Vattenfall Wind Power Ltd

Thanet Extension Offshore Wind Farm

Annex C to Appendix 22 to Deadline 6 Submission: Supplementary Note to ExAQ3.12.34

Relevant Examination Deadline: 6

Submitted by Vattenfall Wind Power Ltd

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1 Introduction

1 The ExA's third Questions (ExQ3) at 3.12.34 identified the Applicant to provide the following:

"Normal" or "Limit" states
The answers given at ISH8 and recorded by the Applicant in REP5-018 paras 82 et seq do not specifically address the question of how and to what extent the risk assessment has taken into account "limit-state" qualitative scenarios combining worst MetOcean conditions in which pilot transfer operations can take place at NE Spit, including:

- *poor visibility; and*
- *encounters involving vessels most restricted in ability to manoeuvre by reason of draught, windage, fishing, towing, etc.; and*
- *ship's master unfamiliar with the local waters; and*
- *technical or communications problems encountered with pilot transfer.*

The notes of the 29 March 2019 Hazard Workshop appear to be silent on assessment of such combination of circumstances in connection with defined hazards. Would the Applicant please provide:

a) written workings (not merely tabulated numbers) of assessment of the most likely consequence of a limit state combination of effects for the top 4 hazards with the proposed TEOW in place subject to SEZ as proposed;

b) a reasoned assessment of frequency of occurrence in construction phase in each case 1-4 above;

c) clarification of the specific risk controls applied in assessing the inherent and residual risk in each case 1-4 in construction phase;

d) explanation for the differential between most likely and worst credible scores for these top 4 hazards 1-4;

e) justification why the doubling of likelihood for a class 1 or 2 collision hazard has resulted in a small percentage change in the risk score calculated by the software;

f) examples in the top 4 hazard assessments 1-4 where the likelihood and consequence scores are close to the threshold for the next category e.g. category L2 to L3 or C2 to C3; and

g) examples in the workshop where a "what-if" feedback loop or iteration took place to test the sensitivity (and thereby robustness) of assessment.

2 The Navigation Risk Assessment Addendum (NRA A), focused on assessing the navigation risk for the operational phase of the TEOW and due to time limitations was not able consider the construction or decommissioning phase which was agreed with IP in the pre hazard workshop.

2 Response to ExA Questions

2.1 a) written workings (not merely tabulated numbers) of assessment of the most likely consequence of a limit state combination of effects for the top 4 hazards with the proposed TEOW in place subject to SEZ as proposed;

3 The Applicant notes that inherent within the qualitative/quantitative workshop process that a most-likely and worst-case assessment considers limit states. It is unlikely that a 'worst credible', or indeed a 'most likely' incident would occur when the weather is fine with good visibility. As it is inherent, it is difficult to meaningfully provide written workings in a manner that would differentiate between the consequence of a 'normal day' and the consequence of a number of limit states combining. As has been discussed during examination the purpose of incorporating the qualitative considerations of mariners within the hazard log likelihood and consequence process is to ensure that the 'dark and stormy night' or 'limit state' is provided for.

4 The FSA risk assessment process as mandated by MCA MGN 543 (M+F) requires the assessment of hazards which are defined as "*something with the potential to cause harm, loss or injury, the realisation of which results in an accident"* as noted at Para 83 of NRA A. The assessment of hazard risk scores within the workshop were specifically to include all eventualities of hazard occurrence – including hazard occurrence at "limit" state conditions. It is important to note in the context of the FSA risk assessment process and the HAZID workshop for Thanet Extension specifically that limit states are considered within the NRA methodology as causes of hazards. This is essentially the difference between a FSA risk assessment format which considers the realisation of hazards to lead to an incident (which may arise as a result of poor weather) from HSE risk assessment formats, in which hazards activities that could be unsafe. For example working at height within a HSE risk assessment is a common hazard title – however within the FSA methodology this would not be considered a hazard as working at height does not in its self-result in an accident occurring. The FSA definition of hazard in this case would be falling, and a cause working at height.

