

Vattenfall Wind Power Ltd

Thanet Extension Offshore Wind Farm

Appendix 25, Annex P to Deadline 1 Submission:
Applicant's Responses to the Examining
Authority's First Written Questions – EXQ1 –
Supplementary Note – Navigation Risk
Assessment Scoring

Relevant Examination Deadline: 1

Submitted by Vattenfall Wind Power Ltd

Date: January 2019

Revision A

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Date of Approval:	January 2018
Revision:	A

Revision A	Original Document submitted to the Examining Authority
N/A	
N/A	
N/A	

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1 Introduction

1 This Supplementary Note answers ExA Questions on the Navigation Risk Assessment scoring methodology.

1.2 Example Scoring – Response to ExQ 1.12.21.

2 The explanation below relates to the 'building up' of Hazard Scoring for Hazard 12 in Annex D of the NRA at page D-3 - "Collision – Large Commercial Vessel ICW Large Commercial". In this context the phrase "building up" is taken to mean the development of the hazard score through consideration of the detail of the hazard, the possible causes, and the potential outcomes (defined as either the most likely, or the worst credible).

3 The Applicant has produced an extract from Annex D – Haz ID 12 Pg D-3, which is presented below in Figure 1.

Hazard ID	Category	Hazard Title	Hazard Detail	Possible Causes	Most Likely Outcome	Worst Credible Outcome
12	Collision	Collision - Large Commercial ICW Large Commercial	Collision between two large commercial vessels (cargo/tanker/passenger) navigating in the vicinity of the wind farm	Increased Traffic volume; Increased Traffic Density; Constriction of Shipping Routes; Human Error; Equipment or Mechanical Failure; Adverse Environmental Conditions;	Minor Injuries; Moderate damage; No Pollution; Minor Adverse Publicity;	Multiple Major Injuries or Fatality; Loss of Vessel; Tier 3 pollution; Major Adverse Publicity;

Figure 1: Extract from NRA Annex D Pg D-3.

4 The definitions of the columns of the hazard log presented in Figure 1 are given below:

- Hazard ID: Incremental hazard number used to identify hazard within series of hazards under consideration (note Construction / Decommission Hazard Log and Operational Hazard Log are separate).
- Category: Hazard category, related to incident type
- Hazard Detail: Description of the hazard.

- Possible Causes: Lists possible reason for hazard occurrence.
- Most Likely Outcome: Identifies consequence of Most Likely Occurrence of the Hazard – generally expressed against the consequence criteria in Table 19: Consequence categories and criteria, NRA Page 112.
- Worst Credible Outcome: Identifies consequence of Worst Credible Occurrence of the Hazard – generally expressed against the consequence criteria in Table 19: Consequence categories and criteria, NRA Page 112.

1.3 Consequence and Likelihood Scoring

5 The next section or phase of completing the Hazard Log is consideration of the hazard consequence scores for People, Property, Environment and Stakeholders, which appear in the corresponding columns in Figure 2 below, for both the “Most Likely” or the “Worst Credible” hazard outcome.

Hazard ID	Category	Most Likely Consequence							Worst Credible Consequence						
		People	Property	Environment	Stakeholders	Baseline Freq	Inherent Freq	Residual Freq	People	Property	Environment	Stakeholders	Baseline Freq	Inherent Freq	Residual Freq
12	Collision	2	3	1	2	3.6	4.0	3.9	4	5	4	4	1.6	2.0	1.9

Figure 2 Extract from HazLog – NRA Annex D Pg D-3- Showing Haz ID, Category and then consequence scores and likelihood scores.

6 It is important to note that these ‘Consequence scores’ are always whole numbers and directly relate back to the defined criteria in Table 19: of the NRA, which are reflected in numbered categories (ie a “moderate” consequence will fall into Category C3, which provides a score of 3 in the log).

