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September 23, 2009

David B. Conroy
Manager, Air Programs Branch
United States Environmental Protection Agency
Region 1 Headquarters
One Congress Street, Suite 1100
Boston, MA 02114-2023

Re: Revised Emissions Estimates
Outer Continental Shelf Air Regulations Permit Application
Cape Wind Energy Project

Dear Mr. Conroy:

A Permit Application for the proposed Cape Wind Offshore Renewable Energy Project (the Project) was submitted by ESS Group, Inc. (ESS) on December 17, 2008 to fulfill the regulatory requirements of the United States Environmental Protection Agency's (EPA) Outer Continental Shelf (OCS) Air Regulations, codified under Title 40 Code of Federal Regulations, Part 55 (40 CFR § 55). The Project, as proposed by Cape Wind Associates, LLC (Cape Wind), will be located at Horseshoe Shoal, Nantucket Sound, Massachusetts, and will utilize offshore wind energy as its renewable fuel to generate electricity for sale.

ESS has prepared revised emissions estimates for the equipment associated with the construction and operation of the Project. The emission estimates were revised at the direction of the EPA and the Minerals Management Service (MMS) during conference calls held on July 16 and July 29, 2009. The emissions estimated were revised in accordance with the EPA's "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories – Final Report", dated April 2009 (EPA Port Study).

Attached is a memorandum to EPA and MMS, dated July 30, 2009, which details the specific revisions made to the emissions estimates, including revised versions of the spreadsheets used to estimate the emissions for each phase of the project subject to OCS permitting, which were included in Appendix A of the Project's OCS Permit Application. Also attached is a revised version of Table 1-1 from the Project's OCS Permit Application. It summarizes the Project's revised potential emissions during preconstruction, construction, and operation from vessels in transit and from stationary sources that will occur inside 25 miles of the Project site. Table 1-1 also includes revised proposed annual emission limits for Phase 1 (preconstruction and construction) and Phase 2 (operation) of the Project. Finally, Table 1-1 summarizes the revised emission offset requirements for Phase 1 of the Project.

The revised emission estimates for the phases of the Cape Wind Energy Project subject to OCS permitting have been done on a consistent basis, at the direction of EPA and MMS, using the most up to date EPA guidance for such estimations. If you have any questions regarding this submittal, do not hesitate to call me at (781) 489-1149.

Sincerely,

ESS GROUP, INC.

Michael E. Feinblatt
Project Manager

Attachments

C: Ida McDonnell, EPA
Karen Regas, MassDEP
Craig Olmsted, Cape Wind Associates
Rachel Pachter, Cape Wind Associates
Chris Rein, ESS
Terry Orr, ESS

Table 1-1
Cape Wind Energy Project
Project Emissions Subject to OCS Permitting - Revised July 2009

PHASE 1 - PRECONSTRUCTION & CONSTRUCTION								
Potential Emissions	Total Emissions (Tons)							
	NO_X	VOC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPS
Preconstruction Potential Emissions - Total	6.0	0.4	0.0	4.1	0.3	0.3	366	0.0
Inside 25 Miles - Transit	5.8	0.3	0.0	3.9	0.3	0.3	325	0.0
Inside 25 Miles - Stationary Sources	0.2	0.1	0.0	0.2	0.0	0.0	41	0.0
Construction Potential Emissions - Total	187.2	7.9	2.1	24.6	7.0	6.5	10,510	0.1
Inside 25 Miles - Transit	172.6	6.3	2.1	16.0	6.5	6.0	8,778	0.1
Inside 25 Miles - Stationary Sources	14.6	1.6	0.0	8.6	0.5	0.5	1,732	0.0
Potential Emissions - Total	193.2	8.3	2.1	28.7	7.3	6.8	10,876	0.1
Inside 25 Miles - Transit	178.4	6.6	2.1	19.9	6.8	6.3	9,103	0.1
Inside 25 Miles - Stationary Sources	14.8	1.7	0.0	8.8	0.5	0.5	1,773	0.0
Proposed Annual Emission Limits	Annual Emissions (Tons Per Year)							
	NO_X	VOC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPS
Phase 1 - Year 1 (Preconstruction + 70% Construction)	137.04	5.93	1.47	21.32	5.20	4.85	7,723	0.07
Phase 1 - Year 2 (30% Construction)	56.16	2.37	0.63	7.38	2.10	1.95	3,153	0.03
Emissions Offsets	Total ERCs (Tons Per Year)							
	NO_X	VOC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPS
Phase 1 - Year 1 Emissions Offsets (1.26:1 Offset Ratio)	173	0	0	0	0	0	0	0
Phase 1 - Year 2 Emissions Offsets (1.26:1 Offset Ratio)	71	0	0	0	0	0	0	0

PHASE 2 - OPERATION								
Potential Emissions	Annual Emissions (Tons Per Year)							
	NO_X	VOC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPS
Potential Emissions - Total	13.0	0.8	0.0	9.6	0.7	0.6	688	0.0
Inside 25 Miles - Transit	13.0	0.8	0.0	9.6	0.7	0.6	688	0.0
Inside 25 Miles - Stationary Sources	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0
Proposed Annual Emission Limits (Note 7)	Annual Emissions (Tons Per Year)							
	NO_X	VOC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPS
Phase 2 - 12-month rolling total	49.9	3.1	0.0	36.8	2.7	2.3	2,641	0.0

Notes

1) Project emissions have been estimated using conservative equipment usage assumptions and EPA approved emission factors. The operating hours of all equipment used will be metered to track actual emissions.

2) The NO_x, VOC, SO_2, PM_{10}, $PM_{2.5}$ and CO_2 emissions from all vessels equipped with diesel engines have been estimated at the direction of the EPA and MMS using the appropriate emission factors and load factors from EPA's "Current Methodologies and Best Practices in Preparing Port Emission Inventories, Final Report", April 2009. The HAP emissions from these vessels have been estimated using AP-42 emission factors for diesel engines. The total engine power output estimated for each vessel has been increased by 10% to account for emissions from auxiliary engines.

3) The NO_X, CO, PM_{10}, and $PM_{2.5}$ emissions from all of the stationary nonroad diesel-fired engines to be used for the project have been estimated using the Tier 2 (or Tier 3 if available) emission standards from 40 CFR 89.112, Table 1 for each engine size. Additional CO and PM emissions control will be achieved through the use of diesel oxidation catalysts (DOC) on all project stationary source diesel engines.

4) The VOC, SO_2, CO_2, and HAP emissions from all of the stationary nonroad diesel-fired engines to be used for the project have been estimated using the appropriate emission factors from EPA's AP-42, "Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources". Additional VOC and HAP emissions control will be achieved through the use of DOC on all project stationary source diesel engines.

5) The SO_2 emissions from all of the diesel-fired non-road engines to be used for the project have been estimated assuming a diesel fuel sulfur content of 15 ppm, which will be the fuel sulfur content standard for all nonroad diesel fuel beginning June 1, 2010. The SO_2 emissions from all diesel-fired marine engines used for preconstruction and construction activities have been estimated assuming a diesel fuel sulfur content of 500 ppm, which is the current marine diesel fuel sulfur content standard. The SO_2 emissions from all diesel-fired marine engines used during operation have been estimated assuming a diesel fuel sulfur content of 15 ppm, which will be the marine diesel fuel sulfur content standard beginning June 1, 2012. The EPA's non-road and marine diesel sulfur content standards can be found at 40 CFR 80.510.

6) The emissions from the zodiac boats to be used for the project have been estimated using worst-case emission factors from the EPA document: "Exhaust Emission Factors for Nonroad Engine Modeling: Spark-Ignition", EPA420-R-05-019, Table 10.

7) The Project will be permitted for up to 49.9 tons per year of NOx emissions during Phase 2, to include a contingency for unexpected equipment maintenance and/or repair activities, while remaining a minor source of emissions. The proposed permit limits of the other pollutants have been determined by scaling their individual potential emissions by the ratio of the permitted versus potential NOx emissions.