5 The reasons that this is especially important in maritime navigation risk assessment is that the number of variables is almost infinite both in terms of hazard occurrence and hazard magnitude from vessel type, size, cargo, crew, flag state, age, speed, environment type from rocky exposed shores to gentle shelving mud, met ocean conditions, before one considers organisational factors and the integration of second order effects between different vessels or other organisations such as port authorities.

6 This is addressed within the FSA methodology by assessing the system as a whole and not scoring hazards on an individual "sub" hazard basis, which whilst they maybe thought significant by one party, only contribute to a small extent to total hazard risk.

7 The question asked by the ExA is to provide a refined written assessment of most likely consequences of a limit state combination of effects for the top 4 hazards with the proposed TEOW in place subject to the SEZ as proposed, which is addressed in the hazard logs of hazards 1 – 4 in the NRA A, as noted above by virtue of the process utilised, this provides for the limit states requested by the ExA. The most likely outcome is therefore not related to a specific set of causes, and to break down hazards in this manner would result in an almost infinite number of hazards to be assessed, each of which would have ever decreasing likelihoods of occurrence. The most likely consequence, and the likelihood of it, has therefore been provided in the hazard logs and these provide for 'limit states' in terms of metocean conditions, or indeed any other limit state, such as periods during which commercial fishing and recreational vessels are at peak activity.

8 As such the Applicant is not able to directly meet this request but can reassure the ExA that these "limit" state conditions are captured in NRA hazard assessment through the use of extensive historical data (incident and vessel traffic) and the input from IP's which specifically resulted in higher hazard likelihoods than historically documented, for even the baseline assessment of risk, which does not include the TEOW.

2.2 b) a reasoned assessment of frequency of occurrence in construction phase in each case 1-4 above;

9 As noted in the NRA A, the focus of the assessment was on the operational stage of the TEOW, and not on the constructions phase, which was primarily due to an understanding that IP concerns relate to structures within the sea, and the associated loss of searoom, rather than the presence of construction vessels which is a far more frequent (and transient) effect. It is also important to note that the original NRA conducted a construction / decommissioning phase risk assessment that considered hazards to be ALARP already, and that additional risk controls were to be in place such as guard vessels. In this context given the impact will be transient, subject to the same risk controls as already put forward, but with a smaller zone of effect (i.e. construction will take place across a smaller area), construction phase impacts with the SEZ in situ can be considered to be no greater than those published with the original NRA because whilst the consequence of an impact may remain the same, the likelihood will likely reduce (or be no greater than) because of the reduction in project area. The Applicant notes that the original NRA considered slightly different hazards but can confirm that the principle of a general reduction in likelihood still applies.

10 The request from the ExA is that a reasoned assessment of frequency of occurrence in the construction phase for hazards 1-4 be assessed.

11 Given the hazards are not considered to have altered for the construction phase, and that IPs have been content to focus on the impact of permanent infrastructure associated with the O&M phase, the Applicant has relied upon the original construction phase NRA, to assess the construction phase risk assessment. The original NRA considers a worst case, as it does not have the SEZ in place, and therefore hazards are scored higher relative to the NRA A.

12 The hazard likelihoods for the construction phase risk assessment are presented in Table 1, which show the hazard likelihood scores for the defined collision hazards, related to baseline, inherent and residual assessment of risk. It is noted that original NRA hazards related to commercial (large/small) vessel collision hazards can be considered broadly comparable with NRAA hazards 1 - 4 because they consider the same vessels and interactions. This table demonstrates the magnitude of hazard likelihood change for vessel collision with the original RLB in place, and the precautionary approaches applied (as noted above in answer to part a)) both in the baseline and inherent assessments.

Table 1: Hazard Likelihood for the original NRA Construction Phase Risk Assessment.

