## Cape Wind 1-Hour SO2 and NO2 Modeling

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Summary

Region 1 EPA has proposed to issue a permit to construct an air pollution source under Section 328 of the Clean Air Act and Massachusetts regulation 310 CMR 7.02 "Plan Approval and Emission Limitations". The state regulation requires that no source be permitted which would violate a National Ambient Air Quality Standard (NAAQS) and to that end allows the reviewing agency to require a demonstration by air quality modeling that construction of the source will not violate any NAAQS. In proposing an air permit for Cape Wind Region 1 relied on air quality modeling prepared in 2008 for the MMS EIS to conclude that the construction would not violate any NAAQS and that no further modeling should be required. (See "Draft Final Cape Wind 6-4-2010.doc"). However, one commentor on the draft asked whether the modeling had examined compliance with the 1-hour SO2 and NO2 NAAQS, which only came into effect in the last year. The modeling had not; and after a review of the 2008 modeling for MMS relative to the level of the new NAAQS (100 ppb for 1-hour NO2, 75 for 1-hour SO2) Region 1 EPA concluded that Cape Wind would need to model against the two new NAAQS before a construction permit could be issued. The table below shows the results from the modeling ESS has submitted to Region 1 in response:


| Air Quality Standard/ Source Modelled | Modelled Impact (ppb)* | Background (ppb) | Total (ppb) | Remarks |
|---|---|---|---|---|
| **75 ppb 1-Hour SO2** | | 23 | | Background 2007-2009 3-year average annual 99%-tile highest daily maximum 1-hour SO2 observed on Long Island, Boston Harbor.** |
| Construction Horseshoe Shoal - overwater | 0.3 | | **24** | Modelled for the 4th highest daily maximum 1-hour. *Check output - receptor W2913500* |
| - breach shore | | | | |
| Cable laying - overwater | 1.4 | | **25** | Used the highest 1-hour SO2 from the model. |
| Vessel traffic - overwater | 0.6 | | **24** | Used the highest 1-hour SO2 from the model. |
| **100 ppb 1-Hour NO2** | | 47 | | Background 2007-2009 3-year average annual highest 1-hour NO2 observed at Consentino School, Haverhill.** |
| Construction Horseshoe Shoal - overwater | 44 | | **91** | Modelled for the 8th highest daily maximum 1-hour *Check output - receptor W281700.* |
| - breach shore | | | | |
| Cable laying - overwater | <53 | | **<100** | No greater 1-hour impact can occur at a receptor on 7 or more days. Therefore with cable installation as planned adding background to the model will yield no violations. |
| Vessel traffic - overwater | 23 | | **70** | Highest 8th high at any receptor ~ 98 %-tile daily maximum 1-hour. |

* As now formulated EPA's guideline models yield concentration impacts in units of of micrograms per cubic meter (µg/m³, below) and do not yield results in the dimensionless levels of parts per volume of the NAAQS for gaseous air pollutants (i.e., O3, NO2, SO2, and CO). In the table above modelled concentrations at ambient conditions of 25º C. and 760 mm were converted as:

1 ppb SO2 = 2.623 µg/m³ and 1 ppb NO2 = 1.884 µg/m³

These estimates originate at on line calculator at http://www.lenntech.com/calculators/ppm/converter-parts-per-million.htm

** Closer monitors have recorded background air quality data than at the Haverhill and Boston locations but length of record, data capture, and nature of local emission sources also matter to the selection of background air quality data. In this case, for example, the closer SO2 monitor in Fall River was not selected because the Brayton Point generating Station has a large local impact which would be unrepresentative of most of the Cape. On the other hand NO2 data from the closer Fox Bottom monitor in Truro was passed over for the Haverhill site with its shorter but more recent record, better data capture, and clearly higher concentrations.

Although ESS used an Appendix W 'guideline' model to develop the tabulated information, the bulleted source types modelled were atypical of the stationary point sources for which Appendix W models are normally employed:

Moving sources (i.e., cable-laying and vessels),

Temporary construction activities rather than constructed operational point sources - Cape Wind's operational emissions will be nil, and

Spatially dispersed activities (i.e., WTG emplacement and vessel traffic).

Notwithstanding the remarks below conservative aspects of the modeling remain - e.g., use of the ARM screening technique which will overestimate NO2 impacts , or representation of dispersed or moving temporary - sporadic - emission sources as point sources. Given the poor fit of Appendix W to modeling Cape Wind's construction, ESS' results should be accepted.

Overview of ESS' Modeling

The NO2 1-hour would be approached more closely than 1- hour SO2 NAAQS so the description of ESS' OCD modeling and EPA comments (in *italics*) will focus on the NO2.

So far three submittals were needed to model compliance with the 1-hour NO2 NAAQS. The submittals share these features:

All depend on the Appendix W ('Guideline') Offshore and Coastal Dispersion (OCD) Model: Air pollutant dispersion in a marine environment differs markedly from pollutant dispersal overland. The model evaluates dispersion in such a setting and also estimates pollutant concentrations in shoreline fumigations which occur when a marine plume passes into an overland boundary layer.

All NO2 concentrations rely on the Ambient Ratio Method (ARM) with a factor of 0.75 to discount NOx emissions (expressed as NO2) to NO2 concentration at each receptor.

The needed meteorology inputs comprised one year of overwater meteorological of 'on-site' surface data from Horseshoe Shoals and concurrent surface water temperature from Buoy # 44018.

