moray offshore renewables ltd

Environmental Statement

Technical Appendix 5.2 A - Hazard Log

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A1. Introduction

This report presents the preliminary Hazard Log for the navigational risks associated with the three proposed wind farm sites (Telford, Stevenson and MacColl) and associated transmission infrastructure.

Due to the proximity of proposed Beatrice offshore wind farm to three wind farm sites, a Hazard Review workshop was held jointly for the two proposed developments. The workshop was held in Inverness on 06 July 2011 attended by local maritime stakeholders, as outlined in Table 1.1. Other stakeholders such as the Royal Yachting Association, Cruising Association and Chamber of Shipping were also invited to attend but unfortunately could not make it on the day; therefore, these issues were represented by the local experts who attended the meeting. (Consultation had already been carried out with each of these stakeholders about the project and their views were known.)

Table 1.1 Hazard Review Workshop Attendees

Attendee	Position	Company/Organisation
Ken Gray	Chief Executive/Harbour Master	Cromarty Firth Port Authority
Keith Stratton	Civil Engineer	Moray Council
Duncan Pockett	Marina Operations Manager	Elgin & Lossiemouth Harbour Company
Andrew Ironside	Harbour Master	Fraserburgh Harbour
Archie Johnstone	Navigation Consultant	Northern Lighthouse Board
Ken MacLean	Harbour Master	Inverness Harbour
Clare Lavelle	Consenting Manager	EDP Renewables
Rosie Scurr	Project Developer	SSE Renewables
Ali MacDonald	Senior Risk Analyst	Anatec Ltd
Peter Carey	Technical Assistant	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 site 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 afterwards based on the discussion 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.

A2. 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 2.1.

Table 2.1 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.
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 2.2 Frequency Bands

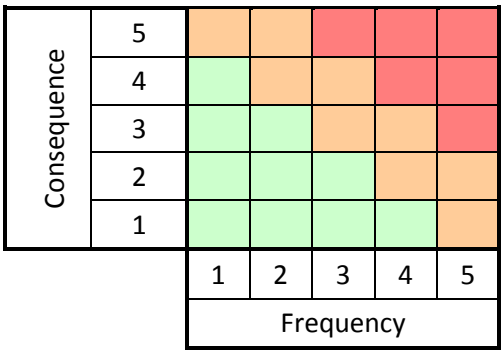
Rank	Description	Definition
1	Negligible	< 1 occurrence per 10,000 years
2	Extremely Unlikely	1 per 100 to 10,000 years
3	Remote	1 per 10 to 100 years
4	Reasonably Probable	1 per 1 to 10 years
5	Frequent	Yearly

Table 2.3 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
3	Moderate	Multiple moderate or single serious injury	£100k-£1M	Tier 2 Limited external assistance required	£100k-£1M Local publicity
4	Serious	serious injury 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 were averaged and multiplied by the frequency to obtain an overall ranking (or score) ranking which determined the hazard's position within the risk matrix shown below.

Table 2.4 Risk Matrix



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.

The following table present the risk ranking of this hazard for the probable (most likely) outcome.

Table 2.5 Risk Matrix: Attendant Vessel Collision with Structure (Probable Outcome)

Consequence (People)	1	2	3	4	5
5					
4					
3					
2				X	
1					
Frequency					

Consequence (Property)	1	2	3	4	5
5					
4					
3					
2				X	
1					
Frequency					

Consequence (Environment)	1	2	3	4	5
5					
4					
3					
2					
1				X	
Frequency					

Consequence (Business)	1	2	3	4	5
5					
4					
3					
2				X	
1					
Frequency					

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.

A3. Results

The following list of hazards were reviewed, with the information recorded using Anatec's Hazard Log Software.

- Fishing vessel collision
- Commercial ship (powered) collision
- Recreational vessel collision
- Drifting ship collision
- Fishing gear interaction with inter-field cabling
- Fishing gear interaction with export cable
- Fishing gear interaction with substructures
- Vessel anchoring on or dragging anchor over subsea equipment
- Vessel-to-vessel collision due to avoidance of site or work vessels in area

The following generic industry hazards were also identified for the site but not discussed in detail:

- Attendant vessel collision with structure
- Man overboard during work activities at site
- Dropped object during work activities at site
- Deliberate unauthorised boarding or mooring to structure

The following overall breakdown by tolerability region was assessed for the identified hazards.

