Dominion Energy Services, Inc.
120 Tredegar Street
Richmond, VA 23219

September 29, 2022

BY EMAIL

Mr. Tim Leon-Guerrero
EPA Region 3
1650 Arch Street
Philadelphia, PA 19103-2029
Email: Leon-Guerrero.Tim@epa.gov

Subject: **Virginia Electric and Power Company - Coastal Virginia Offshore Wind Commercial Project Updated Request for Approval for Use of the Alternative Model AERMOD/AERCOARE for Offshore Modeling of the Coastal Virginia Offshore Wind Commercial Project**

Dear Mr. Leon-Guerrero,

The Virginia Electric and Power Company, doing business as Dominion Energy Virginia (hereafter referred to as Dominion Energy), is proposing to construct, own, and operate the Coastal Virginia Offshore Wind Commercial Project (the Project) off the coast of Virginia. In accordance with the United States Environmental Protection Agency's (EPA) Outer Continental Shelf (OCS) air regulations (40 CFR 55) and the Prevention of Significant Deterioration (PSD) permitting regulations (40 CFR 52.21), the Project expects to perform an ambient air impact analysis. Dominion Energy is hereby requesting approval to use AERMOD in conjunction with AERCOARE prepared meteorological data (AERCOARE/AERMOD) as an alternative model for assessing compliance with air quality standards for the Project emission sources located over water in lieu of the OCD model, which is the Guideline on Air Quality Models (40 CFR 51 Appendix W) preferred model for over-water dispersion. This request has been updated to address comments from EPA on data completeness issues for a portion of the proposed meteorological data set.

Project Background

The Project will be located in the Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf (OCS) Offshore Virginia (Lease No. OCS-A-0483) (Lease Area), which was awarded through the Bureau of Ocean Energy Management competitive renewable energy lease auction of the Wind Energy Area (WEA) offshore of Virginia in 2013. The Lease Area covers approximately 112,799 acres (ac, 45,658 hectares [ha]), and the nearest shoreward boundary is approximately 27 statute miles (mi, 23.75 nautical miles [nm], 43.99 kilometers [km]) off the Virginia Beach coastline, while the farthest oceanward boundary is located approximately 40.5 mi (35.2 nm, 65.2 km) from the nearest point of land. See the Lease Area (Project) boundary presented in Figure 1.

Although the wind turbines themselves do not emit air pollutants and are, therefore, not "OCS sources" as defined in 40 CFR 55, jack-up vessels are expected to be used to construct the wind turbines, and EPA Region 1 has previously determined that when construction vessels are attached to and/or erected upon

