "*Methodology for Assessing the Marine Navigational Safety Risks of Offshore Wind Farms*" produced by The Department of Energy and Climate Change (DECC), in association with the Marine Coastguard Agency (MCA) and the Department for Transport (DfT). This provides a template for developers in preparing their navigation risk assessments. The methodology is centred on risk controls and the feedback from risk controls into risk assessment. It requires a submission that shows sufficient risk controls are, or will be, in place for the assessed risk to be judged as broadly acceptable or tolerable with further controls or actions.

The key maritime hazards associated with the wind farm development were identified and associated scenarios prioritised by risk level. Within each scenario, vessel types were considered separately to ensure the risk levels were assessed for each and the control options were identified on a type-specific basis, e.g., risk control measures for fishing vessels differ to those for commercial ships.

The ranking of the risks associated with the various hazards was carried out following the workshop based on the discussions at the workshop, using a risk matrix with the frequency and consequence categories shown below.

Other general hazards associated with the construction, decommissioning and maintenance phases, such as dropped object and man overboard, were also identified for the site but were not discussed in detail.

C2. Hazard Log Methodology

The hazards were recorded systematically using Anatec's Hazard Management software. The main information logged by the system is presented in Table 2.

Table 2 Hazard Log Field Description

Category	Definition
Hazard ID	Unique Hazard Identification number generated by the software.
Title	Title of hazardous event.
Date Recorded	Date the hazard was logged in the system.
Responsible Person	Person with responsibility to manage the hazard.
Review Period	Minimum time period that hazard should be reviewed.
Event Description	Description of the hazardous event.
Category	General hazard category, e.g., General Navigational Safety.
Sub-Category	Hazard sub-category, e.g., collision.
Area	Location of Hazardous event, e.g., Inside or Outside of wind farm
Phase	Phase(s) of operation e.g. Pre-Installation, Construction, Operation, Maintenance and Decommissioning. (Can be more than one.)
Causes	List all the potential causes of the hazard.
Probable Outcome Description	Description of the probable (or most likely) outcome should the hazard occur.
Worst Credible Outcome Description	Description of the 'worst credible' outcome should the hazard occur.
Frequency (Probable Outcome)	Estimates the frequency of the probable outcome occurring.
Frequency (Worst Credible Outcome)	Estimates the frequency of the worst credible event occurring.
Consequence (Probable Outcome)	Estimates the probable outcome should the event occur in terms of consequence to People, Environment, Asset, Business and overall average.
Consequence (Worst Credible Outcome)	Estimates the worst credible outcome should the event occur in terms of consequence to People, Environment, Asset, Business and overall average.
Risk Estimate (Probable Outcome)	Combines the frequency and (average) consequence to estimate the risk level for probable event.
Risk Estimate (Worst Credible Outcome)	Combines the frequency and (average) consequence to estimate risk level for the worst credible event.

Category	Definition
Risk Reduction Measures	Documents the potential mitigation measures which will aid in the reduction of risk or in the management of the hazardous event.

The following frequency and consequence categories were applied.

Table 3 Frequency Bands

Rank	Description	Definition
1	Negligible	< 1 occurrence per 10,000 years
2	Extremely Unlikely	1 per 100 to 10,000 years
3	Remote	1 per 10 to 100 years
4	Reasonably Probable	1 per 1 to 10 years
5	Frequent	Yearly

The consequence bands (Table 4) estimate the result, (should the event occur) in terms of probable and worst case outcomes to people, property, the environment and business.

The environmental ranking is based on the International Petroleum Industry Environmental Conservation Association (IPIECA) concept of a tiered preparedness and response arrangement as summarised below:

- **Tier 1** spills are generally small, causing localised damage, usually near the company's own facilities. In most cases, this type of spill occurs as a result of the company's own activities;
- A **Tier 2** spill is larger than a Tier 1 spill, but is still one that occurs in the area of the producing company's facilities. Tier 2 spills usually require the aid of other companies and resources, including the government. (It is noted that in terms of the consequence bands the difference between a Rank 3 and Rank 4 is limited/local external assistance would be present for Rank 3 and regional assistance would be required for Rank 4); and
- **Tier 3** spills are the most severe; and cannot be contained with the resources of the producing company and require substantial external resources to deal with them.

Table 4 Consequence Bands

Rank	Description	Definition			
		People	Property	Environment	Business
1	Negligible	No injury	<£10k	<£10k	<10k
2	Minor	Slight injury(s)	£10k-£100k	Tier 1 Local assistance required	£10k-£100k

Rank	Description	Definition			
		People	**Property**	**Environment**	**Business**
3	Moderate	Multiple moderate or single serious injury(s)	£100k-£1M	Tier 2 Limited external assistance required	£100k-£1M Local publicity
4	Serious	Multiple serious injury(s) or single fatality	£1M-£10M	Tier 2 Regional assistance required	£1M-£10M National publicity
5	Major	More than 1 fatality	>£10M	Tier 3 National assistance required	>£10M International publicity

The four consequence scores (on for each of 'people', 'property', 'environment' and 'business') were then averaged and multiplied by the frequency to obtain an overall ranking (or score) which determined the hazard's position within the risk matrix shown below in Table 5.