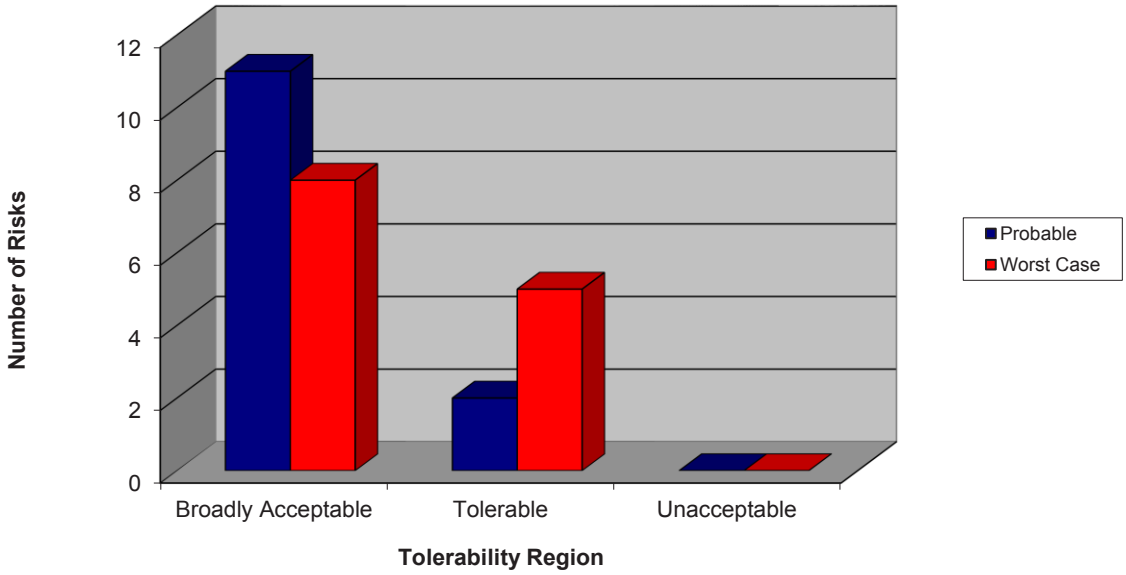


Figure 3.1

Beatrice Risk Ranking Results

No risks were assessed to be unacceptable. As shown in the above figure, two risks were ranked within the Tolerable (As Low as Reasonably Practicable, ALARP) region based on the probable outcome whilst eight were ranked as Tolerable (ALARP) 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
- Fishing vessel collision with structure.

These incidents mostly involve vessels and persons working at the site as opposed to third party (non-wind farm related) vessels and persons.

As well as the three hazards above, the five additional hazards ranked as tolerable based on worst case outcome were:

- Dropped object during construction, decommissioning or major maintenance;
- Vessel-to-vessel collision due to avoidance of site;
- Commercial ship powered collision;
- Fishing gear interaction with inter-field cabling; and
- Fishing gear interaction with export cable.

Several of the 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 construction/decommissioning phases.

It was noted that many of the causes are general maritime accident causation factors outside the control of the Developer.

Full details of the logged and ranked hazards are summarised in

Project:	A2580
Client:	MORL
Title:	Hazard Review Workshop – Moray Firth Eastern Development Area

Table 3.1, sorted by descending order of risk ranking (probable followed by worst credible outcome).