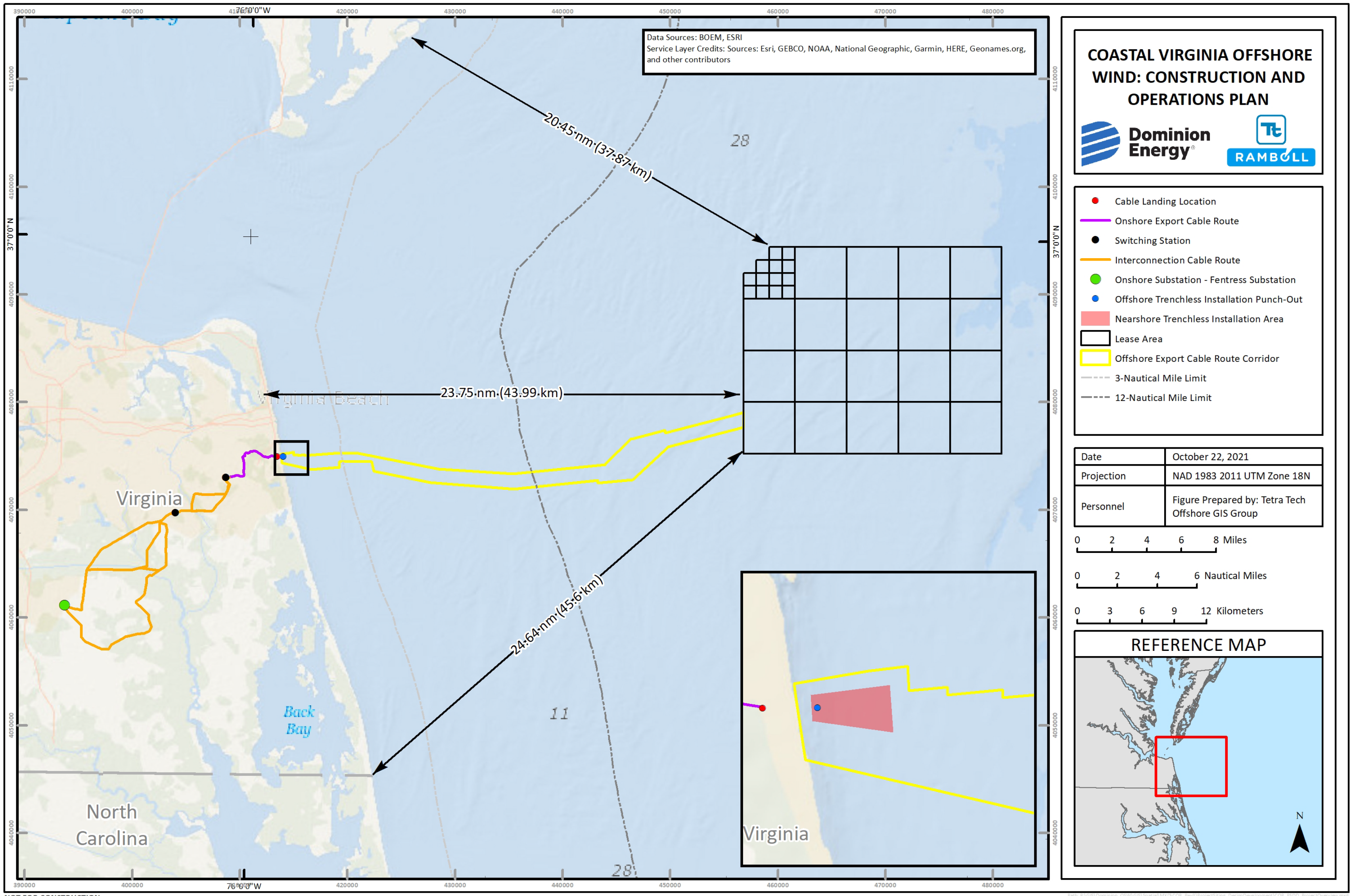

Figure 1. Project Area Overview

the ocean floor, engines located on these vessels that are used for construction are considered OCS sources. Additionally, the completed offshore substation (OSS) facilities will include permanently installed backup generators and electric switchgear containing sulfur hexafluoride (a greenhouse gas), which are also considered OCS sources.

Project emissions are anticipated to be greater than the Prevention of Signification Deterioration (PSD) major source thresholds of 250 tons per year for NO_X, VOC, and CO during construction, and 75,000 tons per year for GHGs during construction. The estimated Project emissions are also expected to be greater than 250 tpy for NO_X during operation. The Project will therefore be considered a PSD major source during both construction and operation.

Regarding exhaust stack parameters, all of the specific vessels to be utilized for the proposed Project have not been finalized. However, representative vessels and appropriate-sized engines have been identified and these characteristics will be used to estimate the potential emissions for vessels not identified. To the extent possible, stack heights and diameters for air dispersion modeling will be based on estimated actual stack dimensions for each of the representative vessels used in the emission inventory, based on vessel specification sheets and/or publicly available photographs. Stack exit velocities and temperatures will be estimated based on the calculated fuel consumption rates used in the emission inventory, and engineering judgment regarding typical exhaust volumes and temperatures for marine diesel engines.

Technical Bases for Alternative Model Request

Dominion Energy is seeking approval for the Project to use the Coupled Ocean-Atmosphere Response Experiment (COARE) bulk flux algorithm, as implemented in the meteorological data processor program (AERCOARE), to prepare meteorological data for use with the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD). AERCOARE is requested as an alternative to replace the regulatory AERMET preprocessor program that is specifically designed for applications over land. The AERCOARE processor will read and process overwater meteorological data using the COARE methodology designed for marine applications. The output from AERCOARE can then be input to AERMOD for modeling applications in a marine environment. AERMOD in conjunction with AERCOARE prepared meteorological data (AERCOARE/AERMOD) is proposed as an alternative refined model for assessing compliance with air quality standards for the Project emission sources located over water. The Offshore and Coastal Dispersion (OCD) model is currently listed as the preferred model for over-water dispersion in USEPA's Guideline on Air Quality Models[1] (*Guideline*) as described in Section 4.2.2.3 of 40 CFR Part 51, Appendix W. AERCOARE/AERMOD is preferred by the Project over OCD for the following technical reasons:

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

[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*. Codified in Appendix W of 40 CFR Part 51. Federal Register Vol. 82, No. 10. Office of Air Quality Planning and Standards, Research Triangle Park, NC. January 17, 2017.

since that time. In contrast, AERMOD is frequently updated (the 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 OSS platform structures will be conservatively evaluated with 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 postprocessor would need to be developed.

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. The Plume Volume Molar Ratio Method (PVMRM) could not be implemented in a postprocessing step, as the adjustments to the predicted concentrations are internal to the AERMOD model calculations that are dependent on the plume characteristics.

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. Ambient background concentrations could be applied to the OCD predicted concentrations in a postprocessing step. A custom postprocessor for OCD must be developed.