Table 5 Risk Matrix

Consequence						
	5					
	4					
	3					
	2					
	1					
		1	2	3	4	5
		Frequency				

where:

	Broadly Acceptable Region (Low Risk)	Generally regarded as insignificant and adequately controlled. None the less the law still requires further risk reductions if it is reasonably practicable. However, at these levels the opportunity for further risk reduction is much more limited.
	Tolerable Region (Intermediate Risk)	Typical of the risks from activities which people are prepared to tolerate to secure benefits. There is however an expectation that such risks are properly assessed, appropriate control measures are in place, residual risks are as low as is reasonably practicable (ALARP) and that risks are periodically reviewed to see if further controls are appropriate.
	Unacceptable Region (High Risk)	Generally regarded as unacceptable whatever the level of benefit associated with the activity.

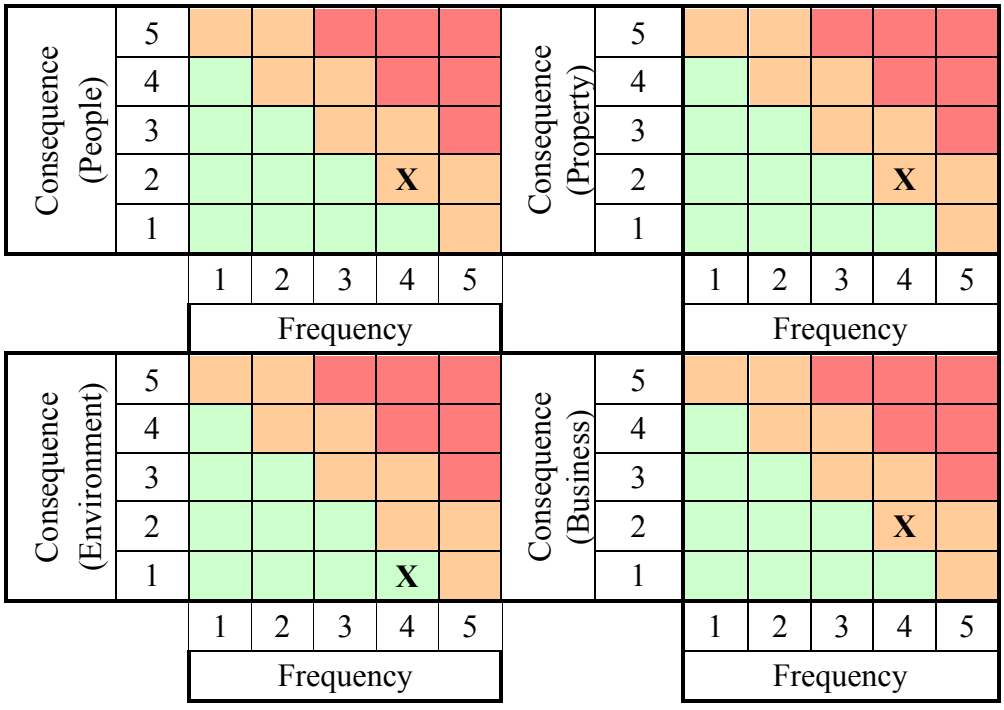
As well as ranking the hazard by expected risk, based on the estimated frequency versus consequence, the worst case risk was also ranked in order to capture scenarios with a particularly high worst-case risk.

The worked example below illustrates the method of ranking hazards.

Hazard Title	Attendant vessel collision with wind farm structure.
Possible Causes	Poor visibility; Manoeuvring error; Machinery failure; Lack of passage planning; Lack of experience; Lack of awareness; Human error; Fatigue; Engine failure/ blackout; Bad weather.
Probable Consequence	Minor bump leading to minor damage to vessel and structure. Vessel most likely to be damaged.
Frequency of Probable Outcome	Reasonably probable (1 to 10 years) based on experience of attendant vessel collisions visiting offshore platforms.
Worst Credible Consequences	Moderate speed collision with significant damage to vessel, holed and vessel sinks, potential fatalities, damage to tower.
Frequency of Worst Credible Outcome	Extremely unlikely (100 to 10,000 years) in terms of significant consequences, i.e., loss of vessel with fatalities.

Table 6 presents the risk ranking of this hazard for the probable (most likely) outcome.

Table 6 Risk Matrix: Attendant Vessel Collision with Structure (Probable Outcome)



The risk for the hazard is calculated by averaging the four consequences, i.e., (2+2+1+2)/4 = 1.75) and multiplying by the frequency, i.e., 4, to obtain a risk ranking of 7 (i.e. 1.75 x 4). A score of 7 puts this hazard in the 'Tolerable' region.
The worst credible risk was also ranked using a similar methodology.

