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STUDY TITLE: Literature Review on the Environmental Risks, Fate and Effects of Chemicals Associated with Wind Turbines on the Atlantic Outer Continental Shelf

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BACKGROUND:

Since 2005, the Bureau of Ocean Energy Management (BOEM) has been charged with issuing leases on the Outer Continental Shelf for potential renewable energy projects including wind energy. BOEM recognizes that renewable energy development should be managed responsibly. As part of this management responsibility BOEM uses the best available science in their environmental assessments of proposed leases, so that precautions are taken to mitigate potential environmental impacts. The main goal of this study was to assess the environmental risks, fates, and effects of chemical releases, including oils, associated with routine operations and maintenance of offshore wind turbines, as well as catastrophic events (e.g., toppling of one, multiple or all wind turbines, and topple of the electrical service platform). This study does not address spills from vessels transiting through wind facility areas (e.g., spills resulting from the collision of a vessel with wind turbines), nor does it address spills arising from the construction of these facilities. The ultimate goals of this study were to use the best available science to address public concerns on the potential environmental consequences of the release of hazardous material from wind facilities, and to generate information to support future Environmental Impact Statements.

OBJECTIVES: The project objectives were to: 1) Identify the types, properties, volumes, and likely spill scenarios and frequencies for oil and chemicals commonly present in different types of commercial wind turbine generators (WTGs) and electrical service platforms (ESPs); and 2) Assess the temporal and spatial scale of potential impacts to ecological and socioeconomic resources from chemical spills from WTGs and ESPs using representative offshore wind farm locations.

DESCRIPTION: Currently available information indicated that petroleum and mineral oils, as well as a selected number of chemicals (glycols and sulfuric acid), are used in ESPs and WTGs. Representative volumes of these oils and chemicals were used to define a series of spill scenarios ranging from spills associated with regular maintenance to catastrophic spills at three areas: a Call Area in North Carolina, and two Wind Energy Areas (WEA) in Maryland and Rhode Island/Massachusetts. Using a fault tree approach, the combined probabilities of events leading to a release were used to determine the spill probability of each scenario.

Oil and chemical spill trajectory and fate models were used to assess the extent of exposure above effects thresholds in the water column, on the water surface, and on shoreline habitats for ten spill scenarios for each of the three locations. The ecological and socioeconomic resources at risk in the potential impact areas were identified. Through consequence analysis, the potential risks to ecological and socioeconomic resources were assessed as a function of the probability that an event would occur (spill risk), the probability that a resource would be exposed to the spilled material (exposure risk), and the impacts that the event would have on such resources (impact risk).

SIGNIFICANT CONCLUSIONS: The highest release probabilities (1 time per month) were in the North Carolina Call Area, resulting from vessel allisions causing small releases of up to several hundred gallons, while at all Call Area/WEAs the probability of catastrophic spills (all oils totaling 129,000 gallons and all chemicals totaling 29,000 gallons) would be very low (1 time in $\geq$1,000 years). The most likely types of releases (e.g., up to a few thousand gallons of oils) would cause minimal environmental consequences, which would be limited spatially and temporally to the vicinity of the point of release. By contrast, a catastrophic oil release would cause moderate environmental consequences to ecological and socioeconomic resources at all locations. However, the probabilities of occurrence of these types of releases are very small. Furthermore, these consequence analyses here used a conservative approach biased towards overestimation of risks.

STUDY RESULTS: As part of the consequence analysis, toxic thresholds of concern were derived from existing toxicological information, and the outputs from oil and chemical spill model fate and effects for each spill scenario were integrated into this analysis. In most cases and based on currently available information, spills of the oils and chemicals commonly present in offshore wind facilities would result in low adverse effects to marine resources, with a few exceptions where highly viscous oils (e.g., biodiesel and dielectric insulating fluids) may pose moderate fouling risks to marine mammals and birds. The toxicity of other chemicals of interest (sulfuric acid and glycols) in seawater has not been extensively studied, but the existing

information indicates low to very low toxicity. The thresholds used in the analyses are extremely conservative, as exposures to an accidental spill of these chemicals in open waters are expected to be short lived. For each risk scoring variable a three-point scale of Low, Medium, and High (color-coded as green, yellow, and red, respectively) was used to distinguish levels of magnitude, probability, and impact.

A detailed interpretation of the catastrophic oil release scenario of all the oils from every wind turbine generator and the electrical service platform indicated potential moderate impacts to ecological and socioeconomic resources at all locations. However, the probabilities of occurrence of these types of releases are very small. By contrast, the most likely types of releases (e.g., a release of up to a few thousand gallons of petroleum and non-petroleum oils) would cause minimal impacts, which would likely be limited spatially and temporally to the immediate vicinity of the point of release. The consequence analysis of petroleum and non-petroleum oils used a conservative approach biased towards overestimation of risks. Consequently, potential ecological and socioeconomic impacts may be actually lower than those presented here.

Similarly, release scenarios involving other chemicals of interest (sulfuric acid and glycols) show low to moderate risks to ecological resources (socioeconomic resources were not evaluated because of the very small area of exposure). Even though a release of 28,630 gallons of ethylene glycol exceeded the toxic threshold in the immediate vicinity of the point of release, this exceedance was short lived (peak concentrations lasting a few hours within a few hundred meters of the release site), suggesting that these analyses are conservative towards overprotection of aquatic resources.

Future studies may be refined if additional information on the types and volumes of chemicals used in offshore wind energy facilities becomes publically available. Also, the results of this study could be used in future environmental assessments to more accurately and quantitatively address the potential environmental consequences of a spill.

STUDY PRODUCTS: Bejarano, A.C., J. Michel, J. Rowe, Z. Li, D. French McCay, L. McStay and D.S. Etkin. 2013. Environmental Risks, Fate and Effects of Chemicals Associated with Wind Turbines on the Atlantic Outer Continental Shelf. US Department of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Gulf of Mexico OCS Region, New Orleans, LA. OCS Study BOEM 2013-213.