Project: A2580
Client: MORL
Title: Hazard Review Workshop – Moray Firth Eastern Development Area

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Table 3.1 Eastern Development Area Hazard Ranking Results

Phase	Category	Hazard Title	Hazard Detail	Possible Causes	Most Likely Consequence	Worst Case Consequence	Most Likely						Worst Case						Potential Risk Reduction	Remarks / Questions
							People	Property	Environment	Business	Frequency	Risk	People	Property	Environment	Business	Frequency	Risk		
Construction; Maintenance; Decommissioning	Navigation	Fishing vessel collision with structure	Fishing vessel collides with structure whilst fishing in area or steaming in transit.	Watchkeeper failure; Poor Visibility; Navigational Aid Failure; Manoeuvring error; Machinery Failure; Lack of awareness; Human error; Gear snagging; Fishing vessels attracted to site; Fatigue; Engine Failure/ Blackout; Bad weather.	Vessel collides with structure with minor damage.	Vessel collides with structure and results in vessel being holed and sinking resulting in man overboard and potential fatality.	3	2	2	2	4	9	5	3	2	4	3	10.5	Promulgation of information to local users; Notices to Fishermen| Notices to Fishermen; Notice to Mariners; Marking and Lighting; Marine Operating Procedures; Kingfisher publications; Fisheries Liaison; Emergency Response Cooperation Plan; Chart Markings.	Squid fishing in the area for 2-3 months of the year, from July. Squid is not a quota controlled species and is fished once quotas for other species have run out. Eastern Development Area is part of the squid fishing grounds.
All	Navigation	Attendant vessel collision with wind farm structure	Vessels will be working in proximity to the structures, e.g., during construction and maintenance. Misjudement, weather or equipment failure could lead to a collision due to limited time to take preventative action.	Poor Visibility; Manoeuvring error; Machinery Failure; Lack of Passage Planning; Lack of experience; Lack of awareness; Human error; Fatigue; Engine Failure/ Blackout; Bad weather.	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 tower.	2	2	1	2	4	7	5	4	2	4	2	7.5	Site personnel trained in fire fighting, first aid and offshore survival.; Sharing of information within Industry; Procedures for all vessels working in the site; Planning of major activities; Passage plan to and from site; Marking and Lighting; Marine Operating Procedures; Marine Coordinator on site during works; Fenders/ bumper bollards installed on structures; Emergency Response Cooperation Plan; Control of Work Procedure; Adverse weather working policy and procedures.	
All	Other	Man overboard during work activities at the site	Man overboard during transfer to/from turbine or working alongside turbine.	Personal injury (slips, trips, falls, heart attack); Manoeuvring error; Lack of experience; Lack of awareness; Human error; Fatigue; Communication failure; Bad weather.	Person in water recovered by transfer boat and crew.	Loss of life. Person lost at sea.	3	1	1	2	4	7	4	1	1	4	3	7.5	Site personnel trained in fire fighting, first aid and offshore survival.; Procedures for all vessels working in the site; Personal Protective Equipments (PPE); Offshore Survival Training; Emergency Response Cooperation Plan; Control of Work Procedure; CDM Regulations; Adverse weather working policy and procedures.	Search and Rescue helicopter access. Transfer vessel trained in recovery operations. Working limits in bad weather.
