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Case No. PUR-2018-00121
Sponsor: STAFF
Exhibit No 19

Witness: NEIL JOSHIPURA
Bailiff: JABARI T. ROBINSON

## Summary of the Testimony of Neil Joshipura

On August 3, 2018, Virginia Electric and Power Company d/b/a Dominion Energy Virginia ("Dominion" or "Company"), filed a petition ("Petition") with the Virginia State Corporation Commission ("Commission") for a prudency determination of the proposed Coastal Virginia Offshore Wind Project ("CVOW Project" or "Project") pursuant to § 56 585.1:4 F of the Code of Virginia ("Code"). My testimony discusses (1) the technical design of the CVOW Project; (2) the potential operational impacts of environmental conditions in the Project area; (3) the various components of the CVOW Project and their associated installation method; and (4) the Staff's assessment of whether a Commission approval is needed for the Project's Virginia Interconnection Facilities. A summary of my conclusions is as follows:

- Due to the potential for extreme weather conditions in the Project area, Staff has some concerns about the ability of the proposed facility to withstand such extreme weather conditions, based on the design specifications provided by the Company. While design specifications for the wind turbine generators indicate an ability to sustain a particular maximum wind speed and wind gust, there appear to be some components of the facility that are designed for a lower maximum wind speed and wind gust. Specifically, some components appear to be designed for a maximum sustained wind speed of 43.3 m/s, which is only equivalent to a low category 2 hurricane, whereas the Staff is aware of five category 3 hurricanes that have travelled in the vicinity of the CVOW Project location.

- The two wind turbine generators and export cable have not been designed for reuse as part of the larger, potential offshore wind project.

- The Staff believes that there are "non-ordinary" components of the Virginia Interconnection Facilities, such that construction of these facilities would fall outside the Company's usual course of business; however, the Staff believes it is up to the Commission to determine whether a certificate of public convenience and necessity is required for construction of these facilities.

EXHIBIT# 19

**PREFILED TESTIMONY
OF
NEIL JOSHIPURA**

**VIRGINIA ELECTRIC AND POWER COMPANY**

**CASE NO. PUR-2018-00121**

**Q1. PLEASE STATE YOUR NAME AND POSITION WITH THE VIRGINIA STATE CORPORATION COMMISSION ("COMMISSION").**

**A1.** My name is Neil Joshipura. I am a Senior Utilities Engineer in the Commission's Division of Public Utility Regulation.

**Q2. WHAT IS THE PURPOSE OF YOUR TESTIMONY IN THIS PROCEEDING?**

**A2.** On August 3, 2018, Virginia Electric and Power Company d/b/a Dominion Energy Virginia ("Dominion" or "Company"), filed a petition ("Petition") with the Virginia State Corporation Commission ("Commission") for a prudency determination of the proposed Coastal Virginia Offshore Wind Project ("CVOW Project" or "Project") pursuant to § 56-585.1:4 F of the Code of Virginia ("Code"). My testimony discusses the design parameters of the CVOW Project and weather conditions located the Project's location. In addition, my testimony discusses the various components of the CVOW Project and their associated installation method. Lastly, my testimony addresses the Staff's opinion on whether a certificate of public convenience and necessity is required for construction of the Virginia Interconnection Facilities.

**Q3. PLEASE PROVIDE AN OVERVIEW OF THE COMPANY'S PROPOSED CVOW PROJECT.**

A3. The CVOW Project consists of two 6 megawatts ("MW") (nominal) wind turbine generators ("WTGs") located approximately 27 statute miles[1] off the coast of Virginia Beach in federal waters and the related generation and distribution interconnection facilities ("CVOW Interconnect Facilities"), which include a smaller subset of generation interconnection facilities that are located entirely within the Commonwealth of Virginia ("Virginia Interconnection Facilities") (collectively, the WTGs and CVOW Interconnection Facilities, inclusive of the Virginia Interconnection Facilities, comprise the "CVOW Project" or "Project").[2]

According to the Company's Petition, the proposed CVOW Project would be interconnected at 34.5 kilovolts ("kV") (*i.e.*, distribution level).[3] Specifically, the Company's proposed new CVOW Interconnection Facilities would begin with a 34.5 kV alternating current ("AC") submarine cable that would interconnect the two WTGs to one another ("Inter-Array Cable"), and also to an approximately 27-mile long, 34.5 kV AC submarine cable ("Export Cable"), which would connect to an onshore transition point located on Camp Pendleton State Military Reservation at an interface cabinet ("Beach Cabinet") in Virginia Beach, Virginia.[4] From the Beach Cabinet, a 34.5 kV underground cable ("Onshore Interconnection Cable") would continue onshore for approximately 1.2 miles and terminate at an

[1] Unless otherwise specified, "miles" in this testimony refers to statute miles.
[2] Petition at 2.
[3] *Id* at 4.
[4] *Id.*

interconnection station ("Interconnection Station"), where switches, auxiliary equipment, and a metering cabinet would be installed.[5]

According to the Petition, in January 2018, the Company executed an engineering, procurement, and construction ("EPC") agreement with Ørsted, a company based in Denmark with North American headquarters in Boston, Massachusetts, to construct the offshore portion of the proposed CVOW Project.[6] Additionally, in June 2018, the Company executed an EPC agreement with L.E. Myers for the onshore portion of the proposed CVOW Project.[7]

The Project site is located next to the commercial Virginia Wind Energy Area ("VWEA"). According to the Company, the CVOW Project is a small-scale demonstration project designed to provide experience and data in several areas, including but not limited to permitting, design, installation, and operations, that would be directly applicable to evaluation of potentially pursuing a much larger commercial wind project located in the commercial VWEA in the future.[8]

**Q4. PLEASE IDENTIFY ANY OTHER OFFSHORE WIND FARMS DEVELOPED BY ØRSTED OR LOCATED IN THE UNITED STATES.**

**A4.** According to the Company, Ørsted owns 22 offshore wind farms in Europe and Asia and has installed 3,800 MW of offshore wind capacity to date in Denmark, Germany, the Netherlands, and the United Kingdom, with plans to reach 7,400 MW by 2020.[9] A list of the offshore wind projects currently developed and owned by

[5] *Id* at 4-5.
[6] *Id* at 5.
[7] *Id.*
[8] Direct Testimony of Mark D. Mitchell at 4 and 12.
[9] Petition at 5.

Ørsted is provided in Attachment 1. Furthermore, in the United States, Ørsted is also involved as the developer or co-developer of the 1,000 MW Bay State Wind project located off the coast of Massachusetts and the 1,950 MW Ocean Wind project located off the coast of New Jersey.[10] Both projects are currently under development.[11] In addition to the Ørsted projects, there is only one other offshore wind project located in the United States, which is the Block Island Wind Project located off the coast of Rhode Island that is owned by Deep Water Wind.[12] The Block Island facility consists of five wind turbines generating up to a combined capacity of 30 MW that became operational in December 2016.[13]

## WEATHER CONDITIONS AND DESIGN PARAMETERS

**Q5. PLEASE DESCRIBE THE EXTREME WEATHER CONDITIONS NEAR THE CVOW PROJECT.**

A5. As proposed, the CVOW Project is located in the mid-Atlantic region. Due to its location, the Project site is subject to potential extreme weather hazards. The ocean temperatures in this region are warmer than the locations of the other offshore wind projects, which are located farther north. As such, the Project site is prone to a greater frequency and intensity of hurricanes compared to the other north-Atlantic offshore wind projects previously described. Additionally, the mid-Atlantic region, where the CVOW Project is located, is also subject to Nor'easters that can also produce hurricane force winds and high waves, all of which provide greater

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[10] Direct Testimony of Mark D. Mitchell at 21.
[11] Company's Response at Office of Attorney General ("OAG") Interrogatory No. 3-53. (Refer to Schedule 1 for all interrogatories.)
[12] Direct Testimony of Mark D. Mitchell at 21.
[13] *Id.*

operational challenges for the CVOW Project than those other offshore wind projects.

**Q6. PLEASE DESCRIBE ANY EXTREME WIND CONDITIONS THAT HAVE BEEN MEASURED NEAR THE CVOW PROJECT.**

A6. The most extreme wind speeds found in the vicinity of the CVOW project typically occur during hurricanes. Hurricanes are classified on the Saffir-Simpson Hurricane Wind Scale,[14] which is based on sustained wind speed. Hurricanes can be hundreds of miles in diameter. While the strongest winds are located near the center of the hurricane, hurricane force winds can extend many miles beyond the center. Accordingly, the Staff reviewed data on hurricane activity within a hundred-mile radius of the CVOW Project site. Attachment 2 provides the hurricane activity that has occurred off the coast of Virginia for hurricanes that are category 1 or higher dating back to the 1840s. There have been 34 hurricanes recorded within the hundred-mile radius of the Project location. Of those 34 hurricanes, five of them have been category 3 hurricanes,[15] of which two (Hurricane Bob and Hurricane Emily) occurred after 1990. There have been no category 4 or 5 hurricanes recorded over the reporting period.

Additionally, the National Oceanic and Atmospheric Administration's ("NOAA") National Hurricane Center uses an analysis tool, called the return period, that quantifies the frequency at which a certain intensity of hurricane can

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[14] The Saffir–Simpson hurricane wind scale classifies hurricanes into five categories distinguished by the intensities of their sustained winds: Category 1 (33-42 meters per second ("m/s")); Category 2 (43-49 m/s); Category 3 (50-58 m/s); Category 4 (58-70 m/s); and Category 5 ($\geq$ 70 m/s). There appears to some overlap in the wind speeds due to rounding.

[15] Four category 3 hurricanes are highlighted in the Attachment 2.

be expected within a given distance (typically 58 miles) of a given location.[16] Attachment 3 depicts the hurricane return period for a hurricane of all categories of hurricane and the return period for a category 3 or higher hurricane.

The return period for the coastal area closest to the CVOW Project is 13 years for any category hurricane and 58 years for category 3 or higher hurricane. However, Staff notes that the coastal area immediately south of the Project location (coastal North Carolina) has a much lower return period of 7 years for all categories of hurricane, and 25 years for category 3 or higher hurricanes.

**Q7. PLEASE PROVIDE THE DESIGN SPECIFICATIONS FOR THE CVOW PROJECT REGARDING MAXIMUM WIND SPEED.**

**A7.** The Staff's investigation found that there appeared to be a discrepancy in the wind speed design specifications for the WTGs pertaining to wind speed. According to specifications found in a table provided by the Company in response to Staff Interrogatory No. 5-66, the WTGs are designed for a maximum sustained[17] wind speed of 43.3 m/s (97 mph) and a maximum wind gust[18] speed of 54.4 m/s (122 mph). However, according to the Virginia Offshore Wind Technology Advancement Project ("VOWTAP")[19] Research Activities Plan ("RAP"),[20] the

[16] In simpler terms, a return period of 20 years for a major hurricane means that *on average* during the previous 100 years, a Category 3 or greater hurricane passed within 50 nm (58 miles) of that location about five times.
[17] 10-minute average.
[18] 3-second average.
[19] CVOW Project was previously identified as VOWTAP.
[20] Report developed by Dominion and the Virginia Department of Mines, Minerals, and Energy ("DMME") and approved by the United States Bureau of Ocean Energy Management ("BOEM"). Commission Staff ("Staff") has elected to attached only the selected pages referenced in Schedule 2.

design specifications for the WTGs are for a maximum sustained wind speed of 50 m/s (112 mph) and a maximum wind gust of 70 m/s (157 mph).[21]

Through discovery, the Staff requested clarification regarding the discrepancy. In response, the Company stated that the figures provided in response to Staff Interrogatory No. 5-66 are representative of site specific design criteria for the entire facility over a 50-year return period in accordance with International Electrotechnical Commission (IEC) 61400 standards.[22] Conversely, the values provided in the VOWTAP RAP, were based on the Alstom Halide turbine design which is consistent with the general technical specifications for the WTGs (Siemens[23] SWT 6.0-154) that are proposed to be installed for the CVOW Project.[24]

**Q8. PLEASE DESCRIBE ANY EXTREME WAVE CONDITIONS THAT HAVE BEEN MEASURED NEAR THE CVOW PROJECT.**

**A8.** There appears to be much less historical data available regarding extreme wave heights that occur in the ocean. Buoy data tends to be the most accurate way to track wave heights. However, since buoys are stationary in nature, they cannot be moved to an area of interest experiencing extreme wave heights when such conditions occur. Satellites have also been used to determine wave heights; however, this data can be less reliable than buoy data. Additionally, historical data often measures wave heights by a measurement called significant wave height, which takes the average of the highest one-third of waves over a given period time,

[21] VOWTAP RAP at 3-6 and 4-10.
[22] Company's Response to Staff Interrogatory No. 9-97.
[23] Siemens Gamesa Renewable Energy.
[24] Company's Response to Staff Interrogatory No. 9-97.

and not maximum wave heights. As such, data on maximum wave heights is often limited.

