



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION 2
290 BROADWAY
NEW YORK, NY 10007-1866

8/29/2023

MEMORANDUM

SUBJECT: Concurrence Request for Approval of Alternative Model AERCOARE in Conjunction with AERMOD, in Support of Outer Continental Shelf PSD air permitting of the Ocean Wind 1 Offshore Wind Power Project

FROM: Brian Marmo, Regional Air Quality Modeler
Permitting Section, Air Programs Branch, Air and Radiation Division
EPA Region 2, New York, New York

THRU: Richard Ruvo, Director
Air and Radiation Division
EPA Region 2, New York, New York

TO: George Bridgers, Director of Model Clearinghouse
Air Quality Modeling Group, Office of Air Quality Planning and Standards

The U.S. Environmental Protection Agency (EPA) Region 2 Office seeks concurrence from the Model Clearinghouse (MCH) regarding the prospective EPA Region 2 approval of an alternative model for an Outer Continental Shelf (OCS) Prevention of Significant Deterioration (PSD) air permitting effort. The AERCOARE meteorological data preprocessor program will be used in conjunction with AERMOD (AERCOARE/AERMOD) to conduct an air quality modeling analysis as part of the OCS air permit application for the proposed Ocean Wind 1, LLC. Ocean Wind 1, LLC's ("Ocean Wind") project is to be located off the coast of New Jersey near Atlantic City. Ocean Wind has sought approval to allow the use of the AERCOARE/AERMOD model for their air quality modeling analysis, under 40 CFR Part 51, Appendix W §3.2.2(b), Condition (3), for the project's OCS air permit application. Under Condition (3), an alternative model may be used if the Regional Office finds the conditions specified in Appendix W §3.2.2(e) are satisfied.

Ocean Wind submitted their alternative model request on August 23, 2023. The request provided evidence and justifications supporting approvability of the modeling approach under Appendix W §3.2.2(b), Condition (3). EPA's prior approvals of the AERCOARE/AERMOD, using measured meteorological measurements from buoys or prognostic meteorological data, are well documented in the Model Clearinghouse's public database. This includes two recent approvals for offshore wind projects in EPA Region 2 in the same general geographical area. On July 27, 2022, EPA approved the use of AERCOARE/AERMOD for Empire Wind Offshore Wind Project located off the coast of Long Island, New York, and on July 28, 2022, EPA approved the use of AERCOARE/AERMOD for Atlantic Shores Offshore Wind Project, which is located adjacent to Ocean Wind's lease area off the coast of Atlantic City, New Jersey.

Region 2 has conducted a thorough review of the request and intends to approve the use of

AERCOARE/AERMOD as an alternative model to conduct the air quality modeling analysis as part of the Ocean Wind OCS air permit application. We have found the proposed application of the model is satisfactory under the requirements of §3.2.2(e).

A technical analysis summarizing our review and the August 23, 2023 alternative model request submitted by Ocean Wind are included below for your consideration. Please feel free to contact Brian Marmo at (212) 637-4352 or Annamaria Colecchia at (212) 637-4016 if you have any questions regarding the request.

Technical Review of the Ocean Wind, LLC Request to Use the AERCOARE Meteorological Data Preprocessor Program in conjunction with AERMOD in support of its Outer Continental Shelf (OCS) Permit Application for the Ocean Wind project

1. Background and Project Overview

Ocean Wind, LLC (“Ocean Wind”) is proposing to construct an offshore wind energy generation project on the Outer Continental Shelf (OCS), approximately 15 miles southeast of the Atlantic City, New Jersey in Bureau of Ocean Energy Management (BOEM) Lease Area (OCS-A0498). The Project is approximately 75,525 acres and will consist of up to 98 wind turbine generators (WTGs) and three small offshore substations. The proposed OCS windfarm requires an OCS air permit under 40 CFR Part 55 and section 328 of the Clean Air Act (CAA). The requirements of EPA’s Prevention of Significant Deterioration (PSD) at 40 CFR Part 52.21, including air quality modeling requirements, apply to the Project.

The Project will trigger PSD review for nitrogen oxides (NO_x), carbon monoxide (CO), particulate matter (PM) with diameter 10 microns or less (PM₁₀), PM with diameter 2.5 microns or less (PM_{2.5}), and greenhouse gases (GHGs). The Projects will trigger Nonattainment New Source Review (NNSR) for the ozone precursors, oxides of nitrogen (NO_x) and volatile organic compounds (VOCs).

Ocean Wind has requested to use an alternative model, as provided in §3.2 of the Guideline on Air Quality Models (40 CFR Part 51, Appendix W, hereafter referred to as the *Guideline*), to conduct its PSD air quality modeling analysis. Specifically, Ocean Wind has requested to use the Coupled Ocean-Atmosphere Response Experiment (COARE) bulk flux algorithm, as implemented in the AERCOARE meteorological data preprocessor program, to prepare meteorological data for use in the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) dispersion program to assess ambient impacts in a marine environment. Ocean Wind submitted their request to initiate the alternative model approval process on August 23, 2023 (Attachment 1).

In its August 23, 2023 request, Ocean Wind indicated its preference to utilize the AERCOARE/AERMOD alternative modeling approach over the EPA’s guideline model, the Offshore and Coastal Dispersion (OCD) model. Ocean Winds’ August 23, 2023 request presented ten technical reasons, options, and/or features available in the alternative model which are not available in OCD to support its request (see Attachment 1).

EPA Region 2 has reviewed the applicant’s alternative model request and determined that the use of the proposed alternative model is acceptable.