Haz ID	Haz Title	Consequence Likelihood			Consequence Likelihood			Relative Changes in Hazard Likelihood Scoring			
		Baseline 1 in X yr	Inherent 1 in X yr	Residual 1 in X yr	Baseline 1 in X yr	Inherent 1 in X yr	Residual 1 in X yr	ML:Baseline to Inherent Reduction	ML: Baseline to Residual Reduction	WC: Baseline to Inherent Reduction	WC: Baseline to Residual Reduction
1	Collision - Large Construction Vessel ICW Large Construction Vessel	N/A	100	100	N/A	10,000	10,000	N/A	N/A	N/A	N/A
2	Collision - Large Construction Vessel ICW Large Commercial	N/A	50	63	N/A	1,000	1,585	N/A	N/A	N/A	N/A
3	Collision - Large Construction Vessel ICW Small Commercial	N/A	10	25	N/A	1,000	2,512	N/A	N/A	N/A	N/A
4	Collision - Large Construction Vessel ICW Fishing Vessel	N/A	10	25	N/A	1,000	2,512	N/A	N/A	N/A	N/A
5	Collision - Large Construction Vessel ICW Recreational	N/A	10	25	N/A	1,000	2,512	N/A	N/A	N/A	N/A
6	Collision - Large Construction ICW Small Construction/O&M	N/A	10	10	N/A	1,000	1,000	N/A	N/A	N/A	N/A
7	Collision - Small Construction/O&M ICW Small Construction/O&M	10	3	3	1,000	251	251	70%	70%	75%	75%
8	Collision - Small Construction/O&M ICW Large Commercial	100	25	32	1,000	251	316	75%	68%	75%	68%
9	Collision - Small Construction/O&M ICW Small Commercial	50	25	50	501	251	501	50%	0%	50%	0%
10	Collision - Small Construction/O&M ICW Fishing	25	10	16	1,000	251	501	60%	36%	75%	50%
11	Collision - Small Construction/O&M ICW Recreational	10	3	5	1,000	251	501	70%	50%	75%	50%
12	Collision - Large Commercial ICW Large Commercial	25	10	13	2,512	1,000	1,259	60%	48%	60%	50%
13	Collision - Large Commercial ICW Small Commercial	25	16	20	2,512	1,000	1,259	36%	20%	60%	50%
14	Collision - Large Commercial ICW Fishing	50	10	16	2,512	1,000	1,585	80%	68%	60%	37%
15	Collision - Large Commercial ICW Recreational Craft	50	10	16	2,512	1,000	1,585	80%	68%	60%	37%
16	Collision - Small Commercial ICW Small Commercial	50	25	32	2,512	1,000	1,585	50%	36%	60%	37%
17	Collision - Small Commercial vs Fishing	50	25	50	2,512	1,000	2,512	50%	0%	60%	0%
18	Collision - Small Commercial vs Recreational	50	25	50	2,512	1,000	2,512	50%	0%	60%	0%

2.3 c) clarification of the specific risk controls applied in assessing the inherent and residual risk in each case 1-4 in construction phase;

13 It is understood that the ExA is looking for the applicant to identify the risk controls that would be in place for the construction phase risk assessment. The Applicant, in agreement with the IPs, did not consider construction phase effects in the NRAA. Notwithstanding this the Applicant has below provided a summary of the relevant risk controls to hazards 1-4 of the NRA A.

14 The Applicant notes that the controls identified within the original NRA would be required, located at Table 20 and Table 21 of the NRA report, which includes Embedded risk controls as noted in Table 2 below and additional controls as noted in Table 3, which have been updated to reflect those refined and enhanced as part of the NRA A.

Table 2: Embedded Risk Control Measures

ID	Risk Control
1.	Promulgation of information and warnings through notice to mariners and other appropriate Maritime Safety Information (MSI) dissemination methods.
2.	Planning and coordination between developer and operators.
3.	All construction, operational and maintenance vessels are to be fully compliant with legislation, guidance and best practice.
4.	All those involved in construction, operational and maintenance operations are to be trained and competent persons, using appropriate PPE.
5.	Incidents and near misses are reported and investigated by developer and operators.
6.	ERCOP to be drafted in conjunction with MCA/HMCG and other stakeholders.
7.	Continuous watch of site by radar, AIS, VHF, DSC and CCTV during construction by project's Marine Coordinator.
8.	Inter-array / export cables to be buried to the depth agreed, or suitably protected, which provides sufficient protection without compromising UKC.
9.	Aids to Navigation management plan (Marking and Lighting) to be submitted to MCA/TH for approval prior to construction.
10.	Blade Clearance of at least 22m above MHWS.

