Navigation Risk Assessment for Large Offshore Wind Developments

Sean Garber[1], David Taylor, Doug Scott
[1] Baird Australia Pty Ltd, Sydney, Australia; sgarber@baird.com

Summary
Renewable energy generated from Offshore Wind Farms (OWF) is emerging as a key energy supply. The first offshore wind developments, with a relatively small number of turbines, managed the interaction between OWF's and marine traffic by having vessels avoid transiting close to or through an OWF. In recent years, OWF have grown rapidly and the interaction of OWF's and marine traffic is increasingly being managed and regulated within a risk framework. PIANC Working Group 161 addressed this risk and outlined a structured approach to assessing impacts. However, over the last 5-years there has been a rapid growth in planning, design and construction of very large OWF's that are interconnected to adjoining developments. These projects have required very detailed navigation risk assessments to support development approval and construction. This paper presents insights into the impact on navigation from large OWF's and factors that need to be considered in navigation risk assessments.

Keywords: navigation, risk assessment, offshore wind

Introduction

The growth in Offshore Wind Farm (OWF) developments over the last 10-years has been significant and will result in increased interaction between OWF's and marine vessel traffic. In the United States leases for large offshore wind developments, for example the 3,000 km^2 Massachusetts/Rhode Island Wind Energy Area (MA/RI WEA), will result in OWF's on a larger scale and with cumulative impacts that may not be addressed in current regulation and guidance.
This paper provides an overview of key items that need to be considered in Navigation Risk Assessments (NRA) for large offshore wind developments where shared use of offshore waterways by wind operators and vessel traffic will be required.

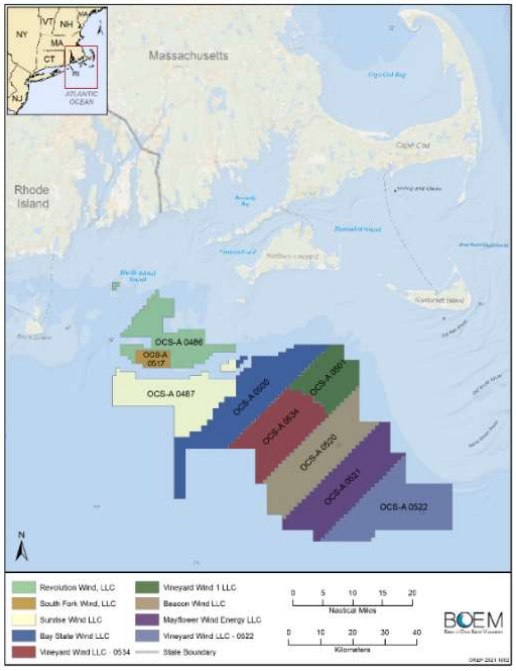

Figure 1 Massachusetts/Rhode Island Wind Energy Area Lease Map [4].

Overview of Large OWF Developments

The largest OWF currently in operation is the Hornsea One OWF located off the England east coast which has 174 turbines with a total generation capacity of 1218 MW [3]. The MA/RI WEA is currently in development with different operators awarded leases that are in different stages of development from planning, permitting through to early phase construction. When fully developed, the MA/RI WEA is expected to have 1060 (approx.) turbines located in the nine development lease areas indicated in Figure 1 and will have turbines extending along an east-west axis for over 50 nm, and north-south for over 30 nm.

There are other OWF developments of similar size planned in the USA and these integrated OWF are requiring government and regulatory agencies to develop new frameworks to plan, design and approve large OWF to meet the needs of a range of stakeholders including OWF operators, recreational and commercial fishing vessels, and large commercial vessel traffic.

In the USA, the Bureau of Ocean Energy Management (BOEM) is the primary federal government agency which oversees the permitting, construction and operations approvals for OWF's. Lease owners seeking to construct and operate an OWF are required to submit a Construction and Operation Plan (COP) to regulatory and public review as part of the permitting process. A key component of the COP is to prepare a Navigation Safety Risk Assessment (NSRA) which is required by the United States Coast Guard (USGC) under regulation NVIC 01-19.