On September 12, 2018, the Twitter account of National Hurricane Center Tropical Analysis & Forecast Branch (@NHC_TAFB) presented a satellite picture of Hurricane Florence, which struck the North Carolina coast on September 14, 2018. This satellite picture depicted waves heights up to 83 feet.[25] Staff recognizes that Hurricane Florence was a category 4 hurricane when this wave height was measured, and that waves of this size are typically rare and often nonrecurring. In addition to hurricanes, wave heights of 40 feet (12 m) and higher have been encountered during Nor'easters, according to the VOWTAP RAP.[26] Staff witness Abbott also provides additional information related to historical storms and wave heights that were produced by those storms.

**Q9. PLEASE PROVIDE THE DESIGN SPECIFICATIONS FOR THE CVOW PROJECT REGARDING MAXIMUM WAVE HEIGHT.**

A9. According to the Company's response to Staff Interrogatory No. 1-17, the design specifications for the WTGs are for a maximum wave height of 15.6 meters (51.2 feet), and that selection was made based on historical storm data relevant to the turbine sites.

**Q10. BASED ON THE WEATHER CONDITIONS ANALYZED BY THE STAFF, DO YOU HAVE ANY COMMENTS ON THE DESIGN PARAMETERS PROPOSED FOR THE CVOW PROJECT?**

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[25] See Attachment 4.
[26] VOWTAP RAP at 4-6.

**A10.** Yes. Staff recognizes that Ørsted has significant real-world experience and expertise in the designing and installing of offshore wind farms. Nevertheless, the CVOW Project would be the first of its kind in the mid-Atlantic region. Moreover, based on the potential for extreme weather conditions in the mid-Atlantic, Staff would have some concern if the design specifications used for the entire facility are based on the maximum sustained wind speed and maximum wind gust that are stated in the Company's response to Staff Interrogatory 5-77 instead of those described in the VOWTAP RAP. The design parameters in the Company's response to Staff Interrogatory No. 5-77 list a maximum wind speed of 43.3 m/s, which is equivalent to a low category 2 hurricane (43-49 m/s). Additionally, it states the design parameters for a maximum wind gust of 54.4 m/s, which is equivalent to a category 3 hurricane (50-58 m/s).[27] In comparison, the design parameters stated in the VOWTAP RAP lists a maximum wind speed of 50 m/s, which is equivalent to a category 3 hurricane, and a maximum wind gust of 70 m/s, which is equivalent to a category 4 hurricane (58-70 m/s). As such, the Staff believes that the design parameters stated in the VOWTAP RAP should be used for the entire facility and not limited to the WTGs because said parameters are more resilient and provide a higher factor of safety than the parameters listed in the Company's response to Staff Interrogatory No. 5-77, and, therefore, may be more suitable for the potential extreme weather conditions found off the coast of the Virginia.

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[27] Used for comparison purposes. The Saffir-Simpson hurricane wind scale classifies hurricanes by their sustained wind speed not by their wind gust.

**Q11. WILL THERE BE ANY INDEPENEDENT VERIFICATION AND REVIEW OF THE CVOW PROJECT'S DESIGN PARAMETERS?**

**A11.** Yes. According to the Company, pursuant to 30 CFR § 585.705, a certified verification agent ("CVA") must certify to BOEM that the proposed facilities are designed to withstand the environmental and functional load conditions for the intended life of a project at its proposed location.[28] BOEM approved DNV-GL as the CVA responsible for conducting an independent assessment of the design of the CVOW Project.[29] Among other things, DNV-GL's review will include an assessment of environmental loading data, load determinations, stress analyses, and safety factors.[30]

## CVOW PROJECT COMPONENTS & CONSTRUCTION

**Q12. PLEASE DESCRIBE THE SPECIFIC WTGS PROPOSED FOR THE CVOW PROJECT AND THE ASSOCIATED CONSTRUCTION PLANS.**

**A12.** As previously mentioned, the CVOW Project would use two Siemens SWT 6.0-154 (6 MW) WTGs.[31] According to the Company, the SWT 6.0-154 wind turbine has an extensive track record in Europe.[32] Through 2017, approximately 491 such turbines have been deployed in European waters.[33] Ørsted first installed these WTGs in 2013.[34]

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[28] Direct Testimony of Mark D. Mitchell at 17.
[29] *Id* at 18.
[30] *Id.*
[31] Revised Schedule 5 of Mark D. Mitchell's Direct Testimony at 1.
[32] *Id.*
[33] *Id.*
[34] *Id.*

The WTGs would have an approximate hub-height of 345 feet (105 meters) and be set apart by approximately 0.6 mile.[35] Each WTG would consist of three 75-foot-long blades and include pitch control, variable speed, and a direct drive.[36] The tower foundation supporting each WTG would consist of a monopile and transition structure connected to the turbine tower.[37] The monopile primarily would be a cylindrical steep pile, with an upper conical section that shrinks the pile diameter to fit with the tower diameter, and would be imbedded approximately 100 feet into the sea bed.[38] The transition structure would contain external and internal platforms, a boat landing system and davit crane, and would connect the turbine tower and monopile by a bolted connection.[39]

**Q13. DO YOU HAVE ANY COMMENT ON THE COMPANY CHOOSING TO CONSTRUCT TWO RATHER THAN ONE OFFSHORE TURBINE FOR THE CVOW PROJECT?**

A13. According to the Company, two WTGs were chosen in order to study the wake effects of one turbine on the other, which can occur as the wind transitions though adjacent turbines.[40]

The Staff believes that wake effect is an important factor to be considered for the CVOW Project. However, there are numerous offshore wind farms already in existence with multiple wind turbines that could be used to obtain the necessary data on wake effects. Additionally, Staff believes that the Company would obtain

[35] Schedule 1 of Mark D. Mitchell's Direct Testimony at 2.
[36] *Id.*
[37] *Id.*
[38] *Id.*
[39] *Id.*
[40] Direct Testimony of Mark D. Mitchell at 16.

more conclusive data on wake effect if more than two wind turbines are constructed as part of the CVOW Project. The Staff takes no position on the number of WTGs to be used for the Project, but simply notes that if wake effect is the primary driver for installing two WTGs, then (i) that information could potentially be obtained by studying other offshore wind farms installed in similar environmental conditions, and (ii) an increased number of WTGs could potentially provide more conclusive information.

**Q14. WILL THE WTGS CONSTRUCTED AS PART OF THE CVOW PROJECT BE UTILIZED FOR THE LARGER OFFSHORE WIND FARM?**

**A14.** No. As previously mentioned, the CVOW Project proposes to construct two 6-MW turbines. While the final design for the larger wind farm project has not been developed, the Company is considering utilizing 8-MW turbines for the larger offshore wind buildout.[41] According to the Company, the technology for the Siemens 8-MW turbines was not selected for the CVOW Project because it would not be released for commercial use in time to support the project schedule.[42] The Company further states that the 8-MW turbine does not have dramatic differences from the 6-MW turbine.[43] The major difference between the two are the longer blades associated with the 8-MW turbine.[44]

[41] Company's Response to Staff Interrogatory 2-29.
[42] Revised Schedule 5 of Mark D. Mitchell's Direct Testimony at 1.
[43] *Id.*
[44] *Id.*

**Q15. IS THE STAFF AWARE OF ANY 8-MW TURBINES INSTALLED ON ANY OTHER OFFSHORE WIND FARMS DEVELOPED BY ØRSTED AND CURRENTLY IN OPERATION?**

A15. Yes. According to an article dated September 12, 2018, published by Windpower Engineering and Development,[45] the recently completed Walney Extension project located in the Irish Sea near the United Kingdom also utilizes 40 8-MW wind turbines. This project is co-owned by Ørsted, PFA, and PKA.[46] However, it appears that those 8-MW turbines are manufactured by a different company (MHI Vestas Offshore Wind) rather than Siemens.

Ultimately, the Staff believes that there is a tradeoff in the knowledge to be gained from (i) utilizing smaller wind turbines than the ones considered for the larger offshore wind farm but manufactured by the same company versus (ii) utilizing the same-size turbines for both projects, but manufactured by different companies and with possibly different technology. However, the Staff takes no position on the preferred approach.

**Q16. PLEASE DESCRIBE THE EXPORT AND INTER-ARRAY CABLES PROPOSED FOR THE CVOW PROJECT AND THE ASSOCIATED CONSTRUCTION PLANS.**

A16. The new, approximate 27-mile long Export Cable Dominion proposes would consist of a single, three-conductor 34.5 kV submarine cable.[47] The cable would

[45] Attachment 5. https://www.windpowerengineering.com/business-news-projects/worlds-biggest-offshore-wind-farm-opens/
[46] PFA and PKA are Danish pension funds.
[47] Schedule 1 of Mark D. Mitchell's Direct Testimony at 2.

consist of three bundled copper cores surrounded by layers of cross-linked polyethylene insulation and various protective armoring and sheathing.[48] A fiber optic cable would also be included in the interstitial space between the three conductors.[49] The bundled cable would be approximately 4.3 inches in diameter, depending on the manufacturer selected.[50]

According to the Company, the MW capacity of the CVOW Project allows the Company to interconnect at the 34.5 kV distribution-level voltage, thereby eliminating the need for a transmission-level voltage interconnection. The distribution-level voltage was selected to save both time relative to the schedule and costs.[51]

The installation of the Export Cable would primarily use either a jet-plow construction method or remote operated vessel ("ROV") jetting.[52] From the origination point at the southern turbine structure, the Export Cable would be installed in the sea bed at a depth of approximately 3-6 feet (1-2 meters) for approximately 27 miles, utilizing the jet-plow method.[53] The jet-plow method of construction involves towing a plow on the seabed behind a vessel while feeding the cable through the plow system.[54] Water jetting at the front of the plow opens a

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[48] *Id.*
[49] *Id.*
[50] *Id.*
[51] Direct Testimony of Mark D. Mitchell at 19.
[52] Schedule 1 of Mark D. Mitchell's Direct Testimony at 2. Both methods of installation are very similar to each other. The jet plow method of construction involves towing a plow on the seabed behind a vessel while feeding the cable through the plow system. Water jetting at the front of the plow opens a trench while the cable is fed into the trench under the plow. ROV jetting similarly opens a trench using jetting while the cable is then laid into the trench.
[53] *Id.*
[54] *Id.*

trench while the cable is fed into the trench under the plow.[55] ROV jetting similarly opens a trench using jetting while the cable is then laid into the trench.[56]

Approximately 0.8 mile offshore, the Export Cable would transition from jet-plow installation to diver/ROV installation into the horizontal directional drill ("HDD") installed conduit.[57] This method of construction would involve pulling the cable onshore through a 10-14 inch conduit.[58] The Export Cable would terminate onshore at the proposed Beach Cabinet.[59]

The approximate 0.6-mile long Inter-Array cable would utilize the same type of submarine cable used in the Export Cable and be installed in the same manner via the jet-plow method.[60]

**Q17. WILL THE EXPORT CABLE CONSTRUCTED AS PART OF THE CVOW PROJECT BE UTILIZED FOR ANY LARGER OFFSHORE WIND BUILDOUT?**

**A17.** No. Through discovery, the Company has stated that the Export Cable would not be used as part of any larger offshore wind project.[61] While the Company represented to Staff that the export cable for any larger offshore wind project has not been designed or sized, due to the possibility of a buildout to 2,000 MW for the larger offshore wind project,[62] the Staff believes an export cable that rated at transmission-level voltage level would have to be utilized for the larger offshore

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55 *Id.*
56 *Id* at 2-3.
57 *Id* at 3.
58 *Id.*
59 *Id.*
60 VOWTAP RAP at 3-7 and 3-8.
61 Company's Response to Staff Interrogatory No. 5-69.
62 Direct Testimony of Ted Fasca at 7.

wind project. Accordingly, while an export cable designed for transmission-level voltage could potentially support both projects, due to the higher cost of such a cable and the uncertainty regarding the development of the larger offshore wind farm, Staff believes utilizing the proposed Export Cable rated at distribution-level voltage for the CVOW Project is the more appropriate choice.