ID	Risk Control
11.	Layout Plan to be submitted to MCA for approval prior to construction. The layout plan should include the proposed location and foundation types of all structures, the height and clearances of blades and length and arrangement of cables.
12.	Cable Burial Risk Assessment and periodic cable inspections to be conducted and protection so not to exceed 5% UKC.
13.	Update navigational charts to show wind farm layout and cable route
14.	Revision of Red Line Boundary - Several stakeholders raised concerns about the restriction of sea room to the west of the extension during the process of this assessment. In order to mitigate these concerns and reduce the level of impact, the project took the decision to reduce the red line boundary of the extension in this area (see **Section** Error! Reference source not found.).
15.	A cable exclusion area should be implemented that covers the port limits, approach channel and dredged channel of the Port of Ramsgate. Within this area no cables will be installed associated with this project. During cable laying and or maintenance, it may be necessary for anchor spreads or moorings to be temporarily placed within this area to assist with the installation, however this will be conducted as per risk control 3.
16.	Introduction of the Structures Exclusion Zone.

15 Additional risk controls for the construction phase risk assessment have been identified through reference to:

- Those identified as part of the original NRA for the construction phase; and
- Those identified and refined as part of the NRA A for the operational phase.

16 An assumption has been made that the NRA A operational phase additional risk controls could also be applied to the construction phase, though as some of these risk controls are enhancements to, or similar to, those identified in the original NRA as embedded controls (as discussed in at ISH 8), as such a consolidated additional risk control list s presented at see Table 3. – which shows that there are three additional risk controls that would need to be applied for the construction phase TEOW.

Table 3: Table showing relationship between original NRA construction phase risk controls and likely NRA A Construction risk controls.

Additional Risk Control	Source	#	NRA A Construction Additional Risk Controls
Enhanced Promulgation of Information (already adopted by the Applicant)	NRA A	1	Enhanced Promulgation of Information (already adopted by the Applicant)
Shipping and Navigation Liaison Group (already adopted by the Applicant)	NRA A	2	Shipping and Navigation Liaison Group (already adopted by the Applicant)
Post Consent Monitoring for Operational Phase (requested by Trinity House)	NRA A	3	Post Consent Monitoring for Operational Phase (requested by Trinity House)
Enhanced Optimisation of TEOW line of orientation and symmetry	NRA A	4	Enhanced Optimisation of TEOW line of orientation and symmetry (already adopted by Applicant)
Aids to Navigation / Buoyage (already adopted by the Applicant)	NRA A	5	Aids to Navigation / Buoyage (already adopted by the Applicant)
Safety Zones	NRA	6	Provision of Safety Zones as necessary - extent and size to be determined as needed in consultation with IP's
Coordination with PLA VTS	NRA	7	Coordination with PLA VTS on active notification of vessels of construction activity.
Guard Vessels	NRA	8	Provision of guard vessels to actively notify vessels of construction activity
Cooperation with Port of Ramsgate	NRA	N/A	Addressed in RC 2 therefore not included separately.
Coordination with Leisure/Fishing	NRA	N/A	Addressed in RC 2 therefore not included separately.
Maintain Lines of Origin/Symmetry	NRA	N/A	Addressed in RC 4 therefore not included separately.
Relocation of Buoyage	NRA	N/A	Addressed in RC 5 therefore not included separately.

17 Further to this it should be noted that the Embedded construction risk control – "*Continuous watch of site by radar, AIS, VHF, DSC and CCTV during construction by project's Marine Coordinator*" to a degree supersedes the "Post – consent monitoring" additional risk control identified by Trinity House for the operational stage, when the construction phase is on going.

18 Finally it should be recognised that the final turbine positions will only be determined following approval of a design plan (Condition 13(1)(a) of Schedule 11 of the dDCO) and as such the MCA and Trinity House would be party to the decision which would take into account any relevant concerns relating to construction effects.

19 A table showing which risk controls would likely be applied to the NRA A hazards 1-4 is presented at Table 4, though it is noted that these would be discussed at the Shipping and Navigation Liaison Group.