All	Other	Dropped object during work activities at the site	Dropped object during construction, decommissioning or major maintenance.	Personal injury (slips, trips, falls, heart attack); Manoeuvring error; Machinery Failure; Lack of experience; Human error; Fatigue; DP failure; Communication failure; Bad weather.	Dropped object into sea, falling onto seabed. Financial loss, potential for damaging structure.	Dropped object onto vessel with fatality of persons working on operation. Damage to vessel.	2	2	1	1	4	6	4	2	1	4	3	8.25	Safety Management System; Procedures for all vessels working in the site; Planning of major activities; Personnel Training; Personal Protective Equipments (PPE); Independent Verification; Emergency Response Cooperation Plan; Control of Work Procedure.	
All	Navigation	Commercial ship powered collision	Commercial ship, e.g., cargo vessel, ferry or tanker, collides with structure when under power (steaming).	Watchkeeper failure; Steering Gear Failure; Poor Visibility; Navigational Aid Failure; Lack of Passage Planning; Lack of experience; Lack of awareness; Human error; Fatigue.	Glancing blow off tower structure, significant damage to tower and hull damage to vessel.	Tower collapse, vessel holed and sinks, potential fatalities and pollution.	2	3	2	4	2	5.5	5	5	5	5	2	10	Site selection; Promulgation of information to local users; Passage Planning by Shipping; Notice to Mariners; Marking and Lighting; Emergency Response Cooperation Plan; Chart Markings.	Could result from automated passage planning as some vessels may use the wind farms as a waypoint, resulting in a collision.
All	Navigation	Vessel-to-vessel collision due to avoidance of site or work vessels in area	Displaced traffic increases congestion outside of site. This can lead to an increase in vessel-to-vessel encounters and ultimately collisions. Radar interference. Cumulative impacts.	Watchkeeper failure; Radar interference; Poor Visibility; Navigational Aid Failure; Manoeuvring error; Lack of awareness; Human error; Fatigue; Displacement of traffic; Communication failure; Bad weather.	Damage to vessel(s) and possible injuries to crew(s).	Loss of vessel, pollution and potential loss of life.	3	3	2	3	2	5.5	4	4	3	4	2	7.5	Work vessel display appropriate lights / marks; Site selection; Promulgation of information to local users; Passage Planning by Shipping; Passage plan to and from site; Notices to Fishermen. Notices to Fishermen; Notice to Mariners; Marking and Lighting; Marine Operating Procedures; Emergency Response Cooperation Plan; Compliance with Colregs.	Generally considered that vessel-to-vessel collision is not a major issue for vessels routeing around the site, due to the sea room available. Potential collisions between vessels routeing around the wind farm and vessels exiting the wind farm (e.g. maintenance vessels) could be an issue. Yachts are more likely to use the inshore route.
All	Navigation	Recreational vessel collides with wind farm structure	Recreational vessel collides with structure.	Yacht becalmed; Watchkeeper failure; Vessels attracted to site - curiosity; Steering Gear Failure; Poor Visibility; Manoeuvring error; Machinery Failure; Lack of Passage Planning; Lack of experience; Lack of awareness; Human error; Engine Failure/ Blackout; Bad weather.	Vessel collides with structure with minor damage.	Vessel collides with structure and results in vessel being holed and sinking resuling in man overboard and potential fatality.	2	2	1	2	3	5.3	4	3	1	4	2	6	Website showing sea obstructions by region; Site selection; Promulgation of information to local users; Notice to Mariners; Minimum Blade Clearance; Marking and Lighting; Emergency Response Cooperation Plan; Chart Markings.	Lossiemouth to Wick is a popular route in the area. Vessels would route to the East or West depending on the wind. Port websites could have links to information on the wind farm.

