NAVIGATIONAL RISK - OMØ SYD WIND FARM

Hazard Identification and Qualitative Risk Evaluation of the Navigational risk for the Omø Syd Wind Farm

Orbicon A/S

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0	2014-12-10	First issue	LSNI	PFH	JORA
1	2014-12-11	Comments from Orbicon	LSNI	PFH	JORA
2	2015-02-27	1. Updated Coarse risk analysis with new frequency data. 2. Added comments from HAZID participants. 3. New turbine layout	LSNI	PFH	JORA

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Appendix A Hazard identification

1 SUMMARY

DNV GL has been contracted to perform a navigational safety analysis in connection with the preparation of the environmental impact assessment (EIA) for the Omø Syd wind farm project.

The analysis follows the IMO "Guidelines for Formal Safety Assessment", where the first step, following the guidelines, is to identify the potential hazards (adverse events) that may result in injury, damage to the environment, economic loss, etc. As background for the HAZID analysis the ship traffic in the area has been mapped based on AIS received from the Danish maritime authority (DMA). The AIS data is covering a period of twelve months from November 1, 2013 to October 1, 2014. Apart from leasure and fishing traffic the AIS data has in the hazard identification been found representative for the assessment of the traffic around Omø Syd wind farm.

The HAZID was conducted at the premises of DNV GL in Hellerup on November 28, 2014.

The hazard group reflected the relevant stakeholders and individuals with extensive experience and skills in navigational safety. The hazard group identified hazards related to commercial traffic, ferry traffic, fishing, leisure sailors and maritime pilots. Most vessels are found covered by AIS apart from small fishing vessels and leisure boats. In these cases the traffic was assessed by the HAZID participants.

For each identified hazard, frequencies and consequences are estimated based on expert elicitation, which in turn are used to evaluate the risk based on the established risk matrix. However, collision and grounding frequencies are calculated using the collision and grounding analysis tool, IWRAP.

It should be noted that the final location of the turbines is not known at this time. The wind farm can either consist of 80 3MW or 40 8MW turbines.

The actual number of turbines is thus currently not decided, but will not have an impact on the identified hazards. For the navigational risk assessment the analysis assumes the worst case scenario of 80 3MW turbines.

Because of the short distance to land no substation is expected to be built offshore.

No hazards have been found to lie above the ALARP range and potential risk reducing measures are thus not identified.

2 BACKGROUND

On February 22 2012 European Energy A/S applied for a permit for feasibility studies and preparation of an EIA for the establishment of an offshore wind farm at Omø Syd. The permit was given by Energistyrelsen on March 3 2014 with additions to permit on June 3 2014. In connection with the feasibility studies a navigational risk analysis shall be carried out.