2. Modeling Approach

Ocean Wind submitted a revised OCS air permit application for its Project on August 23, 2023, which included an air quality impact analysis report, as required under 40 CFR Part 52.21 and 40 CFR Part 55. Also, Ocean Wind provided EPA with a proposed modeling protocol (Protocol) for the Project in which AERCOARE/AERMOD was proposed as an alternative modeling platform for near-field impact assessment. The Project used prognostic meteorological data provided by EPA from the WRF model and extracted by EPA using Mesoscale Model Interface (MMIF) for overwater and on-land locations. A prognostic model evaluation was provided to demonstrate that the WRF data adequately replicates observed conditions in the 2018-2020 time period at the selected sites. Secondary formation of PM_{2.5} and ozone were determined using EPA's *Photochemical Model Estimated Relationships Between Offshore Wind Energy Project Precursor Emissions and Downwind Air Quality (O₃ and PM_{2.5}) Impacts*¹.

3. Alternative Model Proposal Review

a. Regulatory Analysis and Background

40 CFR Part 52.21(l) states that all applications of air quality modeling shall be based on the applicable models specified in the *Guideline*. However, Part 52.21(l) also provides that on a case-by-case basis a modification or substitution of an air quality model may be used following written approval. In addition, the use of a modified or substituted model is subject to notice and opportunity for public comment. The alternative model approval process and conditions are outlined in Section 3.2 of the *Guideline*. Section 3.2.2(a) specifies that the determination of acceptability of an alternative model is a Regional Office responsibility in consultation with EPA's Model Clearinghouse. An alternative model may be used subject to Regional Office approval if found to satisfy the requirements listed in Section 3.2.2. This includes when a more appropriate model or technique is available and applicable given the 10 additional features referenced in Ocean Wind's AERCOARE/AERMOD request. Section 3.2.2(b) states the alternative model shall be evaluated from both a theoretical and performance perspective before regulatory use and outlines the three separate conditions where an alternative model may be approved. Condition 3 under Section 3.2.2(b), where there is no preferred model for the specific project, applies to this case where Ocean Wind has requested the use of the AERCOARE/AERMOD.

The *Guideline* specifies the preferred model for overwater sources is the OCD model. OCD is a straight-line Gaussian model developed to determine the impacts of offshore emissions from point, area, or line sources on the air quality of coastal regions. Some of the key features of OCD potentially applicable to offshore sources are the inclusion of platform building downwash and continuous shoreline fumigation. However, OCD does have limitations, as described by Ocean Wind in its request to use an alternative model for its air quality modeling analyses. All ten reasons are valid. However, of the ten reasons Ocean Wind provided, the following five limitations are of particular importance to the Project:

- (1) OCD does not provide for the multi-tiered screening approach for NO₂ modeling (specifically the Tier 2 ARM2 or Tier 3 PVMRM/OLM refined screening approaches);
- (2) OCD does not contain options to generate outputs in the statistical forms consistent with current NAAQS;
- (3) OCD does not account for calm wind conditions when calculating predicted pollutant concentrations;
- (4) OCD cannot be used to model volume sources, and has a limited ability to model line

¹ <https://www.epa.gov/system/files/documents/2023-01/EPA454-R-22-007%2029DEC2022.pdf>

sources; and
(5) OCD does not account for current advancements in dispersion theory.

In addition, the key features of OCD not provided in AERCOARE/AERMOD are either not applicable to the project, or AERCOARE/AERMOD provides a more appropriate and conservative approach. This includes shoreline fumigation and platform downwash. Regarding the impact of shoreline fumigation, Ocean Wind referenced a test modeling study performed by Empire Wind. Ocean Wind noted that Empire Wind has similar emissions sources and is a similar distance from shore. Ocean Wind is also in a similar geographical area as Empire Wind. Based on these similarities, Ocean Wind concluded that the shoreline fumigation assessment conducted by Empire Wind also demonstrates that the exhaust plumes from Ocean Wind emission sources will be substantially dispersed before encountering a potential thermal internal boundary layer. Furthermore, Ocean Wind concluded that absence of the shoreline fumigation algorithms in the AERCOARE/AERMOD model does not make the model inappropriate for the proposed purpose. Additionally, Atlantic Shores, which is adjacent to Ocean Wind and a similar distance from the shore, also conducted analysis to conclude that shoreline fumigation will not be a concern for the project.

Regarding downwash features, while OCD accounts for platform downwash, Ocean Winds' proposed use of AERCOARE/AERMOD as an alternative model will utilize the PRIME downwash algorithm, which will provide conservative results by treating the proposed platform structure as a solid structure without airflow under the platform.

For these reasons, Ocean Wind has requested the use of an alternative model (AERCOARE/AERMOD) via Condition 3 under Section 3.2.2(b) and provided justification for the alternative model consistent with the requirements listed in Section 3.2.2(e).

Section 3.2.2(e) sets forth the five elements that must be satisfied for alternative model approval under Condition 3 of Section 3.2.2(b). These are discussed below.