**Q18. PLEASE DESCRIBE THE OTHER MAJOR COMPONENTS PROPOSED FOR THE CVOW PROJECT AND THEIR ASSOCIATED CONSTRUCTION PLANS.**

A18. The following components are part of the CVOW Interconnection Facilities located onshore.

Beach Cabinet

The Beach Cabinet would serve as the transition point where the bundled submarine Export Cable would be connected to the Onshore Interconnection Cable and separate fiber optic cable.[63] The Beach Cabinet would be approximately 6 feet long by 6 feet wide by 6 feet tall, and located at the landfall site on Camp Pendleton Beach.[64]

Onshore Interconnection Cable

The Onshore Interconnection Cable would be a three-conductor 34.5 kV cable, subject to final design.[65] A separate 1-inch diameter fiber optic cable would also be installed parallel with the Onshore Interconnection Cable.[66]

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[63] Schedule 1 of Mark D. Mitchell's Direct Testimony at 3.
[64] *Id.*
[65] *Id.*
[66] *Id.*

From the origination point at the Beach Cabinet, the Onshore Interconnection Cable would extend approximately 1.2 miles and be installed underground via HDD in approximately 13 segments before terminating at the proposed Interconnection Station.[67] HDD was selected as the preferred method of installation in order to avoid impacts to wetlands or waterbodies.[68] According to the Company, the preliminary proposed route of the Onshore Interconnection Cable would generally follow the Red Alternative route outlined in Schedule 11 of Company witness Mitchell's pre-filed testimony.[69] Discussions between the Company and Camp Pendleton are ongoing regarding the final route.[70]

Interconnection Station

The Interconnection Station would be located on the east side of an access road located just north of an entrance for Camp Pendleton at Gate No. 10 (Gate 10 Access Road, also called Jefferson Avenue) off South Birdneck Road.[71] The Interconnection Station would be constructed in an area approximately 140 feet long by 40 feet wide.[72] The major components of the Interconnection Station would consist of a 12.5 megavolt-ampere ("MVA") 34.5 kV/34.5 kV transformer with an on-load tap changer and a 4.3 megavolt-ampere reactive ("MVAR") shunt reactor.[73] The Interconnection Station would be surrounded by an 8-foot-tall fence.[74]

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[67] *Id.*
[68] Direct Testimony of Mark D. Mitchell at 27.
[69] Company's Response to Staff Interrogatory No. 2-25.
[70] Company's Response to Staff Interrogatory No. 5-77.
[71] Schedule 1 of Mark D. Mitchell's Direct Testimony at 3.
[72] *Id.*
[73] Schedule 1 of Mark D. Mitchell's Direct Testimony at 4.
[74] *Id.*

## ANALYSIS OF VIRGINIA INTERCONNECTION FACILITIES

**Q19. PLEASE DESCRIBE THE VIRGINIA INTERCONNECTION FACILITIES.**

**A19.** The Virginia Interconnection Facilities would comprise, starting from the Virginia jurisdictional line demarcating state-owned submerged lands, approximately 3.6 miles of Export Cable, the Beach Cabinet, the approximately 1.2-mile long Onshore Interconnection Cable, and the Interconnection Station.[75] From the Interconnection Station, the proposed CVOW Project would interconnect with the Company's existing distribution system via a new 34.5 kV underground line, approximately 0.25 mile in length, to a new terminal pole on nearby existing distribution Circuit #421, which terminates at the Company's existing Birdneck Substation.[76] Dominion proposes to replace relays inside the existing control house at Birdneck Substation to ensure Circuit #421 has proper protection to accept reverse flow from the WTGs onto the Company's system.[77]

**Q20. WHAT IS THE COMPANY'S POSITION ON THE VIRGINIA INTERCONNECTION FACILITIES WITH REGARD TO ORDINARY EXTENSION OR IMPROVEMENTS?**

**A20.** The Company states that there is nothing unusual regarding the cost, materials, or construction of the Virginia Interconnection Facilities that would distinguish them from the approximately 24,000 miles of underground 34.5 kV line already installed on the Company's system.[78] According to the Company, many of these

[75] Petition at 5.
[76] *Id* at 5, ftn. 5.
[77] *Id.*
[78] *Id* at 10.

underground lines go under water resources.[79] Additionally, the owner of the property impacted by the placement of the Virginia Interconnection Facilities has consented to and worked closely with the Company regarding the routing and installation.[80] Therefore, the Company considers the Virginia Interconnection Facilities as ordinary extensions or improvements in the usual course of business pursuant to Va. Code § 56-265.2 that do not require Commission approval.[81]

**Q21. PLEASE PROVIDE THE TOTAL MILES OF EXISTING 34.5 KV SUBMARINE UNDERGROUND LINES ON THE COMPANY'S SYSTEM.**

A21. Through discovery, the Company stated that it has approximately 37.5 miles of 34.5 kV submarine distribution lines in service.[82]

**Q22. PLEASE COMPARE THE TOTAL MILES PROVIDED IN QUESTION 21 TO THE CVOW INTERCONNECTION FACILITIES.**

A22. Only 3.6 miles of the Export Cable is considered to be part of the Virginia Interconnection Facilities. However, if constructed, the entire 27 miles of the Export Cable and 0.6 mile of the Inter-Array Cable would be considered part of the Company's system. As such, the Staff is using the entire 27.6 miles as part of its analysis.

If constructed, the newly installed 27.6 miles of 34.5 kV submarine cable would lead to an increase of 73.6% over the Company's existing mileage of 34.5 kV submarine distribution lines.

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[79] *Id.*
[80] *Id* at 10-11.
[81] *Id* at 11.
[82] Company's Response to OAG Interrogatory No. 3-39.

Through discovery, the Staff also requested that the Company provide a list of all distribution lines located in Virginia that include a submarine crossing length of more than 1.0 mile. In response, the Company identified six distribution lines in Virginia that have a submarine crossing length greater than 1.0 mile.[83] The longest existing submarine crossing of a distribution line is approximately 4.4 miles long.[84]

**Q23. PLEASE COMPARE THE JET-PLOW METHOD OF INSTALLATION TO THE COMPANY'S METHOD OF INSTALLATION FOR THE EXISTING SUBMARINE DISTRIBUTION LINES.**

A23. As previously mentioned, the submarine portion of the CVOW Interconnection Facilities is proposed to be installed via the jet-plow method. Through discovery, the Staff requested that the Company identify all distribution lines located in Virginia that include a submarine crossing installed using the jet-plow method. In response, the Company stated that it does not track the installation methodology of submarine distribution cable crossings.[85] Nevertheless, the jet-plow installation method is typically reserved for submarine crossings that are greater in length. As such, based on only six distribution lines with submarine crossings identified by the Company, Staff believes the Company has a limited experience with the jet-plow installation methodology.

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[83] Company's Response to Staff Interrogatory 5-75.
[84] *Id.*
[85] Company's Response to Staff Interrogatory 5-76.

**Q24. PLEASE COMMENT ON THE COMPANY'S EXPERIENCE REGARDING CONSTRUCTION OF THE REMAINING VIRGINIA INTERCONNECTION FACILITIES LOCATED ONSHORE.**

**A24.** The Staff believes that the Company has extensive experience with the remaining Virginia Interconnection Facilities located onshore and the installation of underground 34.5 kV distribution lines using the HDD method of installation.

**Q25. PLEASE COMMENT ON THE STAFF'S POSITION ON THE COMISSION'S REGULATORY REQUIREMENTS REGARDING THE VIRGINIA INTERCONNECTION FACILITIES.**

**A25.** As previously mentioned, as part of its analysis, the Staff evaluated components of the CVOW Interconnection Facilities that include but also extend beyond the Virginia Interconnection Facilities. The Staff believes that the 27.6 miles of submarine distribution cable installed via the jet-plow method is not an ordinary improvement or extension in the Company's usual course of business. Accordingly, the Staff believes that there are non-ordinary components of the Virginia Interconnection Facilities (*i.e.* 3.6 miles of the Export Cable installed via the jet-plow method) that fall outside the Company's usual course of business. However, the Staff believes it is up to the Commission's determination as to whether a certificate of public convenience and necessity is required.

**Q26. DOES THIS CONCLUDE YOUR TESTIMONY?**

**A26.** Yes.

Schedule 1: Company's Response to Interrogatories

OAG Interrogatories

Set 3 Question 39

Set 3 Question 53

Staff Interrogatories

Set 1 Question 17

Set 2 Question 25

Set 2 Question 29

Set 3 Question 39

Set 5 Question 66

Set 5 Question 69

Set 5 Question 75

Set 5 Question 76

Set 5 Question 77

Set 9 Question 97

Virginia Electric and Power Company
Case No. PUR-2018-00121
Office of the Attorney General
Third Set

The following response to Question No. 39 of the Third Set of Interrogatories and Requests for Production of Documents Propounded by the Office of the Attorney General received on August 14, 2018 has been prepared under my supervision.

Robert Wright
Director, Distribution Planning, Reliability & GIS Services
Dominion Energy Virginia

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Question No. 39

Provide the total miles of existing 34.5 kV submarine underground distribution lines on the Company's system.

Response:

The Company has approximately 37.5 miles of 34.5 kV submarine distribution lines in service.

**Virginia Electric and Power Company**
**Case No. PUR-2018-00121**
**Office of the Attorney General**
**Third Set**

The following response to Question No. 53 of the Third Set of Interrogatories and Requests for Production of Documents Propounded by the Office of the Attorney General received on August 14, 2018 has been prepared under my supervision.

Bradley M. Hanks
Manager – Construction Services
Dominion Energy Services, Inc.

The following response to Question No. 53 of the Third Set of Interrogatories and Requests for Production of Documents Propounded by the Office of the Attorney General received on August 14, 2018 has been prepared under my supervision.

Lisa R. Crabtree
McGuireWoods LLP

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**Question No. 53**

Refer to page 21 of Company witness Mitchell's direct testimony. Provide the status and estimated costs and completion dates of the referenced two offshore wind projects in the United States that are being developed by Orsted.