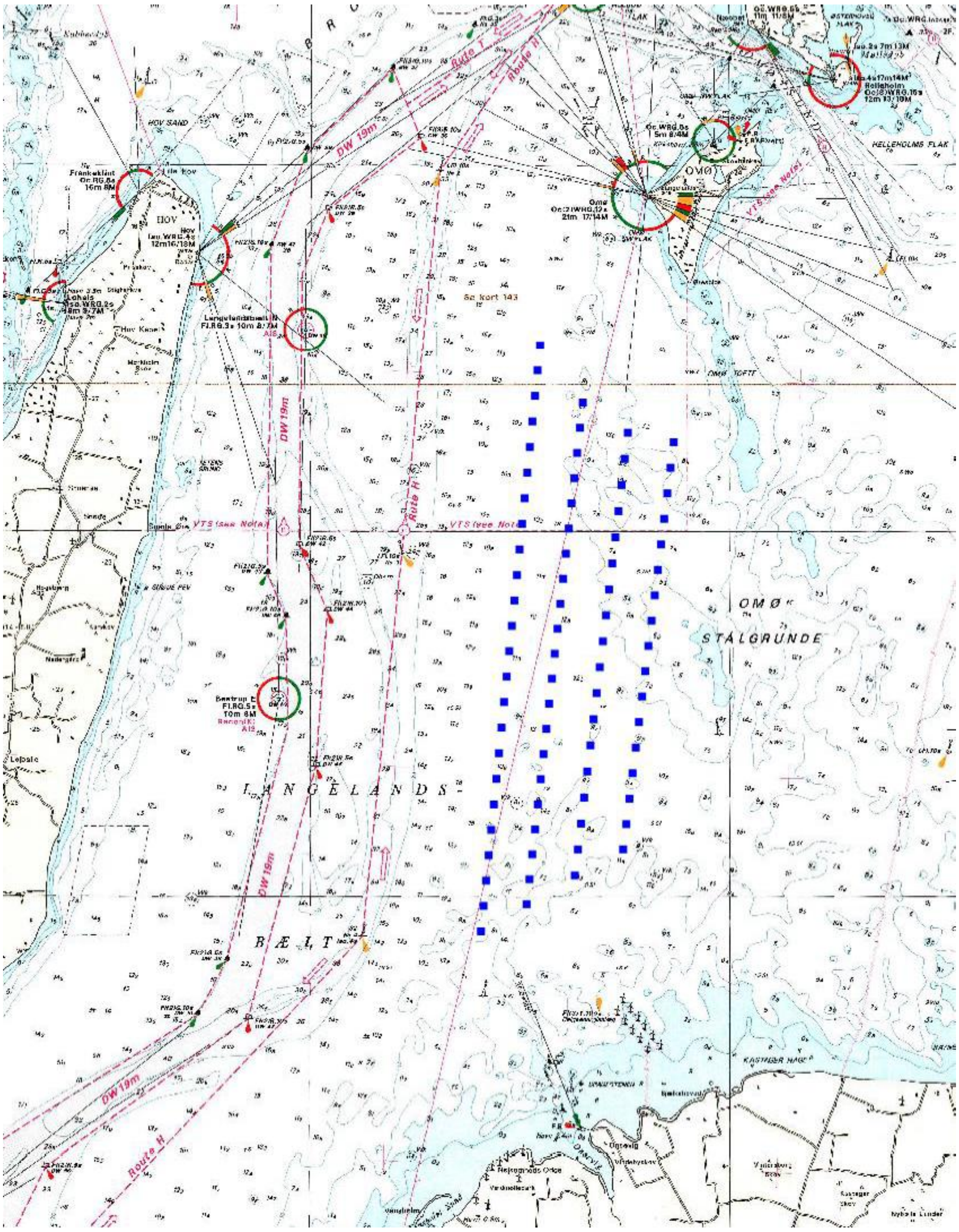

Figure 1: Investigation area and worst case turbine configuration

DNV GL has been contracted to perform a navigational safety analysis in connection with the preparation of the environmental impact assessment (EIA) for the Omø Syd wind farm project.

The worst case hazards are evaluated based on the mapped AIS traffic around the investigation area, which were presented at the HAZID. The mapped traffic intensities in the area are shown in Figure 2

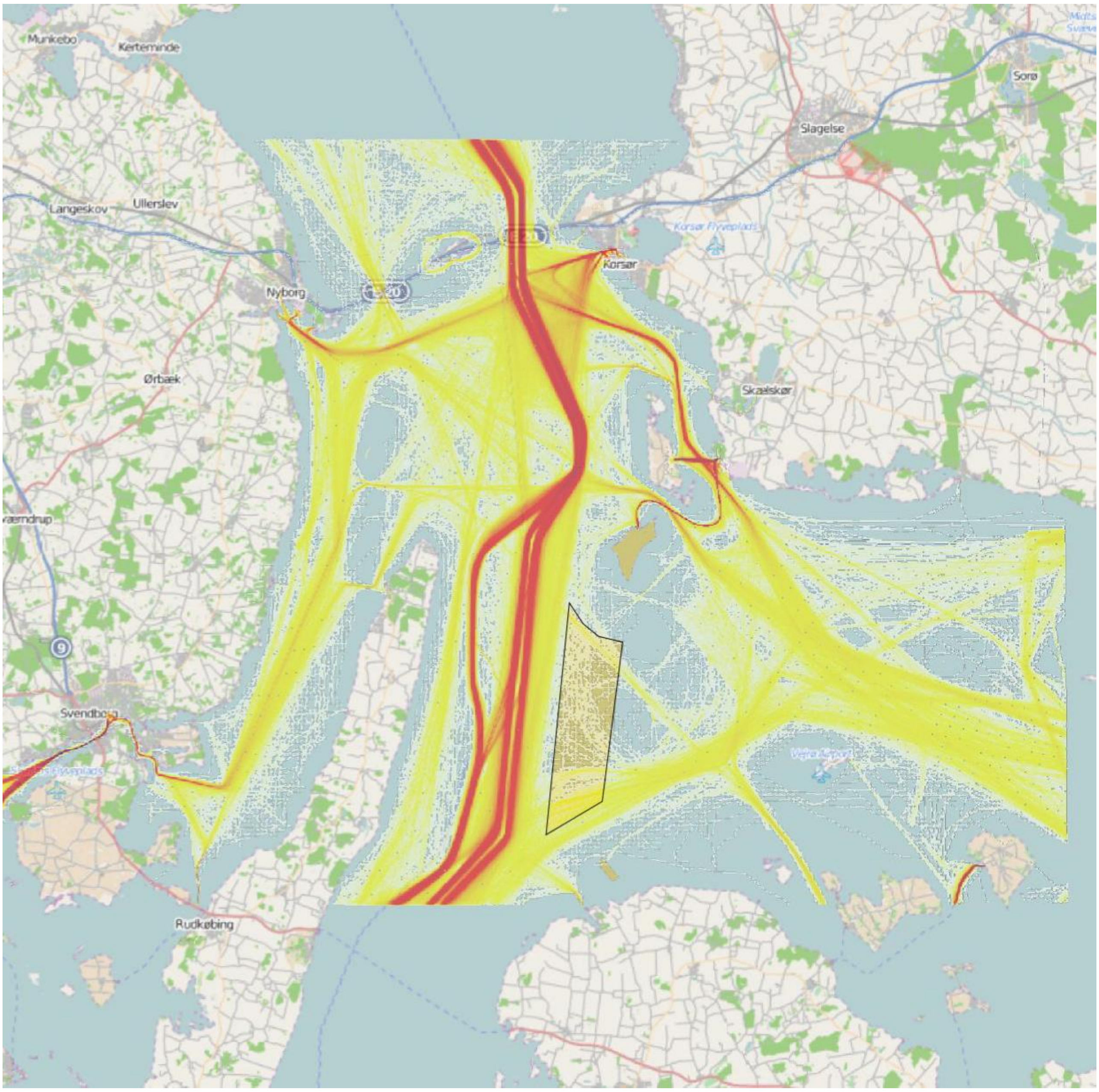

Figure 2: Mapped traffic based on AIS

3 STRUCTURE OF THE HAZID STUDY

3.1 The HAZID workshop

The HAZID workshop was carried out November 28, 2014 at DNV GL Hellerup. The participants and their field of expertise are listed in section 3.2.