The potential mitigation measures for this event were logged as follows:

- Adverse weather working policy and procedures;
- Control of work procedures;
- Fenders/bumper bollards installed on turbines;
- Emergency Response Cooperation Plan;
- Marine Coordinator on site during works;
- Marine operating procedures;
- Marking and lighting;
- Passage plan to and from the site;
- Planning of major activities;
- Site personnel trained in fire fighting, first aid and offshore survival;
- Safety Management Systems for all vessels working in the site;
- Sharing of information within the industry.

C3. Results

The following list of hazards were reviewed, with the information recorded using Anatec's Hazard Log Software. It is noted that Hazard 3 and Hazard 5 were split up by vessel type following feedback received during the workshop.

1. Attendant vessel collision with wind farm structure
Support vessel collides with wind farm structure during construction or maintenance activities at the site.

2. Man overboard during work activities at site.
Man overboard during work activities at site.

3. Commercial vessel (powered) collision with wind farm structure
Commercial vessel, e.g. cargo vessel, ferry or tanker, collides with wind farm structure when under power (steaming).

4. Vessel anchoring on or dragging over subsea equipment
Vessels may anchor over a subsea cable/structure or a nearby vessel at anchor may drag its anchor over a subsea cable/structure. It is also possible that vessels anchor in an emergency and drop their anchor on a subsea cable/structure.

5. Vessel drifting collision with wind farm structure
Vessel Not Under Command (NUC) due to machinery failure and drifts, e.g. cargo vessel, ferry or tanker, drifting collision with wind farm structure (NUC).

6. Fishing gear interaction with inter-array cabling or other subsea structures
There is potential for fishing gear to interact with inter-array cables

7. Fishing vessel collision with wind farm structure and/or substations
Fishing vessel collides with wind farm structure whilst fishing in area or steaming in transit.

8. Recreational craft collision with wind farm structure
Recreational craft collide with wind farm structure.

9. Unauthorised mooring/boarding to structure and/or deliberate damage to device
Vessels moor to the structure without the authority to do so and/or with the intention to cause damage to the device.

10. Vessel-to-vessel collision due to avoidance of site or support vessels in area
Displaced traffic increases congestion outside of the site. This can lead to an increase in vessel-to-vessel encounters and ultimately collisions.

11. Dropped object during work activities at the site
Dropped object during construction and/or maintenance operations

12. Increased navigational risks during the construction and decommissioning

There could be an increased risk of vessels colliding with the turbines during construction due to lower levels of awareness and transient construction/decommissioning activities.

13. Fishing gear interaction with export cable

Fishing gear is dragged over an export cable.

14. Access to structure in an emergency situation

During emergency situations, a vessel may have to moor to a wind farm structure or a person in the water may seek a safe haven.

As noted above, based on stakeholder feedback received from the workshop held in Dunfermline, Hazard 3 (**Commercial vessel powered collision with wind farm structure**) and Hazard 5 (**Vessel drifting collision with wind farm structure**) were ranked post-workshop based on vessel type:

- Cargo vessel (powered and drifting [NUC] collision with wind farm structure)
- Tanker (powered and drifting [NUC] collision with wind farm structure)

The overall breakdown by tolerability region was assessed for the 16 hazards and is presented in Figure 1.