**Response:**

The Company objects to this request to the extent it asks for information about offshore wind projects undertaken by utilities or developers other than the Company, as the Company only has access to information that is publically available, and that information is equally available to the Office of Attorney General. Subject to and notwithstanding this objection, the Company provides the following response.

The Ocean Wind and Bay State Wind Farm projects are under development per the latest public information available.

Ocean Wind is a proposed offshore wind project located off the coast of Atlantic City, New Jersey. See https://oceanwind.com for additional information.

Bay State Wind is a proposed offshore wind project located 25 miles off the south coast of Massachusetts, and 15 miles off the coast of Martha's Vineyard. The project is a 50-50 joint venture between Ørsted, the global leader in offshore wind, and Eversource, the premier transmission builder in the New England states. See https://baystatewind.com for additional details.

Virginia Electric and Power Company
Case No. PUR-2018-00121
Virginia State Corporation Commission Staff
First Set

The following response to Question No. 17 of the First Set of Interrogatories and Requests for Production of Documents Propounded by the Virginia State Corporation Commission Staff received on August 8, 2018 has been prepared under my supervision.

Bradley M. Hanks
Manager - Construction Services
Dominion Energy Services, Inc.

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**Question No. 17**

Please indicate the design specifications for the CVOW Project regarding maximum wind speed and maximum wave load.

**Response:**

The Wind turbine generators must meet all design envelope conditions as certified by the Certified Verification Agent ("CVA") including hurricanes and hurricane ride through coincident with loss of shore power for seven days. Based on historical storm data relevant to the turbine sites, which dates back to ~ 1890, the initial design specifications for maximum wind speed is 54.4 meters per second (122 Mph) with a maximum wave height of 15.6 meters.

**Virginia Electric and Power Company**
**Case No. PUR-2018-00121**
**Virginia State Corporation Commission Staff**
**Second Set**

The following response to Question No. 25 of the Second Set of Interrogatories and Requests for Production of Documents Propounded by the Virginia State Corporation Commission Staff received on August 10, 2018 has been prepared under my supervision.

Bradley M. Hanks
Manager – Construction Services
Dominion Energy Services, Inc.

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Question No. 25

Please reference Company witness Mark D. Mitchell's prefiled direct testimony at Schedule 11. Please provide a status update of all communications between Dominion and the U.S. Navy in connection with the CVOW Project.

Response:

The onshore export cable has been verbally approved by Camp Pendleton and generally follows the Red Alternative route outlined in Schedule 11 of Company Witness Mark D. Mitchell's pre-filed testimony. The route does not utilize Navy property except for a small portion of the previously designated utility easement. Camp Pendleton has provided a draft easement from the Navy for the small utility corridor. The Company is working to finalize the easement and survey for formal approval.

Virginia Electric and Power Company
Case No. PUR-2018-00121
Virginia State Corporation Commission Staff
Second Set

The following response to Question No. 29 of the Second Set of Interrogatories and Requests for Production of Documents Propounded by the Virginia State Corporation Commission Staff received on August 10, 2018 has been prepared under my supervision.

Bradley M. Hanks
Manager – Construction Services
Dominion Energy Services, Inc.

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**Question No. 29**

Please reference the prefiled direct testimony of Company witness Mark D. Mitchell at page 12, lines 10-11, which states that "[t]he Company must pursue the CVOW Project now if it is to be ready to potentially pursue a larger offshore wind project in the future — likely mid-2020 timeframe" and at page 12, lines 17-20 which states that "[t]his timeline would provide several years of valuable data on turbine operation and performance prior to potential deployment of a larger commercial wind project in the adjacent VWEA, which could be deployed as early as 2024, if economic." Respond to the following:

(a) Provide a schedule, in Microsoft Excel format with formulas intact, of the Company's actual and projected capital expenditures for such a larger offshore wind project, by month through December 2024, assuming that such project is deployed in 2024; and

(b) Indicate the nameplate megawatt output of such larger offshore wind project assumed for purposes of developing the projected capital expenditures provided in response to part (a) of this interrogatory.

**Response:**

(a) See Extraordinarily Sensitive Attachment Staff Set 2-29 (BMH) for the capital expenditure data used in the 2018 Integrated Resource Plan.

Extraordinarily Sensitive Attachment Staff Set 2-29 (BMH) contains extraordinarily sensitive information and is provided subject to pursuant to the protections set forth in 5 VAC 5-20-170, the Company's Motion for Entry of a Protective Order filed on August 3, 2018, in this proceeding and the Hearing Examiner's Protective Ruling entered August 10, 2018, in this proceeding, any subsequent protective order or protective ruling that may be issued for confidential or extraordinarily sensitive information in this proceeding, and the Agreements to Adhere executed pursuant to any such orders or rulings.

(b) The wind project block size is 440 MWs, which assumes fifty-five 8 MW turbines.

**Virginia Electric and Power Company**
**Case No. PUR-2018-00121**
**Virginia State Corporation Commission Staff**
**Third Set**

The following response to Question No. 39 of the Third Set of Interrogatories and Requests for Production of Documents Propounded by the Virginia State Corporation Commission Staff received on August 24, 2018 has been prepared under my supervision.

Bradley M. Hanks
Manager - Construction Services
Dominion Energy Services, Inc.

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**Question No. 39**

Please explain why the DMME Lease was not included in the Company's response to Staff Interrogatory 2-24.

**Response:**

The DMME Lease was not included in the Company's response to Staff Set 2-24 because the lease is not viewed as a federal permit or approval.

Virginia Electric and Power Company
Case No. PUR-2018-00121
Virginia State Corporation Commission Staff
Fifth Set

The following response to Question No. 66 of the Fifth Set of Interrogatories and Requests for Production of Documents Propounded by the Virginia State Corporation Commission Staff received on August 30, 2018 has been prepared under my supervision.

[signature] for
Bradley M. Hanks
Manager - Construction Services
Dominion Energy Services, Inc.

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**Question No. 66**

Please provide for the following information for the WTGs:

(a) The manufacturer's power curve.

(b) The rated extreme wind speed(s) including maximum duration for each rated speed.

(c) The maximum and minimum operating air temperatures.

**Response:**

(a) See Attachment Staff Set 3-44 (1) (BMH) for public technical specifications for SWT-6.0-154. The power curve is proprietary information and has not been released to the Company.

(b) See the table below for the requested information.

| | | |
|---|---|---|
| Max 50-year wind speed, 10-min. mean | m/s | 43.3[1] |
| Max 3-sec gust, 50-year recurrence | m/s | 54.4[1] |

[1] For a hub height of 108.88 mLAT

(c) See the table below for the requested information.

| | | |
|---|---|---|
| Minimum Air Temperature | °C | -20 |
| Maximum Air Temperature | °C | +35 |

**Virginia Electric and Power Company**
**Case No. PUR-2018-00121**
**Virginia State Corporation Commission Staff**
**Fifth Set**

The following response to Question No. 69 of the Fifth Set of Interrogatories and Requests for Production of Documents Propounded by the Virginia State Corporation Commission Staff received on August 30, 2018 has been prepared under my supervision.

Bradley M. Hanks
Manager - Construction Services
Dominion Energy Services, Inc.

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**Question No. 69**

The Company's Petition describes the possibility of constructing a larger offshore wind farm in the vicinity of the CVOW Project. For that larger project, please answer the following:

(a) Does the Company anticipate interconnecting that facility using the same 34.5 kV Export Cable constructed as part of CVOW Project? If not, please explain why CVOW Project's Export Cable is not being designed to support interconnection of the larger project.

(b) Please provide all known information related to the design and specifications of the projected submarine cable that would interconnect that larger offshore wind farm to an onshore point of interconnection ("Large Export Cable"). Specifically, identify the projected ampacity and voltage of the Large Export Cable, including, at a minimum, whether the Large Export Cable is expected to be rated at 69 kV or greater.

(c) Please provide all known information related to the construction and operation of the Large Export Cable. Specifically, identify the number of cables projected to be utilized and the anticipated installation method.

**Response:**

(a) The interconnecting cable being used for the CVOW Project will not be used as part of a larger offshore wind project. Increasing the capacity of the cable would lead to increased capital construction costs for the CVOW Project and would require the onshore scope to be fully redesigned for a transmission level interconnection facility.

(b) This information is not available. If the Company determines to move forward with the larger scale offshore wind project, the engineering to define the size of an export cable will be finalized at that time.

(c) See the Company's response to subpart (b) of this request.

<u>Virginia Electric and Power Company</u>
<u>Case No. PUR-2018-00121</u>
<u>Virginia State Corporation Commission Staff</u>
<u>Fifth Set</u>

The following response to Question No. 75 of the Fifth Set of Interrogatories and Requests for Production of Documents Propounded by the Virginia State Corporation Commission Staff received on August 30, 2018 has been prepared under my supervision.

F. Dale Robertson
Manager GIS Services
Dominion Energy Virginia

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Question No. 75

Please identify all of the Company's distribution circuits in Virginia that include a submarine (underwater) crossing of more than 1.0 mile in length. For each such circuit, identify the following: (a) the circuit number; (b) the voltage of the circuit; (c) the body of water that it crosses; (d) the approximate length of the submarine crossing; (e) the type of submarine distribution cable utilized; and (f) the installation methodology of the submarine crossing.

Response:

See Attachment Staff Set 5-75 for a list of all submarine (underwater) crossings of more than 1.0 mile in length based on a desktop Geographic Information System ("GIS") submarine crossings review. The Company does not track the installation methodology of submarine cable crossings, and can make no representations regarding whether the lines identified in Attachment Staff Set 5-75 were installed via any particular methodology.

# Attachment 5-75

| Circuit Number | Voltage of the Circuit/s | Body of Water Crossed | Approximate Crossing Length (mi.) | Submarine Cable Attributes |
|---|---|---|---|---|
| 71481, 71480, 71483 | 19.9 kV | Currituck Sound | 4.4 | 9 Conductors of 1000 KCM Jacketed Aluminum |
| 68408 | 19.9 kV | Roanoke Sound | 3.3 | 3 Conductors of 1000 KCM Laterally Cor. Copper Shield Aluminum |
| 03306 | 19.9 kV | Rappahannock River | 1.8 | 3 Conductors of 700 KCM Laterally Cor. Copper Shield Copper |
| 68427 | 19.9 kV | Kitty Hawk Bay | 1.4 | 4 Conductors of 1000 KCM Jacketed Aluminum |
| 26455 | 19.9 kV | Nansemond River | 1.1 | 4 Conductors of 1000 KCM Jacketed Aluminum |
| 26470 | 19.9 kV | James River | 1.0 | 4 Conductors of 700 KCM Laterally Cor. Copper Shield Copper |

Virginia Electric and Power Company
Case No. PUR-2018-00121
Virginia State Corporation Commission Staff
Fifth Set

The following response to Question No. 76 of the Fifth Set of Interrogatories and Requests for Production of Documents Propounded by the Virginia State Corporation Commission Staff received on August 30, 2018 has been prepared under my supervision.

F. Dale Robertson
Manager GIS Services
Dominion Energy Virginia

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Question No. 76

Please identify all of the Company's distribution circuits in Virginia that include a submarine (underwater) crossing installed using jet-plow construction. For each such circuit, identify the following: (a) the circuit number; (b) the voltage of the circuit; (c) the body of water that it crosses; (d) the approximate length of the submarine crossing; (e) the type of submarine distribution cable utilized.

Response:

The Company does not track the installation methodology of submarine distribution cable crossings. See the Company's response to Staff Set 5-75.

Virginia Electric and Power Company
Case No. PUR-2018-00121
Virginia State Corporation Commission Staff
Fifth Set

The following response to Question No. 77 of the Fifth Set of Interrogatories and Requests for Production of Documents Propounded by the Virginia State Corporation Commission Staff received on August 30, 2018 has been prepared under my supervision.