Since this is a first overall assessment of the safety in the area, standard question words often used in HAZID's were not applied. Instead, there was a "systematic brainstorming" where each hazard was examined in the operational phase.

The main objective was to identify risk scenarios caused by the presence of the Omø Syd wind farm in the operational phase. The current navigational risk in the area is not covered, and thus only the increased risk caused by the new wind farm.

The ship traffic was grouped into following categories:

- Fishing ships
- Oil products tanker
- General cargo ships
- Passenger ships
- Leisure boats
- Support ships
- Other ships

Although there will be no passage restrictions through the park area, it is expected that the entire area automatically will be kept free of commercial traffic and only fishing and leisure boats will sail through the park area.

The information of fishing in the area is based on AIS and does not cover small vessels without AIS. A qualitative assessment of fishing vessels without AIS have been included based on information from HAZID participants.

3.2 The HAZID group

The composition of the HAZID group reflected the various stakeholders in the area, as well as various professions, thus ensuring that all relevant risks were identified.

NAME	COMPANY / ORGINISATION / PROFESSION
Jens Chr. Eskjær Jensen	Bisserup Sejlklub
Henrik S. Lund	Danmarks Fiskeriforening
Morten Glamsø	Danmarks Rederiforening
Steen Wintlev	Dansk Sejlunion
Bjarne Cæsar	Danske Lodser
Peter Friis Hansen	DNV GL
Lasse Sahlberg-Nielsen	DNV GL
Jonathan Rahbek	DNV GL
Christina Andersen	European Energy
Ian Wallentin	European Energy
Arne Rydahl	Kalundborg Havn
Flemming Caspersen	Kragenæs Sejlklub
Thorbjørn Kragesteen	Langelandsfærgen
Birgitte Nielsen	Orbicon
Peter Dam	Søfartsstyrelsen
Flemming S. Sørensen	Søfartsstyrelsen
Erik Ravn	Søfartsstyrelsen

Figure 3: HAZID participants

3.3 Risk evaluation

The consequences are grouped into the following categories:

label		None	Negligible	Significant	Serious	Critical	Catastrophic
Consequence Class	Abbreviation	2	3	4	5	6	7
Health	H	Bruises and minor damages that do not require hospital treatment	1 injury requiring hospital treatment	Several incidents requiring hospital treatment	Several incidents requiring hospital treatment. 1 disabled	1-2 killed	More than 2 killed
Material	M	Costs due to ship-ship or ship-turbine collision	Costs due to ship-ship or ship-turbine collision	Costs due to ship-ship or ship-turbine collision	Costs due to ship-ship or ship-turbine collision	Costs due to ship-ship or ship-turbine collision	Costs due to ship-ship or ship-turbine collision
Environment	E	None/negligible	Minor environmental damages. Restored within days	Serious environmental damages. Restored within weeks	Serious environmental damages. Oilspill larger than 3 tons	Critical environmental damages. Oilspil larger than 30 tons	Catastrophic environmental damages. Oilspill larger than 300 tons
Monetary value	€	100	1,000	10,000	100,000	1,000,000	10,000,000
Acceptability per year		Negligible	Tolerable	Unwanted	Unwanted	Unacceptable	Unacceptable

Table 1: Consequence classes

Likewise the probability is grouped into the following categories:

Frequency class	Label	More than X incidents per year
2	Dayli - Month	10
1	Month-year	1
0	1-10 year	0.1
-1	10-100 year	0.01
-2	100-1000 year	0.001
-3	1000-10.000 year	0.0001
-4	10.000-100.000 year	0.00001
-5	> 100.000 year	0.000001

Table 2: Probability classes

The risk for a particular hazard can be evaluated based on the estimated consequences and frequencies. A coarse risk analysis has been carried out based on the risk matrix shown in Table 3 where it can be judged whether the accumulated hazards are acceptable or unacceptable and risk reducing measures should be evaluated further.