Concurrent overland surface meteorology came from Nantucket and upper air data from Chatham. ESS postulated a 500 m. overwater mixing height as was used for 2008 modeling for MMS. *Much lower mixing heights are not unusual overwater and can produce higher air pollutant concentrations. At Ventura and Pismo Beach on the Pacific where the OCD model was validated overwater mixing heights lower than 100 m. occurred about half the time, but at Cameron, site of another validation, such low mixing heights were much less frequent. However, Cameron is on the Gulf which has much*

*higher average water temperatures than would be expected in Nantucket Sound. The waters off California, on the other hand, are quite cold.*

All pollutant sources or construction activities were aggregated and modelled as point sources as follows:

| Construction Activity - Source | Emission rate | Bldg.Ht. | Stack Ht. | Exit Temp. | Exit Diam. | Exit Velo. | Grnd.Level Elevation | Bldg.Width |
|---|---|---|---|---|---|---|---|---|
| | (g NO2/s) | (m.) | (m.) | (deg.K) | (m.) | (m/s) | (m.) | (m.) |
| Each of 14 WTGs | 2.12 | 18.3 | 10.0 | 300 | 1.0 | 5.0 | 18.3 | 91.75 |
| Electric Service Platform(ESP) | 8.21 | 18.3 | 10.0 | 300 | 1.0 | 5.0 | 18.3 | 91.75 |
| 6000 Hp vessel ("sea route") | 0.492 | 9.75 | 10.0 | 300 | 1.0 | 5.0 | 9.75 | 91.75 |
| Cable installation | 5.49 | 9.75 | 10.0 | 300 | 1.0 | 5.0 | 9.75 | 91.75 |

Each WTG point source represents hydraulic ram, crane, and vessel stabilization work activity on one of 14 inner array cables. The "Cable installation" point represents emissions from a 400 Hp crane barge, its 1500 Hp tug, and a 4000 Hp anchoring tug.

*It should be noted that OCD input files set the model calculations to ignore transient plume rise and stack tip downwash. Also note in the table above (and the modeling files) ground level elevation has been set to the 'building'- - vessel in this case? - -height. Page 3-4 of the OCD User's Guide states that ground level elevation should be set at the building height for stilted structures like platforms such as the ESP but not for vessels or others in contact with the water.*

Description and Remarks on Individual Modeling Analyses

The 14 WTGs and ESP, "sea route", and "cable installation" differ in character and must be modeled differently to show compliance with the new 1-hour NO2 NAAQS:

Modeling the construction activity emissions for the 14 WTG and ESP points which were stationary and longer duration operations was most direct. ESS used a radial grid of receptors sufficiently numerous to require three model runs: The grid origin positioned at the ESP location (appears from figures in the EIS to have coordinates of 70º 20' 00" west and 41º 30' 35" north) was also used to locate the 14 WTG/inner grid cable point sources. No receptors were placed within the Horseshoe Shoal wind farm or within 100 m. of any construction or support site - i.e., the sea route and the cable installation path. Public traffic should not be expected this close to the construction. The highest impacts occurred overwater but the model runs also yielded the locations of highest shoreline concentration.

The vessel used to model traffic associated with construction of the facility within 25 miles of the ESP was assumed to travel 15 km every hour or about 500 m. every two minutes. Vessel concentrations were calculated over a 1 km. Cartesian grid with receptors at 100 m. spacings. The vessel was then modeled for the amount of pollutant it could release while in the grid - that is at one thirtieth of the hourly emission rate in grams per second.

*To reach a conclusion with this approach one must assume there will be no interaction among adjacent 500 m. vessel spacings and also that an hour's average total pollutant discharge will have the same air quality impact whether spread over the entire hour or confined to a few minutes. The nonguideline Inpuff model might be used test the first assumption but probably not the second.*

Shoreline impacts could not be modelled because the position of the cable-laying operation relative to

the shore was always changing.

"Cable installation" is a transient (300 feet per hour) operation and conducted in two passes. Modeling considered three Cartesian grids centered on the operation: one with 100 m. resolution to 1 km, another with 200 m. spacing from 200 m. to 2.0 km, and the third with 250 m resolution from 250 m. to 2.5 km. ESS examined all the cases in which 1-hour impacts combined with background NO2 could exceed the level of the standard - 100 ppb - and found the furthest such receptor would be 1900 meters from the cable laying activity. From this and the activity's 300 foot per hour movement ESS 3.4 days would be the most any receptor could exceed the level of the standard:

2 X 3800 m / (300 ft/hr X 0.3048 m/ft) = 41.6 hr. or 1.7 days -

And the second pass doubles this.

A violation of the standard would require eight separate days with concentrations above 100 ppb NO2 at the same receptor.

Shoreline impacts could not be modelled because the position of the vessel relative to the shoreline was always changing.

*VERIFIED THAT: The spreadsheet shows cable-laying NO2 impacts of interest ranging down from 447 ppb at 100 m. distance (receptor CB0021 on the 1 km grid) to 53 at 1904 m. (receptor CB0365 on the 2.5 km grid)*

Extract FY1985 Model CH on STP adjust.pdf

Exhibits

Draft Final Cape Wind 6-4-2010.doc

ESS modeling furnished to Region 1 for Cape Wind:

ESS 11-4-2010.doc

ESS 11-22-2010.doc

ESS 11-30-2010.doc

ESS 12-3-2010.doc

ESS 12-7-2010.doc