Bradley M. Hanks
Manager - Construction Services
Dominion Energy Services, Inc.

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Question No. 77

Please provide a detailed breakdown of the estimated costs of constructing the onshore cable utilizing the red alternative route. Provide material quantities, material costs, and labor costs. The following items should be among those costs individually subtotaled: engineering, project management, substation work, geologic services, easements of right-of-way, right-of-way clearing, cable/conductor, cable pulling, cable splicing, cable terminating, splice vault construction, duct bank construction, HDD installation.

Response:

See the Exhibit C, page 42 of Extraordinarily Sensitive Attachment 4-58 (BMH). Additional information, including the cost category breakdowns requested by Staff in this Request are not available at this time.

Please note, the red alternative route was a preliminary interconnection design concept and there are ongoing discussions between the Company and Camp Pendleton regarding the final route.

Virginia Electric and Power Company
Case No. PUR-2018-00121
Virginia State Corporation Commission Staff
Ninth Set

The following response to Question No. 97 of the Ninth Set of Interrogatories and Requests for Production of Documents Propounded by the Virginia State Corporation Commission Staff received on September 14, 2018 has been prepared under my supervision.

Jeffrey G. Miscikowski
Director Generation Construction Financial
Management & Controls
Dominion Energy Services, Inc

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**Question No. 97**

Please reference Section 3.2.1 of the VOWTAP RAP describing the wind turbine generators. It states that "The design is specifically suited for offshore wind sites with referenced wind speeds of 112 miles per hour (mph) (50 m/s over a 10-minute average) and 50-year extreme gusts of 157 mph (70 m/s over a 3-sec average) . . . ." Please explain the discrepancy in the figures listed above and the figures provided in the Company's response to Staff Interrogatory No. 5-66 (b).

**Response:**

The figures provided in response to Staff Interrogatory No. 5-66 (b) are representative of site specific design criteria for the entire facility over a 50 year return period in accordance with International Electrotechnical Commission (IEC) 61400 standards. The values provided in Section 3.2.1 of the VOWTAP RAP, 70 m/s over a 3-sec average gust for example, were based on the Alstom Haliade turbine design but are also consistent with the general technical specifications for the Siemens SWT 6.0-154 Class-1B turbine which will be installed for the CVOW Project. See Attachment Staff Set 3-44(a).

Schedule 2: VOWTAP RAP Selected Pages

Pages

3-6

3-7

3-8

4-6

4-10

Each of the WTGs will require various oils, fuels, and lubricants to support the operation of the WTG's hydraulic system, generator, transformers, and emergency back-up generator. Table 3.2-2 provides a summary of the physical characteristics of these oils and lubricants per WTG. The spill containment strategy for each WTG is comprised of preventive, detective and containment measures. These measures include 100 percent leakage free joints to prevent leaks at the connectors; high pressure and oil level sensors that can detect both water and oil leakage; and two retention tanks – one 132 gallon (gal) (500 liter [L]) at the bottom of each generator and one 528.3 gal (2000 L) at the bottom of each transformer – capable of containing 110 percent of the volume of potential leakages at each WTG.

**Table 3.2-2. Alstom Haliade 150 Summary of Oils, Fuels and Lubricants**

| WTG System | Oil/Fuel Type | Oil/Fuel Capacity |
|---|---|---|
| Hydraulic System | Hydraulic fluid, ISO Viscosity Grade DIN 51519 | 10.6 gal / 40 L |
| Generator Cooling System (Primary and Secondary) | Water and Glycol | 132 gal / 500 L |
| Primary Transformer Cooling System | Class 3k synthetic ester liquid | 528 gal / 2000 L |
| Secondary Transformer Cooling System | Water and Glycol | 53 gal / 200 L |
| Converter | Water and Glycol | 53 gal / 200 L |
| Emergency Back-up Generator | Diesel fuel | 1000 gal / 3785 L |

The WTGs have been designed following Class I-B specifications of the standards IEC-61400-1/IEC-61400-3. The design is specifically suited for offshore wind sites with referenced wind speeds of 112 miles per hour (mph) (50 m/s over a 10-minute average) and 50-year extreme gusts of 157 mph (70 m/s over a 3-sec average) as well as air temperatures greater than -4°F (-20°C) and less than 122°F (50°C) However, standard environmental operating conditions for the proposed WTGs include wind speeds between 6.7 mph and 55.9 mph (3 m/s and 25 m/s), and air temperatures between 14°F and 104°F (-10°C and +40°C). The WTG will automatically shut down outside of these operational limits.

The WTGs will also be protected both externally and internally by a lightning protection system. The external lightning protection system is comprised of lightning receptors located within the both the nacelle and blade tips which are designed to handle direct lightning strikes and will conduct the lightning's peak current through a conductive cabling system that leads through the tower into the WTG grounding/earthing system. To avoid and/or minimize internal damage from the secondary effects of lightning (e.g., power surges), the WTG's internal electrical systems will be protected by equipotential bonding, overvoltage protection, and electromagnetic coordination.

Operation of the WTGs will be continuously monitored by the Haliade Control System which has the capability of being both locally and remotely operated over a local area network to ensure the WTGs are operating within their specified design limits. The Haliade Control System is comprised of several key components that include GALILEO, which serves as the main controller of WTGs, and a SCADA. The GALILEO is an automatic, self-diagnosing turbine management system that monitors and manages the operation of the WTGs based on real-time environmental conditions and turbine status. The SCADA provides remote control and monitoring of the WTGs from an operations center onshore, including real-time information on electrical and mechanical data, operation and fault status, meteorological data, and grid station data. No form of communication other than fiber optic is currently being considered. Depending on further analysis of design requirements, other forms of redundancy may be considered. The 24 optical fibers in the Inter-Array and Export Cables provide for multiple fiber optic cable connections to address concerns with potential failures, such as loss of port or electronic card.

Additional operational safety systems on each WTG include a back-up power generator, FAA and USCG-compliant aviation and navigation obstruction lighting, fire suppression, and first aid and survival equipment. WTG safety systems and equipment are described in detail in Section 4.14.

### 3.2.2 IBGS Foundations

Each WTG will be supported by an IBGS foundation. The IBGS foundation consists of one approximately 10.2-ft (3.1-m) diameter central caisson, the structural jacket, and three through-the-leg inward battered piles approximately 5.9-ft (1.8-m) in diameter spaced approximately 95 ft (29 m) apart. The total footprint of each IBGS foundation is approximately 0.09 acre (0.04 hectare) on the seafloor. At sea level, the IBGS foundation measures approximately 56 ft by 56 ft (17 m by 17 m). A transition deck, boat landing, ladders and stairs, guide tubes for the Export Cable, Inter-Array Cable and other appurtenances will be installed on the foundation. Appendix D-1, Figure 1 provides a plan and profile of the IBGS foundation.

Table 3.2-3 provides a summary of the construction and operation footprints for the two IBGS foundations.

**Table 3.2-3. IBGS Foundation and WTG Construction and Operation Footprint**

| IBGS Foundation and WTG | Construction | Operation |
|---|---|---|
| IBGS Foundation a/ | 0.2 ac / 0.1 ha | 0.2 ac / 0.1 ha |
| Heavy Lift Vessel b/ | 0.8 ac / 0.3 ha | 0 |
| High Lift Jack-up Vessel c/ | 0.001 ac / 0.0004 ha | 0 |
| WTG Temporary Work Area d/ | 190 ac / 76.9 ha | 0 |
| **IBGS Foundation and WTG Total** | **191 ac / 77.3 ha** | **0.2 ac / 0.1 ha (No Change)** |

a/ IBGS foundation area immediately under foundation is based on piles being placed 95 ft (29 m) apart. Includes two foundation structures of 0.1 ac (0.04 ha) each. Impacts will all occur within 95 ac (38.5 ha) WTG Temporary Work Area at each foundation location.

b/ Assumes a single set of an 8-point anchored vessel per WTG. Impact area includes anchors (0.006 ac [ 0.002 ha] per anchor) and anchor chain sweep (0.09 ac [0.04 ha]) based on approximate 200 ft (61 m) of anchor chain resting on the bottom and a maximum of 20 ft (6.1 m) of lateral drag per chain.

c/ Assume 1 jack-up per WTG (approximately .0003 ac [0001 ha]). Impacts will all occur within the 95 ac (38.5 ha) WTG Temporary Work Area at each foundation location.

d/ Includes the two WTG Work Areas of 95 ac (38.5 ha) each.

### 3.2.3 Inter-Array Cable

The Inter-Array Cable will comprise a single, three-conductor 34.5 kV submarine cable. Because the Inter-Array Cable and grid connection voltage will be the same (34.5 kV) the VOWTAP does not require an offshore substation. The cable will consist of three bundled copper conductor cores surrounded by layers of cross-lined polyethylene insulation and various protective armoring and sheathing. Appendix D-1, Figure 2 provides an example of a typical three-conductor marine cable. A fiber optic cable will also be included in the interstitial space between the three conductors and will be used to transmit data from each of the VOWTAP WTGs to the SCADA system. The bundled cable will be approximately 4.3 in (110 millimeter [mm]) in diameter, depending on the manufacturer selected. Appendix D-2 shows the preliminary Inter-Array Cable plan and profile drawings.

Dominion is currently evaluating the use of a towed jet plow and/or self-propelled remotely operated vehicle (ROV) jet trencher supported by a dynamically positioned (DP) cable-lay vessel to support the installation of the Inter-Array Cable. The method selected will be based upon final engineering design and the space available between the two WTGs to support the installation equipment and vessels (see Section 3.3.4.3 for a description of cable installation).

Installation using the jet plow will create a narrow, temporary trench up to 3.3 ft (1 m) wide. The cable will be fed into this trench as the jet plow is towed along the ocean floor. The jet plow will rest on skids or wheels with a width of approximately 18.4 ft (5.6 m). Installation using the self-propelled ROV jet trencher will be similar to the process described for the jet plow; however, installation activities would result in a narrower trench than the jet plow (approximately 1.6 ft. [0.5 m]). Both the jet plow and ROV jet trencher will bury the Inter-Array Cable to a minimum depth of 3.3 ft (1 m); however, the exact depth will be dependent on the substrate encountered along the route.

Regardless of the technique selected for the installation of the Inter-Array Cable a ROV jet trencher will be required for the installation of the Inter-Array Cable within a distance of not less than 656.2 ft (200 m) from each foundation.

Table 3.2-4 provides a summary of the total construction and operation footprints for the Inter-Array Cable. To be conservative, impacts have been based upon the use of the jet plow.

**Table 3.2-4. Inter-Array Cable Construction and Operation Footprint**

| Inter-Array Cable | Construction | Operation |
|---|---|---|
| Jet Plow / ROV Jet Trencher a/ | 1.5 ac / 0.6 ha | 0 |
| Inter-Array Cable Total | 1.5 ac/ 0.6 ha | 0 |

a/ Assume a temporary trench up to 3.3 ft (1 m) wide and jet plow skids or wheels with a width of approximately 18.4 ft (5.6 m) to the boundaries of the revised Temporary WTG Work Areas. The size of the impacts footprints associated with cable installation within the Temporary WTG Work Areas is included in Table 3.2-3.

### 3.2.4 Export Cable

The Export Cable will transmit the energy produced by the VOWTAP WTGs to shore and will be located within a 200-ft (61-m) wide easement. The preliminary Export Cable plan and profile drawings inclusive of the proposed Easement are provided in Appendix D-2.