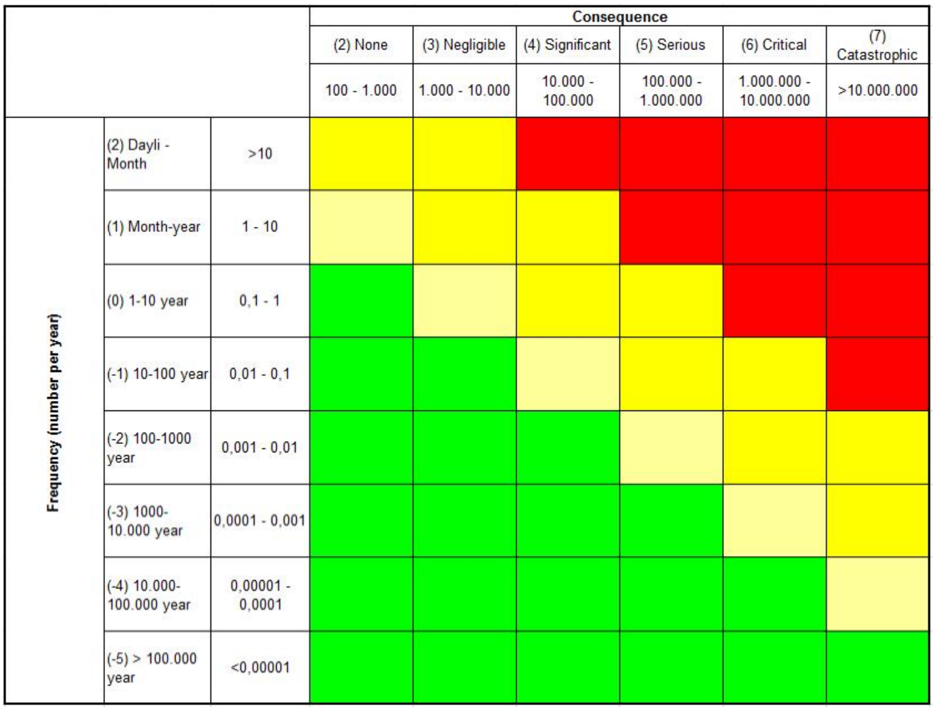

Table 3: Risk matrix – Red area is unacceptable, yellow area is unwanted, bright yellow is tolerable and green area is negligible. Consequences in the yellow area shall be evaluated using ALARP (As low as reasonably possible)

4 REPORTING AND ITEMS NOT COVERED BY THE HAZARD LIST

The identified hazards, evaluated consequences and barrier factors regarding ship-turbine collision are shown in appendix A of this report. The ship-turbine collision frequencies for each hazard are taken from a frequency analysis /1/ performed by DNV GL based on the AIS data.

In addition to the hazards listed in appendix A, the following items were discussed in the HAZID.

- The Omø Syd investigation area is located in "Smålandsfarvandet" which is an area popular for recreational sailing. It is estimated that between 25.000 and 30.000 boats visits the area during the high season of June/Juli/August. The waters between the turbines are not ideal for sailing and the presence of the farm may force the leisure traffic out in the densely trafficked cargo routes. The leisure traffic from "bøgestrømmen" will most probably go through Omøsund. Most of these vessels does not carry AIS.
- The registered AIS for fishery will not give a realistic picture since only larger vessels above 24 m carry an AIS transmitter. Danmarks Fiskeriforening evaluates that the typical size of the vessel is around 12 m and that 45 vessels is in the area around Omø Syd.
- Fishing patterns tend to be different from year to year. It is suggested that AIS for 5 years may give a better picture.
- The wind farm foundations will act like an artificial reef which is favourable for some fish species. Hence the presence of the wind farm might tend to increase the fishery between the turbines.
- For emergency manoeuvres on the H-route DMA has recommended that there should be 3-4 km to the west side border of the park. There is approximately now 2.9 km to the center of route H, see section 4.2.
- The traffic on the H-route will probably keep a safe distance to the park and thus be narrower.
- The southern part of the farm is located in a trafficked area. The presence of the farm will force the ship traffic further south into shallower waters near Lolland. This could be problematic for commercial traffic and the fact that Nakskov will be construction harbour for the new Storstrøms bridge

- The northern part of the farm is situated in deeper waters and can thus force traffic into shallower waters at "Omø stålgrunde"

4.1 Proposed risk reducing measures

In response to this HAZID report in revision 1 "Bisserup Sejlklub" has proposed the following risk reducing measures. It is proposed that:

- A marked route from "Ståldyb" and NNW between "Omø Stålgrunde" and "Omø tofte". And a larger distance between wind turbines where the route will pass through
- A marked route from "Ståldyb" and NNE north of "Vejrø"
- The wind turbines near the routes are clearly marked with red and green colors
- Clear marking where power cables are present and emergency anchoring is not allowed.

As both wind farms "Omø Syd" and "Smålandsfarvandet" can be a reality this could be carried out in response to the many potential ships (commercial and leisure vessels) which could shortcut through the areas. By establishing well defined routes based on the AIS (which passes through the area) the traffic would be more safe. Further it could result in the fact that not all ships to and from "Great Belt" will use Omø sund as access.

4.2 Revised layout in response to distance to route H and traffic south of the area

In response to DMA's concerns regarding the distance between 1) the wind farm and route H and 2) the distance between the turbine area and Lolland, the turbine area has per January 21, 2015 been revised.

According to DMA the distance of 3-4km, mentioned in section 4, should be measured from where the actual traffic density tends to decrease. A graphic representation of such analysis is shown in Figure 4.

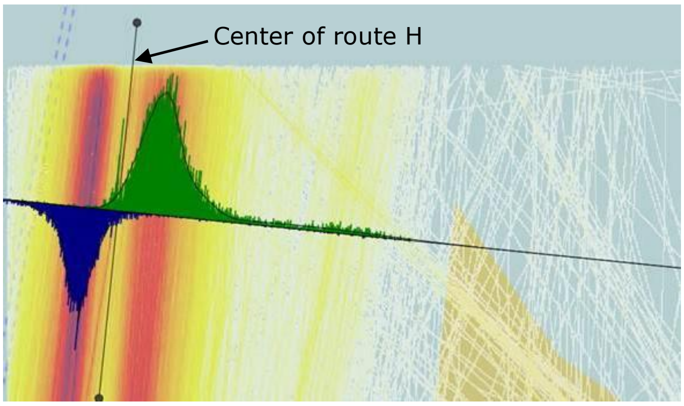

Figure 4: Detailed traffic density analysis of route H along with northern part of wind farm.