7. AERMOD can generate the output concentrations in the form required for comparison to the newer multi-year averaged statistically based NAAQS, namely for 1-hour NO_2, 1-hour SO_2, and 24-hour and annual $PM_{2.5}$. OCD cannot output any statistical or multi-year average results, so for a proper comparison to the NAAQS, a custom postprocessor for OCD must be developed.

8. 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.

9. Modeling of the temporally and spatially varying construction emission sources will be done with an hourly emissions input scheme that will necessitate many unique emission points. OCD limits the number of stationary sources to 8,500. AERMOD does not limit the number of sources.

10. The very large project area footprint will necessitate a substantial number of receptors be defined to ensure maximum impact concentrations are determined. OCD limits the number of receptors (3,000 discrete, 720 polar, and 1,600 cartesian). AERMOD does not place a limit on the number of receptors.

11. Unlike OCD, AERMOD does not specifically treat angled stack exhaust emissions. AERMOD is configured to treat vertical or horizontal venting stacks, but not angled stacks (between vertical and horizontal). Because many of the vessels that make up the Project emissions source inventory will include angled stacks, the modeling will conservatively treat the exhaust emissions from these stacks by using the horizontal stack options. This is a conservative approach which effectively takes credit for the plume rise due to buoyancy but does not take any credit for the momentum plume rise. Unlike OCD, AERMOD does not include algorithms to evaluate shoreline fumigation conditions. However, shoreline fumigation is not expected to be an important impact consideration for the Project emission sources. Shoreline fumigation can occur when plumes traveling in relatively stable air near the shoreline encounter the thermal internal boundary layer (TIBL) and fumigate downward, potentially resulting in elevated pollutant concentrations at the ground. The TIBL is the boundary layer that can form between the more stable over-water air mass and the less stable over-land air mass and typically forms during sea breeze conditions. EPA modeling guidance indicates that shoreline fumigation can be an important phenomenon on and near the shoreline of bodies of water for sources with tall stacks located on or just inland of a shoreline. However, the Project emissions (primarily vessels) are emitted from stacks with low release heights that will generally be located far offshore (the Project site is located 37.9 km or more offshore). Exhaust plumes are expected to be substantially dispersed before encountering the TIBL and potential fumigation conditions. Therefore, shoreline fumigation is not expected to be an important impact condition for Project emissions and is not proposed to be specifically evaluated for the air quality analysis.

Proposed Modeling Approach

Dominion Energy has not yet submitted its PSD application for the Project, which will include an air quality impact analysis (AQIA) report, as required to fulfill requirements under 40 CFR Part 52.21. On July 18, 2022 Dominion Energy provided EPA with a proposed revised modeling protocol (Protocol) for the Project in which AERCOARE/AERMOD was proposed as an alternative modeling platform for near-field impact assessment. A brief summary of the protocol's proposed modeling approach is provided in this section. AERCOARE/AERMOD will be used to conduct the analyses necessary to demonstrate compliance with the NAAQS, PSD Increments, and other applicable near-field impact assessments. The near-field NAAQS and PSD increment AERCOARE/AERMOD modeling will first determine if modeled Project potential-to-emit (PTE) impacts exceed the EPA-prescribed pollutant significant impact levels (SILs) and if so, then determine the associated significant impact area (SIA) for each pollutant. For project impacts that exceed the SILs, a cumulative impact analysis will be conducted to demonstrate compliance with the associated NAAQS and/or PSD Increments. If necessary, Dominion Energy will work with EPA to develop the background source inventory for cumulative modeling.

The AERMOD model requires hourly meteorological data to simulate plume transport and dispersion. The AERCOARE meteorological data preprocessor program was specifically designed to process overwater hourly meteorological data for use in AERMOD dispersion model simulations in a marine environment. AERCOARE applies the COARE air-sea flux procedure to estimate surface energy fluxes from either overwater meteorological measurements or prognostic predicted meteorological parameters extracted at a particular location using the EPA's Mesoscale Model Interface (MMIF) program. Meteorological data collected at Buoy Station #44014 (LLNR 550, 64 nautical miles east of Virginia Beach, VA) will be processed with AERCOARE to create the overwater meteorological data files for each of the five years for input to AERMOD. Based on EPA's comments on data completeness requirements, the meteorological data is based on measurements collected for the years 2001, 2002, 2003 (quarters 1 and 2), 2017 (quarters 3 and 4), 2018 and 2019. All of these periods have more than 90% quarterly data completeness for each meteorological parameter necessary for air quality modeling. The dates for the earlier years will be artificially adjusted to create a continuous fiveyear period (2015-2019) for modeling purposes.

Secondary formation of $PM_{2.5}$ and ozone will be determined using EPA's Modeled Emission Rate for Precursors (MERP) methodology based on low-level stack modeling results for nearby representative hypothetical sources.