The EPA has approved use of AERCOARE/AERMOD as an alternative model in the past under §3.2.2(b). The first approval was in 2011, where EPA Region 10 approved the use of the AERCOARE/AERMOD system for a project in the Arctic Ocean off the north coast of Alaska.² EPA Region 6 approved the use of AERCOARE/AERMOD for a project off the coast of Texas in the Gulf of Mexico in 2019³ and another project off the Louisiana coast in 2023⁴. EPA Region 1 approved the use of AERCOARE/AERMOD in four instances for windfarm projects - Park City

²The Model Clearinghouse Information Storage and Retrieval System (MCHISRS) Record for the April 2011 Region 10 approval of AERCOARE/AERMOD is available at:

<https://cfpub.epa.gov/oarweb/MCHISRS/index.cfm?fuseaction=main.resultdetails&recnum=11-X-01>

³The Model Clearinghouse Information Storage and Retrieval System (MCHISRS) Record for the November 2019 Region 6 approval of AERCOARE/AERMOD is available at:

<https://cfpub.epa.gov/oarweb/MCHISRS/index.cfm?fuseaction=main.resultdetails&recnum=19-VI-01>

⁴ The Model Clearinghouse Information Storage and Retrieval System (MCHISRS) Record for the March 2023 Region 6 approval of AERCOARE/AERMOD is available at:

<https://cfpub.epa.gov/oarweb/MCHISRS/index.cfm?fuseaction=main.resultdetails&recnum=23-VI-01>

Wind on January 28, 2022⁵ New England Wind Phase 2 on July 5, 2022⁶, Mayflower Wind on December 13, 2022⁷, and Beacon Wind on December 15, 2022⁸. As mentioned, Region 2 approved the use of AERCOARE/AERMOD in two instances for windfarm projects, Empire Wind on July 27, 2022⁹ and Atlantic Shores on July 28, 2022¹⁰. EPA Region 3 approved the use of AERCOARE/AERMOD for a windfarm project off the coast of Virginia on November 23, 2022.¹¹

The following section of this technical review document provides an examination of Ocean Winds' justification for the approval of AERCOARE/AERMOD for its overwater source with respect to the requirements of Section 3.2.2(e).

b. Evaluation of Approach under Section 3.2.2(e)

In its alternative model request, Ocean Wind referenced the April 2011 EPA Region 10 approval and EPA MCH concurrence with the use of AERCOARE/AERMOD for an Arctic marine ice-free environment on the basis that the alternative model satisfied the five criteria contained in Section 3.2.2(e) of the Guideline. The April 2011 EPA MCH concurrence memorandum stated the Region 10 approval did not constitute a general approval of AERCOARE/AERMOD for other applications. However, the memorandum did state that the April 2011 Region 10 approval concurrence request did provide “a good basis for consideration of AERCOARE/AERMOD for other applications, subject to Regional Office approval based on an assessment of the appropriateness of the performance evaluations (3.2.2(e), element 4) and the availability of the necessary data bases (3.2.2(e), element 3) on a case-by-case basis.” In addition, the request references the EPA Region 1, Region 2, and Region 6 AERCOARE/AERMOD approvals, that do not constitute a generic approval of this alternative model system but do provide a good basis for such considerations provided technical justifications are provided. Therefore, the justification for the use of AERCOARE/AERMOD for the Ocean Wind modeling analysis addressed each of the five elements in Section 3.2.2(e), with emphasis on elements 3 and 4, as discussed below.

I. The model or technique has received a scientific peer review.

As detailed in the April 2011 Region 10 approval, the science behind the COARE algorithm,

⁵ The Model Clearinghouse Information Storage and Retrieval System (MCHISRS) Record for the January 2022 Region 1 approval of AERCOARE/AERMOD is available at:

<https://cfpub.epa.gov/oarweb/MCHISRS/index.cfm?fuseaction=main.resultdetails&recnum=22-I-01>

⁶ The Model Clearinghouse Information Storage and Retrieval System (MCHISRS) Record for the July 2022 Region 1 approval of AERCOARE/AERMOD is available at:

<https://cfpub.epa.gov/oarweb/MCHISRS/index.cfm?fuseaction=main.resultdetails&recnum=22-I-02>

⁷ The Model Clearinghouse Information Storage and Retrieval System (MCHISRS) Record for the December 13, 2022 Region 1 approval of AERCOARE/AERMOD is available at:

<https://cfpub.epa.gov/oarweb/MCHISRS/index.cfm?fuseaction=main.resultdetails&recnum=22-I-03>

⁸ The Model Clearinghouse Information Storage and Retrieval System (MCHISRS) Record for the December 15, 2022 Region 1 approval of AERCOARE/AERMOD is available at:

<https://cfpub.epa.gov/oarweb/MCHISRS/index.cfm?fuseaction=main.resultdetails&recnum=22-I-04>

⁹ The Model Clearinghouse Information Storage and Retrieval System (MCHISRS) Record for the July 27, 2022 Region 2 approval of AERCOARE/AERMOD is available at:

<https://cfpub.epa.gov/oarweb/MCHISRS/index.cfm?fuseaction=main.resultdetails&recnum=22-II-01>

¹⁰ The Model Clearinghouse Information Storage and Retrieval System (MCHISRS) Record for the July 28, 2022 Region 2 approval of AERCOARE/AERMOD is available at:

<https://cfpub.epa.gov/oarweb/MCHISRS/index.cfm?fuseaction=main.resultdetails&recnum=22-II-02>

¹¹ The Model Clearinghouse Information Storage and Retrieval System (MCHISRS) Record for the November 2022 Region 3 approval of AERCOARE/AERMOD is available at:

<https://cfpub.epa.gov/oarweb/MCHISRS/index.cfm?fuseaction=main.resultdetails&recnum=22-III-01>

which has been incorporated into AERCOARE, has been published in scientific peer review journals. Information pertaining to the scientific peer review can be found at: <http://www.coaps.fsu.edu/COARE/>.