Phase	Category	Hazard Title	Hazard Detail	Possible Causes	Most Likely Consequence	Worst Case Consequence	Most Likely						Worst Case						Potential Risk Reduction	Remarks / Questions
							People	Property	Environm	Business	Frequency	Risk	People	Property	Environm	Business	Frequency	Risk		
All	Navigation	Drifting ship collision	Vessel loses power and drifts with wind and/or tide towards structure. Fowled propellers for fishing vessels.	Machinery Failure; Lack of awareness; Engine Failure/ Blackout; Dragged anchor; Bad weather.	Glancing blow off tower structure, significant damage to tower and hull damage to ship.	Significant damage, potential collapse of tower. Likely to be hull damage to vessel. Injuries to personnel.	2	3	2	3	2	5	3	3	2	3	2	5.5	Tug Availability; Site selection; Minimum Blade Clearance; Marking and Lighting; Emergency Response Cooperation Plan; Anchoring by drifting vessel.	
All	Navigation	Fishing gear interaction with interfield cabling	There is potential for fishing gear to interact with the subsea cabling. i.e. Interfield cables.	Uncharted obstruction on seabed; Poor Visibility; Lack of experience; Lack of awareness; Installation not planned or carried out properly; Human error; Fishing vessels attracted to site.	Loss of fishing gear, minimal damage to cables.	Fishing vessel capsizes with loss of life, loss of vessel and pollution.	1	2	1	2	3	4.5	5	2	2	4	3	9.75	Promulgation of information to local users; Notice to Mariners; Kingfisher publications; Installation procedures; Inspection and maintenance procedures; Fisheries Liaison; Emergency Response Cooperation Plan; Chart Markings; Cable protection, e.g., burial; Abandon gear.	Will there be guard vessels during the construction of the wind farms? Cautionary notice on charts.
All	Navigation	Fishing gear interaction with export cable	Fishing drags gear over export cable, 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.	1	2	1	2	3	4.5	5	2	2	4	3	9.75	Notices to Fishermen Notices to Fishermen; Fisheries Liaison; Chart Markings; Cable protection, e.g., burial; Abandon gear.	Scallop dredgers and nephrop trawlers operate in the area.
All	Navigation	Floating turbine Anchor failure	Anchor fails on turbine, causing it either to collapse or multiple anchor failure resulting in drifting turbine. Also potential for substructure or whole turbine to be lying on the sea bed.	Structural Failure; Fatigue; Design Flaw.	Failure of a single anchor but the turbine is still held by remaining mooring lines, resulting in a small excursion of the turbine from its original position. Failure is detected by monitoring system and turbine is recovered.	Turbine becomes completely free of moorings, and remains buoyant. Vessel collides with drifting turbine structure, is holed and sinks. Potential loss of life.	1	2	1	2	3	4.5	3	4	2	4	2	6.5	Monitoring system; Look at possibility of tracking device GPS to track floating structure; Look at possibility of hydrostatic release if structure sinks; Emergency Response Cooperation Plan. Supervisory Control And Data Acquisition (SCADA) systems for monitoring floating or tension moored devices and Emergency Position Indicating Radio Beacons (EPIRDBs) for mooring line failures.	Independent verification of the mooring line design required. Use of SCADA systems to monitor mooring system. Tension monitoring devices. Also the potential for the substructure or whole turbine to be lying on the seabed.
All	Navigation	Fishing Gear Interaction with Sub Structures	Fishing vessel drags gear and snags with turbine foundations. Dependent on foundation type selected.	Manoeuvring error; Lack of experience; Lack of awareness; Human error; Gear snagging; Fishing vessels attracted to site.	Loss of fishing gear, minimal damage to equipment.	Fishing vessel capsizes with loss of life, loss of vessel and pollution.	1	2	1	2	3	4.5	5	2	2	4	2	6.5	Notices to Fishermen Notices to Fishermen; Marking and Lighting; Kingfisher publications; Fisheries Liaison; Exclusion zone during construction; Emergency Response Cooperation Plan; Chart Markings.	If floating turbines were to be deployed within the Eastern Development Area, then fishing gear could interact with the mooring lines.
Operation	Other	Deliberate unauthorised boarding of or mooring to structure	Structures designed to allow access for inspection, maintenance and repair. There is potential for 'trespassers' to attempt to moor to or board the structure. This has the potential to lead to a member of public falling into the sea or being stranded on a structure.	Vandalism; Protest.	Vessel moors alongside the structure or person climbs onto structure in good weather and no damage. Possible for person to get stranded on structure and require rescue by emergency services. Potential for minor vandalism, e.g., graffiti.	Person is stranded on structure or person falls overboard as a result of clambering on structure resulting in a fatality. Potential for more serious vandalism such as equipment damage.	1	1	1	3	3	4.5	4	2	1	3	2	5	Promulgation of information to local users; Inspection and maintenance procedures; Emergency Response Cooperation Plan.	Generally considered that the development is too far offshore for this to be a major issue.
All	Navigation	Anchor on or dragging over subsea equipment	In this scenario a vessel anchors over subsea cable or a nearby vessel at anchor drags its anchor over a subsea cable. Also possible that vessels anchors in an emergency , drops anchor on export cable.	Uncharted obstruction on seabed; Poor Holding Ground; Machinery Failure; Lack of awareness; Human error; Engine Failure/ Blackout; Dragged anchor.	Damage to cable.	Serious damage to cable, loss of anchor, major business interruption.	1	3	1	3	2	4	3	5	2	4	1	3.5	Promulgation of information to local users; Installation procedures; Inspection and maintenance procedures; Emergency Response Cooperation Plan; Chart Markings; Cable protection, e.g., burial.	There are two anchorages around Fraserburgh. One comercial vessel anchoring per month, generally 75 - 90m in length. Anchorage areas are sandy. AIS monitoring of the cable route. During severe weather in the North Sea, vessels anchor close to the Moray coast for shelter. Vessel types include shuttle tankers, supply vessels and cable laying vessels.