Dominion Energy proposes to perform an initial assessment of Class I area impacts at a nominal 50-km distance using the AERCOARE/AERMOD modeling system, in accordance with the screening technique outlined in §4.2 of the *Guideline*. As directed in §4.2, if the analysis finds Class I area significant impacts at the screening distance, a long-range transport analysis will be conducted using the CALPUFF model. If necessary, CALPUFF will be used to assess if the Project has significant impacts at the nearest Class I areas, specifically the Swanquarter Wilderness (located approximately 178 kilometers to the south-southwest of the lease area) and Shenandoah National Park (located approximately 295 kilometers to the northwest). If CALPUFF finds Project impacts are significant at Class I areas, a full-scale cumulative analysis may be necessary, under the direction specified in §4.2(d) of the *Guideline*.

Prognostic meteorological model data will be used if long-range transport modeling for Class I area impact analysis is required. Gridded Weather Research and Forecasting (WRF) model-derived multi-level meteorological data will be used for CALPUFF Class I area modeling, if necessary.

Regulatory Summary for Alternative Modeling Request

The PSD preconstruction air permit requirements of 40 CFR Part 52.21 apply to new OCS sources under 40 CFR Part 55.13(d). Part 52.21(k) requires a source impact analysis be conducted as part of the permitting process to confirm the new source will not cause or contribute to the violation of an air quality standard.

The PSD regulations (40 CFR Part 52.21(l)) state that all applications of air quality modeling shall be based on the preferred models specified in the *Guideline* but also provides on a case-by-case basis that an alternative air quality dispersion model may be used if written approval from the EPA Regional Administrator is obtained. 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 an EPA Regional Office responsibility in consultation with EPA's Model Clearinghouse (MCH). An alternative model may be used subject to Regional Office approval if found to satisfy the requirements listed in Section 3.2.2. Section 3.2.2(e) sets forth the five elements that must be satisfied for alternative model approval:

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

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

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

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

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

The EPA has approved the use of AERCOARE/AERMOD as an alternative model for overwater modeling on three previous occasions. The first such approval was by USEPA Region 10 on April 1, 2011, when approval was granted for the use of output from the COARE algorithm coupled with AERMOD to estimate ambient air pollutant concentrations in an ice-free marine environment.[2,3] The COARE algorithm output was assembled with other meteorological variables in a spreadsheet to form the AERMOD overwater meteorological input files. After USEPA's 2011 approval of the use of the COARE algorithm in spreadsheet form the COARE air-sea flux procedure was coded into the AERCOARE program.

On November 19th, 2019, EPA Region 6 approved the use of AERCOARE/AERMOD for the proposed Sea Port Oil Terminal (SPOT) offshore oil export facility located in EPA Region 6 off the Louisiana coast. The SPOT request documented several limitations of OCD, as well as the key dispersion features of OCD that are not available within AERCOARE/AERMOD (i.e., platform downwash and shoreline fumigation). The SPOT request documented that the applicant would model the platform sources as solid structures and that the project's operation was sufficiently offshore that shoreline fumigation would not be a concern. On November 19th, 2019, USEPA approved the use of AERCOARE/AERMOD for SPOT.[4]

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[2] COARE Bulk Flux Algorithm to Generate Hourly Meteorological Data for Use with the AERMOD Dispersion Program; Section 3.2.2.e Alternative Refined Model Demonstration, Herman Wong, USEPA to Tyler Fox, USEPA, April 1, 2011

[3] Model Clearinghouse Review of AERMOD-COARE as an Alternative Model for Application in an Arctic Marine Ice-Free Environment, George Bridgers, USEPA to Herman Wong, USEPA, May 6, 2011.

[4] Model Clearinghouse review of an alternative model application of AERCOARE in conjunction with AERMOD for the proposed Sea Port Oil Terminal (SPOT) Terminal Services LLC's Deepwater Port Project, George Bridgers, USEPA to Ashley Mohr, USEPA. November 19th, 2019.

On January 28, 2022, EPA Region 1 approved the use of AERCOARE/AERMOD for the proposed Park City Wind (PCW) offshore wind power project located off Martha's Vineyard, Massachusetts.[5] The Park City Wind alternative model request referenced the aforementioned 2011 EPA Region 10 and 2019 EPA Region 6 alternative model requests and listed several limitations of OCD that AERCOARE/AERMOD- can accomplish.

As documented in the EPA Region 1 and the USEPA Region 6 approvals, the AERCOARE/AERMOD model was approved for use in an arctic marine ice-free environment because it satisfied the five criteria contained in Section 3.2.2.e of the *Guideline*. In the previous MCH concurrence memorandums, it stated that its concurrences with the approvals does not constitute a generic approval of the alternative AERCOARE-AERMOD modeling system for other applications, however it does provide a good basis for such considerations provided technical justifications are provided.

The following section of this request for alternative model approval provides Dominion Energy's justification for the approval of AERCOARE/AERMOD for its overwater sources with respect to each of the five elements contained in Section 3.2.2(e).