Figure 4 shows the AIS density with a cell size of 10m along with the lateral traffic distribution with a bin size of 5m. The associated probability distribution with mean μ and spreading β is shown in Figure 5.

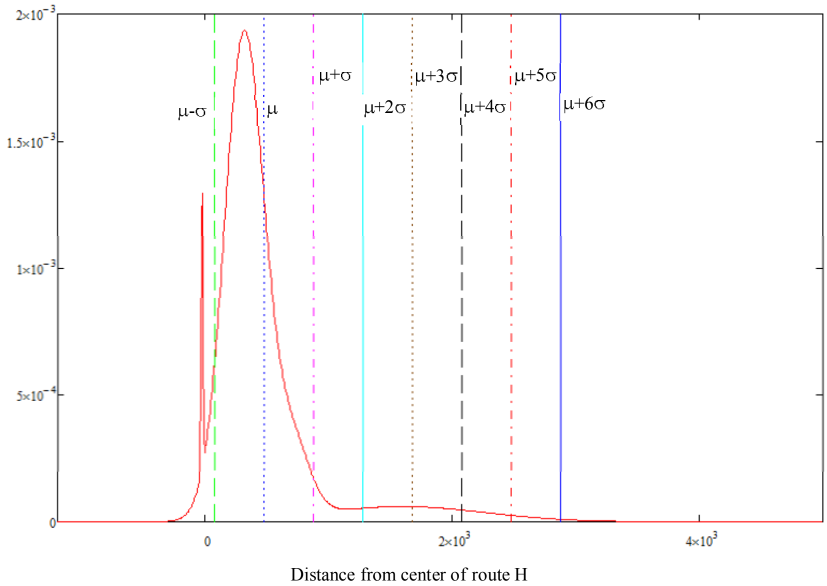

Figure 5: Probability distribution for north bound traffic on route H

Table 4 shows the amount of traffic (in a percentage of the total traffic) which is included when the traffic is summed from left to right (i.e. a distance from center of route H, denoted $\mu+\beta\sigma$).

β	Distance from center of route H. $\mu+\beta\sigma$	North bound traffic included
[–]	[m]	[-]
1	873.417	90.27%
2	1273.714	91.15%
3	1674.011	95.47%
4	2074.308	97.63%
5	2474.605	99.06%
6	2874.902	99.72%

Table 4: Amount of traffic (out of total traffic) included at different distances from center of route H

Based on the above table DMA has suggested that the 3-4 km requirement should be measured 1km from center of route H. The end result was that a combination of the baseline between Omø and Lolland and a distance of 4km measured som center of route H should define the boundary of the wind farm.

Also, the southern area has been cut off at latitude of 55 degrees. The new wind turbine area is for the case of 80 3MW turbines shown in Figure 6.