Table 4: Risk controls applied to NRA A Hazards 1-4 for construction phase

Haz#	Hazard Title	Additional Risk Controls #
1	Class 1 or 2 vessels	1, 2, 4, 5, 6, 7, 8
2	Class 3 or 4 Vessels	1, 2, 4, 5 6, 7, 8
3	Vessel less than 90m	1, 2, 4, 5 6, 7, 8
4	Fishing or Recreational	1, 2, 4, 6, 7, 8

2.4 d) explanation for the differential between most likely and worst credible scores for these top 4 hazards 1-4;

20 The differences in most likely and worst credible hazard likelihood scores is, at its most basic level documented at para.103 and 104 of the NRA, which shows that national incident data analysis (from MAIB reported navigation incidents), identifies a relationship between hazard likelihood for the most likely and worst credible hazard outcomes of 100 fold difference. Through the hazard workshop these outline rules were used to identify hazard likelihoods, which were further refined by the interested parties based on their understanding of the local area. Thus, hazard scores are generated which are amalgamation of the views of the workshop attendees and the starting point which is the empirical historical data.

21 The same principles apply to each NRA phase (construction/ operation and decommissioning), and also to each risk profile (baseline/ inherent/ residual) assessment of likelihood between the most likely and the worst credible occurrence.

22 In terms of hazard consequences however, then these were addressed through the workshop with interested parties, with reference to known outcomes of historical incidents. This is the same for the construction, operation and decommissioning phases of the TEOW (addressed in the original or addendum NRA), and typically, this relates in the most likely case to incidents individuals attending the workshop may have come across themselves in the study area or through their career. In the worst credible assessment information is drawn from hazard workshop attendees and also from individual incident investigation reports, which provide for an indication of the likely magnitude of consequence from accidents of comparable vessels, in a comparable area and of a similar hazard type. An example of this approach was evident in the hazard workshop where ESL requested that the MAIB Investigation into the Collision between the *Norwegian Dream* (cruise ship) and the *Ever Decent* (container ship) be considered in relation to worst credible outcomes of collision hazards of large commercial vessels. This particular accident was considered to relate to a worst credible event, and did not occur within the study area, but several nautical miles to the east. The consequences of this particular accident included major damage to both vessels (including some cargo on the Ever Decent and would also have included delays), but there were no injuries or pollution. However, it is evident from the hazard logs for worst credible consequences for a collision of Class 1 or 2 commercial vessel included:

- People - Multiple injuries or a single fatality in relation to people,
- Property - Catastrophic damage to property
- Environment - Catastrophic environmental consequences
- Stakeholders / Business - Major-National adverse media publicity

23 It was noted, whilst this accident was discussed in the workshop, that the technical consultant from PoTLL (Mr Vince Crockett) had also reviewed this particular incident in preparation for scoring hazard consequence at the hazard workshop.

24 Thus, the differential scoring, for most likely and worst credible assessment of risk, for likelihood and consequence scoring, within the NRA process is related both to the available data, analysis and modelling - the “quantitative” element, and also the “qualitative” element - derived from input provided by the interested parties, either through the consultation meetings that were undertaken in the original NRA or the hazard workshop conducted as part for the NRA Addendum and the project experts including master mariners and scientists.

2.5 e) justification why the doubling of likelihood for a class 1 or 2 collision hazard has resulted in a small percentage change in the risk score calculated by the software;

25 The Applicant would draw the ExA to para 129 of the NRA A where it is explained why the doubling of likelihood for any particular hazard does not relate to a doubling of risk score. This explanation is true irrespective of any particular hazard.

26 The Applicants answer to ExA Question 3.12.22 also addresses this point in more detail.

2.6 f) examples in the top 4 hazard assessments 1-4 where the likelihood and consequence scores are close to the threshold for the next category e.g. category L2 to L3 or C2 to C3; and

27 The assessment of likelihood for the NRA and NRA A was undertaken with a sliding scale for likelihood, as explained at Para. 105 of the NRA A, and as such the actual frequency scores applies to the Haz ID 1 to 4 in the NRA A is as noted in the accompanying hazard log and as summarised in the table below.