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MEMORANDUM

TO: Bob McConnell, EPA
Dirk Herkhof, MMS

DATE: July 30, 2009

FROM: Mike Feinblatt

SUBJECT: Revised Cape Wind Emissions Estimates – Methodology

PROJECT NO.: E159-504.1

COPY TO: Chris Rein, ESS

Rachel Pachter & Craig Olmsted, Cape Wind

ESS Group, Inc. (ESS) has prepared revised emissions estimates for the equipment associated with the construction and operation of the Cape Wind Energy Project. The emission estimates were revised at the direction of the U.S. Environmental Protection Agency (EPA) and the Minerals Management Service (MMS) during the July 16 and July 29, 2009 conference calls regarding the June 2009 emissions estimates for the project.

The emissions from all diesel powered vessels associated with the project have been estimated in accordance with the EPA's "Current Methodologies in Preparing Mobile Source Port-Related Emissions Inventories – Final Report", April 2009. The emissions estimates have been further revised to address the specific comments made by EPA and MMS during the July 16 and July 29 calls.

The following sections describe the specific revisions made to the June 2009 emissions estimates, at the direction of EPA and MMS.

Load Factors

In the June 2009 emissions estimates, reference EPA load factors from Table 3-3 of the EPA Port Study were used for all harbor craft associated with the project. The June 2009 emission estimates utilized a load factor of 0.83 for all ocean going vessels except for tow tugs. A load factor of 0.17 was utilized for ocean going tow tugs, as determined using the Propeller Law.

At the direction of EPA and MMS, Table 3-4 of the EPA Port Study, which presents actual load factors for specified vessels from an emissions inventory conducted at the Port of Los Angeles and Long Beach, has been used for the revised emissions estimates. Table 3-4 recommends a load factor of 0.68 for ocean tugs, which is significantly higher than the 0.17 load factor which had previously been determined using the Propeller Law. This difference is reflective of the fact that a significant percentage of the power of the ocean tug propulsion engine will actually be used to push or pull another vessel, and not for propulsion.

Based on the guidance provided by the EPA Port Study, and at the further direction of EPA and MMS, load factors have been revised and applied to each of the project vessels as follows:

Vessel Category	Engine Size	Load Factor
OG Vessels	>3,000 kW	0.83
Crane Barges	>3,000 kW	0.83

Ocean Tugs	>3,000 kW	0.68
Crew Boats	<3,000 kW	0.45
Work Boats	<3,000 kW	0.43
Crane Barges	<3,000 kW	0.43
Tugboats	<3,000 kW	0.31

Auxiliary Engine Emissions

Previous project vessel emissions estimates have not considered emissions from auxiliary engines, because of the uncertainty in the actual vessels to be used, and the level of conservatism built into the emissions estimates. At the direction of EPA and MMS, the project emission estimates have been revised to include the potential for emissions from auxiliary engines on project vessels.

Table 3-10 of the EPA Port Study presents the average number of engines, engine power, and annual operating hours for the main engines and auxiliary engines for different vessel types determined from the Port of Los Angeles, Long Beach, and Puget Sound emissions inventories. According to Table 3-10, the auxiliary engine annual kilowatt-hour power output (number of engines x engine power x annual operating hours) represented approximately 7.9% of the annual main engine power output for work boats, and approximately 7.3%, 5.4%, and 6.8% of the annual main engine power output for assist tugs, harbor tugs, and ocean tugs, respectively.

Based on the information provided in the EPA Port Study, and at the direction of EPA and MMS, each of the project vessel engine kilowatt-hour power outputs, and resulting emissions estimates have been increased by 10%, to conservatively account for emissions from the operation of auxiliary engines on the vessels during project activities.

Trip Durations

Previous project vessel emissions estimates have very conservatively estimated the duration of vessel trips to and from the 25-mile boundary, and from the 25-mile boundary to the project site. At the direction of EPA and MMS, the estimates of the duration of such project vessel transit trips have been revised assuming a travel speed of 8 knots, as follows:

Transit Trip	Total Distance	Trip Duration
Quonset Point to/from 25-mile boundary	34.9 miles	34.9/8 = 4.3625 hrs
25-mile boundary to/from site	25 miles	25/8 = 3.125 hrs
Quonset Point to/from RI Border	19 miles	19/8 = 2.375 hrs
MA Border to/from 25-mile boundary	7.3 miles	7.3/8 = 0.9125 hrs

Diesel Fuel Sulfur Content

In the previous emissions estimates, the sulfur content of the diesel fuel for all vessels was assumed to be 500 ppm, which is the current sulfur content standard for marine diesel fuel. The sulfur content standard for marine diesel fuel will become 15 ppm beginning June 1, 2012, in accordance with 40 CFR 80.510(c). For this purpose, it is conservatively estimated that construction will be completed by that date; therefore the assumed sulfur content for marine diesel fuel remains 500 ppm for preconstruction and construction vessels. However, in anticipation of the 2012 change in the marine diesel sulfur standard, the assumed sulfur content for marine diesel fuel has been revised to 15 ppm for vessels to be used during operation.

The current sulfur content standard for nonroad diesel fuel is 500 ppm. The sulfur content standard for nonroad diesel fuel will become 15 ppm beginning June 1, 2010, in accordance with 40 CFR 80.510(b). Since construction activities will not be completed by June 1, 2010, the assumed sulfur content for nonroad diesel fuel has been revised to 15 ppm for all stationary sources equipped with diesel engines associated with the project.

Conclusion

Attached are the revised versions of the individual spreadsheets that were used to estimate the emissions from the project based on additional direction from MMS and EPA during the July 16 and July 29 conference calls. Also attached is a table summarizing the revised estimated project emissions for all phases and activities. These revised emission estimates for each of the phases and activities associated with the Cape Wind Energy Project have been done on a consistent basis, at the direction of EPA and MMS, using the most up to date EPA guidance for such estimations.

Please review the attached revised estimation of the project emissions, which should now be considered final. Please call me at (781) 489-1149 if you have any questions. Thank you for your assistance in this effort.

Cape Wind Energy Project
Estimated Project Emissions - Revised July 2009

Preconstruction & Construction Emissions	Total Emissions (Tons)							
	NO_X	VOC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPS
Total	497.1	28.0	8.1	133.2	20.2	18.1	26,870	0.3
OCS Permit Emissions	193.2	8.3	2.1	28.7	7.3	6.8	10,876	0.1
Pre-Construction - Inside 25 Miles - Transit	5.8	0.3	0.0	3.9	0.3	0.3	325	0.0
Pre-Construction - Inside 25 Miles - Stationary Sources	0.2	0.1	0.0	0.2	0.0	0.0	41	0.0
Construction - Inside 25 Miles - Transit	172.6	6.3	2.1	16.0	6.5	6.0	8,778	0.1
Construction - Inside 25 Miles - Stationary Sources	14.6	1.6	0.0	8.6	0.5	0.5	1,732	0.0
Year 1 - Preconstruction + 70% Construction	137.04	5.93	1.47	21.32	5.20	4.85	7,723	0.07
Year 2 - 30% Construction	56.16	2.37	0.63	7.38	2.10	1.95	3,153	0.03
Conformity Emissions	259.7	18.0	5.4	100.7	11.3	9.8	13,827	0.1
Construction - Onshore Activities - RI	101.3	4.7	1.2	20.1	3.8	3.6	5,511	0.1
Construction - Onshore Activities - MA	23.0	8.2	2.1	69.4	2.7	1.8	1,689	0.0
Construction - Outside 25 Miles - Transit in RI Waters	97.8	3.7	1.5	8.1	3.5	3.2	4,788	0.0
Construction - Outside 25 Miles - Transit in MA Waters	37.6	1.4	0.6	3.1	1.3	1.2	1,839	0.0
Year 1 - 70% Construction	181.82	12.59	3.78	70.47	7.89	6.83	9,679	0.07
Year 2 - 30% Construction	77.92	5.39	1.62	30.20	3.38	2.93	4,148	0.03
Other Emissions								
Construction - Outside 25 Miles - Transit in Federal Waters	44.2	1.7	0.6	3.8	1.6	1.5	2,167	0.1