Furthermore, the EPA supported a study to evaluate AERCOARE/AERMOD performance when specifically using inputs from a prognostic meteorological model, as is proposed for Ocean Winds' application. The peer-reviewed EPA report demonstrated the approach, using meteorological inputs from WRF-MMIF, performed similarly to AERCOARE/AERMOD modeling using measured data from buoys, in most scenarios.¹²

II. The model or technique can be demonstrated to be applicable to the problem on a theoretical basis.

The EPA has previously found the AERCOARE/AERMOD approach to be applicable, on a theoretical basis, for the simulation of pollutant dispersion in the marine atmospheric boundary layer. In the April 2011 Region 10 alternative model approval, EPA deemed AERCOARE/AERMOD to be appropriate for use in the Arctic marine ice-free environment. In the 2019 Region 6 approval of AERCOARE/AERMOD, EPA determined the model was also appropriate on a theoretical basis for use in the subtropical marine environment off the coast of Louisiana. In the 2022 AERCOARE/AERMOD approvals, Region 1 deemed it was appropriate on a theoretical basis for use in the marine environment off the coast of Massachusetts, and Region 2 deemed it was appropriate on a theoretical basis for use in the marine environment off the coast of New York and New Jersey. In addition, the user manual for AERCOARE¹³ developed by Region 10 indicates that AERCOARE is expected to be appropriate for marine conditions at all latitudes.

III. The databases which are necessary to perform the analysis are available and adequate.

This element of §3.2.2 of the Guideline refers to the databases collected to develop and verify the proposed modeling methodology. The marine meteorological databases used to develop the COARE algorithm are available publicly in the scientific literature, as listed in Fairall et al.¹⁴ Datasets from dispersion experiment campaigns have been used to verify the accuracy of the AERCOARE/AERMOD modeling approach. There are a limited number of historical overwater dispersion datasets available in the record that involve study of air pollutant dispersion in the marine atmospheric boundary layer. Historically, four robust tracer studies from the 1980s have been used in the performance evaluations of OCD, CALPUFF, and AERCOARE/AERMOD that are discussed in the request by Ocean Wind and in the Region 10, Region 6, Region 1, and Region 2 approvals of AERCOARE/AERMOD.

Ocean Wind referenced the additional comparisons provided in the previous Region 2 approvals, in particular Atlantic Shores' comparison of the meteorological data from the Delaware Bay Buoy (#44009), located near the Projects. These sufficiently demonstrate that the referenced tracer studies were representative of the marine environment off the coast of New Jersey where

¹² U.S. EPA (2015): Combined WRF/MMIF/AERCOARE/AERMOD Overwater Modeling Approach for Offshore Emission Sources, Vol. 2. EPA 910-R-15-001b, October 2015.

¹³ U.S. EPA (2012): *User's Manual AERCOARE Version 1.0*, EPA 910-R-12-008, October 2012.

¹⁴ Fairall, C.W.; Bradley, E.F.; Hare, J.E.; Grachev, A.A.; Edson, J.B. (2003): Bulk Parameterization of Air-Sea Fluxes: Updates and Verification for the COARE Algorithm. *Journal of Climate*, Vol. 16, pp. 571-591. [https://doi.org/10.1175/1520-0442\(2003\)016%3C0571:BPOASF%3E2.0.CO;2](https://doi.org/10.1175/1520-0442(2003)016%3C0571:BPOASF%3E2.0.CO;2).

both these projects are located.

IV. Appropriate performance evaluations of the model or technique have shown that the model or technique is not inappropriately biased for regulatory application.

In their request, Ocean Wind stated that based on the two Region 2 approvals in 2022, it is clear that the AERCOARE/AERMOD approach does not result in systematic underprediction of concentrations and that, instead, the evidence more likely leads to the conclusion the approach is conservative. The approvals also noted that a key element to prior approvals was an evaluation of the sensitivity of the modeling results to a minimum mixing height. The evaluation determined that AERCOARE/AERMOD results were highly overpredicted when using AERMOD's default minimum mixing height of 1 meter and that a minimum mixing height of 25 meters for overwater sources resulted in better model performance. Prior approvals allowed for the use of a minimum mixing height of 25 meters when using AERCOARE/AERMOD and a minimum limit on the absolute value of Monin-Obukhov Length of 5 meters. These limits are recommended in the AERCOARE User's Manual¹⁵.

V. A protocol on methods and procedures to be followed has been established.

Ocean Wind submitted a modeling protocol to EPA on August 23, 2022. The modeling protocol outlined the modeling techniques employed in the air modeling analyses conducted in support of the Projects. This modeling protocol supplemented the applicant's demonstration of AERCOARE/AERMOD as an alternative model contained in their August 23, 2022 request to initiate the alternative model approval process.

Ocean Wind used EPA's national 2018-2020 12-km WRF prognostic model dataset to provide meteorological inputs to the AERCOARE/AERMOD system. Ocean Wind provided a prognostic model evaluation as part of their permit application, as required under §8.4.5.2. of the *Guideline*.

4. Conclusions and Conditions for Use

EPA Region 2 has reviewed the alternative model request submittal provided by Ocean Wind and has determined that the proposed AERCOARE/AERMOD modeling approach is acceptable as an alternative model for the air quality modeling analysis submitted in support of its OCS air permit application. Based on our review, we find that the proposed approach addresses the five elements contained in Section 3.2.2(e) of the *Guideline*. As such, pursuant to Sections 3.0(b) and 3.2.2(a), Region 2 currently intends to approve the use of AERCOARE/AERMOD as an acceptable alternative model for the Ocean Wind projects. We seek the concurrence from the Model Clearinghouse.

As with the prior alternative model approvals of AERMOD-COARE, approval to use this alternative model is made on a case-by-case basis. Should an air permit applicant or state desire to use AERCOARE/AERMOD in an overwater modeling analysis for a different facility and/or location, a

¹⁵ https://gaftp.epa.gov/Air/aqmg/SCRAM/models/related/aercoare/AERCOAREv1_0_Users_Manual.pdf

request for alternative approval must be made to the appropriate EPA Regional Office containing the appropriate technical justifications/demonstrations consistent with the *Guideline*.