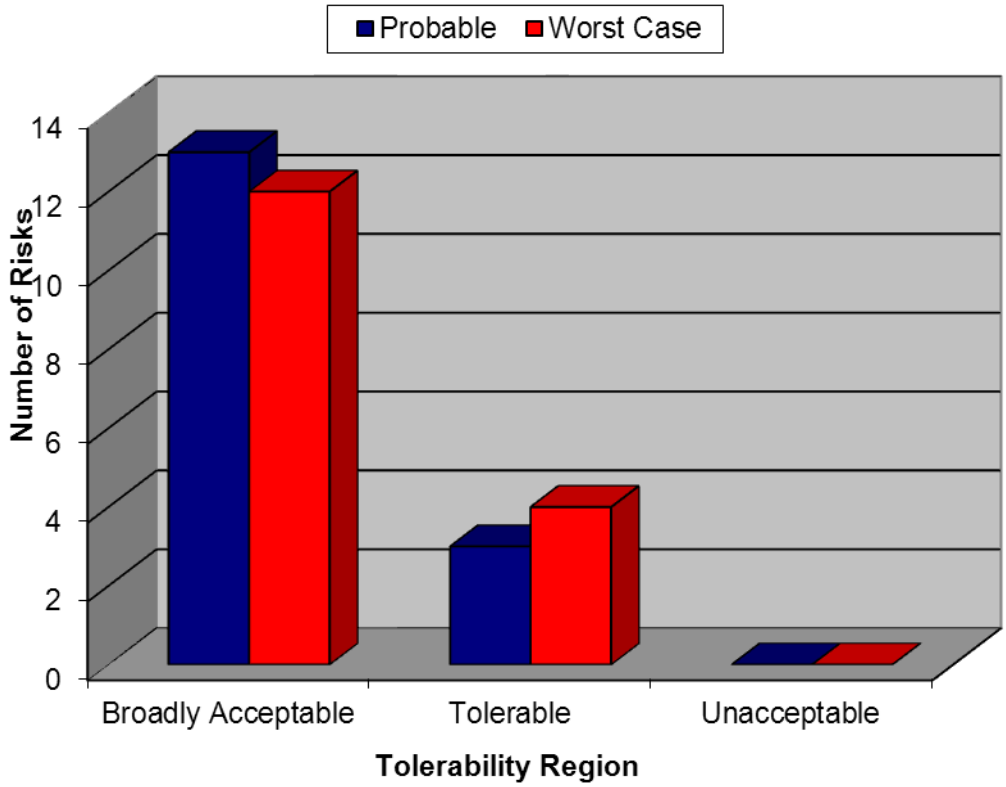


Figure 1 Phase 1 Risk Ranking Results

No risks were assessed to be unacceptable. As shown in Figure 1, three risks were ranked within the 'Tolerable' region based on the probable outcome whilst four were ranked as 'Tolerable' based on the worst case outcome.

The hazards ranked as tolerable based on probable outcome were:

- Attendant vessel collision with wind farm structure;
- Man overboard during transfer to/from turbine or working alongside turbine; and
- Tanker powered collision with turbines or offshore substation.

The hazard ranked as tolerable based on worst case outcome were:

- Attendant vessel collision with wind farm structure;
- Man overboard during transfer to/from turbine or working alongside turbine;
- Fishing gear interaction with inter-array cabling or subsea equipment; and
- Fishing vessel collision.

Several of the tolerable and worst case outcomes involve third party vessels, but these incidents have a lower likelihood of occurring. In addition, it is not known at this stage if there will be guard vessels used during the construction and decommissioning phases.

Full details of the logged and ranked hazards are summarised in Table 7, sorted by descending order of risk ranking (probable followed by worst credible outcome).

Table 7 Phase 1 Hazard Ranking Results

Phase	Category	Hazard Title	Hazard Detail	Possible Causes	Most Likely Consequence	Worst Case Consequence	Most Likely						Risk Reduction	Worst Case						Notes
							Frequency	People	Environment	Property	Business	Risk		Frequency	People	Environment	Property	Business	Risk	
All	Navigation	Attendant vessel collision with wind farm structure	Vessels will be working in proximity to the wind farm structures, e.g., during construction and maintenance. Mis-judgement, weather conditions or equipment failure could lead to a collision due to limited time to take preventative action.	Lack of experience; Communication failure; DP failure; Engine Failure/ Blackout; Fatigue; Fouled propeller; Gear snagging; Bad weather; Installation not planned or carried out properly; Watchkeeper failure; Machinery Failure; Manoeuvring error; Marine coordinator; Navigational Aid Failure; Poor Visibility; Steering Gear Failure; Target not visible on radar; Human error.	Minor bump leading to minor damage to vessel and structure. Vessel most likely to be damaged.	Moderate speed collision with significant damage to vessel, holed and vessel sinks, potential fatalities, damage to turbine or substation structure.	4	2	1	2	2	7	Marking and Lighting; AIS fitted on all workboats working within site; AIS Transceiver; Compliance with Colregs; Continuous Watch by multi-channel VHF, including DSC; Control of Work Procedure; Emergency contact available 24hrs per day; Emergency Response Cooperation Plan; Emergency shutdown system; Exclusion zone during construction; Adverse weather working policy and procedures; Marine Operating Procedures; Tug Availability; Monitoring system; Passage plan to and from site; Personal Protective Equipments (PPE); Personnel Training; Pollution response plans; Position Monitoring; Procedures for all vessels working in the site; Safety Management System; Site personnel trained in fire fighting, first aid and offshore survival.; Marine Coordinator on site during works.	2	5	2	4	4	7.5	A multi-purpose vessel could provide emergency response functions at the wind farms
All	Marine Renewables	Man overboard during work activities at site	Man overboard during transfer to/from turbine or working alongside wind farm structure.	Structural Failure; Personal injury (slips, trips, falls, heart attack); Manoeuvring error; Lack of experience; Lack of awareness; Installation not planned or carried out properly; Human error; Fatigue; Engine Failure/ Blackout; Design Flaw; Communication failure; Bad weather.	Person in water recovered by transfer or support boat crew.	Loss of life. Person lost at sea.	4	3	1	1	2	7	VHF Carriage; Site personnel trained in fire fighting, first aid and offshore survival.; Safety Management System; Procedures for all vessels working in the site; Personnel Training; Personal Protective Equipments (PPE); Offshore Survival Training; Operation and/or Maintenance vessel intervenes; Marine Coordinator on site during works; Guard Vessel during Construction; Emergency Response Cooperation Plan; Control of Work Procedure; Continuous Watch by multi-channel VHF, including DSC; CDM Regulations; Adverse weather working policy and procedures.	3	4	1	1	4	7.5	