Navigation Safety Risk Assessments

Large OWF's need to consider a range of navigation risks including:

- Exclusion/re-routing of large vessels that cannot safely manoeuvre within the turbine array;
- Changes to navigation routes for smaller vessels that are able to manoeuvre within turbine arrays;

- Impact on commercial fishing vessels that may undertake fishing activities within a turbine array;
- Impacts on marine radar and communications from turbines area; and
- Impact on vessel traffic from construction.

The impact on vessel traffic needs to consider existing vessel traffic risks and traffic characteristics, as well as assess the impacts of the proposed OWF on vessel traffic. Analysis of large AIS vessel traffic data sets as presented in Figure 2 is a key component of NSRA's that are submitted to the USGC.

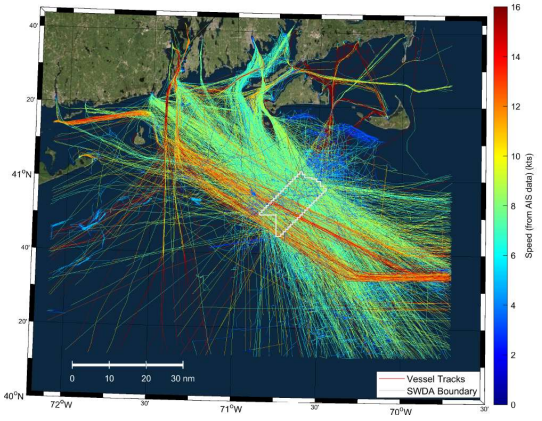

Figure 2 Vessel tracks from AIS which pass through the OCS-A 0534 lease area in the MA/RI WEA [5].

The impact of an OWF needs to consider vessel traffic that may re-route to avoid transiting through a turbine array, and also vessel traffic that may continue to transit through a turbine array during construction and operation. A quantitative vessel traffic risk model should be applied to examine the impacts of an OWF on the risk of collision of vessels, or allision of vessels with the turbine structure. Quantitative risk can be assessed with statistical models that are parameterised from AIS vessel traffic data and collision/allision models. Navigation risk can also be assessed with a discrete simulation model that can simulate existing, construction and operation phase vessel traffic, and interactions between vessels and turbine structures. A statistical risk model described in [5] based on the geometric probability functions presented in [6] and causation factors of [7] has been applied for MA/RI WEA developments.

The impact of large OWF's on commercial fishing activities is a critical consideration in the planning and approval process. Ideally, turbine arrays should be orientated to align with fishing traffic and have sufficient turbine spacing to allow fishing vessels to manoeuvre within turbine arrays. Where large OWF developments adjoin each other, it is beneficial for turbine arrays to have consistent alignments. This is an important component of the MA/RI WEA where the various OWF development proponents, and the USGC both recommended consistent turbine alignment and spacing between the 9 lease areas as outlined in [8] and [9].

The impact of large OWF's on marine radar and communications is a key risk that is identified in [2]. Recently, [9] has summarised the potential impacts on marine radar from OWF developments and provided recommendations to better define adverse impacts and develop practical mitigations.

Search and rescue activities within OWF areas can been significantly impacted due to restriction in aircraft movements within the turbine array. For the MA/RI WEA, this was a key constraint identified in [10] to provide sufficient turbine spacing for aircrews to execute rescue missions in challenging conditions.

Conclusions

The navigation risk considerations for large, adjoining OWF developments that are being planned and constructed at present require new standards and guidelines to support the site selection, design and operation of large OWF developments where vessel navigation will occur through large turbine arrays. Regulators in the United States are having to develop new guidelines and requirements concurrently with the design and early construction works for a number of large OWF projects. There is a clear need to review and update guidelines such as PIANC WG 161's report [2] on a frequent basis in the coming years to keep pace with the rapid development of large OWF projects.

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