Attachment 1 – Ocean Wind’ Alternative Model Request dated August 23, 2023

Ms. Annamaria Colecchia
EPA Region 2
290 Broadway
New York, NY 10007-1866
[submitted via email to Annamaria.Colecchia@epa.gov]

21 August 2023

**RE: Request for Approval for Use of AERCOARE in Conjunction with AERMOD
for Offshore Modeling of the Ocean Wind Offshore Wind Project**

Ms. Colecchia:

Ocean Wind LLC (Ocean Wind), an affiliate of Orsted Wind Power North America LLC, submits this request for approval of an alternative model, as described below, for use in air quality dispersion modeling analyses, to support Ocean Wind's application to EPA Regional Office 2 for an OCS Air Permit for the Ocean Wind Offshore Wind Project (Project). Ocean Wind is submitting a revised air permit application concurrently with this request on August 21, 2023. The revised permit application contains a description of the proposed project and includes a revised modeling protocol in Appendix D, as well as a revised modeling report in Appendix E.

The Offshore and Coastal Dispersion (OCD) model is currently listed as the preferred model for overwater dispersion in EPA's Guidance on Air Quality Models¹ (*Guideline*) as described in Section 4.2.2.3 of 40 CFR Part 51, Appendix W. Ocean Wind is seeking approval to instead use the Coupled Ocean-Atmosphere Response Experiment (COARE) bulk flux algorithm, as incorporated into the meteorological data processor program (AERCOARE), to prepare meteorological data for use with the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD). Ocean Wind proposes that the use of AERCOARE will replace the use of the meteorological data preprocessor AERMET, which is designed for overland applications. The COARE algorithm is designed to describe the behavior of meteorological conditions overwater; the AERCOARE processor will incorporate this algorithm to read and process overwater meteorological data. The processed meteorological data from AERCOARE can then be read into AERMOD for modeling applications overwater. This combined approach (AERCOARE/AERMOD) is proposed as the alternate model for assessing compliance with applicable air quality standards (i.e., national ambient air quality standards (NAAQS), PSD Class I increment, and PSD Class II increment).

AERCOARE/AERMOD is proposed for several reasons, including the following that were adapted from historic EPA Region 2 approval requests from 2022² ³:

1. The OCD modeling system was developed in the 1980-90s and as such the dispersion algorithms are outdated and have not been updated to account for advancements in dispersion modeling since that time. In contrast, AERMOD is frequently updated (the

¹ EPA. 2017. *Revisions to the Guideline on Air Quality Models: Enhancements to the AERMOD Dispersion Modeling System and Incorporation of Approaches to Address Ozone and Fine Particulate Matter*. Retrieved from https://www.epa.gov/sites/default/files/2020-09/documents/appw_17.pdf.

² EPA. 2022. *Concurrence Request for Approval of Alternative Model AERCOARE in Conjunction with AERMOD, in Support of Outer Continental Shelf PSD air permitting of the Atlantic Shores offshore wind power project*. Retrieved from https://gaftp.epa.gov/Air/aqmg/SCRAM/mchisrs/22-II-02_Region2_MCHRequest_AtlanticShores.pdf.

³ EPA. 2022. *Concurrence Request for Approval of Alternative Model AERCOARE in Conjunction with AERMOD, in Support of Outer Continental Shelf PSD air permitting of the Empire Wind offshore wind power project*. Retrieved from https://gaftp.epa.gov/Air/aqmg/SCRAM/mchisrs/22-II-01_Region2_MCHRequest_EmpireWind.pdf.

latest version was issued in 2021) and is considered the state-of-the-art for nearfield dispersion modeling.

2. The AERMOD model utilizes the Plume Rise Model Enhancements (PRIME) downwash algorithms to assess impacts in the cavity and wake regions of structures. For offshore wind projects, the vessels themselves may affect the wind flow in the area and cause aerodynamic downwash. This effect can be treated in AERMOD using the vessels as structures in the PRIME algorithms. In contrast, the OCD model only provides downwash for platform structures and is based on more simplistic algorithms.
3. Unlike OCD, AERMOD does not specifically evaluate downwash conditions for platform structures. Therefore, the Project's offshore substation (OSS) platform structures will be conservatively evaluated with Building Profile Input Program for PRIME (BPIPPRM) by assuming the platform structures extend all the way down to the sea. This is a very conservative assumption since in reality air will flow under these structures.
4. AERMOD has the capability to treat missing or calm wind hours by implementing the calm wind processing procedures recommended in the Guideline. In contrast, OCD does not have the ability to process either missing or calm hours, and to address this in accordance with the recommended Guideline procedures, a custom postprocessor must be developed and used.
5. AERMOD incorporates options for the treatment of the conversion from oxides of nitrogen (NO_x) to nitrogen dioxide (NO_2). Multiple tier NO_x to NO_2 conversion techniques are available to the modeler in AERMOD. The OCD model does not employ any NO_2 conversion techniques and only assumes full conversion of NO_x to NO_2 . Some of the NO_2 conversion methods available in AERMOD could be applied to the OCD predicted concentrations in a postprocessing step, but to account for the Tier 2 ARM2 technique or Ozone Limiting Method (OLM), a custom postprocessor for OCD must be developed and used.
6. AERMOD incorporates options for the inclusion of varying ambient background concentrations during the model run. In contrast, OCD does not have an option to incorporate ambient background concentrations within the model. To add background concentrations a custom postprocessor must be developed and used.
7. The AERCOARE meteorological processor utilizes the COARE algorithm that uses air-sea temperature difference, overwater humidity and wind speed to estimate the heat fluxes in the atmosphere over water. AERCOARE is expected to be appropriate for use in marine conditions at all ice-free latitudes. For this application of modeling offshore sources, the use of AERCOARE to prepare the meteorological data for use in AERMOD is more appropriate than using AERMET, the regulatory meteorological processor that is part of the AERMOD modeling system.
8. The AERMOD output can be generated in the statistical form that is needed to assess compliance with the newer statistically based NAAQS, such as 1-hour NO_2 and $\text{PM}_{2.5}$.
9. The AERMOD-AERCOARE combination can model multiple line sources, more than 5 areas sources within the same model run and does not limit the number of sources that