Construction Phase Emissions Offsets Required	Total ERCs (Tons Per Year)							
	NO_X	VOC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPS
OCS Permit (1.26:1 Offset Ratio, see Note 12) - Year 1	173	0	0	0	0	0	0	0
OCS Permit (1.26:1 Offset Ratio, see Note 12) - Year 2	71	0	0	0	0	0	0	0
RI Conformity (1:1 Offset Ratio) - Year 1	139	0	0	0	0	0	0	0
RI Conformity (1:1 Offset Ratio) - Year 2	60	0	0	0	0	0	0	0
MA Conformity (1:1 Offset Ratio) - Year 1	42	0	0	0	0	0	0	0
MA Conformity (1:1 Offset Ratio) - Year 2	18	0	0	0	0	0	0	0

Operation Emissions	Annual Emissions (Tons Per Year)							
	NO_X	VOC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPS
Total	13.3	0.8	0.0	9.6	0.7	0.6	704	0.0
OCS Permit Emissions	13.0	0.8	0.0	9.6	0.7	0.6	688	0.0
Inside 25 Miles - Transit	13.0	0.8	0.0	9.6	0.7	0.6	688	0.0
Inside 25 Miles - Stationary Sources	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0
Conformity Emissions	0.3	0.0	0.0	0.0	0.0	0.0	16	0.0
Outside 25 Miles - Transit in RI Waters	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0
Outside 25 Miles - Transit in MA Waters	0.3	0.0	0.0	0.0	0.0	0.0	16	0.0
Other Emissions								
Outside 25 Miles - Transit in Federal Waters	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0

Notes

1) Project emissions have been estimated using conservative equipment usage assumptions and EPA approved emission factors. The operating hours of all equipment used will be metered to track actual emissions.

2) The NO_x, VOC, SO_2, PM_{10}, $PM_{2.5}$ and CO_2 emissions from all vessels equipped with diesel engines have been estimated at the direction of the EPA and MMS using the appropriate emission factors and load factors from EPA's "Current Methodologies and Best Practices in Preparing Port Emission Inventories, Final Report", April 2009. The HAP emissions from these vessels have been estimated using AP-42 emission factors for diesel engines. The total engine power output estimated for each vessel has been increased by 10% to account for emissions from auxiliary engines.

3) The NO_X, CO, PM_{10}, and $PM_{2.5}$ emissions from all of the stationary nonroad diesel-fired engines to be used for the project have been estimated using the Tier 2 (or Tier 3 if available) emission standards from 40 CFR 89.112, Table 1 for each engine size. Additional CO and PM emissions control will be achieved through the use of diesel oxidation catalysts (DOC) on all project stationary source diesel engines.

4) The VOC, SO_2, CO_2, and HAP emissions from all of the stationary nonroad diesel-fired engines to be used for the project have been estimated using the appropriate emission factors from EPA's AP-42, "Compilation of Air Pollutant Emission Factors, Volume 1: Stationary Point and Area Sources". Additional VOC and HAP emissions control will be achieved through the use of DOC on all project stationary source diesel engines.

5) The SO_2 emissions from all of the diesel-fired non-road engines to be used for the project have been estimated assuming a diesel fuel sulfur content of 15 ppm, which will be the fuel sulfur content standard for all nonroad diesel fuel beginning June 1, 2010. The SO_2 emissions from all diesel-fired marine engines used for preconstruction and construction activities have been estimated assuming a diesel fuel sulfur content of 500 ppm, which is the current marine diesel fuel sulfur content standard. The SO_2 emissions from all diesel-fired marine engines used during operation have been estimated assuming a diesel fuel sulfur content of 15 ppm, which will be the marine diesel fuel sulfur content standard beginning June 1, 2012. The EPA's non-road and marine diesel sulfur content standards can be found at 40 CFR 80.510.

6) The emissions from the zodiac boats to be used for the project have been estimated using worst-case emission factors from the EPA document: "Exhaust Emission Factors for Nonroad Engine Modeling: Spark-Ignition", EPA420-R-05-019, Table 10.

7) The transit emissions from vessels outside 25 miles have been segregated by jurisdiction by proportioning the estimated total transit time for each vessel based on an average assumed speed of 8 knots and the number of nautical miles traveled within each jurisdiction during each trip.

8) All emissions resulting from staging activities in Rhode Island during the construction period have been estimated assuming approximately 8-hours of crane operations required for unloading, staging, and unloading of materials for each vessel trip identified.

9) Emissions from onshore construction equipment have been estimated using emission factors from EPA's Nonroad Engine Model Guidance Document, EPA420-P-04-009.

10) Emissions from vehicles associated with onshore construction and port activities have been estimated using emission factors from EPA's MOBILE6 Vehicle Model Guidance Document, EPA420-F-05-022.

11) Fugitive emissions resulting from onshore construction activities have been estimated using emission factors from the Mid-Atlantic Regional Air Management Association's (MARAMA) Fugitive Dust-Construction Calculation Sheet.

12) MassDEP nonattainment rules require an offset ratio of at least 1.2:1. According to Massachusetts ERC Bank Rules, if ERCs are to be used as offsets, an amount of credit equal to five percent more than the amount needed for the offset calculation must be purchased to ensure progress towards attainment, and for the benefit of the environment, resulting in an overall 1.26:1 offset ratio.

13) Emissions from onshore activities in RI include an estimate of emissions from ship deliveries of parts and materials to the port at Quonset Point. It has been assumed that all parts and materials will be transported to the port by ship for this analysis.

Revised July 2009 as directed by EPA & MMS

Cape Wind Energy Project
Preconstruction Emissions Inside of 25 miles

Emission Factors from EPA's "Current Methodologies and Best Practices in Preparing Port Emission Inventories", April 2009

Diesel Fuel Sulfur Content:	500 ppm

Emission Factors - Ocean Going Vessel Main Engines, Medium-Speed Diesel, Marine Diesel Oil, g/kWh (Table 2-9)								
Engine	NOx	VOC (HC)	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
MSD & MDO	13.2	0.50	0.20	1.10	0.47	0.43	646.08	0.00635

Emission Factors - Harbor Craft, Tier 0, g/kWh (Table 3-8)								
Engine Power	NOx	VOC (HC)	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
225 - 449 kW (Cat. 1)	10.0	0.27	0.043	1.50	0.30	0.29	690.00	0.0161
450 - 559 kW (Cat. 1)	10.0	0.27	0.043	1.50	0.30	0.29	690.00	0.0161
560 - 999 kW (Cat. 1)	10.0	0.27	0.043	1.50	0.30	0.29	690.00	0.00635
1,000 kW (Cat. 1)	13.0	0.27	0.043	2.50	0.30	0.29	690.00	0.00635
1,000 - 3,000 kW (Cat. 2)	13.2	0.50	0.043	1.10	0.72	0.70	690.00	0.00635

Category 1 vessels are defined by EPA as small harbor craft and recreational propulsion (<1,000 kW)
Category 2 vessels are defined by EPA as OGV auxiliary engines, harbor craft, and smaller OGV propulsion (1,000-3,000 kW)
Category 3 vessels are defined by EPA as OGV propulsion engines (>3,000 kW)
HAP emission factors are from AP-42 (Sections 3.3 & 3.4)
Load Factors are from Table 3-4 of the EPA Port Emissions Guidance Document
Emissions (tons) = Engine Power Rating (kW) x Load Factor (%) x Activity (hrs) x Emission Factor (g/KWh) x (1 lb/454 g) x (1 ton/2000 lb) x (# of sources)

Diesel Fuel Sulfur Content:	15 ppm

Emission Factors (g/hp-hr) Diesel Recip. <600 hp Based on AP-42 Vol.1 , Tables 3.3-1 - 3.3-2							
NOx	TOC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
	1.14	0.01				521.63	0.012

EPA Nonroad Diesel Engine Emission Standard (Tier 2 or Tier 3 if available), g/KW-hr								
Engine Size	NOx *	VOC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
225≤kW<450	4.0			3.5	0.20	0.20		

* EPA emission standard is for NOx+NMHC. It has been assumed that all emissions are NOx to be conservative.