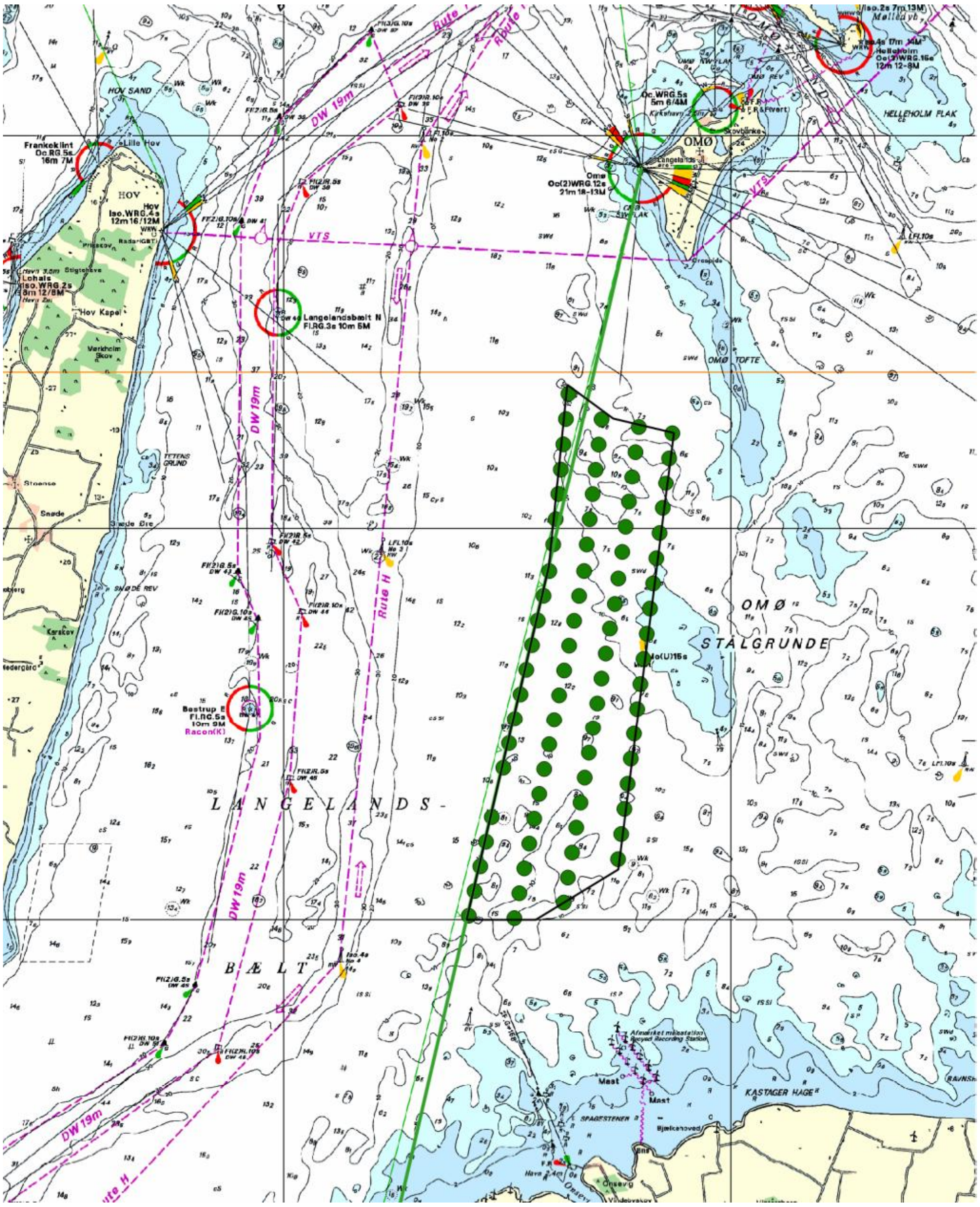

Figure 6: Revised turbine area. Note that the map contains an old baseline between Omø and Lolland. The current baseline as per 18-07-2003 is shown as the thicker green line.

5 RESULTS FROM COARSE RISK ANALYSIS

Using the identified hazards and evaluated consequences regarding ship-turbine collision it is possible to accumulate each item in appendix A of this report into a single risk. In table Table 1 it is thus seen that the notable risks involved with ship-turbine collisions is environmental damage. According to Table 1 the environmental risks lies somewhere between the "none" and "negligible" classification. Risks involved with personal safety and damage to equipment both lies below the "none" classification.

All Sheets	Total Risk	Estimated loss
Health		1
Material	.4	3
Environment	2.4	232
GrandTotal	2.4	235

Table 5: Accumulated risk based on hazards listed in appendix A

Table 6 summarizes the accumulated risks for "Health", "Material" and environment in a risk matrix. It is seen that the accumulated hazards does not lie in the ALARP range.

All Sheets			Consequence					
			(2) None	(3) Negligible	(4) Significant	(5) Serious	(6) Critical	(7) Catastrophic
			100 - 1.000	1.000 - 10.000	10.000 - 100.000	100.000 - 1.000.000	1.000.000 - 10.000.000	>10.000.000
Frequency (number per year)	(2) Dayli - Month	>10						
	(1) Month-year	1 - 10						
	(0) 1-10 year	0,1 - 1						
	(-1) 10-100 year	0,01 - 0,1						
	(-2) 100-1000 year	0,001 - 0,01						
	(-3) 1000-10.000 year	0,0001 - 0,001						
	(-4) 10.000-100.000 year	0,00001 - 0,0001					Environment; TOTAL	
	(-5) > 100.000 year	<0,00001				Material		

Table 6: Risk Matrix based on hazards listed in appendix A. Note that "Health" with an accumulated risk of 0.0 falls outside the plotting range of the table.

6 CONCLUSION

The HAZID covered hazards/incidents caused by the presence of Omø Syd wind farm. The wind farm can consist of either 80 3MW turbines or 40 8MW turbines with a total capacity of maximum 320 MW. The actual number of turbines is currently not decided, but will not have an impact on the identified hazards, but can have an impact on the found frequencies.

The current legislation does require that small fishing and leisure vessels carry AIS. Based on input from the HAZID participants a more realistic number of vessels will be included in the navigational risk analysis.

No hazards have been found to be in the ALARP range.

7 REFERENCES

/1/ Navigational Risk Assesment Omø Syd Offshore Wind Farm, DNV GL, Doc no. 1KNPOEP-3.

APPENDIX A
Identified Hazards

Abrv	Summary for	Total risk	Total estimated loss
H	Health	-2	1

1	*Ship - turbine collisions*	*Damages to persons*				-2	1	
ID	**Incident**	**Cause**	**Frequency. One incident per**	**Barrier factor**	**Consequence**	**Risk class**	**Estimated Loss**	**Comments**
H1.1	Fishing ship collides with turbine	Drifting collision due to e.g. black out	(-5) > 100.000 year	5	(H2) Bruises and minor damages that do not require hospital treatment	-2.3	0	Barrier factor increased to incorporate the fishing vessels not covered by AIS
H1.2	Fishing ship collides with turbine	Powered collision due to human or technical error	(-5) > 100.000 year	5	(H3) 1 injury requiring hospital treatment	-1.3	0	Barrier factor increased to incorporate the fishing vessels not covered by AIS
H1.3	Oil products tanker collides with turbine	Drifting collision due to e.g. black out	(-3) 1000-10.000 year	0.01	(H2) Bruises and minor damages that do not require hospital treatment	-3.0	0	The size of the ship and the low number of crewmen entails that the consequence will occour 1 of 100 times
H1.4	Oil products tanker collides with turbine	Powered collision due to human or technical error	(-3) 1000-10.000 year	0.01	(H3) 1 injury requiring hospital treatment	-2.0	0	The size of the ship and the low number of crewmen entails that the consequence will occour 1 of 100 times
H1.5	Cargo ship collides with turbine	Drifting collision due to e.g. black out	(-3) 1000-10.000 year	0.01	(H2) Bruises and minor damages that do not require hospital treatment	-3.0	0	The size of the ship and the low number of crewmen entails that the consequence will occour 1 of 100 times
H1.6	Cargo ship collides with turbine	Powered collision due to human or technical error	(-3) 1000-10.000 year	0.01	(H3) 1 injury requiring hospital treatment	-2.0	0	The size of the ship and the low number of crewmen entails that the consequence will occour 1 of 100 times
H1.7	Passenger ship collides with turbine	Drifting collision due to e.g. black out	(-5) > 100.000 year	10	(H2) Bruises and minor damages that do not require hospital treatment	-2.0	0	The vessel carries a large amount of crew and passengers. Estimated 10 people will be affected.
H1.8	Passenger ship collides with turbine	Powered collision due to human or technical error	(-5) > 100.000 year	10	(H3) 1 injury requiring hospital treatment	-1.0	0	The vessel carries a large amount of crew and passengers. Estimated 10 people will be affected.
H1.9	Pleasure boat collides with turbine	Drifting collision due to e.g. black out	(-3) 1000-10.000 year	0.05	(H2) Bruises and minor damages that do not require hospital treatment	-2.3	0	Most leisure vessels are small and will bounce off the structure. The consequence is evaluated to occur 1 of 20 times