can be modeled simultaneously eliminating the need to run multiple models and combine the results with post-processing.

10. AERCOARE will directly accept Weather Research and Forecasting (WRF) data model predicted hourly meteorological output from the Mesoscale Model Interface (MMIF) program.

OCD Features Not Incorporated in Alternate Model

OCD features that are potentially relevant to the Project, but that are not incorporated into the AERCOARE/AERMOD alternate model, include platform building downwash and continuous shoreline fumigation.

Platform Downwash

The Project proposes to utilize the PRIME downwash algorithm which will provide conservative results by treating the platform structures as a solid structure without airflow under the platform. This is the same approach proposed and approved for the historic Region 2 approval requests from 2022 referenced above.^{2,3}

Shoreline Fumigation

As described in the 2022 EPA approvals referenced above, shoreline fumigation can occur when plumes traveling in relatively stable air near the shoreline encounter the thermal internal boundary layer that can form between the more stable overwater air mass and the less stable overland air mass. The formation of this boundary layer can force the plume to fumigate downward, resulting in elevated pollutant concentrations at the surface level. This boundary layer typically forms during sea breeze conditions and EPA indicates that shoreline fumigation can be an important condition on/near the shoreline for sources with tall stacks located on or just inland of the shoreland. However, the Project emissions (primarily from vessel engines) are emitted from stacks with low release heights that will generally be located far offshore (24 km or more offshore).

Empire Wind conducted test modeling with OCD to confirm that shoreline fumigation would not be a concern for the types of emissions released from offshore wind farms at substantial distances from the shoreline. The description of the analysis and the conclusion is repeated here:

... test modeling has been conducted with the OCD model (which includes algorithms to assess shoreline fumigation conditions). The OCD test modeling was based on a representative Project vessel emission source and a year of meteorological data (2019 hourly meteorological data from the New York Harbor Entrance Buoy (#44065) in OCD overwater format and overland format data from JFK airport meteorological station with upper air observations from Brookhaven) for which the wind direction for every hour have been artificially adjusted to blow due north toward the nearest coast (Long Island). Receptors were placed to the north from the coastline at 100-meter intervals out to approximately 5 kilometers to predict inland concentrations in the area where fumigation conditions could potentially increase predicted concentrations. This modeling shows that maximum 1-hour predicted concentrations decrease in magnitude along the string of receptors that extend from the coastline inland and does not show any indication of

concentrations increasing. A set of four OCD test runs were made, first for a full year (2019) of meteorological conditions, then with the case study option turned on for the individual hours (three of them) that produced the maximum impacts at the 50 receptors in the full year run. The case study output lists the plume rise and dispersion parameters at each receptor. The case study output showed that a TIBL did form during these stable hours and the plume did intersect the TIBL, however the predicted concentrations decreased due to the TIBL intersection. This is likely because the plume is substantially dispersed before encountering the TIBL and is further diluted when it is fumigated to the ground and uniformly mixed. This demonstrates that shoreline fumigation is not a concern with emission sources having an emissions configuration consistent with the marine vessels to be used for project construction and located far offshore the coast.³

Ocean Wind has emissions sources similar to those of Empire Wind and is a similar distance from shore as Empire Wind. Based on these similarities, Ocean Wind concludes that the shoreline fumigation assessment conducted by Empire Wind also demonstrates that the exhaust plumes from Ocean Wind emission sources will be substantially dispersed before encountering a potential thermal internal boundary layer. Therefore, the fact that the proposed AERCOARE/AERMOD model does not have shoreline fumigation algorithms incorporated does not make the model inappropriate for the proposed purpose.

Regulatory Basis for Alternate Model Request

The PSD rules⁴ provide a means for requesting the approval of use of an alternative model. Such approval must be requested, and approved, on a case-by-case basis and the approval must be granted in writing from the Administrator. Use of an alternate model must be subject to notice and opportunity for public comment in accordance with the PSD rules. The alternative model approval process is outlined in Section 3.2 of the Guideline.

Section 3.2.2(a) of the Guideline states that five criteria must be met in order to approve an alternative model request. These are:

1. The model or technique has received a scientific peer review;
2. The model or technique can be demonstrated to be applicable to the problem on a theoretical basis;
3. The databases which are necessary to perform the analysis are available and adequate;
4. Appropriate performance evaluations of the model or technique have shown that the model or technique is not inappropriately biased for regulatory application; and
5. A protocol on methods and procedures to be followed has been established.