Emission Factors (lb/MMBtu) Natural Gas 4-Stroke Based on AP-42 Vol.1 , Table 3.2-2							
NOx	VOC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
0.65	0.12	0.00059	0.56	0.000077	0.000077	110.00	0.072

Emission Factors (g/bhp-hr) for 50-100HP 4-stroke, outboard marine engines. Based on Exhaust Emission Factors for Nonroad Engine Modeling: Spark-Ignition. EPA420-R-03-019, Table 10. Worst case emissions factors were selected from carbureted, indirect injection and direct injection engine types. When calculating emissions, HC and PM were equated with VOC and PM10, respectively.

NOx	HC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
5.82	5.82		152.25	0.06			

Activity Type	Vessel Type/ Emission Source	Number of Sources	Equipment Size (HP)	Equipment Size (kW)	Activity	Count	Duration	Operating Hours (per unit)	Assumptions	Load Factor	Auxiliary Engine Power Adjustment	Emissions (tons)							
												NOx	VOC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
Preconstruction Period - Activities within 25 Miles of the Project																			
Geophysical - WTG's	42' Diesel Lobster Boat	1	1,000	746	-Travel b/w Falmouth and WP - 30 miles of transect	6 days	10 hrs/day	60	- 2 hrs. @ 15 knots then 8 hrs. @ 3 knots	0.43	1.100	0.2	0.0	0.0	0.0	0.0	0.0	16.1	0.0
Geophysical - 33 kV Inner Array Cable	42' Diesel Lobster Boat	1	1,000	746	-Travel b/w Falmouth and WP - 30 miles of transect	20 days	10 hrs/day	200	- 2 hrs. @ 15 knots then 8 hrs. @ 3 knots	0.43	1.100	0.8	0.0	0.0	0.1	0.0	0.0	53.6	0.0
Geophysical - 115 kV Interconnect Cable	42' Diesel Lobster Boat	1	1,000	746	-Travel b/w Falmouth and WP - 30 miles of transect	7 days	10 hrs/day	70	- 2 hrs. @ 15 knots then 8 hrs. @ 3 knots	0.43	1.100	0.3	0.0	0.0	0.0	0.0	0.0	18.8	0.0
Electrical Generator	Gas Fired	1	8.7	6.5		30 days	10 hrs/day	300				0.008	0.001	0.000	0.005	0.000	0.000	1.007	0.001
Borings	Tug Boat	1	1,500	1,119	Travel b/w Falmouth and	30 days	24 hrs/day	720	Full Load @ 1hr/day	0.31	1.100	4.0	0.2	0.0	0.3	0.2	0.2	208.7	0.0
Boring Drill Rig	Truck mtd Rig	1	350	261	1 boring/day	20 days	10 hr/day	200	Rig Stays on HSS till done			0.2	0.1	0.0	0.2	0.0	0.0	40.2	0.0
Vibracore Boat		1	1,000	746	Final Cable Design and Constructability survey	8 days	10 hr/day	80	- 33 kV: 1 core/3 miles of cable, total 22 - 115 kV: 2 /mile of cable, total 26 - 6 /day	0.43	1.100	0.3	0.0	0.0	0.0	0.0	0.0	21.4	0.0
Multibeam Survey	26' Boat	1	300	224	Shallow area multibeam survey	8 days	10 hr/day	80		0.43	1.100	0.1	0.0	0.0	0.0	0.0	0.0	6.4	0.0
Electrical Generator	Gas Fired	1	4	3		8 days	10 hr/day	80				0.001	0.000	0.000	0.001	0.000	0.000	0.124	0.000
Crew Movement	Zodiac Boat	1	100	75	1 boring/day	20 days	10 hr/day	200	Zodiac only needed for boring program			0.1	0.1		3.4	0.001			
Preconstruction Emissions - Stationary Sources												0.2	0.1	0.0	0.2	0.0	0.0	41	0.0
Preconstruction Emissions - Transit												5.8	0.3	0.0	3.9	0.3	0.3	325	0.0
Total Preconstruction Emissions												6.0	0.4	0.0	4.1	0.3	0.3	366	0.0

All operating hours will be metered to track actual emissions.

Revised July 2009 as directed by EPA & MMS

Cape Wind Energy Project
Construction Emissions Inside of 25 miles - Transit

Note: All trips are one-way (not round trips).

Emission Factors from EPA's "Current Methodologies and Best Practices in Preparing Port Emission Inventories", April 2009

Emission Factors - Ocean Going Vessel Main Engines, Medium-Speed Diesel, Marine Diesel Oil, g/kWh (Table 2-9)								
Engine	NOx	VOC (HC)	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
MSD & MDO	13.2	0.50	0.20	1.10	0.47	0.43	646.08	0.00635

Emission Factors - Harbor Craft, Tier 0, g/kWh (Table 3-8)								
Engine Power	NOx	VOC (HC)	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
225 - 449 kW (Cat. 1)	10.0	0.27	0.043	1.50	0.30	0.29	690.00	0.0161
450 - 559 kW (Cat. 1)	10.0	0.27	0.043	1.50	0.30	0.29	690.00	0.0161
560 - 999 kW (Cat. 1)	10.0	0.27	0.043	1.50	0.30	0.29	690.00	0.00635
1,000 kW (Cat. 1)	13.0	0.27	0.043	2.50	0.30	0.29	690.00	0.00635
1,000 - 3,000 kW (Cat. 2	13.2	0.50	0.043	1.10	0.72	0.70	690.00	0.00635

Diesel Fuel Sulfur Content: 500 ppm

Category 1 vessels are defined by EPA as small harbor craft and recreational propulsion (<1,000 kW)
Category 2 vessels are defined by EPA as OGV auxiliary engines, harbor craft, and smaller OGV propulsion (1,000-3,000 kW)
Category 3 vessels are defined by EPA as OGV propulsion engines (>3,000 kW)
HAP emission factors are from AP-42 (Sections 3.3 & 3.4)
Ocean Going Vessel Load Factors were assumed to be 0.83, consistent with Section 2.5 of the EPA Port Emissions Guidance Document.
Harbor Craft Load Factors are from Table 3-4 of the EPA Port Emissions Guidance Document
Emissions (tons) = Engine Power Rating (kW) x Load Factor (%) x Activity (hrs) x Emission Factor (g/kWh) x (1 lb/454 g) x (1 ton/2000 lb) x (# of sources)