All	Marine Renewables	Tanker powered collision	Tanker powered collision with the turbines or offshore substation.	Manoeuvring error; Displacement of traffic; Failure to comply with Colregs; Fire/ Explosion; Human error; Lack of awareness; Lack of experience; Bad weather; Machinery Failure; Watchkeeper failure; Navigational Aid Failure; Personal injury (slips, trips, falls, heart attack); Poor Visibility; Radar interference; Steering Gear Failure; Structural Failure; Vessels attracted to site - curiosity; Lack of Passage Planning.	Glancing blow off turbine or substation structure, significant damage to structure and damage to the vessels hull. Serious impact on the environment due to potential for pollution from the tanker.	Turbine or substation structure collapse, vessel holed and sinks, potential fatalities and major pollution.	2	3	4	3	4	7	Website showing sea obstructions by region; Safety Zone; Promulgation of information to local users; Passage Planning by Shipping; Notice to Mariners; Navigational information broadcasts; Monitoring system; MGN 372; Marking and Lighting; Marine Coordinator on site during works; Guard Vessel during Construction; Exclusion zone during construction; Compliance with Colregs; Chart Markings.	1	5	5	5	5	5	Closed Circuit Television (CCTV) cameras were proposed on the turbines (at different points) and there is the potential for radar monitoring. This could be monitored from both shore and offshore, (e.g. on a mothership or on substations).
All	Navigation	Anchor on or dragging over subsea equipment	Vessel drops anchor over subsea equipment or a nearby vessel drags anchor over a subsea cable. Vessel may drop anchor over cable(s) in an emergency, i.e. machinery failure when changing over engines when approaching port.	Watchkeeper failure; Vessels attracted to site - curiosity; Uncharted obstruction on seabed; Poor Holding Ground; Manoeuvring error; Machinery Failure; Lack of experience; Lack of awareness; Installation not planned or carried out properly; Human error; Engine Failure/ Blackout; Dragged anchor; Cable becomes exposed (unprotected cable); Bad weather.	Damage to cable(s).	Serious damage to cable(s), loss of anchor, major business interruption.	3	2	1	3	3	6.8	Tug Availability; Position Monitoring; Monitoring system; Marking and Lighting; Marine Coordinator on site during works; Chart Markings; Cable protection, e.g., burial; Adverse weather working policy and procedures; Abandon gear.	2	2	2	5	4	6.5	Tugs are available within the Firth of Forth. The export cable will be trenched and possibly buried / raised above the sea bed if the cable cannot be protected in the sediment. Rock dumping could also be used to protect the export cable.
All	Marine Renewables	Tanker drifting collision	Tanker looses power and drifts into turbines/substations.	Structural Failure; Steering Gear Failure; Poor Holding Ground; Machinery Failure; Lack of Passage Planning; Human error; Fouled propeller; Fire/ Explosion; Engine Failure/ Blackout; Dragged anchor; DP failure.	Glancing blow off turbine or substation structure, significant damage to offshore structure and damage to the hull of the tanker. Serious impact on the environment due to pollution from the tanker.	Significant damage, potential collapse of wind farm structure. Likely to be significant damage to the ships hull, serious injuries to crew and major pollution.	2	2	4	3	4	6.5	Tug Availability; Operation and/or Maintenance vessel intervenes; Monitoring system; Marine Coordinator on site during works; Emergency Response Cooperation Plan; Anchoring by drifting vessel.	1	4	5	5	5	4.8	Tugs are available within the Firth of Forth.