EPA has approved the use of AERCOARE/AERMOD as an alternative model for overwater modeling on several previous occasions, including other offshore wind projects in Region 2. On July 27, 2022, EPA approved the use of AERCOARE/AERMOD for Empire Wind Offshore Wind Project located off the coast of Long Island, New York.³ On July 28, 2022, EPA approved the use of AERCOARE/AERMOD for Atlantic Shores Offshore Wind Project located near Ocean Wind's lease area off the coast of Atlantic City, New Jersey.² These approvals both reference prior approvals of AERCOARE/AERMOD for other offshore sources, including a 2022 Region 1

⁴ 40 CFR 52.21(l)

approval of another offshore wind farm⁵, a 2019 Region 6 approval of an offshore oil export facility⁶, and a 2011 Region 10 approval for use in an ice-free marine environment.⁷ The 2022 Region 2 approvals each concluded that the use of AERCOARE/AERMOD satisfies the five criteria contained in Section 3.2.2(a) of the Guideline; they also state that the approvals do not constitute a generic approval of the alternative AERCOARE/AERMOD modeling system for other offshore applications but that they do provide a basis for future approvals provided sufficient technical justification is provided. The following section provides such technical justification for Ocean Wind; the justification presented is based on the Empire Wind and Atlantic Shores requests.

Justification for Alternate Model Request

1. The model or technique has received a scientific peer review.

As described in the 2011 EPA Region 10 approval⁷ and referenced in the 2022 EPA Region 2 approvals, the science undergirding the COARE algorithm, which is incorporated into AERCOARE, has been published in scientific peer review journals. The scientific peer review can be found at the following site: <http://www.coaps.fsu.edu/COARE/>. In its approval, Region 10 referenced the scientific body of peer-reviewed literature that demonstrates the COARE algorithm is an appropriate method to model the behavior of bulk air-sea fluxes including latent and sensible heat flux, net heat flux, and other associated fluxes including evaporation, evaporation minus precipitation, sensible heat flux due to rain, buoyancy flux, and wind stresses.

2. The model or technique can be demonstrated to be applicable to the problem on a theoretical basis.

The EPA has previously determined that AERCOARE/AERMOD is applicable to offshore sources, on a theoretical basis, and can be used to simulate the dispersion of pollutants in the marine atmospheric boundary layer. The 2022 Region 2 approvals cite multiple previous approvals where AERCOARE/AERMOD was deemed appropriate on a theoretical basis for an Arctic marine ice-free environment, a subtropical marine environment off the coast of Louisiana, and a marine environment off the coast of Massachusetts. Additionally, Region 2 found that AERCOARE/AERMOD was applicable to the environment off the coast of Atlantic City for Atlantic Shores, an offshore wind project located in a lease area adjacent to Ocean Wind to the northeast. Finally, as cited by the 2022 Region 2 approvals, EPA's current user manual for AERCOARE⁸ indicates that AERCOARE is expected to be appropriate for marine conditions at all latitudes:

AERCOARE uses Version 3.0 of the COARE algorithm that has been updated several times since the initial international TOGA-COARE field program in the western Pacific

⁵ The Model Clearinghouse Information Storage and Retrieval System (MCHISRS) Record for the January 2022 Region 1

approval of AERCOARE/AERMOD is available at:

<https://cfpub.epa.gov/oarweb/MCHISRS/index.cfm?fuseaction=main.resultdetails&recnum=22-I-01>

⁶ The Model Clearinghouse Information Storage and Retrieval System (MCHISRS) Record for the November 2019 Region 6 approval of AERCOARE/AERMOD is available at:

<https://cfpub.epa.gov/oarweb/MCHISRS/index.cfm?fuseaction=main.resultdetails&recnum=19-VI-01>

⁷ The Model Clearinghouse Information Storage and Retrieval System (MCHISRS) Record for the April 2011 Region 10

approval of AERCOARE/AERMOD is available at:

<https://cfpub.epa.gov/oarweb/MCHISRS/index.cfm?fuseaction=main.resultdetails&recnum=11-X-01>

⁸ U.S. EPA (2012): User's Manual AERCOARE Version 1.0, EPA 910-R-12-008, October 2012.

Ocean from November 1992 to February 1993. The basic algorithm uses air-sea temperature difference, overwater humidity, and wind speed measurements to estimate the sensible heat, latent heat, and momentum fluxes. The original algorithm was based on measurements in the tropics with winds generally less than 10 m/s but has since been modified and extensively evaluated against measurements in high latitudes with winds up to 20 m/s. Based on these studies, AERCOARE is expected to be appropriate for marine conditions found at all latitudes including the Arctic.

3. The databases which are necessary to perform the analysis are available and adequate.

As discussed in the 2022 Region 2 approvals, the meteorological databases that were used to develop the COARE algorithms are available in published scientific literature; the 2022 Region 2 approvals cite the study Fairall et al⁹, which contains a discussion of these datasets. Previous EPA approvals have described the four comprehensive historical overwater dispersion datasets, utilizing tracer gas studies, that are available in the record and that have been used to study air pollutant dispersion in the marine atmospheric boundary layer. The four studies are:

- Cameron, Louisiana: July 1981 and February 1982 (Dabberdt, Brodzinsky, Cantrell, and Ruff, 1982¹⁰)
- Carpinteria, California: September 1985 (Johnson & Spangler, 1986¹¹)
- Pismo Beach, California: December 1981 and June 1982 (Schacher, et al., 1982¹²)
- Ventura, California: September 1980 and January 1981 (Schacher, et al., 1982)¹²

The 2011 Region 10 alternative model approval utilized tracer gas experiments from the four studies listed above. In all previous approvals of AERCOARE/AERMOD for offshore sources, EPA determined that these datasets were adequate for verification of the AERCOARE/AERMOD system.