The Export Cable will use the same type of cable as described for the Inter-Array Cable (Section 3.2.3). Installation of the cable will be achieved using a jet plow. Due to water-depth constraints, installation via jet plow will be supported by a maximum 8-point anchored barge from the proposed HDD punch-out location, for a distance of approximately 4.5 mi (7.2 km) followed by the use of DP cable-lay vessel for the remainder of the route. At a distance of not less than 656.2 ft (200 m), a ROV jet trencher will be used to install the Export Cable at the foundation location. Installation via anchored barge will require a temporary 95 ac (39 ha) Nearshore Work Area (Figure 3.2-2).

The target depth of burial for the Export Cable is approximately 6.6 ft (2 m). Conditions along the proposed Export Cable route indicate that the target depth of burial is achievable; however, Dominion has identified five areas along the route where the presence of mobile sand waves may require additional

**Table 4.1-1. Seawater Temperature, Salinity, and Density at Near Surface**

| Combined Period (2006-2012) | Seawater Temperature (°C) | | | Seawater Salinity (PSU) | | | Seawater Density (km/m³) | | |
|---|---|---|---|---|---|---|---|---|---|
| | Min | Max | Std Dev | Min | Max | Std Dev | Min | Max | Std Dev |
| January | 4.66 | 13.46 | 1.82 | 27.43 | 33.68 | 1.15 | 1020.72 | 1025.97 | 0.96 |
| February | 3.75 | 9.75 | 1.36 | 26.08 | 33.90 | 0.97 | 1020.24 | 1026.33 | 0.73 |
| March | 4.26 | 15.39 | 1.63 | 27.63 | 33.55 | 1.14 | 1021.21 | 1026.23 | 0.99 |
| April | 7.17 | 15.83 | 1.78 | 24.04 | 33.14 | 1.37 | 1018.04 | 1025.58 | 1.26 |
| May | 9.56 | 22.24 | 2.34 | 24.81 | 33.42 | 1.75 | 1017.59 | 1025.43 | 1.63 |
| June | 18.12 | 26.92 | 1.72 | 24.67 | 32.89 | 1.68 | 1015.95 | 1023.07 | 1.46 |
| July | 20.14 | 28.32 | 1.21 | 24.19 | 34.42 | 1.97 | 1014.92 | 1022.57 | 1.60 |
| August | 22.57 | 29.87 | 1.17 | 26.61 | 34.47 | 1.68 | 1016.32 | 1022.17 | 1.41 |
| September | 19.37 | 26.97 | 1.26 | 28.07 | 32.48 | 0.83 | 1017.91 | 1022.80 | 0.83 |
| October | 15.96 | 24.70 | 1.75 | 28.58 | 32.77 | 0.88 | 1019.20 | 1023.57 | 0.86 |
| November | 10.86 | 20.47 | 1.67 | 27.26 | 32.98 | 0.90 | 1020.55 | 1024.52 | 0.71 |
| December | 7.03 | 15.83 | 1.55 | 26.32 | 33.04 | 0.88 | 1019.53 | 1025.27 | 0.79 |
| All Year | 3.75 | 20.87 | 6.84 | 24.04 | 34.47 | 1.55 | 1014.92 | 1026.33 | 2.32 |
| Source: Fugro 2013 (Appendix E) | | | | | | | | | |

**Tides**

The tidal levels relative to lowest astronomical tide for the Project Area are presented in Table 4.1-2.

**Table 4.1-2. Tidal Levels Relative to Lowest Astronomical Tide**

| Tidal Levels | Lowest Astronomical Tide (m) |
|---|---|
| Highest Still Water Level | 2.98 |
| Highest Astronomical Tide | 1.46 |
| Mean Higher High Water | 1.22 |
| Mean Sea Level | 0.67 |
| Mean Lower Low Water | 0.16 |
| Mean Low Water Spring | 0.06 |
| Lowest Astronomical Tide | 0 |
| Lowest Still Water Level | -1.06 |
| Source: Fugro 2013 (Appendix E) | |

**Meteorology**

The coastal region of the Mid-Atlantic Bight is subject to potential weather hazards year-round, including tropical cyclones and Nor'easters. Nor'easters are macro-scale storm systems along the upper east coast of the United States. They are one of the more frequent weather features encountered in the winter months, though they can develop at any time of the year. These systems vary in size from insignificant to a large circulation that covers most of the western North Atlantic. Winds can reach hurricane force, and seas of 40 feet (12 m) and more have been encountered. While these storms are usually forecasted, they can develop rapidly, particularly off Cape Hatteras over the Gulf Stream. These storms are most frequent and intense between the months of November through March. Between December and February, an average of four to six storms per month develop in the area (NOAA 2013b). Persistent northeasterly winds and long wind distances over water can raise spring tides to record levels, generating high seas in the open ocean.

**Table 4.1-5. Air Temperature and Density**

| Combined Period | Air Temperature (°C) | | | Air Density (kg/m³) | | |
|---|---|---|---|---|---|---|
| (1984-2012) | Min | Max | Std Dev | Min | Max | Std Dev |
| January | -16.70 | 21.20 | 4.91 | 1.18 | 1.36 | 0.03 |
| February | -9.50 | 21.10 | 4.27 | 1.18 | 1.34 | 0.03 |
| March | -6.50 | 24.90 | 4.23 | 1.17 | 1.34 | 0.03 |
| April | 0.00 | 29.10 | 3.86 | 1.16 | 1.28 | 0.02 |
| May | 8.00 | 31.30 | 3.54 | 1.16 | 1.26 | 0.02 |
| June | 12.10 | 32.20 | 2.85 | 1.14 | 1.22 | 0.01 |
| July | 17.20 | 33.10 | 1.99 | 1.14 | 1.21 | 0.01 |
| August | 16.50 | 32.30 | 1.89 | 1.12 | 1.20 | 0.01 |
| September | 12.60 | 30.80 | 2.39 | 1.14 | 1.23 | 0.01 |
| October | 5.90 | 29.30 | 3.44 | 1.15 | 1.28 | 0.02 |
| November | -0.20 | 24.40 | 3.95 | 1.18 | 1.31 | 0.02 |
| December | -8.80 | 23.00 | 4.59 | 1.18 | 1.33 | 0.03 |
| All Year | -16.70 | 33.10 | 7.91 | 1.12 | 1.36 | 0.04 |
| Source: Fugro 2013 (Appendix E) | | | | | | |

#### *4.1.1.2 Potential Impact Producing Factors, Proposed Environmental Protection Measures, and BMPs*

The principle impact producing factor related to meteorological conditions is whether storms or temperatures in the Project Area have the potential to disrupt the construction process or damage any of the Project components once installed. To minimize risk and ensure an efficient and effective construction process, Dominion has selected a construction schedule that takes into consideration both weather and environmental conditions in the Project Area (see Table 3.4-1). Weather will be monitored carefully throughout construction, and will ultimately dictate the sequence and duration of onshore and offshore construction activities to ensure the safety of construction personnel and the integrity of the VOWTAP facilities and equipment.

Dominion has designed the VOWTAP to account for the meteorological conditions within the Project Area. The Alstom Haliade 150 WTG was chosen for the Project based on its suitability for offshore wind sites, with referenced wind speeds of 112 mph (50 m/s over a 10-minute average) and 50-year extreme gusts of 157 mph (70 m/s over a 3-sec average) (see Section 3.2.1). These wind speeds are considerably higher than the maximum wind speeds expected for the Project Area, as shown in Table 4.1-4. Confirmation of the VOWTAP WTG's ability to withstand extreme weather conditions is a goal of this demonstration Project (see Section 1.2)

Standard environmental operating conditions for the WTGs include wind speeds between 6.7 mph and 56 mph (3 m/s and 25 m/s), and air temperatures between 14°F and 104°F (-10°C and +40°C). The WTGs will not operate in extreme weather conditions. If wind speeds exceed 56 mph (25 m/s) over a 10-minute average, or the air temperature reaches less than -4°F (-20°C) or greater than 122°F (50°C), the WTGs will automatically shut down. In addition, the Haliade 150 WTG is equipped with an ice sensor on the top of the nacelle. If the sensor detects the presence of snow, freezing rain, or similar, a warning is issued in the SCADA which can then be used to shut down the WTG if needed. Overall, there is little likelihood that meteorological conditions will impact the Project. However, the need for additional measures/sensors to evaluate and respond to ice or other meteorological conditions at VOWTAP will be further evaluated during final engineering design.

Attachment 1

List of Ørsted Offshore Wind Farms

| Wind Farm | Country | In-service Date | Nameplate Capacity (MW) |
|---|---|---|---|
| Nysted | Denmark | December, 2003 | 166 |
| Middelgrunden | Denmark | March, 2001 | 20 |
| Horns rev 1 | Denmark | July, 2003 | 158 |
| Horns rev 2 | Denmark | January, 2010 | 209 |
| Vindeby | Denmark | 1991 | 4.95 - de-commissioned |
| Anholt | Denmark | July 13, 2013 | 400 |
| Gode Wind 1 | Germany | Q4 2016 | 345 |
| Gode Wind 2 | Germany | Q4 2016 | 263 |
| Borkum Riffgrund 1 | Germany | October 9, 2015 | 312 |
| Walney 1 | UK | March 2011 | 184 |
| Walney 2 | UK | November 2012 | 184 |
| Walney Extension | UK | April 13 2018 | 660 |
| Burbo Bank | UK | October, 2008 | 90 |
| Burbo Banks Extension | UK | May 16 2017 | 259 |
| Racebank | UK | February 1, 2018 | 573 |
| Lincs | UK | October, 2013 | 270 |
| London Array | UK | May 1, 2013 | 630 |
| Westermost Rough | UK | June 29, 2015 | 210 |
| West of Duddon Sands | UK | October 6, 2014 | 389 |
| Barrow | UK | September, 2006 | 90 |
| Gunfleet sands 1 | UK | April, 2010 | 108 |
| Gunfleet Sands 2 | UK | January, 2010 | 64.8 |