Phase	Category	Hazard Title	Hazard Detail	Possible Causes	Most Likely Consequence	Worst Case Consequence	Frequency	People	Environment	Property	Business	Risk	Risk Reduction	Frequency	People	Environment	Property	Business	Risk	Notes
All	Navigation	Fishing gear interaction with inter-array cabling or subsea equipment	Fishing vessel gear is snagged on subsea equipment or J-tube.	Uncharted obstruction on seabed; Steering Gear Failure; Navigational Aid Failure; Lack of experience; Lack of awareness; Installation not planned or carried out properly; Human error; Gear snagging; Fishing vessels attracted to site; Cable becomes exposed (unprotected cable).	Loss of fishing gear, minimal damage to subsea equipment.	Fishing vessel capsizes with loss of life, loss of vessel and pollution.	3	3	1	2	2	6	Installation procedures; Cable protection, e.g., burial; Chart Markings; Emergency contact available 24hrs per day; Emergency Response Cooperation Plan; Emergency shutdown system; Abandon gear; Inspection and maintenance procedures; Safety Zone; Kingfisher publications; Marine Coordinator on site during works; Navigational information broadcasts; Notice to Mariners; Notices to Fishermen; Notices to Fishermen; Promulgation of information to local users; Fisheries Liaison.	2	5	2	4	4	7.5	There is a low frequency of fishing in the Phase 1 areas. Fisheries liaison should be carried out to promulgate information on activities and works.
All	Navigation	Fishing vessel collision	Fishing vessel collides with wind turbine and/or offshore substations.	Lack of Passage Planning; Displacement of traffic; Engine Failure/ Blackout; Fatigue; Fouled propeller; Gear snagging; Human error; Bad weather; Lack of experience; Watchkeeper failure; Machinery Failure; Navigational Aid Failure; Personal injury (slips, trips, falls, heart attack); Poor Visibility; Radar interference; Steering Gear Failure; Vessels attracted to site - curiosity; Lack of awareness.	Vessel collides with structure with minor damage.	Vessel collides with structure and results in vessel being holed and sinking resulting in men overboard and potential fatalities.	3	2	2	2	2	6	Tug Availability; Safety Zone; Promulgation of information to local users; Notices to Fishermen; Notices to Fishermen; Notice to Mariners; Navigational information broadcasts; Marking and Lighting; Marine Coordinator on site during works; Kingfisher publications; Guard Vessel during Construction; Fisheries Liaison; Exclusion zone during construction; Compliance with Colregs; Chart Markings; Abandon gear.	2	5	2	3	4	7	There is a low frequency of fishing in the Phase 1 areas. Closed Circuit Television (CCTV) cameras were proposed on the turbines (at different points) and there is the potential for radar monitoring. This could be monitored from both shore and offshore, (e.g. on a mothership or on substations).
All	Navigation	Recreational vessel collision	Recreational vessel collides with wind farm structure.	Navigational Aid Failure; Engine Failure/ Blackout; Fatigue; Fouled propeller; Human error; Lack of awareness; Lack of experience; Bad weather; Machinery Failure; Watchkeeper failure; Personal injury (slips, trips, falls, heart attack); Poor Visibility; Radar interference; Steering Gear Failure; Structural Failure; Vessels attracted to site - curiosity; Lack of Passage Planning.	Vessel looses power and collides with wind farm structure resulting in minor damage.	Vessel looses power and collides with wind farm structure and results in vessel being holed and sinking resulting in people overboard and fatalities. Vessels on auto-pilot.	3	3	1	2	2	6	Promulgation of information to local users; Personal Protective Equipments (PPE); Passage Planning by Shipping; Notice to Mariners; Navigational information broadcasts; Minimum Blade Clearance; Marking and Lighting; Marine Coordinator on site during works; Continuous Watch by multi-channel VHF, including DSC; Compliance with Colregs; Chart Markings.	2	5	1	3	2	5.5	The main issue is yachts carrying out of date charts. The damage to a recreation vessel following a collision with a wind farm structure would be dependent on hull type, sea conditions and speed at contact.
All	Navigation	Cargo ship powered collision	Cargo vessel powered collision with the turbines or offshore substation.	Manoeuvring error; Displacement of traffic; Failure to comply with Colregs; Fatigue; Fire/ Explosion; Human error; Lack of awareness; Lack of experience; Bad weather; Machinery Failure; Watchkeeper failure; Navigational Aid Failure; Personal injury (slips, trips, falls, heart attack); Poor Visibility; Radar interference; Steering Gear Failure; Structural	Glancing blow off turbine or substation structure, significant damage to structure and damage to the vessels hull.	Turbine or substation structure collapse, vessel holed and sinks, potential fatalities and pollution.	2	3	2	3	4	6	Website showing sea obstructions by region; Safety Zone; Promulgation of information to local users; Passage Planning by Shipping; Notice to Mariners; Navigational information broadcasts; Monitoring system; MGN 372; Marking and Lighting; Marine Coordinator on site during works; Guard Vessel during Construction; Exclusion zone during construction; Compliance with Colregs; Chart Markings.	1	5	5	5	5	5	Tugs are available within the Firth of Forth.
Operation	Marine Renewables	Deliberate unauthorised boarding of/or mooring to structure and damage to device	Structures designed to allow access for inspection, maintenance and repair. There is potential for 'trespassers' to attempt to moor to or board a structure. This has the potential to lead to a member of the public falling into the sea or being stranded on a structure.	Vandalism; Protest.	Vessel moors alongside the structure or person climbs onto the structure in good weather and no damage. Its possible the reason for accessing the structure is to take part in protest requiring the emergency services. Potential for minor vandalism, e.g., graffiti.	Person is stranded / maintains protest on structure or falls into the sea as a result of climbing on the structure resulting in a fatality. Potential for more serious vandalism such as equipment damage.	4	1	1	1	3	6	Safety Zone; Safety Management System; Promulgation of information to local users; Inspection and maintenance procedures; Emergency shutdown system; Emergency Response Cooperation Plan; CCTV Coverage.	2	4	1	2	3	5	If a protestor gains access to a wind farm structure, the police and the UK Police Offshore Group would have jurisdiction.