Activity Type	Vessel Type/ Emission Source	Number of Sources	Equipment Size (HP)	Equipment Size (kW)	Activity	Count	Duration	Operating Hours (per unit)	Assumptions	Travel Origin beyond 25 Mile Radius	Load Factor	Auxiliary Engine Power Adjustment	Emissions (tons)							
													NOx	VOC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
Construction Period - Transit Activities within 25 Miles of the Project																				
Pile Installation																				
Move jack up barge to Wind Park	attendant tug	1	3,000	2,237	Travel b/w 25-mile boundary and WP	4 trips	3	13	This is done twice (once per year)	Quonset Point, RI	0.31	1.100	0.1	0.0	0.0	0.0	0.0	0.0	7.2	0.0
Transport piles and transition pieces to wind park	tow tug	1	6,000	4,474	Travel b/w 25-mile boundary and WP	86 trips	3	269	avg. 3 piles per trip, 130 piles, duration only w/in 25 miles	Quonset Point, RI	0.68	1.100	13.1	0.5	0.2	1.1	0.5	0.4	640.0	0.0
Pile barge handling tug @ Wind Park	attendant tug	1	3,000	2,237	Daily activity	130 days	3 hrs/day	390	3 piles per week, attendant tugs only operate equiv of 1/2 day		0.31	1.100	4.3	0.2	0.0	0.4	0.2	0.2	226.1	0.0
Moving crew in and out	crew boats	2	750	559	daily travel b/w Falmouth and WP	130 days	1	182			0.45	1.100	1.1	0.0	0.0	0.2	0.0	0.0	76.4	0.0
Transition piece handling tugs @ Wind Park	attendant tug	1	3,000	2,237	Daily activity	130 days	4 hrs/day	520	3 pieces per week, attendant tugs only operate equiv of 1/2 day		0.31	1.100	5.8	0.2	0.0	0.5	0.3	0.3	301.4	0.0
Installation of scour protection																				
Move scour protection installation equipment to Wind Park	attendant tug	1	3,000	2,237	Travel b/w 25-mile boundary and WP	4 trips	3	13	This is done twice (once per year)	Quonset Point, RI	0.31	1.100	0.1	0.0	0.0	0.0	0.0	0.0	7.2	0.0
Transport rock armor barges	tow tug	1	6,000	4,474	Travel b/w 25-mile boundary and WP	276 trips	3	863	Spd. 8 knts	Quonset Point, RI	0.68	1.100	42.0	1.6	0.6	3.5	1.5	1.4	2053.9	0.0
Transport filler material barges	tow tug	1	6,000	4,474	Travel b/w 25-mile boundary and WP	370 trips	3	1,156	Spd. 8 knts	Quonset Point, RI	0.68	1.100	56.3	2.1	0.8	4.7	2.0	1.8	2753.4	0.0
Armor/filler barge handling tugs @ Wind Park	attendant tugs	2	3,000	2,237	Daily activity	130 days	4 hrs/day	520			0.31	1.100	11.5	0.4	0.0	1.0	0.6	0.6	602.9	0.0
Subtotal													134.3	5.1	1.8	11.3	5.2	4.8	6,669	0.1
Cable laying																				
115 kV Cable laying barge to wind farm	tow tug	1	1,500	1,119	Travel b/w 25-mile boundary and WP	4 trips	3	13		Quonset Point, RI	0.31	1.100	0.1	0.0	0.0	0.0	0.0	0.0	3.6	0.0
Put cable in place	crane barge	1	400	298		15 days	10 hrs/day	150	10 hrs/day for 15 work days		0.43	1.100	0.2	0.0	0.0	0.0	0.0	0.0	16.1	0.0
Put cable in place	attendant tug	1	1,500	1,119		15 days	10 hrs/day	150	10 hrs/day for 15 work days		0.31	1.100	0.8	0.0	0.0	0.2	0.0	0.0	43.5	0.0
Put cable in place	anchoring tug	1	4,000	2,983		15 days	10 hrs/day	150	10 hrs/day for 15 work days		0.31	1.100	2.2	0.1	0.0	0.2	0.1	0.1	115.9	0.0
Moving crew in and out	crew boats	1	750	559		15 days	2 hrs/day	30			0.45	1.100	0.1	0.0	0.0	0.0	0.0	0.0	6.3	0.0
33 kV Cable laying barge to wind farm	tow tug	1	1,500	1,119	Travel b/w 25-mile boundary and WP	26 trips	3	81	13 round trips	Quonset Point, RI	0.31	1.100	0.4	0.0	0.0	0.1	0.0	0.0	23.6	0.0
Put cable in place	crane barge	1	400	298		130 days	10 hrs/day	1300	10 hrs/day for 10 work days/string - 13 strings		0.43	1.100	2.0	0.1	0.0	0.3	0.1	0.1	139.4	0.0

Revised July 2009 as directed by EPA & MMS

Cape Wind Energy Project
Construction Emissions Inside of 25 miles - Transit

Note: All trips are one-way (not round trips).

Emission Factors from EPA's "Current Methodologies and Best Practices in Preparing Port Emission Inventories", April 2009

Emission Factors - Ocean Going Vessel Main Engines, Medium-Speed Diesel, Marine Diesel Oil, g/kWh (Table 2-9)								
Engine	NOx	VOC (HC)	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
MSD & MDO	13.2	0.50	0.20	1.10	0.47	0.43	646.08	0.00635
Emission Factors - Harbor Craft, Tier 0, g/kWh (Table 3-8)								
Engine Power	NOx	VOC (HC)	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
225 - 449 kW (Cat. 1)	10.0	0.27	0.043	1.50	0.30	0.29	690.00	0.0161
450 - 559 kW (Cat. 1)	10.0	0.27	0.043	1.50	0.30	0.29	690.00	0.0161
560 - 999 kW (Cat. 1)	10.0	0.27	0.043	1.50	0.30	0.29	690.00	0.00635
1,000 kW (Cat. 1)	13.0	0.27	0.043	2.50	0.30	0.29	690.00	0.00635
1,000 - 3,000 kW (Cat. 2	13.2	0.50	0.043	1.10	0.72	0.70	690.00	0.00635

Diesel Fuel Sulfur Content: 500 ppm

Category 1 vessels are defined by EPA as small harbor craft and recreational propulsion (<1,000 kW)
Category 2 vessels are defined by EPA as OGV auxiliary engines, harbor craft, and smaller OGV propulsion (1,000-3,000 kW)
Category 3 vessels are defined by EPA as OGV propulsion engines (>3,000 kW)
HAP emission factors are from AP-42 (Sections 3.3 & 3.4)
Ocean Going Vessel Load Factors were assumed to be 0.83, consistent with Section 2.5 of the EPA Port Emissions Guidance Document.
Harbor Craft Load Factors are from Table 3-4 of the EPA Port Emissions Guidance Document
Emissions (tons) = Engine Power Rating (kW) x Load Factor (%) x Activity (hrs) x Emission Factor (g/KWh) x (1 lb/454 g) x (1 ton/2000 lb) x (# of sources)

Activity Type	Vessel Type/ Emission Source	Number of Sources	Equipment Size (HP)	Equipment Size (kW)	Activity	Count	Duration	Operating Hours (per unit)	Assumptions	Travel Origin beyond 25 Mile Radius	Load Factor	Auxiliary Engine Power Adjustment	Emissions (tons)							
													NOx	VOC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
Put cable in place	attendant tug	1	1,500	1,119		130 days	10 hrs/day	1300	10 hrs/day for 10 work days/string - 13 strings		0.31	1.100	7.1	0.1	0.0	1.4	0.2	0.2	376.8	0.0
Move Crane barge to cofferdam location	tow tug	1	1,500	1,119	Travel b/w 25-mile boundary and WP	4 trips	3	13		Quonset Point, RI	0.31	1.100	0.1	0.0	0.0	0.0	0.0	0.0	3.6	0.0
HDD Cofferdam Excavation	crane barge	1	400	298	Excavation	2 days	10 hrs/day	20	2 day @10 hrs/day - Spd. ~ 12 knts		0.43	1.100	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0
Moving crew in and out	crew boat	1	750	559		10 days	2 hrs/day	20	1hr each way per crew boat		0.45	1.100	0.1	0.0	0.0	0.0	0.0	0.0	4.2	0.0
Subtotal													**13.2**	**0.3**	**0.0**	**2.2**	**0.4**	**0.4**	**735**	**0.0**
Turbine installation																				
Turbines to Wind Farm	one specialized vessel	1	6,000	4,474	Travel b/w 25-mile boundary and WP	86 trips	3	269	Only emissions within 25 miles of Wind Park	Quonset Point, RI	0.83	1.100	16.0	0.6	0.2	1.3	0.6	0.5	781.2	0.0
Moving crew in and out	crew boats	4	750	559		130 days	2 hrs/day	260	2 days per WTG		0.45	1.100	3.2	0.1	0.0	0.5	0.1	0.1	218.8	0.0
Subtotal													**19.1**	**0.7**	**0.3**	**1.8**	**0.7**	**0.6**	**1,000**	**0.0**
ESP Installation																				
Crane barge towing	tow tug	1	3,000	2,237	Travel b/w 25-mile boundary and WP	2 trips	3	6		Quonset Point, RI	0.31	1.100	0.1	0.0	0.0	0.0	0.0	0.0	3.6	0.0
Handling crane barge	attendant tug	1	3,000	2,237		1	16 hrs.	20	4 hrs. transit and 16 hrs. on site		0.31	1.100	0.2	0.0	0.0	0.0	0.0	0.0	11.6	0.0
Pile Installation barge towing	tow tug	1	3,000	2,237	Travel b/w 25-mile boundary and WP	2 trips	3	6		Quonset Point, RI	0.31	1.100	0.1	0.0	0.0	0.0	0.0	0.0	3.6	0.0
Handling barge	attendant tug	1	3,000	2,237		6	3 hrs.	18			0.31	1.100	0.2	0.0	0.0	0.0	0.0	0.0	10.4	0.0
ESP deck to wind farm	tow tug	1	6,000	4,474	Travel b/w 25-mile boundary and WP	2 trips	3	6		Quonset Point, RI	0.68	1.100	0.3	0.0	0.0	0.0	0.0	0.0	14.9	0.0
Crane barge towing	tow tug	1	3,000	2,237	Travel b/w 25-mile boundary and WP	2 trips	3	6		Quonset Point, RI	0.31	1.100	0.1	0.0	0.0	0.0	0.0	0.0	3.6	0.0
Setting the deck for ESP installation	crane barge	1	6,000	4,474		1	16 hrs.	16			0.83	1.100	1.0	0.0	0.0	0.1	0.0	0.0	46.5	0.0
Handling crane barge	attendant tug	1	3,000	2,237		2 trips	9 hrs/trip	18	12 hrs. out, 6 hours back		0.31	1.100	0.2	0.0	0.0	0.0	0.0	0.0	10.4	0.0
Moving crew in and out	crew boats	4	750	559		160 trips	2 hrs/trip	320	40 days, 2 RT/day - 2 hrs.each way		0.45	1.100	3.9	0.1	0.0	0.6	0.1	0.1	269.3	0.0
Subtotal													**6.0**	**0.2**	**0.0**	**0.8**	**0.2**	**0.2**	**374**	**0.0**
TOTAL Construction Emissions Over 1 to 2-Year Construction Duration													**172.6**	**6.3**	**2.1**	**16.0**	**6.5**	**6.0**	**8,778**	**0.1**