- 7 The consequence scores are derived from review of the Marine Accident Investigation Branch (MAIB) historical incident database and specific detailed investigation reports, both within the local area (if available) and nationally – (see NRA Section 5.7 Historical Incidents), and a review of the stakeholder consultation (especially in respect of any incidents of significance). The combination of empirical MAIB data and review of more qualitative stakeholder input is considered to offer the most robust source for consequence scoring.
- 8 For Haz ID 12 the consequence scores in the baseline case were as follows:
- “Most Likely” outcome of hazard – low speed collision, likely to be glancing blow, with limited consequence values:
 - People – 2: indicative of minor injury associated with a low consequence collision such as a glancing blow at relatively low speed between two large commercial vessels
 - Property – 3: indicative of a cost of property damage of £100,000 to £1 Million pounds – which is representative of the requirement to repair one or both vessels in a ship repair facility (e.g. dry dock)
 - Environment – 1: it is unlikely that in a most likely occurrence serious environmental damage occurs due to design requirements and the low-level significance.
 - Stakeholders – 2: indicative of minor adverse publicity such as local reporting of the incident and short term loss of revenue by the vessel owners.
 - “Worst Credible” outcome of hazard – serious collision involving two large commercial vessels, with significant consequence outcome.
 - People – 4: indicative of multiple major injuries or a single fatality – derived from incident investigations into high consequence collisions. It is unlikely that multiple fatalities would occur in this location due to the proximity of emergency responders, the types of vessel involved, and availability of third party vessels able to assist following an incident.
 - Property – 5: indicative of a cost of property damage of greater than £10 Million pounds (the highest category of consequence), and is representative of the requirement significant repair to one or both vessels or total write-off.
 - Environment – 4: this relates to a major environmental consequence equivalent to a Tier 3 oil spill or similar, which therefore requires national support. The reason this score does not achieve the highest category (5) is due to the types and sizes of vessels navigating in this area, the relative sheltered nature of the area, and the availability of responders to action any clean up.

- Stakeholders – 4: Consequence Level 4 relates to widespread national adverse publicity, and potential to severely affect windfarm and vessel traffic in the area.

9 Next, it is necessary to consider the Baseline likelihoods. The following frequency scores were determined on the basis of frequency criteria contained in NRA Table 18 pg 122. These ranged on a defined scale from F1 (remote - less than once in 1000 years) to F5 (at least once a year), giving corresponding scores of 1-5). Whilst consequence scores by their nature do not necessary fall into standard units of measurement (e.g. people consequence - injury/fatal, environmental consequences – oil spill, or stakeholder – adverse publicity), and therefore are not continuous, likelihoods are simple probabilities. The IMO FSA process using the risk matrix, takes a wide proportion of likelihoods (once a year up to greater than once in 1,000 years) and splits them into 5 categories. It is very often possible however, to be able to make more nuanced assessments of likelihood, and as such the methodology employed in the NRA is able to input any likelihood (or probability) value, based on the frequency criteria table to link to the matrix. Therefore, the NRA was able to utilise likelihood scores that use decimal places to deliver more detailed return periods:

- The baseline frequency score for “Most Likely Outcome” is 3.6 which is equal to a 1 in 25 year return rate. This is referenced to the incident data which shows a 1 in 18 year return rate for all commercial vessel to commercial vessel collisions. This was based on the only collision between commercial vessels that occurred within the study area based on the Marine Accident investigation Branch incident dataset. The incident was between two small tankers within Margate Roads anchorage prior to the existing wind farm being constructed. The incident consequences were also identified within the data as “minor damage”. As this hazard is only associated with Large Commercial Vessels and not all commercial vessels the incident rate was reduced to 1 in 25-year return rate from the 1 in 15-year return rate for collision for all commercial vessels. Also as the data set is only 18 years, and only a single incident was reported, with no other collisions noted by the stakeholders before the commencement of the incident database, the 1 in 25 year rate represents a conservative estimate of Baseline hazard likelihood.
- The baseline frequency score for “Worst Credible” is 1.6 which is equal to 1 in 2,500 years. As “Worst Credible” occurrences are rare and have never occurred within the study area, industry research was utilised to benchmark the relationship between “Most Likely” occurrences and “Worst Credible Occurrences”, which has determined that the relationship between the two is that a “Worst Credible” occurrence is likely to occur approximately one time for every 100 “Most Likely” occurrences (see report section 8.3.1 Benchmarking for details).