H1.10	Pleasure boat collides with turbine	Powered collision due to human or technical error	(-5) > 100.000 year	0.05	(H6) 1-2 killed	-.3	1	Most leisure vessels are small and will bounce off the structure. The consequence is evaluated to occur 1 of 20 times
H1.11	Support ship collides with turbine	Drifting collision due to e.g. black out	(-4) 10.000-100.000 year	0.01	(H2) Bruises and minor damages that do not require hospital treatment	-4.0	0	The size of the ship and the low number of crewmen entails that the consequence will occour 1 of 100 times
H1.12	Support ship collides with turbine	Powered collision due to human or technical error	(-4) 10.000-100.000 year	0.01	(H3) 1 injury requiring hospital treatment	-3.0	0	The size of the ship and the low number of crewmen entails that the consequence will occour 1 of 100 times
H1.13	"Other ship" collides with turbine	Drifting collision due to e.g. black out	(-4) 10.000-100.000 year	0.01	(H2) Bruises and minor damages that do not require hospital treatment	-4.0	0	The size of the ship and the low number of crewmen entails that the consequence will occour 1 of 100 times
H1.14	"Other ship" collides with turbine	Powered collision due to human or technical error	(-4) 10.000-100.000 year	0.01	(H3) 1 injury requiring hospital treatment	-3.0	0	The size of the ship and the low number of crewmen entails that the consequence will occour 1 of 100 times

Abrv	Summary for	Total risk	Total estimated loss
M	Material	.4	3

1	*Material*	*Damages to materials*				.4	3	
ID	**Incident**	**Cause**	**Frequency. One incident per**	**Barrier factor**	**Consequence**	**Risk class**	**Estimated Loss**	**Comments**
M1.1	Fishing ship collides with turbine	Drifting collision due to e.g. black out	(-5) > 100.000 year	5	(M3) Costs due to ship-ship or ship-turbine collision	-1.3	0	Barrier factor increased to incorporate the fishing vessels not covered by AIS
M1.2	Fishing ship collides with turbine	Powered collision due to human or technical error	(-5) > 100.000 year	5	(M4) Costs due to ship-ship or ship-turbine collision	-.3	1	Barrier factor increased to incorporate the fishing vessels not covered by AIS
M1.3	Oil products tanker collides with turbine	Drifting collision due to e.g. black out	(-3) 1000-10.000 year	0.01	(M3) Costs due to ship-ship or ship-turbine collision	-2.0	0	The consequence was evaluated to occur 1 of 100 times
M1.4	Oil products tanker collides with turbine	Powered collision due to human or technical error	(-3) 1000-10.000 year	0.01	(M5) Costs due to ship-ship or ship-turbine collision	.0	1	The consequence was evaluated to occur 1 of 100 times
M1.5	Cargo ship collides with turbine	Drifting collision due to e.g. black out	(-3) 1000-10.000 year	0.01	(M3) Costs due to ship-ship or ship-turbine collision	-2.0	0	The consequence was evaluated to occur 1 of 100 times
M1.6	Cargo ship collides with turbine	Powered collision due to human or technical error	(-3) 1000-10.000 year	0.01	(M5) Costs due to ship-ship or ship-turbine collision	.0	1	The consequence was evaluated to occur 1 of 100 times
M1.7	Passenger ship collides with turbine	Drifting collision due to e.g. black out	(-5) > 100.000 year	0.01	(M3) Costs due to ship-ship or ship-turbine collision	-4.0	0	The consequence was evaluated to occur 1 of 100 times
M1.8	Passenger ship collides with turbine	Powered collision due to human or technical error	(-5) > 100.000 year	0.01	(M5) Costs due to ship-ship or ship-turbine collision	-2.0	0	The consequence was evaluated to occur 1 of 100 times
M1.9	Pleasure boat collides with turbine	Drifting collision due to e.g. black out	(-3) 1000-10.000 year	0.01	(M3) Costs due to ship-ship or ship-turbine collision	-2.0	0	The consequence was evaluated to occur 1 of 100 times
M1.10	Pleasure boat collides with turbine	Powered collision due to human or technical error	(-5) > 100.000 year	0.01	(M4) Costs due to ship-ship or ship-turbine collision	-3.0	0	The consequence was evaluated to occur 1 of 100 times
M1.11	Support ship collides with turbine	Drifting collision due to e.g. black out	(-4) 10.000-100.000 year	0.01	(M3) Costs due to ship-ship or ship-turbine collision	-3.0	0	The consequence was evaluated to occur 1 of 100 times
M1.12	Support ship collides with turbine	Powered collision due to human or technical error	(-4) 10.000-100.000 year	0.01	(M4) Costs due to ship-ship or ship-turbine collision	-2.0	0	The consequence was evaluated to occur 1 of 100 times