Phase	Category	Hazard Title	Hazard Detail	Possible Causes	Most Likely Consequence	Worst Case Consequence	Most Likely						Risk Reduction	Worst Case						Notes
							Frequency	People	Environment	Property	Business	Risk		Frequency	People	Environment	Property	Business	Risk	
All	Navigation	Vessel-to-vessel collision due to avoidance of site or work vessels in area	Displaced traffic increases congestion outside of the site. This can lead to an increase in vessel-to-vessel encounters and risk of collisions.	Lack of Passage Planning; Communication failure; Displacement of traffic; Failure to comply with Colregs; Fatigue; Human error; Bad weather; Lack of awareness; Watchkeeper failure; Manoeuvring error; Navigational Aid Failure; Poor Visibility; Radar interference; Steering Gear Failure; Target not visible on radar; Installation not planned or carried out properly.	Damage to vessel(s) and possible injuries to crew(s).	Loss of vessel(s), pollution and potential loss of life.	2	3	2	3	3	5.5	Marine Coordinator on site during works; AIS fitted on all workboats working within site; AIS Transceiver; Compliance with Colregs; Continuous Watch by multi-channel VHF, including DSC; Emergency contact available 24hrs per day; Emergency Response Cooperation Plan; Adverse weather working policy and procedures; Guard Vessel during Construction; VTS Coverage of area; Marking and Lighting; MGN 372; Monitoring system; Passage plan to and from site; Passage Planning by Shipping; Routeing Measures - New or Amended; Exclusion zone during construction.	1	4	4	4	4	4	
All	Marine Renewables	Dropped object during work activities at site	Dropped object during construction, maintenance, decommissioning or lifting operations. Could also occur during an incident which results in a dropped object.	Installation not planned or carried out properly; collision leading to dropped object; Communication failure; Design Flaw; Fatigue; Fire/ Explosion; Bad weather; Human error; Structural Failure; Lack of awareness; Lack of experience; Machinery Failure; Manoeuvring error; Personal injury (slips, trips, falls, heart attack); Poor Visibility; Helicopter operations.	Dropped object into sea, falling onto the seabed. Financial loss, potential for damaging wind farm structure and/or the dropped object.	Dropped object onto vessel with fatality of persons working on the lifting operation. Damage to vessel.	3	2	1	3	1	5.2	Personal Protective Equipments (PPE); CDM Regulations; Control of Work Procedure; Exclusion zone during construction; Inspection and maintenance procedures; Installation procedures; Marine Coordinator on site during works; Adverse weather working policy and procedures; Marking and Lighting; Site personnel trained in fire fighting, first aid and offshore survival.; Personnel Training; Planning of major activities; Procedures for all vessels working in the site; Promulgation of information to local users; Safety Management System; Sharing of Information within Industry; Marine Operating Procedures.	2	4	1	4	4	6.5	A significant or large dropped object could be marked on admiralty charts
All	Navigation	Cargo ship drifting vessel collision	Cargo vessel looses power and drifts into turbines/substations.	Structural Failure; Steering Gear Failure; Poor Holding Ground; Machinery Failure; Lack of Passage Planning; Human error; Fouled propeller; Fire/ Explosion; Engine Failure/ Blackout; Dragged anchor; DP failure; Bad weather.	Glancing blow off turbine or substation structure, significant damage to offshore structure and damage to the hull of the vessel.	Significant damage, potential collapse of wind farm structure. Likely to be significant damage to the ships hull and injuries to crew.	2	2	2	3	3	5	Tug Availability; Operation and/or Maintenance vessel intervenes; Monitoring system; Marine Coordinator on site during works; Emergency Response Cooperation Plan; Anchoring by drifting vessel.	1	4	3	5	5	4.2	Tugs are available within the Firth of Forth.
Construction / Decommissioning	Marine Renewables	Increased navigational risks during construction and decommissioning	There could be an increased risk of vessels colliding with a structure during the construction phase due to lower awareness of offshore works and increased traffic from transient construction/decommissioning activities.	Lack of Passage Planning; Communication failure; DP failure; Failure to comply with Colregs; Fatigue; Helicopter operations; Human error; Bad weather; Lack of experience; Uncharted obstruction on seabed; Machinery Failure; Manoeuvring error; Marine coordinator; Navigational Aid Failure; Poor Visibility; Steering Gear Failure; Installation not planned or	A passing vessel could collide or be involved in a glancing collision with a partially constructed structure at the wind farm during the construction phase. The wind farm structure would sustain minor damage, with minor damage and injuries onboard the passing vessel.	A higher speed collision with wind farm structure during the construction phase resulting in serious damage to wind farm structure, the passing vessel and multiple injuries.	2	2	2	3	3	5	Work vessel display appropriate lights / marks; Safety Zone; Safety Management System; Procedures for all vessels working in the site; Planning of major activities; MGN 371; Marking and Lighting; Marine Coordinator on site during works; Installation procedures; Guard Vessel during Construction; Exclusion zone during construction; AIS fitted on all workboats working within site.	1	3	3	4	4	3.5	Vessel monitoring could take place during the construction phase.
All	Navigation	Fishing gear interaction with export cable	Fishing vessels drags gear over export cable(s), e.g., scallop dredger or trawler.	Lack of awareness; Human error; Gear snagging; Cable becomes exposed (unprotected cable).	Loss of fishing gear, minimal damage to cables.	Fishing vessel capsizes with loss of life, loss of vessel and pollution.	3	1	1	2	2	4.5	Notices to Fishermen/ Notices to Fishermen; Inspection and maintenance procedures; Fisheries Liaison; Chart Markings; Cable protection, e.g., burial; Abandon gear.	2	5	2	2	4	6.5	There is a low frequency of fishing in the Phase 1 areas. The export cable will be trenched and possibly buried / raised above the sea bed if the cable cannot be protected in the sediment. Rock dumping could also be used to protect the export cable. Fisheries liaison should be carried out to promulgate information on activities and works.
Operation	Marine Renewables	Access to structure in an emergency situation	During an emergency situation, a vessel may need to moor with a wind farm structure or a person in the water may seek a safe haven on a turbine.	Bad weather; Any emergency situation.	A vessel enters the wind farm to seek a safe haven and moors to a wind farm structure. During this process a small level of damage may occur to both vessel and wind farm structure and persons involved could sustain minor injuries attempting to climb the structure.	A vessel enters the wind farm to seek a safe haven and moors to a structure. Minor damage occurs to both vessel and structure. The rotors may need shutdown if SAR operations are used to evacuate casualties. Injuries to people attempting to climb the structure.	3	2	1	1	2	4.5	Structure design; MGN 371; CDM Regulations.	2	3	1	2	3	4.5	Access ladders should be provided on wind farm structures for a distressed mariner.