Evaluation of Approach under Section 3.2.2(e)

The justification for the use of AERCOARE/AERMOD for the modeling analysis addresses each of the five elements in Section 3.2.2(e), as discussed below.

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

As described in the 2011 EPA Region 10 approval[6] (and referenced in the 2019 EPA Region 6 approval[7] and 2022 EPA Region 1 approval[8]), the science behind the COARE algorithm, which is incorporated into AERCOARE, has been published in scientific peer review journals. In its approval, Region 10 confirmed the scientific legitimacy and applicability of the COARE algorithm to various over-water conditions through a sufficient body of peer-reviewed literature. The Region 10 approval also documented that the algorithms in COARE are configured to handle a wide range of temperature gradient conditions including the extremes that could be found in the Arctic or the tropics.

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[5] Model Clearinghouse review of an alternative model application of AERCOARE in conjunction with AERMOD in Support of Outer Continental Shelf PSD air permitting of the Park City Wind offshore wind power project, George Bridgers, USEPA to Jay McAlpine, USEPA. January 28th, 2022.

[6] 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

[7] 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

[8] The Model Clearinghouse Information Storage and Retrieval System (MCHISRS) Record for the January 28, 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

A key peer reviewed article that demonstrated the effectiveness of the COARE 3.0 algorithm when compared to datasets from multiple air-sea flux and bulk meteorological data collection campaigns was presented by Fairall et al.[9] in 2003.

Wong et al.[10] also described the concepts and configuration of the AERCOARE model and its association with AERMOD in the 2016 peer-reviewed article by Region 10 and partner scientists.

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 approval for the PCW project, EPA Region 1 deemed it was appropriate on a theoretical basis for use in the marine environment off the coast of Massachusetts. In addition, as shown below, EPA's current user manual for AERCOARE[11] 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 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."***

As described in the AERCOARE user's manual, AERCOARE calculates the meteorological input parameters needed for AERMOD by accounting for heat flux to and from the atmosphere due to the difference in temperature between the water surface and the air. AERMOD alone does not depend on parameterizations specific to overland conditions. The meteorological inputs provided by AERCOARE (for input to AERMOD) provide the information necessary to parameterize the structure of the marine atmospheric boundary layer using Monin-Obukhov Similarity Theory. This parameterization scheme is universally applicable to over-land and over-water domains. The COARE 3.0 algorithms use standard meteorological variables such as wind speed, air temperature, relative humidity, and water temperature

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[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. https://doi.org/10.1175/1520-0442(2003)016%3C0571:BPOASF%3E2.0.CO;2.*

[10] *Wong, H.; Elleman, R.; Wolvovsky, E.; Richmond, K.; Paumier, J. (2016): AERCOARE: An overwater meteorological preprocessor for AERMOD, Journal of the Air & Waste Management Association, 66:11, 1121-1140, DOI: 10.1080/10962247.2016.1202156*

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

to determine bulk transfer coefficients used in Monin-Obukhov Similarity Theory to describe the structure of the atmospheric surface layer.

Based on the information summarized above, Dominion Energy believes that the coupled AERCOARE/AERMOD modeling approach is applicable to the project on a theoretical basis.

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

The *Guideline* refers to the databases collected to develop and verify the proposed modeling methodologies. The meteorological databases that were used to develop the COARE algorithms for marine conditions are publicly available in the scientific literature. Datasets from previous dispersion experiment studies have been used to verify the accuracy of the AERCOARE/AERMOD modeling approach. There are four comprehensive historical overwater dispersion datasets available in the record that involve study of air pollutant dispersion in the marine atmospheric boundary layer. The following four tracer gas studies from the 1980s have been used in performance evaluations of OCD, CALPUFF, and AERCOARE/AERMOD:

- Cameron, Louisiana: July 1981 and February 1982 (Dabberdt, Brodzinsky, Cantrell, & Ruff, 1982[12])
- Carpinteria, California: September 1985 (Johnson & Spangler, 1986[13])
- Pismo Beach, California: December 1981 and June 1982 (Schacher, et al., 1982[14])
- Ventura, California: September 1980 and January 1981 (Schacher, et al., 1982)

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

Additional information was provided by Vineyard Wind to Region 1 to demonstrate the referenced tracer studies were sufficiently representative of the PCW marine environment off the coast of Massachusetts. Likewise, Dominion Energy provides statistics for key meteorological parameters for the Virginia Beach buoy station (#44014) located in the Project area. The buoy is located 25.4 miles southeast of the southeast corner of the Project area and is the nearest offshore meteorological station with the necessary meteorological parameters. Table 1 summarizes key meteorological data and compares them to data from the tracer studies. The data demonstrates that the range of atmospheric conditions that typically occur in the Virginia offshore region fit the range of conditions used to develop and verify the COARE 3.0 algorithm.