Table 5:Hazard Likelihood Scores

Haz Id	Hazard Detail	Most Likely Likelihood 1 in x yrs			Worst Credible Likelihood 1 in x yrs		
		Baseline Risk	Inherent Risk	Residual Risk	Baseline Risk	Inherent Risk	Residual Risk
1	Collision Class 1 or 2 vessel with another navigating vessel	36	18	25	450	225	307
2	Collision Class 3 or 4 vessel with another navigating vessel	27	18	21	360	240	284
3	Collision vessel less than 90m with another navigating vessel	27	18	21	401	267	316
4	Collision Fishing Vessel or recreational craft with another navigating vessel	10	8	9	500	400	435

28 In the table above it is clear that in terms of likelihoods then for the most likely occurrence, Haz ID 1-3 all fall within the general frequency classification of F3 (Possible – one of more times in 100 years) when related to Table 16 of the NRA A. Though it is important to note that the Hazman 2 risk algorithm is not bound by these fixed categories and that risk scores are directly calculated from the actual return periods entered.

29 It is however noted that Haz 4, in the Baseline assessment has a score of 1 in 10 years and therefore lies in a frequency category of F3 (Possible – one of more times in 100 years – 10-99 year return rate), but that the inherent and residual assessments are more likely and therefore fall into the top of an F2 category ("Likely" – one or more times in 10 years – 1-9 year return rate).

30 However, as the Hazman 2 risk algorithm is not bound to categories, and actual return rates are used, the premise of the ExA question regarding thresholds doesn't hold true for likelihood, there are no thresholds as the algorithm provides for a continuous logarithmic scale.

31 With regards to the consequence assessment, then it is not possible to identify whether any consequence scores are close to a category threshold as theses scores are generated based on discussions with IPS at the hazard work shop, based on a review of available data.

2.7 g) examples in the workshop where a "what-if" feedback loop or iteration took place to test the sensitivity (and thereby robustness) of assessment.

32 A feed back loop in the form of correlation to historical incident data, national incident data and vessel traffic analysis was used to assess whether the qualitative input received from the stakeholders was broadly in line with expectation. The hazard workshop is therefore a form of what if feedback process in that participants are able to test each assumption and discuss whether a given hazard adequately accounts for a combination of perception and statistical analysis. In this context the hazard workshop allows and encourages iterative discussion and development of a given hazard scores until a consensus is reached that reflects a combination of qualitative and quantitative data.

33 During the workshop there was an instance where the IP's determined that the likelihood of a fishing vessel collision resulting in a fatality was comparatively very high. The hazard Workshop lead, Dr Rogers questioned the numbers provided and as an agreement could not be made at the workshop, it was agreed that additional sources of information be sort from those parties in disagreement. Whilst no further details were received from IP's, Dr Rogers provided additional analysis from an MAIB report to help refine the likelihood scores – this is captured in the hazard Log in the notes column for HazID 4, and presented below:

"Agreement on likelihood of WC outcome was not reached at the workshop. A review of literature published by the Marine Accident Investigation Branch - Analysis of UK Fishing Vessel Safety 1992 to 2006 , shows that for fishing vessels under 12m vessels

(typical of those operating in the study area) there were 10 collision/contacts between 1992-2006 that results in vessel loss. The UK under 12m fishing fleet at 2006 was 6119, and therefore the likelihood of vessel loss (note that most vessels lost did not result in multiple fatalities) was 10 losses for 6119 vessels over 14 years. This gives an incident rate for loss of a fishing vessel from collision/contact of 1 in 12,238 per vessel years. The fleet operating in the study area is around 10 vessels, who also operate in other areas, and as such based on national incidents, it would be expected that the area would have a WC likelihood value at most 1 in 2000 years. Based on the complexity of traffic profile this could be increased to 1 in 1000 years, and when added to recreational craft incidents which show a similar return rate, then a conservative estimate would be around 1 in 500 year likelihood for the WC assessment.

Based on continued navigation (and fishing) of fishing vessels and recreational craft through the windfarm then the workshop agreed that an increase in likelihood for the inherent assessment would be expected of around 20%."

34 This indicates that where agreement was not made, additional sources of information were sought. However, the NRA FSA methodology does not in itself, mandate the need for any “what if” feed back loops.