Attachment 2

# Hurricane Activity near CVOW Project

# Historical Hurricane Tracks

**National Oceanic and Atmospheric Administration**

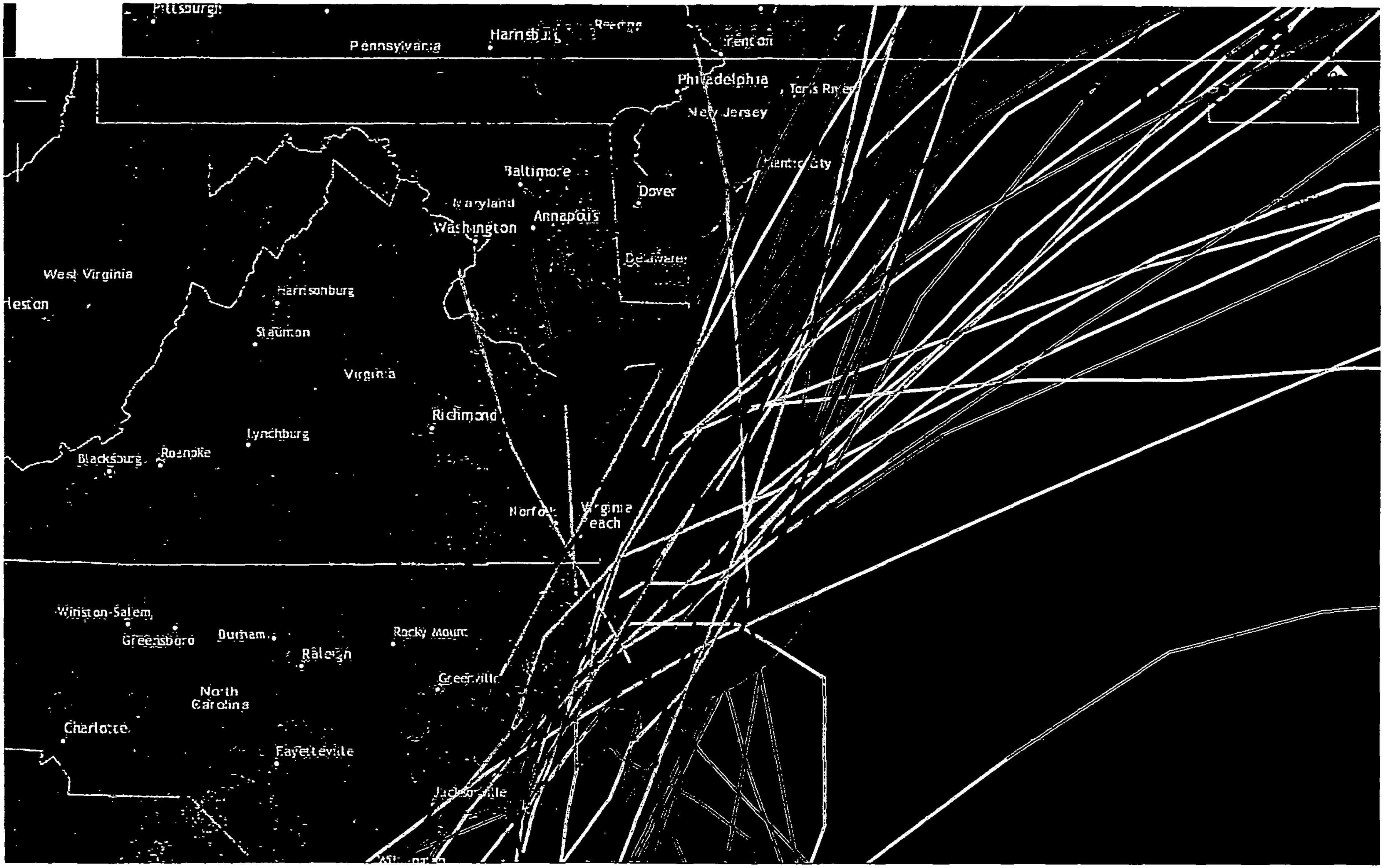
**Summary of Search**

Location: 36.9,-75.5
Buffer: 160900 Meters (86 Nautical Miles)

**Search Refined By**

Categories : H5,H4,H3,H2,H1

| Storm Name | Date |
|---|---|
| UNNAMED 1858 | Sep 14, 1858 to Sep 17, 1858 |
| UNNAMED 1861 | Nov 01, 1861 to Nov 03, 1861 |
| UNNAMED 1879 | Aug 13, 1879 to Aug 20, 1879 |
| UNNAMED 1880 | Sep 06, 1880 to Sep 11, 1880 |
| UNNAMED 1885 | Aug 21, 1885 to Aug 28, 1885 |
| UNNAMED 1894 | Sep 18, 1894 to Oct 01, 1894 |
| UNNAMED 1894 | Oct 01, 1894 to Oct 12, 1894 |
| UNNAMED 1899 | Aug 03, 1899 to Sep 04, 1899 |
| UNNAMED 1901 | Jul 04, 1901 to Jul 13, 1901 |
| UNNAMED 1903 | Sep 12, 1903 to Sep 17, 1903 |
| UNNAMED 1908 | May 24, 1908 to May 31, 1908 |
| UNNAMED 1924 | Aug 16, 1924 to Aug 28, 1924 |
| UNNAMED 1933 | Aug 13, 1933 to Aug 28, 1933 |
| UNNAMED 1933 | Sep 08, 1933 to Sep 22, 1933 |
| UNNAMED 1934 | Sep 05, 1934 to Sep 10, 1934 |
| UNNAMED 1935 | Aug 29, 1935 to Sep 10, 1935 |
| UNNAMED 1936 | Sep 08, 1936 to Sep 25, 1936 |
| UNNAMED 1944 | Sep 09, 1944 to Sep 16, 1944 |
| UNNAMED 1945 | Jun 20, 1945 to Jul 04, 1945 |
| BARBARA 1953 | Aug 11, 1953 to Aug 16, 1953 |
| CAROL 1954 | Aug 25, 1954 to Sep 01, 1954 |
| CONNIE 1955 | Aug 03, 1955 to Aug 15, 1955 |
| IONE 1955 | Sep 10, 1955 to Sep 27, 1955 |
| DONNA 1960 | Aug 29, 1960 to Sep 14, 1960 |
| DORIA 1967 | Sep 08, 1967 to Sep 21, 1967 |
| BELLE 1976 | Aug 06, 1976 to Aug 10, 1976 |
| GLORIA 1985 | Sep 16, 1985 to Oct 02, 1985 |
| CHARLEY 1986 | Aug 13, 1986 to Aug 30, 1986 |
| BOB 1991 | Aug 16, 1991 to Aug 29, 1991 |
| EMILY 1993 | Aug 22, 1993 to Sep 06, 1993 |
| BONNIE 1998 | Aug 19, 1998 to Aug 31, 1998 |
| FLOYD 1999 | Sep 07, 1999 to Sep 19, 1999 |
| IRENE 2011 | Aug 21, 2011 to Aug 30, 2011 |
| ARTHUR 2014 | Jun 28, 2014 to Jul 09, 2014 |