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[12] 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.

[13] 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

[14] 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.

Table 1: Comparison of Meteorological Data Summary Statistics

Location	Observations	Range	10th Percentile	25th Percentile	Median	Average	75th Percentile	90th Percentile
	Wind Speed (m/s)							
Cameron, LA	26	2.1 to 6.2	3.5	3.7	4.6	4.5	5.0	5.7
Carpinteria, CA	27	1 to 5.4	1.0	1.4	2.4	2.5	3.2	3.9
Pismo Beach, CA	31	1.6 to 12.7	2.7	3.9	5.6	6.1	8.3	9.9
Ventura, CA	17	3.1 to 6.9	3.7	4.2	4.9	5.0	5.8	6.2
Virginia Beach, VA	43,695	0 to 28.3	2.2	3.6	5.7	6.2	8.3	10.8
	Air/Sea Temperature Difference (K)							
Cameron, LA	26	-4.5 to 5	-2.7	-1.6	0.5	0.3	1.9	4.2
Carpinteria, CA	27	-1.1 to 2.8	-0.8	-0.7	-0.4	0.2	1.0	2.2
Pismo Beach, CA	31	-0.8 to 3.7	0.0	0.4	1.3	1.3	2.2	3.2
Ventura, CA	17	-2.1 to 1.8	-2.0	-1.0	0.0	-0.2	0.4	1.6
Virginia Beach, VA	43,699	-6.2 to 17.9	-2.0	-0.8	0.3	1.1	2.1	5.5

The Virginia Beach buoy air-sea temperature gradient data and wind data from the years 2001,2003, 2003 Q1 and Q2, 2017 Q3 and Q4, 2018 and 2019 were obtained for comparison to the range of conditions used to develop the COARE 3.0 algorithm and the conditions during the four tracer experiments. Data statistics are provided on the distribution of wind speed and air-sea temperature differences from the four tracer studies, consisting of a total of 101 hourly observations. The maximum hourly average wind speed measured at the Virginia Beach buoy was 28.3 m/s and the 99th percentile of wind speed was 15.1 m/s. The COARE algorithm was developed and verified with conditions up to 20 m/s. Therefore, more than 99 percent of the Virginia offshore winds are within the COARE evaluation wind speed range. The highest wind speeds that exceed the values in the COARE evaluation range will be associated with highly dispersive conditions such that maximal predicted concentrations will not be a consideration at the wind speeds in excess of the range.

The maximum wind speed in the four tracer studies was 12.7 m/s, during the Pismo Beach study. Average wind speeds during each study ranged from 2.5 to 6.1 m/s. Average wind speed at the Virginia Beach buoy was 6.2 m/s, with a median wind speed of 5.7 m/s. Highest concentrations from the project are likely to occur during lower wind speeds. The range of wind speed conditions observed during the tracer experiments covers the range of conditions when the maximum project concentrations are expected.

Because the air-sea temperature difference is an important parameter in characterizing the marine boundary layer, a comparison of the air-sea temperature difference at the Virginia Beach buoy was made with the air-sea temperature differences observed in the evaluation tracer studies. The average air-sea temperature difference at the Virginia Beach buoy (1.1 degrees K) is within the range of averages at the tracer study sites (-0.2 to 1.3 degrees K). The air-sea temperature difference ranges were -4.5 to 5.0, -1.1 to 2.8, -0.8 to 3.7, and -2.1 to 1.8 degrees Kelvin (K) from the Cameron, Carpinteria, Pismo Beach, and Ventura tracer studies, respectively. The range of air-sea temperature differences at the Virginia Beach buoy is -6.2 to 17.9 degrees K. It should be noted that the data period analyzed at the Virginia offshore buoy was much longer (5 years of hourly data) and included many more hours than the tracer studies and covered all seasons of the year. The Virginia Beach buoy 10th and 90th percentile air-sea temperature differences were -2.0 and 5.5 degrees K respectively, indicating most of the conditions fall within or are very near the most extreme range of the conditions tested in the AERMOD simulations of the tracer experiments as represented by the range of the Cameron, LA study.

Box and whisker plots were used to further examine and compare the Virginia Beach and tracer study data sets. Figure 2 presents the box and whisker plots for wind speed, which show that wind speeds at Virginia Beach are generally within the range of those observed during the tracer studies. Figure 3 presents the box and whisker plots for air-sea temperature difference, which show that air-sea temperature difference at Virginia Beach is generally within the range of those observed during the tracer studies. The four tracer studies evaluated do cover a range of wind and temperature gradient conditions and represent the majority of the range of conditions that occur at the project site, as inferred through the Virginia Beach dataset. Most importantly, the low wind speed conditions that are most likely to result in highest predicted concentrations are well addressed in the tracer studies.