A vessel speed of 8 knots was assumed to determine the duration for each trip
All operating hours will be metered to track actual emissions.

Revised July 2009 as directed by EPA & MMS

Note: All trips are one-way (not round trips).

Cape Wind Energy Project
Construction Emissions Inside of 25 miles - Stationary Activities

Emission Factors (g/hp-hr)Diesel Recip. >600 hp Based on AP-42 Vol.1 , Tables 3.4-1 - 3.4-4							
NOx	VOC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
	0.33	0.01				526.16	0.00474
Emission Factors (g/hp-hr) Diesel Recip. <600 hp Based on AP-42 Vol.1 , Tables 3.3-1 - 3.3-2							
NOx	TOC*	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
	1.14	0.01				521.63	0.012

Diesel Fuel Sulfur Content:	15 ppm

* Emission factor for VOC was not available; TOC emission factor is used instead, which will result in a very conservative estimation of VOC emissions.

EPA Nonroad Diesel Engine Emission Standard (Tier 2 or Tier 3 if available), g/KW-hr								
Engine Size	NOx *	VOC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
75≤kW<130	4.0			5.0	0.30	0.30		
225≤kW<450	4.0			3.5	0.20	0.20		
kW>560	6.4			3.5	0.20	0.20		

* EPA emission standard is for NOx+NMHC. It has been assumed that all emissions are NOx to be conservative.

Activity Type	Vessel Type/ Emission Source	Number of Sources	Equipment Size (HP)	Equipment Size (kW)	Activity	Count	Duration	Operating Hours (per unit)	Assumptions	Emissions (tons)							
										NOx	VOC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
Construction Period - Stationary Activities within 25 Miles of the Project																	
Pile Installation																	
Put piles in place	primary 500 ton crane	1	800	597	Set piles	130 days	4 hrs/day	520		2.2	0.2	0.0	1.2	0.1	0.1	241.1	0.0
Pile driving	Hydraulic ram	1	1,600	1,193	Set piles	130 piles	4 hrs/pile	520	IHC S-1200 hydrohammer	4.4	0.3	0.0	2.4	0.1	0.1	482.1	0.0
Set transition pieces	primary 500 ton crane	1	800	597	Set Pieces	130 days	4 hrs/day	520		2.2	0.2	0.0	1.2	0.1	0.1	241.1	0.0
Installation of scour protection																0.0	0.0
Install rock armor	crane	1	400	298	Daily activity	65 days	8 hrs/day	520	2 towers per day	0.7	0.3	0.0	0.6	0.0	0.0	119.5	0.0
Install filler material	crane	1	400	298	Daily activity	65 days	8 hrs/day	520	2 towers per day	0.7	0.3	0.0	0.6	0.0	0.0	119.5	0.0
Subtotal										**10.1**	**1.1**	**0.0**	**6.0**	**0.3**	**0.3**	**1,203**	**0.0**
Cable laying																	
Sheet Pile Driving for cofferdam		1	400	298		2 days	10 hrs/day	20	2 day @10 hrs/day	0.0	0.0	0.0	0.0	0.0	0.0	4.6	0.0
Compressor Drive		1	100	75		2 days	8 hrs/day	16	2 day @8 hrs/day	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0
Sheet Pile Removal		1	400	298		2 days	10 hrs/day	20	2 day @10 hrs/day	0.0	0.0	0.0	0.0	0.0	0.0	4.6	0.0
Cofferdam Backfill	crane barge	1	400	298	Backfill	2 days	10 hrs/day	20	2 day @10 hrs/day	0.0	0.0	0.0	0.0	0.0	0.0	4.6	0.0
Subtotal										**0.1**	**0.0**	**0.0**	**0.1**	**0.0**	**0.0**	**15**	**0.0**
Turbine installation																	
Stabilizing the the WTG vessel in correct location and elevation	jacking system with 6 legs	1	476	355		130 days	2 hrs/day	260		0.4	0.2	0.0	0.4	0.0	0.0	71.1	0.0
Tower Installation	primary 500 ton crane	1	800	597		130 days	2 hrs/day	260		1.1	0.1	0.0	0.6	0.0	0.0	120.5	0.0
Nacelle installation	primary 500 ton crane	1	800	597		130 days	2 hrs/day	260		1.1	0.1	0.0	0.6	0.0	0.0	120.5	0.0
Rotor installation	primary 500 ton crane	1	800	597		130 days	2 hrs/day	260		1.1	0.1	0.0	0.6	0.0	0.0	120.5	0.0
Subtotal										**3.7**	**0.4**	**0.0**	**2.1**	**0.1**	**0.1**	**433**	**0.0**
ESP Installation																	
Setting template for ESP installation	crane	1	3,000	2,237		1	16 hrs.	16		0.3	0.0	0.0	0.1	0.0	0.0	27.8	0.0
Pile setting	crane	1	3,000	2,237		6	3 hrs.	18		0.3	0.0	0.0	0.2	0.0	0.0	31.3	0.0
Pile driving	Hydraulic ram	1	3,200	2,386		6	2 hrs.	12	IHC S-500 hydrohammer	0.2	0.0	0.0	0.1	0.0	0.0	22.3	0.0
Subtotal										**0.7**	**0.1**	**0.0**	**0.4**	**0.0**	**0.0**	**81**	**0.0**
TOTAL Construction Emissions Over 1 to 2-Year Construction Duration										**14.6**	**1.6**	**0.0**	**8.6**	**0.5**	**0.5**	**1,732**	**0.0**

All operating hours will be metered to track actual emissions.

Revised July 2009 as directed by EPA & MMS

Cape Wind Energy Project
Operation Emissions Inside of 25 miles

Note: All trips are one-way (not round trips).

Emission Factors from EPA's "Current Methodologies and Best Practices in Preparing Port Emission Inventories", April 2009

Diesel Fuel Sulfur Content:	15 ppm

Emission Factors - Ocean Going Vessel Main Engines, Medium-Speed Diesel, Marine Diesel Oil, g/kWh (Table 2-9)								
Engine	**NOx**	**VOC (HC)**	**SO_2**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**HAPs**
MSD & MDO	13.2	0.50	0.01	1.10	0.47	0.43	646.08	0.00635

Emission Factors - Harbor Craft, Tier 0, g/kWh (Table 3-8)								
Engine Power	**NOx**	**VOC (HC)**	**SO_2**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**HAPs**
225 - 449 kW (Cat. 1)	10.0	0.27	0.001	1.50	0.30	0.29	690.00	0.0161
450 - 559 kW (Cat. 1)	10.0	0.27	0.001	1.50	0.30	0.29	690.00	0.0161
560 - 999 kW (Cat. 1)	10.0	0.27	0.001	1.50	0.30	0.29	690.00	0.00635
1,000 kW (Cat. 1)	13.0	0.27	0.001	2.50	0.30	0.29	690.00	0.00635
1,000 - 3,000 kW (Cat. 2	13.2	0.50	0.001	1.10	0.72	0.70	690.00	0.00635

Category 1 vessels are defined by EPA as small harbor craft and recreational propulsion (<1,000 kW)
Category 2 vessels are defined by EPA as OGV auxiliary engines, harbor craft, and smaller OGV propulsion (1,000-3,000 kW)
Category 3 vessels are defined by EPA as OGV propulsion engines (>3,000 kW)
HAP emission factors are from AP-42 (Sections 3.3 & 3.4)
Load Factors are from Table 3-4 of the EPA Port Emissions Guidance Document
Emissions (tons) = Engine Power Rating (kW) x Load Factor (%) x Activity (hrs) x Emission Factor (g/KWh) x (1 lb/454 g) x (1 ton/2000 lb) x (# of sources)

Outboard Emission Factors (g/bhp-hr) for 50-100HP 4-stroke, outboard engines. Based on Exhaust Emission Factors for Nonroad Engine Modeling: Spark-Ignition. EPA420-R-05-019, Table 10. Worst case emissions factors were selected from carbureted, indirect injection and direct injection engine types. When calculating emissions, HC and PM were equated with VOC and PM10, respectively.