1.4 Scoring of Hazard Risk

- 10 The next step is to combine these “frequency” and “consequence” scores.
- 11 Risk scores are derived for each of the four “Most Likely” consequences (relating to People, Property, Environment and Stakeholders), having regard to the assessed frequency. This is repeated for each of the four “Worst Credible” consequences and frequency, giving a total of eight scores.
- 12 The risk scores are reached using the risk matrix (NRA Annex B-7), which is based on the “consequence” categories and “frequency” scale explained above, with both consequence and likelihood values based on numerical scores of 1-5. Note it is the Hazman II algorithm (see answer to ExA question 1.12.27) that combines the consequence and frequency values, based on the matrix, to calculate the risk score. This process therefore produces eight assessments of risk for each individual hazard once for each “Most Likely” and “Worst Credible” frequency for each of the four consequence categories – People, Property, Environment and Stakeholders. The risk matrix in NRA is presented as a simplified matrix, with risk scores rounded to whole numbers - a more detailed representation of the same matrix is at Figure 3.

Consequences	Cat 5	5.1	5.9	7.0	8.3	10.0
	Cat 4	4.1	4.9	5.9	7.4	9.4
	Cat 3	2.9	3.5	4.4	5.9	8.3
	Cat 2	1.5	1.8	2.4	3.5	5.9
	Cat 1	0	0	0	0	0
	Frequency	>1,000 years	100-1,000 years	10-100 years	1 to 10 years	Yearly

Figure 3: Detailed Risk Matrix For frequency - >1,000 year = F1, 100-1000 years = F2, 10-100 years = F3, 1 -10 years = F4 and Yearly = F5).

- 13 The resultant risk scores for each of the eight combinations of consequence and frequency are not shown in the hazard logs in Annex D, but could be estimated by looking up frequency and consequence categories on against the matrix (noting that only whole number frequency categories are presented in the matrix).
- 14 A single numeric risk score is calculated based on taking the average of four indices related to the eight risk scores. The four indices are as follows:
- average of the four “most likely” risk scores

- the maximum “most likely” risk score
- the average “worst credible” risk score
- the maximum “worst credible” risk score

15 The eight individual hazard risk scores and the four indices for Hazard ID 12 are given in Figure 4, along with the resulting risk score (4.59).

Hazard ID	Category	Baseline								
		Most Likely Consequence				Worst Credible Consequence				
		People	Property	Environment	Stakeholders	People	Property	Environment	Stakeholders	
12	Collision	2.98	5.24	0.00	2.98	4.51	5.56	4.51	4.51	
Max Risk Score				5.24	Max Risk Score				5.56	
Average Risk Score				2.80	Average Risk Score				4.78	
Risk Score										4.59

Figure 3 Haz ID #12 – resultant risk scores for 8 individual assessment of consequence (left), right risk scores plotted on risk matrix (right)

16 The single numeric value of risk for Haz ID # 12 is therefore calculated as:

$$Single\ numeric\ risk\ score = \frac{2.8 + 5.24 + 5.56 + 4.78}{4} = 4.59$$

17 This numeric risk score for “Baseline risk” is reflected in the hazard log for Haz ID #12 (NRA p. D-3).

- 18 The single numeric risk score is therefore weighted towards the maximum risk scores generated in the “most likely” and “worst credible” assessments of risk. The weighted amalgamation of individual hazard risk scores in this way is a standard risk management practice.
- 19 The resultant baseline risk score of 4.59/10 is classified as an ALARP level hazard based on the risk banding (see Figure 5 below).