Figure 2: Box and Whisker Plots for Virginia Beach and 4 Tracer Study Data Sets – Wind Speed (m/s)

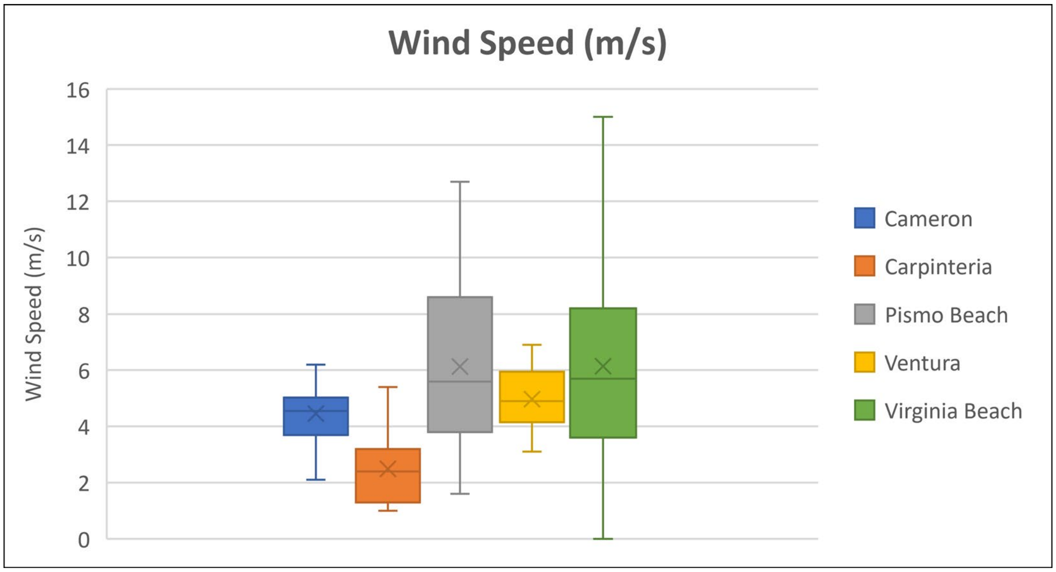
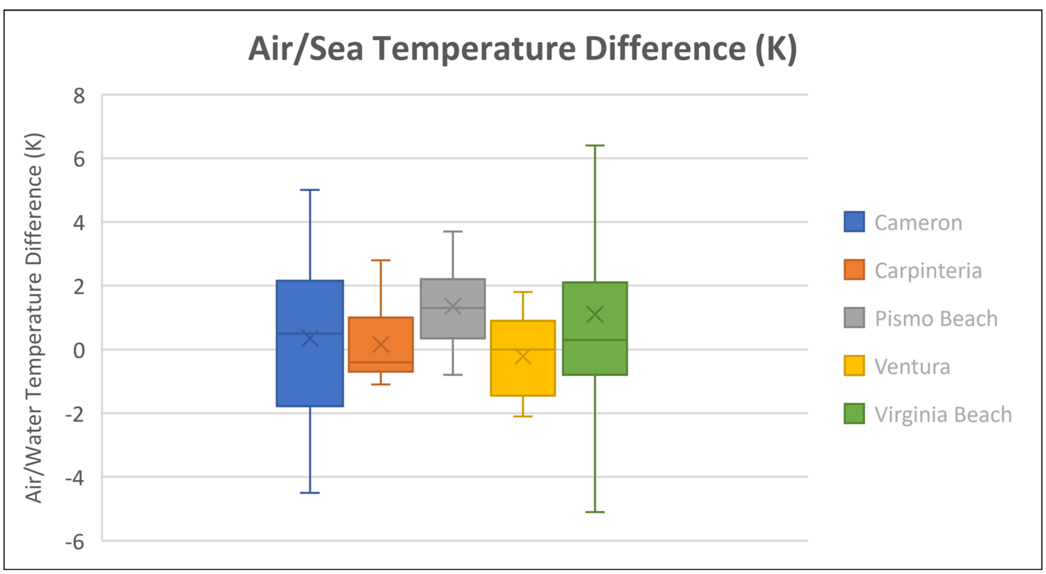


Figure 3: Box and Whisker Plots for Virginia Beach and 4 Tracer Study Data Sets – Air-Sea Temperature Difference (K)



Dominion Energy believes the meteorological dataset from the Virginia Beach buoy proposed for use in AERCOARE and the four tracer studies data sets used in the evaluation of the COARE 3.0 algorithms in AERCOARE are sufficiently available and adequate for determining the effectiveness of the proposed modeling approach.