HC	Nox	SO_2	CO	PM	$PM_{2.5}$	CO_2	HAPs
5.82	5.82		152.25	0.06			

Activity Type	Vessel Type/ Emission Source	Number of Sources	Equipment Size (HP)	Equipment Size (kW)	Activity	Count	Duration	Operating Hours (per unit)	Assumptions	Load Factor	Auxiliary Engine Power Adjustment	Emissions (tons)							
												NOx	VOC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
Maintenance - per year																			
Crew transport	Crew boats	1	750	559	Travel b/w Falmouth and WP	504 trips	1 hr/trip	504	avg. 1 trips/day X 252 days	0.45	1.100	1.5	0.0	0.0	0.2	0.0	0.0	106.0	0.0
Support vessel	Maintenance vessels	1	1,500	1,119	Travel b/w Falmouth and WP	504 trips	1 hr/trip	504	avg. 1 trips/day X 252 days	0.43	1.100	3.9	0.1	0.0	0.3	0.2	0.2	202.6	0.0
Special duty supply vessel	Maintenance vessel	1	3,000	2,237	Travel b/w New Bedford and WP	48 trips	5 hrs/trip	230	Required irregularly - assume 2 rund trips per month	0.43	1.100	3.5	0.1	0.0	0.3	0.2	0.2	185.1	0.0
Support vessel	Maintenance vessels	1	1,500	1,119	Travel b/w New Bedford and WP	504 trips	1 hr/trip	483	avg. 1 trips/day X 252 days	0.43	1.100	3.7	0.1	0.0	0.3	0.2	0.2	194.3	0.0
Crew Movement	Zodiac Boat	1	100	75	Daily activity	504 trips	1 hr/trip	504	avg. 1 trips/day X 252 days			0.3	0.3		8.5	0.003			
Sub-Total												13.0	0.8	0.0	9.6	0.7	0.6	688	0.0
Total Annual Operation Emissions (tons per year)												13.0	0.8	0.0	9.6	0.7	0.6	688	0.0

Note: Hours were prorated based on the following assumptions:
- New Bedford to 25-mile Radius Border = 2.2 Miles
- New Bedford to Wind Park = 53.8 Miles
- Miles are nautical miles

All operating hours will be metered to track actual emissions.

Revised July 2009 as directed by EPA & MMS

Cape Wind Energy Project
Operation Emissions Outside of 25 miles in MA Waters

Note: All trips are one-way (not round trips).

Emission Factors from EPA's "Current Methodologies and Best Practices in Preparing Port Emission Inventories", April 2009

Diesel Fuel Sulfur Content:	15 ppm

Emission Factors - Ocean Going Vessel Main Engines, Medium-Speed Diesel, Marine Diesel Oil, g/kWh (Table 2-9)								
Engine	**NOx**	**VOC (HC)**	**SO_2**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**HAPs**
MSD & MDO	13.2	0.50	0.01	1.10	0.47	0.43	646.08	0.00635
Emission Factors - Harbor Craft, Tier 0, g/kWh (Table 3-8)								
Engine Power	**NOx**	**VOC (HC)**	**SO_2**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**HAPs**
225 - 449 kW (Cat. 1)	10.0	0.27	0.001	1.50	0.30	0.29	690.00	0.0161
450 - 559 kW (Cat. 1)	10.0	0.27	0.001	1.50	0.30	0.29	690.00	0.0161
560 - 999 kW (Cat. 1)	10.0	0.27	0.001	1.50	0.30	0.29	690.00	0.00635
1,000 kW (Cat. 1)	13.0	0.27	0.001	2.50	0.30	0.29	690.00	0.00635
1,000 - 3,000 kW (Cat. 2	13.2	0.50	0.001	1.10	0.72	0.70	690.00	0.00635

Category 1 vessels are defined by EPA as small harbor craft and recreational propulsion (<1,000 kW)
Category 2 vessels are defined by EPA as OGV auxiliary engines, harbor craft, and smaller OGV propulsion (1,000-3,000 kW)
Category 3 vessels are defined by EPA as OGV propulsion engines (>3,000 kW)
HAP emission factors are from AP-42 (Sections 3.3 & 3.4)
Load Factors are from Table 3-4 of the EPA Port Emissions Guidance Document
Emissions (tons) = Engine Power Rating (kW) x Load Factor (%) x Activity (hrs) x Emission Factor (g/KWh) x (1 lb/454 g) x (1 ton/2000 lb) x (# of sources)

Activity Type	Vessel Type/ Emission Source	Number of Sources	Equipment Size (HP)	Equipment Size (kW)	Activity	Count	Duration	Operating Hours (per unit)	Assumptions	Load Factor	Auxiliary Engine Power Adjustment	Emissions (tons)							
												NOx	VOC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
Operation Period - Activities beyond 25 Miles of the Project in MA Waters																			
Maintenance - per year																			
Special duty supply vessel	Maintenance vessel	1	3,000	2,237	Travel b/w New Bedford and WP	48 trips	5 hrs/trip	10	Required irregularly - assume 2 trips per month	0.43	1.100	0.2	0.0	0.0	0.0	0.0	0.0	7.9	0.0
Support vessel	Maintenance vessels	1	1,500	1,119	Travel b/w New Bedford and WP	504 trips	1 hr/trip	21	avg. 1 trips/day X 252 days	0.43	1.100	0.2	0.0	0.0	0.0	0.0	0.0	8.3	0.0
Total Operation Emissions												**0.3**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**16**	**0.0**

Note: Hours were prorated based on the following assumptions:
- New Bedford to 25-mile Radius Border = 2.2 Miles
- New Bedford to Wind Park = 53.8 Miles
- Miles are nautical miles

All operating hours will be metered to track actual emissions.

Revised July 2009 as directed by EPA & MMS

Cape Wind Energy Project
Construction Emissions Onshore Activities - Rhode Island

Emission Factors (g/mile) from EPA's MOBILE6 Vehicle Model Guidance Document, EPA420-F-05-022								
Vehicle	NOx	VOC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
Pickup truck/SUV	1.22	1.61		15.7	0.0065	0.006		
Emission Factors (g/hp-hr) Diesel Recip. >600 hp Based on AP-42 Vol.1 , Tables 3.4-1 - 3.4-4								
Equipment	NOx *	VOC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
Diesel Engine	6.86	0.33	0.01	2.4	0.32	0.32	526.16	0.00474

* NOx emission factor used is the Tier 1 Emission Standard for nonroad engines (40 CFR 89.112(1)).