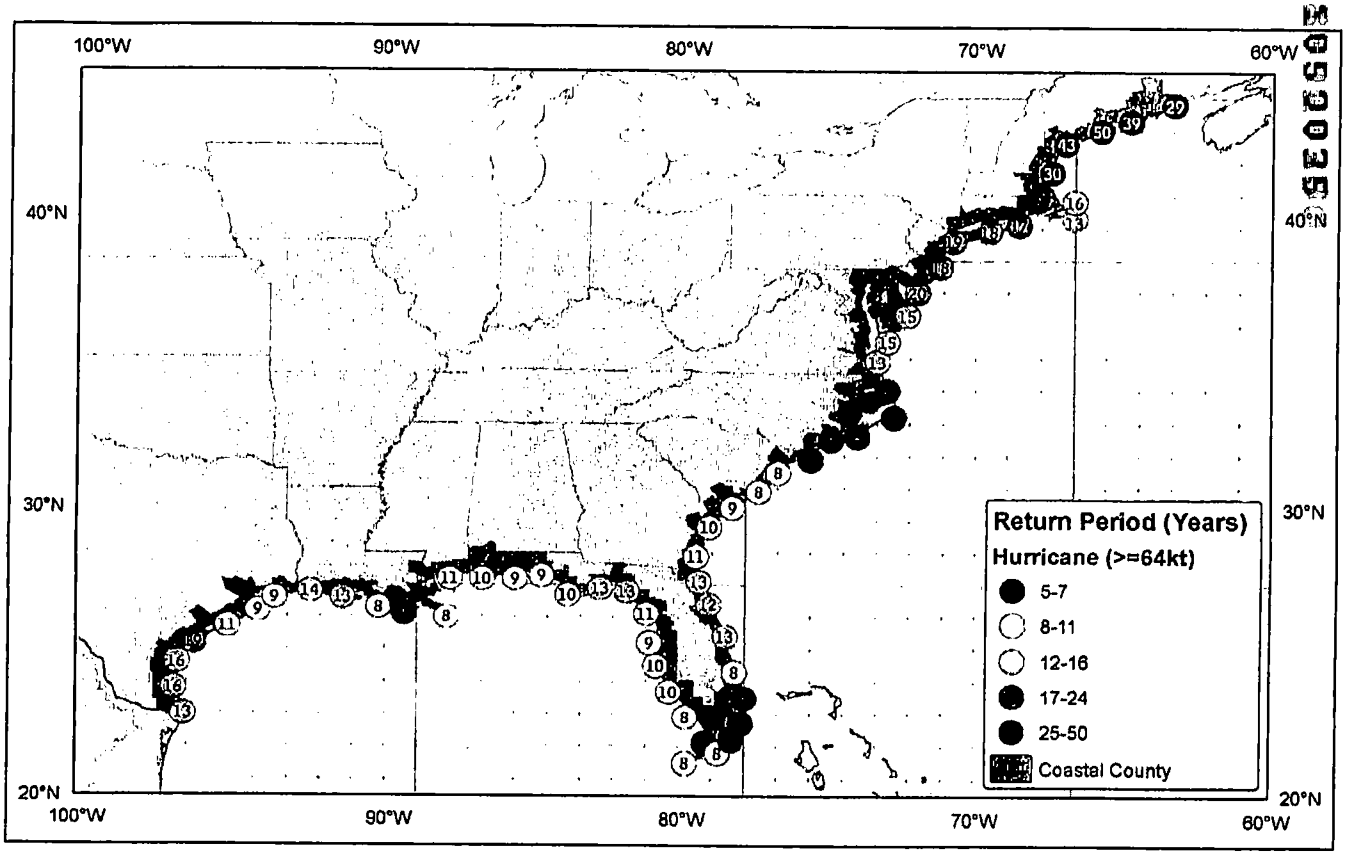



**Pos:** 39.36 , -78.93 **Search Center:** 36.90 , -75.50

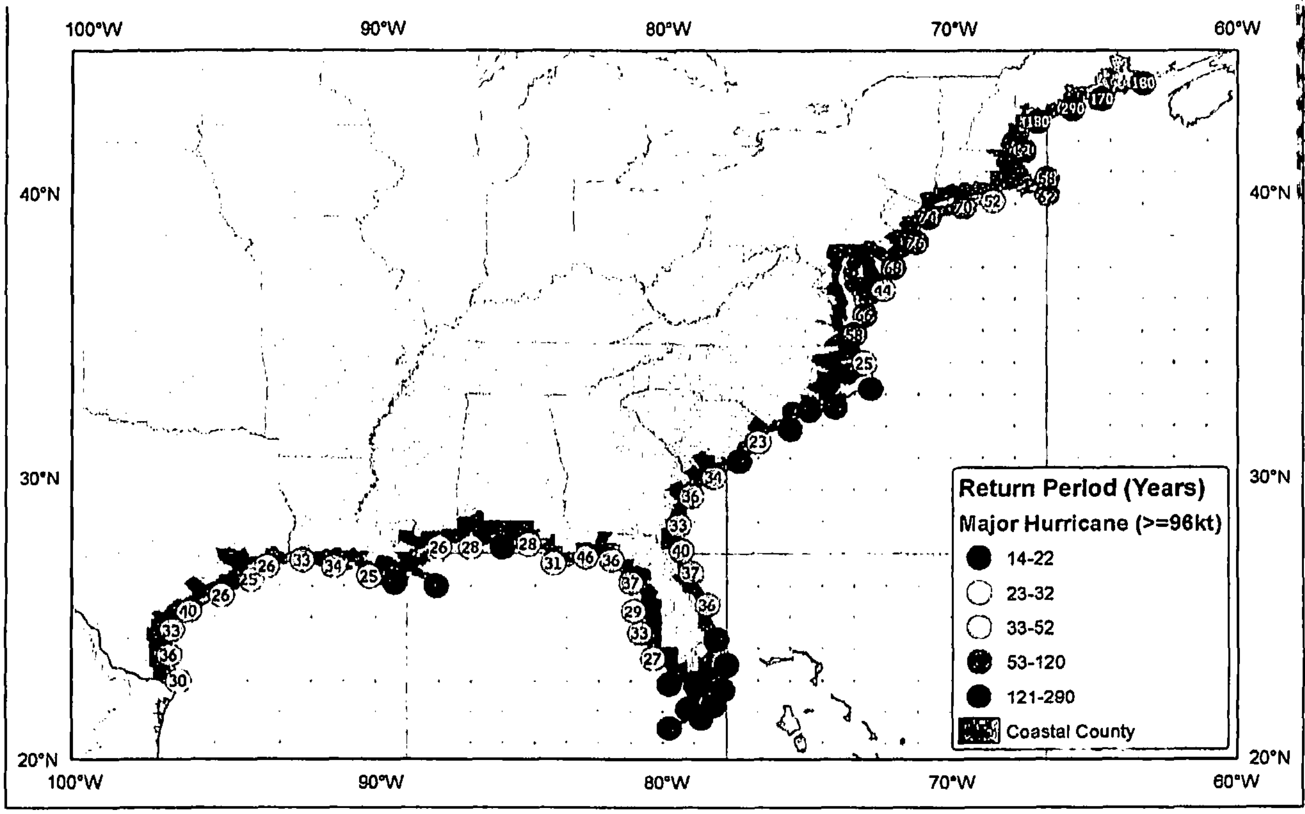
**View Legend**

Attachment 3

Hurricane Return Periods




Hurricane - Category 1 or higher

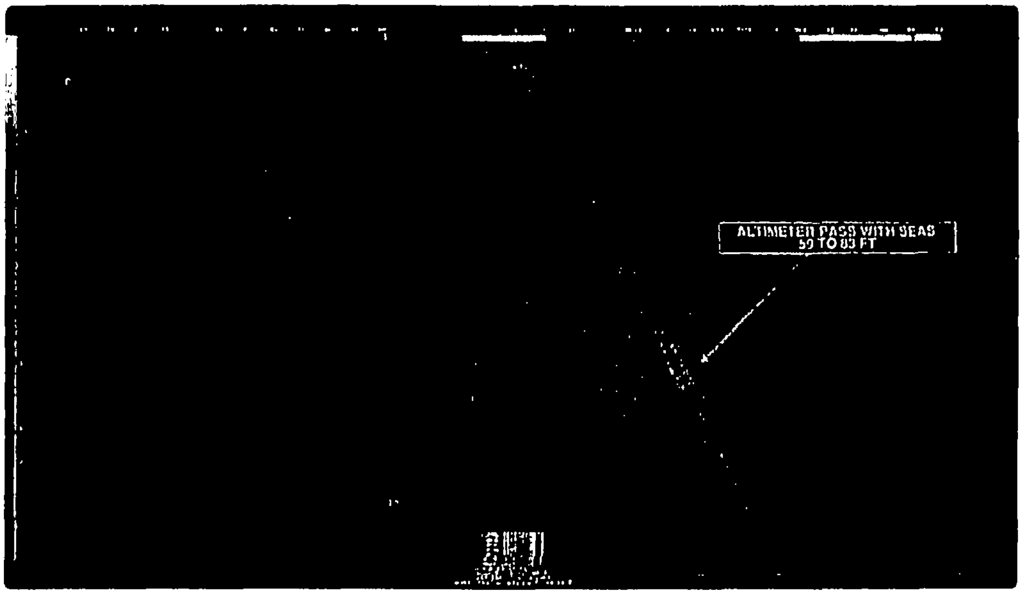



Hurricane - Category 3 or higher

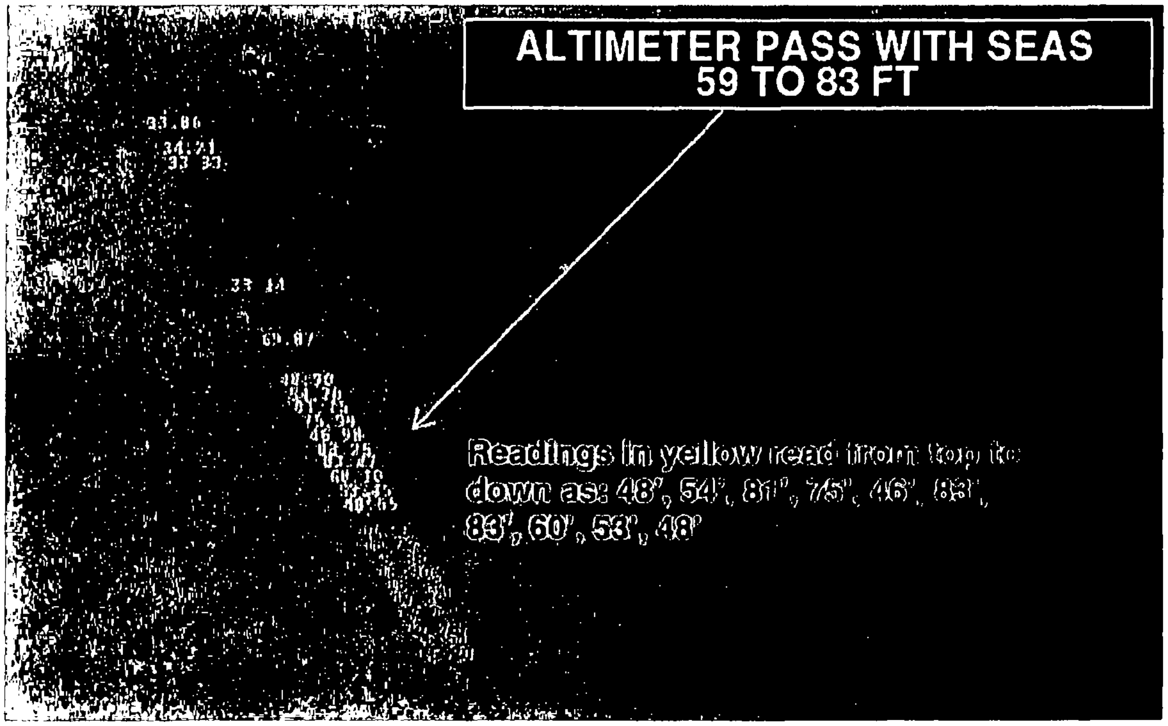
**NHC_TAFB**
@NHC_TAFB

Follow

Wave heights to 83 ft were measured early this morning under the NE quadrant of Hurricane Florence. These enormous waves are produced by being trapped along with very strong winds moving in the same direction the storm's motion. #HurricaneFlorence hurricanes.gov/marine




10:23 AM - 12 Sep 2018




Twitter Picture (Zoomed In)

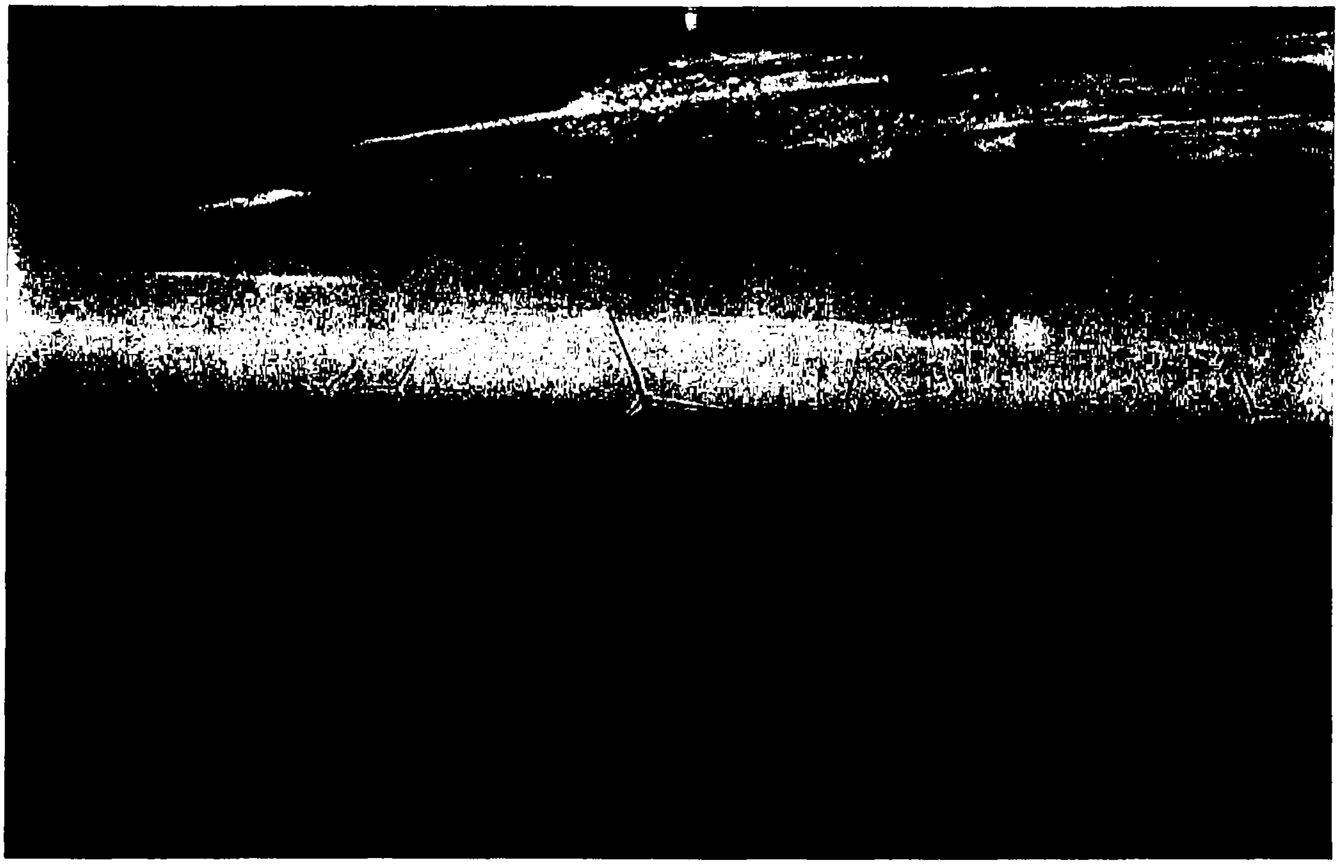
# Attachment 5

## Windpower Engineering and Development Article

# World's biggest offshore wind farm opens

**By Michelle Froese | September 12, 2018**

The world's largest operational offshore wind farm, Walney Extension, officially opened this month. The project is owned by Ørsted (50%) and its partners PFA and PKA (25% each). It is the first project to use wind turbines from two different manufacturers.



*Walney Extension Offshore Wind Farm uses more than 200km of cables to connect the turbines offshore to the national grid onshore and features two offshore substations, each weighing 4,000 tonnes. The jacket foundation height is 50m, and topside height is 18.5m.*

The 659-MW project leapfrogs London Array to become the world's largest operational wind farm. Walney Extension's 87 wind turbines can generate enough green energy to power almost 600,000 UK homes. Covering an area of 145km$^2$ in the Irish Sea, the project becomes Ørsted's 11$^{th}$ operational offshore wind farm in the UK.

Using the latest technology from two of the world's leading turbine manufacturers, Walney Extension features 40 MHI Vestas 8-MW wind turbines and a further 47 Siemens Gamesa 7-MW wind turbines.

The completion of Walney Extension brings Ørsted's total capacity operating out of Barrow up to 1.5GW. Ørsted's ongoing operations and maintenance activities will support more than 250 direct jobs in the region.

"The UK is the global leader in offshore wind and Walney Extension showcases the industry's incredible success story," said Matthew Wright, Ørsted UK Managing Director. "The project, completed on time and within budget, also marks another important step towards Ørsted's vision of a world that runs entirely on green energy. The North-West region plays an important role in our UK offshore wind operations and our aim is to make a lasting and positive impact here."

He added: "We want to ensure that the local community becomes an integral part of the renewable energy revolution that's happening along its coastline."

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Ørsted & Siemens Gamesa sign first U.S. offshore turbine supplier...

Dominion Energy & Ørsted advance Virginia offshore wind development

Offshore wind industry heading out to deeper water

Global offshore wind market expected to reach $50.45 billion by...

ABOUT THE AUTHOR