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

Previous performance evaluations have demonstrated that AERCOARE/AERMOD predicted concentrations are not biased toward underestimates. EPA Region 10's approval of AERCOARE/ AERMOD relied on the results of demonstrations showing no bias toward underestimates, using the overwater study datasets listed above. EPA Region 6's approval of AERCOARE/AERMOD also relied on the demonstrations presented in the EPA Region 10 approval. The Region 10 evaluation described in the AERCOARE/AERMOD predictions from three of the four tracer study datasets (the Ventura dataset was not included because it was considered not representative due the receptors being located well inland and not representative of marine conditions) using various combinations of meteorological data (including different approach to mixing height calculation, use or no use of wind direction variance, and other settings). A statistical analysis was conducted to evaluate whether the AERCOARE/AERMOD alternative modeling approach was biased towards underpredictions.

EPA Region 1's approval considered quantile-quantile (Q-Q) plots for the Cameron and Pismo Beach studies, comparing the combinations of AERCOARE/AERMOD simulations to measurements from each study. The Q-Q plots demonstrate the model tends to overestimate concentrations at the upper-end of the distribution for both studies. The plot for the Cameron case shows that the highest predicted concentrations match well to observations. The plot for the Pismo Beach case shows that the highest predicted concentrations are much greater than the observations, exceeding by more than the factor-of-two threshold. The Region 10 approval included a Q-Q plot of the results from the Carpinteria study. The Carpinteria data showed the AERCOARE/AERMOD results at the upper tail of the distribution exceeded the observations. The data also showed that the five combinations of AERCOARE configurations tested result in predicted concentrations that are all generally of the same magnitude.

Both the original Region 10 approval study and a 2015 EPA[15] study included evaluations of the sensitivity of the modeling results to a minimum mixing height. As described in the Region 10 approval, the AERCOARE/AERMOD results were shown to be highly overpredicted when using AERMOD's default minimum mixing height of 1 meter. Region 10's sensitivity study, summarized in ENVIRON (2012)[16] found a minimum mixing height of 25 meters for overwater applications was more physically realistic and

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[15] *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.*

[16] *ENVIRON 2012. Evaluation of the Combined AERCOARE/AERMOD Modeling Approach for Offshore Sources. Prepared for U.S. Environmental Protection Agency Region 10, Seattle, WA. EPA Contract EP-D-08-102, Work Assignment 5-17, EPA 910-R-12-007, October 2012.*

resulted in better model performance. The Region 10 approval allowed for the use of a minimum mixing height of 25 meters for the application of AERCOARE/AERMOD and a minimum limit on the absolute value of Monin-Obukhov Length of 5 meters. These limits are recommended in the EPA's AERCOARE User's Guide[9].

Based on the study information described above, Dominion Energy believes it is evident the AERCOARE/AERMOD approach is not likely to result in underprediction of concentrations, but rather more likely the approach is conservative.

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

Dominion Energy submitted a revised modeling protocol to EPA on July 18, 2022 for the Project's proposed modeling analysis. The modeling protocol outlines the modeling procedures to be employed in the air modeling analyses including the use of AERCOARE/AERMOD for the Project. Dominion Energy intends to run AERCOARE using the following settings recommended in EPA's AERCOARE User's Guide[17], as specified below:

- The default threshold wind speed will be used to identify calm hours (i.e., WSCALM = 0.5 m/s). Wind speeds below this value will be considered calms;
- Mechanical mixing heights will be calculated by AERCOARE from the friction velocity using the Venkatram method. During convective hours, the convective mixing height will be set to the mechanical mixing height. The same smoothing technique as employed in AERMET will be used. The default minimum mixing height of 25 meters will be assigned.
- Warm layer and cool-skin effects will not be considered.
- Friction velocity will be determined from wind speed only; wave-height will not be considered.

Conclusion

Dominion Energy believes that AERCOARE/AERMOD meets the requirements for approval for use as an alternative model for offshore dispersion modeling for the Project located in the Atlantic Ocean off the Virginia Beach coast. As shown above, the proposed approach satisfies each of the five elements contained in Section 3.2.2(e) of the *Guideline* required for alternative model approvals. Dominion Energy requests EPA's concurrence on this request for approval.

[17] https://gaftp.epa.gov/Air/aqmg/SCRAM/models/related/aercoare/AERCOAREv1_0_Users_Manual.pdf

If you have any questions or require additional information, please contact either Mr. Scott Lawton at (804) 205-6077 or Scott.Lawton@dominionenergy.com, or Mr. T.R. Andrake at (804) 839-2760 or Thomas.R.Andrake@dominionenergy.com.

Sincerely,

Jason P. Ericson
Director Environmental Services

Cc: Ms. Cristina Fernandez, U.S. EPA Region 3 (fernandez.cristina@epa.gov)
Ms. MaryCate Opila, U.S. EPA Region 3 (Opila.MaryCate@epa.gov)
Ms. Gwendolyn Supplee, U.S. EPA Region 3 (Supplee.Gwendolyn@epa.gov)
Mr. Timothy Leon-Guerrero, U.S. EPA Region 3 (Leon-Guerrero.Tim@epa.gov)