M1.13	"Other ship" collides with turbine	Drifting collision due to e.g. black out	(-4) 10.000-100.000 year	0.01	(M3) Costs due to ship-ship or ship-turbine collision	-3.0	0	The consequence was evaluated to occur 1 of 100 times
M1.14	"Other ship" collides with turbine	Powered collision due to human or technical error	(-4) 10.000-100.000 year	0.01	(M4) Costs due to ship-ship or ship-turbine collision	-2.0	0	The consequence was evaluated to occur 1 of 100 times

Abrv	Summary for	Total risk	Total estimated loss
E	Environment	2.4	232

1	*Environment*	*Damanges to environment*				2.4	232	
ID	**Incident**	**Cause**	**Frequency. One incident per**	**Barrier factor**	**Consequence**	**Risk class**	**Estimated Loss**	**Comments**
E1.1	Fishing ship collides with turbine	Drifting collision due to e.g. black out	(-5) > 100.000 year	5	(E3) Minor environmental damages. Restored within days	-1.3	0	Barrier factor increased to incorporate the fishing vessels not covered by AIS
E1.2	Fishing ship collides with turbine	Powered collision due to human or technical error	(-5) > 100.000 year	5	(E3) Minor environmental damages. Restored within days	-1.3	0	Barrier factor increased to incorporate the fishing vessels not covered by AIS
E1.3	Oil products tanker collides with turbine	Drifting collision due to e.g. black out	(-3) 1000-10.000 year	0.001	(E7) Catastrophic environmental damages. Oilspill larger than 300 tons	1.0	10	Double hull tankers not likely to cause oilspill
E1.4	Oil products tanker collides with turbine	Powered collision due to human or technical error	(-3) 1000-10.000 year	0.001	(E7) Catastrophic environmental damages. Oilspill larger than 300 tons	1.0	10	Double hull tankers not likely to cause oilspill
E1.5	Cargo ship collides with turbine	Drifting collision due to e.g. black out	(-3) 1000-10.000 year	0.01	(E6) Critical environmental damages. Oilspil larger than 30 tons	1.0	10	Consequence evalutated to occur 1 of 100 times
E1.6	Cargo ship collides with turbine	Powered collision due to human or technical error	(-3) 1000-10.000 year	0.2	(E6) Critical environmental damages. Oilspil larger than 30 tons	2.3	200	Consequence evalutated to occur 1 of 5 times to due the speed involved in a powered grounding. Sharp edges from the damaged windturbine may cut the ship hull open
E1.7	Passenger ship collides with turbine	Drifting collision due to e.g. black out	(-5) > 100.000 year	0.01	(E6) Critical environmental damages. Oilspil larger than 30 tons	-1.0	0	Consequence evalutated to occur 1 of 100 times
E1.8	Passenger ship collides with turbine	Powered collision due to human or technical error	(-5) > 100.000 year	0.2	(E6) Critical environmental damages. Oilspil larger than 30 tons	.3	2	Consequence evalutated to occur 1 of 5 times to due the speed involved in a powered grounding. Sharp edges from the damaged windturbine may cut the ship hull open
E1.9	Pleasure boat collides with turbine	Drifting collision due to e.g. black out	(-3) 1000-10.000 year	0.01	(E2) None/negligible	-3.0	0	Consequence evalutated to occur 1 of 100 times

E1.10	Pleasure boat collides with turbine	Powered collision due to human or technical error	(-5) > 100.000 year	0.2	(E2) None/negligible	-3.7	0	Consequence evalutated to occur 1 of 5 times to due the speed involved in a powered grounding. Sharp edges from the damaged windturbine may cut the ship hull open
E1.11	Support ship collides with turbine	Drifting collision due to e.g. black out	(-4) 10.000-100.000 year	0.01	(E3) Minor environmental damages. Restored within days	-3.0	0	Consequence evalutated to occur 1 of 100 times
E1.12	Support ship collides with turbine	Powered collision due to human or technical error	(-4) 10.000-100.000 year	0.2	(E3) Minor environmental damages. Restored within days	-1.7	0	Consequence evalutated to occur 1 of 5 times to due the speed involved in a powered grounding. Sharp edges from the damaged windturbine may cut the ship hull open
E1.13	"Other ship" collides with turbine	Drifting collision due to e.g. black out	(-4) 10.000-100.000 year	0.01	(E3) Minor environmental damages. Restored within days	-3.0	0	Consequence evalutated to occur 1 of 100 times
E1.14	"Other ship" collides with turbine	Powered collision due to human or technical error	(-4) 10.000-100.000 year	0.2	(E3) Minor environmental damages. Restored within days	-1.7	0	Consequence evalutated to occur 1 of 5 times to due the speed involved in a powered grounding. Sharp edges from the damaged windturbine may cut the ship hull open

About DNV GL

Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil and gas, and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our 16,000 professionals are dedicated to helping our customers make the world safer, smarter and greener.