<i>Risk Number</i>	<i>Risk</i>
0 to 1.9	<i>Negligible</i>
2 to 3.9	<i>Low Risk</i>
4 to 6.9	<i>As Low as Reasonably Practical</i>
7 to 8.9	<i>Significant Risk</i>
9 to 10.0	<i>High Risk</i>

Figure 5: Risk score scale from NRA Annex B Pg 7

- 20 This hazard falls into the ALARP category for the Baseline condition – which is with no Thanet extension in place. As no stakeholders raised any concerns over the Baseline level of risk in the area or specifically identified the need for additional controls measures over the last 8 years of operation, the hazard can be termed Tolerable.
- 21 Next, the hazard log goes on to address the inherent and residual assessment of risk. The inherent assessment relates the proposals being in place with "embedded risk controls" drawn from Table 20 of the NRA (p. 117). The residual assessment is based on the proposals being in place, with embedded and “additional recommended risk controls” (drawn from Table 21 of the NRA, p. 119).
- 22 These assessments utilise the same consequence values as the Baseline level (i.e. the values shown in the People, Property, Environment and Stakeholders columns remain the same under each assessment); so that as seen in Figure 2 above, only Inherent and Residual Likelihood values are given. This is a conservative approach as it assumes there is no consequence effect of risk controls.
- 23 It can be seen in Figure 2 above that the specific likelihood scores for the inherent assessment of risk (which includes the Thanet Extension Offshore Wind Farm and the Embedded risk controls of Promulgation/NtM and the reduction in RLB) for Haz ID #12 are:
- “Most Likely Outcome” – 4.0 which is equal to a 1 in 10 year return rate.

- “Worst Credible” – 2.0 which is equal to 1 in 1,000 years.

24 An increase in hazard frequency is evident from these changes . The resultant risk score, derived from the eight assessments of risk for “most likely” and “worst credible” and combined using the four indices, is 5.05/10 based on the same calculations as described above (see Figure 6 below, which gives risk scores that are shown for this Haz ID #12 at the NRA p. D-3).

Hazard ID	Category	Inherent								Residual							
12	Collision	Most Likely Consequence	People	3.50	5.92	0.00	3.50	4.85	4.85	4.85	Worst Credible Consequence	People	4.76	5.83	4.76	4.76	
			Property	5.92	5.92	5.92	5.92	5.92	5.92	5.92		5.83	5.83	5.83	5.83		
			Environment	0.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	0.00	0.00	0.00	0.00	
			Stakeholders	3.50	3.50	3.50	3.50	3.50	3.50	3.50		3.50	3.50	3.50	3.50	3.50	
				Max Risk Score	5.92	5.92	5.92	5.92	5.92	5.92	5.92			Max Risk Score	5.83	5.83	5.83
				Average Risk Score	3.23	3.23	3.23	3.23	3.23	3.23	3.23			Average Risk Score	3.11	3.11	3.11
				Risk Score							5.05			4.93			

Figure 6: Baseline, Inherent and Residual risk scores for HazID # 12.

- 25 The same process is repeated for the residual assessment of risk, the result of which is also shown in Figure 6 (above). The specific likelihood scores for the residual assessment of risk (which includes the Thanet Extension Offshore Wind Farm, the Embedded risk controls of Promulgation/NtM and the reduction in RLB and the Additional Risk control of "Coordination with PLA VTS) for Haz ID #12 are:
- "Most Likely Outcome" – 3.9 which is equal to a 1 in 13 year return rate.
 - "Worst Credible" – 1.9 which is equal to 1 in 1,259 years.
- 26 This shows a slight reduction in hazard frequency. The resultant risk score, derived from the eight assessments of risk for "most likely" and "worst credible" and combined using the four indices, is 4.93 based on the same calculations as described above (see Figure 6 and Haz ID #12 in the NRA p. D-3). The residual risk score falls within the ALARP categorisation of risk as explained above.