Additional information was provided to Region 2 by Empire Wind and by Atlantic Shores in their alternative model requests.^{13 14} Atlantic Shores provided a comparison of meteorological data from the Delaware buoy (44009) over the time period of January 4th, 1984 to December 31st, 2020 to the four tracer gas studies, demonstrating that the range of atmospheric conditions that typically occur in the Atlantic City offshore region fit the range of conditions used to develop and

⁹ Fairall, C.W.; Bradley, E.F.; Hare, J.E.; Grachev, A.A.; Edson, J.B. (2003): Bulk Parameterization of Air-Sea Fluxes: Updates and Verification for the COARE Algorithm. *Journal of Climate*, Vol. 16, pp. 571-591.

¹⁰ Dabberdt, W., Brodzinsky, R., Cantrell, B., & Ruff, R. (1982). *Atmospheric Dispersion Over Water and in the Shoreline Transition Zone, Final Report Volume II: Data*. Menlo Park, CA: Prepared for American Petroleum Institute by SRI International.

¹¹ Johnson, V., & Spangler, T. (1986). *Tracer Study Conducted to Acquire Data for Evaluation of Air Quality Dispersion Models*. San Diego, CA: WESTEC Services, Inc. for the American Petroleum Institute.

¹² Schacher, G., Spiel, D., Fairall, C., Davidson, K., Leonard, C., & Reheis, C. (1982). *California Coastal Offshore Transport and Diffusion Experiments: Meteorological Conditions and Data*. Monterey, CA: Report NPS-61-82-007, Naval Postgraduate School.

¹³ The Atlantic Shores request for approval is included in the appendix to the *Concurrence Request for Approval of Alternative Model AERCOARE in Conjunction with AERMOD, in Support of Outer Continental Shelf PSD air permitting of the Atlantic Shores offshore wind power project*. Retrieved from https://gaftp.epa.gov/Air/aqmg/SCRAM/mchisrs/22-II-02_Region2_MCHRequest_AtlanticShores.pdf.

¹⁴ The Empire Wind request for approval is included in the appendix to the *Concurrence Request for Approval of Alternative Model AERCOARE in Conjunction with AERMOD, in Support of Outer Continental Shelf PSD air permitting of the Empire Wind offshore wind power project*. Retrieved from https://gaftp.epa.gov/air/aqmg/SCRAM/mchisrs/22-II-01_Region2_MCHRequest_EmpireWind.pdf.

verify the COARE 3.0 algorithm. The comparison found that wind speeds at Delaware Bay are moderately higher than those observed in the validation studies. However, as documented in the Atlantic Shores alternative model request, the COARE algorithm utilized the Fronts and Atlantic Storm (FASTEX) dataset as it generally contained higher wind speeds than were observed at tropical latitudes. Therefore, the COARE algorithm has been validated against a dataset to specifically account for higher wind speeds like those observed at the Delaware Bay buoy. Additionally, the COARE algorithm was developed to be applicable for water temperatures ranging from the arctic to the tropics, as documented in the EPA's user manual for AERCOARE.

In the 2022 approval granted to Atlantic Shores², Region 2 agreed that the meteorological data comparison presented by Atlantic Shores demonstrated that the four tracer studies were representative of the marine environment off the coast of New Jersey. Given that Ocean Wind's lease area is adjacent to Atlantic Shores' lease area and is also off the coast of New Jersey, Ocean Wind concludes that the meteorological data comparison presented by Atlantic Shores also demonstrates that the four tracer studies are representative of the marine environment of Ocean Wind.

4. Appropriate performance evaluations of the model or technique have shown that the model or technique is not inappropriately biased for regulatory application.

The 2022 Region 2 approvals conclude that it is evident the AERCOARE/AERMOD approach does not result in systematic underprediction of concentrations and that, instead, the evidence more likely leads to the conclusion the approach is conservative. The approvals also state that a key element to prior approvals was an evaluation of the sensitivity of the modeling results to a minimum mixing height. The evaluation determined that AERCOARE/AERMOD results were highly overpredicted when using AERMOD's default minimum mixing height of 1 meter and that a minimum mixing height of 25 meters for overwater sources resulted in better model performance. As stated by Region 2, prior approvals allowed for the use of a minimum mixing height of 25 meters when using AERCOARE/AERMOD and a minimum limit on the absolute value of Monin-Obukhov Length of 5 meters. As stated by the 2022 Region 2 approvals, these limits are recommended in the EPA's AERCOARE User's Guide¹⁵.

5. A protocol on methods and procedures to be followed has been established.

Ocean Wind has submitted a revised modeling protocol concurrent with this request in August 2023 that was updated to reflect the proposed AERCOARE/AERMOD modeling methodology. It outlines the modeling procedures proposed for the Project and conforms with the modeling procedures outlined in the *Guideline* as well as the New Jersey Department of Environmental Protection (NJDEP) Air Quality Modeling Guidelines.

Conclusion

Ocean Wind believes that AERCOARE/AERMOD meets the requirements for approval for use as an alternative model for offshore dispersion modeling for the Ocean Wind Project located in the Atlantic Ocean off the coast of Atlantic City, New Jersey. As shown above, the proposed approach meets each criterion contained in Section 3.2.2(e) of the *Guideline*.

¹⁵ EPA. 2012. User's Manual AERCOARE Version 1.0. Retrieved from https://gaftp.epa.gov/Air/aqmg/SCRAM/models/related/aercoare/AERCOAREv1_0_Users_Manual.pdf.

Thank you in advance for your consideration of this request for an alternative model. Please contact me, Katharine Perry, Ocean Wind 1 Permit Manager, at KAPER@orsted.com or (917) 524-4633 if you have any questions or require additional information. We look forward to working with you in the review of this request.

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