C4. Summary of Key Findings

This section summarises the key findings of the Hazard Log workshop for the navigational risks associated with the proposed Phase 1 wind farms in the outer approaches to the Firth of Forth and Tay off the east coast of Scotland.

From the hazard ranking, several of the tolerable and worst case outcomes involve third party vessels. It is considered these incidents have a lower likelihood of occurring due to operator procedures and Safety Management Systems (SMS).

The key information summarised from the workshop relative to the proposed Phase 1 wind farms and wider region is presented below.

Search and Rescue/Emergency Response:

- The area is well covered in terms of Search and Rescue (SAR) – the Tay Bridge is equidistant between SAR helicopters at Boulmer, Prestwick and Lossiemouth.
- It was highlighted that tugs are on stand-by at the Hound Point / Braefoot Bay marine terminals.

Commercial Vessels:

- Regarding a drifting vessel collision it was highlighted that tugs are on stand-by at the Hound Point and Braefoot Bay marine terminals.
- An operation or maintenance vessel could intervene in a drifting vessel incident. It is likely that an operation or maintenance vessel would have towing capabilities (particularly if it is a multi-use vessel).

Recreational Vessels/Activities:

- In terms of a recreational vessel colliding with a wind farm structure in the Phase 1 sites, one of the main issues is yachts carrying out of date charts.

Fishing Issues:

- There is generally a low level of fishing in the Phase 1 areas. However, there could be a future increase in squid fisheries in the area as there are no quota restrictions.
- Inshore fishing in the area is carried out by vessels under 15m. However, in the future the Pittenweem fleet could change to fishing squid and vessels would operate further from shore (in and around the Phase 1 area.)
- The export cable will be trenched and possibly buried / raised above the sea bed if the cable cannot be protected in the sediment. Rock dumping could also be used to protect the export cable.
- A small vessel could lift a concrete mattress and therefore rock dumping is considered lower risk to gear/fishing vessels.
- In terms of the two proposed export cable routes, comments during the workshop indicated there was no difference in the impact to fishing from either the Arbroath or

Carnoustie cable corridors. Static fishing gear (including pots/creels) is located along the coastal areas and could be impacted during cable works.

Vessel Monitoring:

- The Forth Ports Vessel Traffic Service (VTS) area covers to Bell Rock.
- It was noted that Closed Circuit Television (CCTV) cameras were proposed on the turbines (at different points) and there is the potential for radar monitoring. This could be monitored from both shore and offshore, (e.g. on a mothership or on substations).
- The need for monitoring shipping during the construction and decommissioning phases was also raised.

Cumulative Issues (Regional Developments):

- A potential cumulative issue with vessel 'squeeze' was identified between Inch Cape and the Foxtrot site in Phase 2 of the Firth of Forth Round 3.
- The use of joint monitoring of vessels through the outer Firth of Forth and Tay region was noted. As part of this monitoring an information service could be provided to passing shipping.
- Concern was raised in relation to coastal traffic routeing around regional the developments. Deep draughted vessels could also pushed west of Bell Rock during an easterly wind. Tay bound traffic could be cumulatively impacted on approach, as the entrance to the Tay is narrow and there can be a localised swell in the area.
- The Firth of Forth to Scandinavia route could be impacted by Phase 2 and Phase 3, as vessels deviate around the sites increasing voyage time and fuel cost. (It is noted that re-routeing will be dependent on Phase 2 and Phase 3 developments as indicative project sites have been proposed at the current time [January 2012]).
- Concern was raised with regards to a potential 'choke point' off Bell Rock where two coastal routes will be forced inshore of the Inch Cape development.
- Navigational issues were raised in terms of the channel between Inch Cape and the Alpha/Foxtrot project areas in the Firth of Forth Round 3 Zone. The implementation of a Traffic Separation Scheme (TSS) in this channel was also noted.
- In terms of fishing activities, if vessels are required to route further inshore on coastal routes this could cumulatively impact inshore fishing grounds and static gear.