Diesel Fuel Sulfur Content: 15 ppm

Emission Factors from EPA's "Current Methodologies and Best Practices in Preparing Port Emission Inventories", April 2009

Emission Factors - Ocean Going Vessel Main Engines, Medium-Speed Diesel, Marine Diesel Oil, g/kWh (Table 2-9)								
Engine	NOx	VOC (HC)	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
MSD & MDO	13.2	0.50	0.20	1.10	0.47	0.43	646.08	0.00635
Emission Factors - Harbor Craft, Tier 0, g/kWh (Table 3-8)								
Engine Power	NOx	VOC (HC)	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
225 - 449 kW (Cat. 1)	10.0	0.27	0.000	1.50	0.30	0.29	690.00	0.0161
450 - 559 kW (Cat. 1)	10.0	0.27	0.000	1.50	0.30	0.29	690.00	0.0161
560 - 999 kW (Cat. 1)	10.0	0.27	0.000	1.50	0.30	0.29	690.00	0.00635
1,000 kW (Cat. 1)	13.0	0.27	0.000	2.50	0.30	0.29	690.00	0.00635
1,000 - 3,000 kW (Cat. 2	13.2	0.50	0.000	1.10	0.72	0.70	690.00	0.00635

Diesel Fuel Sulfur Content: 500 ppm

Category 1 vessels are defined by EPA as small harbor craft and recreational propulsion (<1,000 kW)
Category 2 vessels are defined by EPA as OGV auxiliary engines, harbor craft, and smaller OGV propulsion (1,000-3,000 kW)
Category 3 vessels are defined by EPA as OGV propulsion engines (>3,000 kW)
HAP emission factors are from AP-42 (Sections 3.3 & 3.4)
Load Factors are from Table 3-4 of the EPA Port Emissions Guidance Document
Emissions (tons) = Engine Power Rating (kW) x Load Factor (%) x Activity (hrs) x Emission Factor (g/KWh) x (1 lb/454 g) x (1 ton/2000 lb) x (# of sources)

Activity Type	Emission Source	Number of Sources	Equipment Size (HP)	Equipment Size (kW)	Activity	Count	Duration	Operating Hours (per unit)	Units	Load Factor	Auxiliary Engine Power Adjustment	Emissions (tons)							
												NOx	VOC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
Construction Period - Onshore - Rhode Island																			
Port Worker Commute																			
Vehicle Emissions	pickup trucks/SUV	25			240 days	480 trips	30 miles/trip	14,400	miles			0.5	0.6	0.0	6.2	0.0	0.0	0.0	0.0
Subtotal												**0.5**	**0.6**	**0.0**	**6.2**	**0.0**	**0.0**	**0**	**0.0**
Delivery of Parts & Materials																			
Cargo Barge Tow Tug - Light	tow tug	1	1,500	1,119	Cable	15 trips	4 hrs/trip	60	hours	0.31	1.100	0.3	0.0	0.0	0.0	0.0	0.0	17.4	0.0
Cargo Barge Tow Tug - Middle	tow tug	1	3,000	2,237	Scour	2 trips	4 hrs/trip	8	hours	0.31	1.100	0.1	0.0	0.0	0.0	0.0	0.0	4.6	0.0
Cargo Barge Tow Tug - Heavy	tow tug	1	6,000	4,474	All Else	410 trips	4 hrs/trip	1,640	hours	0.68	1.100	79.8	3.0	1.2	6.6	2.8	2.6	3905.4	0.0
Subtotal												**80.2**	**3.0**	**1.2**	**6.7**	**2.9**	**2.6**	**3,927**	**0.0**
Construction Staging Activities - Unloading/Staging/Loading																			
Piles & Transition Pieces	Crane	1	800	597		43 trips	8 hrs/trip	344	hours			2.1	0.1	0.0	0.7	0.1	0.1	159	0.0
Scour Installation Equipment	Crane	1	800	597		2 trips	8 hrs/trip	16	hours			0.1	0.0	0.0	0.0	0.0	0.0	7	0.0
Rock Armor	Crane	1	800	597		138 trips	8 hrs/trip	1,104	hours			6.7	0.3	0.0	2.3	0.3	0.3	512	0.0
Filler Material	Crane	1	800	597		185 trips	8 hrs/trip	1,480	hours			8.9	0.4	0.0	3.1	0.4	0.4	686	0.0
115 kV Cable	Crane	1	800	597		2 trips	8 hrs/trip	16	hours			0.1	0.0	0.0	0.0	0.0	0.0	7	0.0
33 kV Cable	Crane	1	800	597		13 trips	8 hrs/trip	104	hours			0.6	0.0	0.0	0.2	0.0	0.0	48	0.0
Turbines	Crane	1	800	597		43 trips	8 hrs/trip	344	hours			2.1	0.1	0.0	0.7	0.1	0.1	159	0.0
ESP Deck	Crane	1	800	597		1 trip	8 hrs/trip	8	hours			0.0	0.0	0.0	0.0	0.0	0.0	4	0.0
Subtotal								**3,416**				**20.6**	**1.0**	**0.0**	**7.2**	**1.0**	**1.0**	**1,584**	**0.0**
TOTAL Emissions Over Construction Duration												**101.3**	**4.7**	**1.2**	**20.1**	**3.8**	**3.6**	**5,511**	**0.1**

Tow tug hours were based on traveling 32 nautical mile round-trips from the RI Border to Quonset Point and back to the RI Border at a speed of 8 knots (4 hours per round trip).
Assumes 8 hours of total crane operating time for unloading/staging/loading for each vessel trip.
All operating hours will be metered to track actual emissions.

Cape Wind Energy Project
Construction Emissions Onshore Activities - Massachusetts

Emission Factors (g/hp-hr) from EPA's Nonroad Engine Model Guidance Document, EPA420-P-04-009								
Equipment	NOx	VOC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
Backhoes	7.220	1.850	0.950	8.210	1.370	1.330	691.100	
Bore/Drill Rigs	7.150	0.600	0.730	2.290	0.500	0.490	529.700	
Cement Mixers	7.280	0.610	0.730	2.320	0.480	0.470	529.700	
Dump Trucks	5.490	0.440	0.740	2.070	0.410	0.400	536.000	
Excavators	4.600	0.340	0.740	1.300	0.320	0.310	536.300	
Front End Loaders	5.000	0.380	0.740	1.550	0.350	0.340	536.200	
Graders	4.730	0.350	0.740	1.360	0.330	0.320	536.300	
Trenchers	5.810	0.510	0.740	2.440	0.460	0.440	535.800	

Emission Factors (g/mile) from EPA's MOBILE6 Vehicle Model Guidance Document, EPA420-F-05-022								
Vehicle	NOx	VOC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
Heavy-Duty Trucks	4.97	0.29		1.32	0.13	0.13		
Pick-up Trucks	1.22	1.61		15.70	0.0065	0.006		

Emission Factor (tons/acre-month) from Mid-Atlantic Regional Air Management Association guidance.								
Emission	NOx	VOC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
Fugitive Emissions					0.11	0.02		

Emission Factors (g/hp-hr) Diesel Recip. <600 hp Based on AP-42 Vol.1 , Tables 3.3-1 - 3.3-2								
Equipment	NOx **	TOC *	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
Crane/Winch	6.86	1.14	0.01	3.02	1.00	1.00	521.63	0.00003

Diesel Fuel Sulfur Content:	15 ppm

* Emission factor for VOC was not available; TOC emission factor is used instead, which will result in a very conservative estimation of VOC emissions.
** NOx emission factor used is the Tier 1 Emission Standard for nonroad engines (40 CFR 89.112(1)).

Activity Type	Emission Source	Number of Sources	Equipment Size (HP)	Equipment Size (kW)	Activity	Count	Duration	Operating Hours (per unit)	Units	Emissions (tons)							
										NOx	VOC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
Construction Period - Onshore - Massachusetts																	
Ductbank, Conduit, and Vault Installation																	
Breaking Pavement/Stripping Topsoil	Excavators	1	300	224		75 days	10 hrs/day	750	hours	1.1	0.1	0.2	0.3	0.1	0.1	133	0.0
	Backhoes	1	100	75		75 days	10 hrs/day	750	hours	0.6	0.2	0.1	0.7	0.1	0.1	57	0.0
	Dump Trucks	1	300	224		75 days	10 hrs/day	750	hours	1.4	0.1	0.2	0.5	0.1	0.1	133	0.0
Trench Excavation	Excavators	1	300	224		75 days	10 hrs/day	750	hours	1.1	0.1	0.2	0.3	0.1	0.1	133	0.0
	Trenchers	1	175	131		75 days	10 hrs/day	750	hours	0.8	0.1	0.1	0.4	0.1	0.1	77	0.0
	Dump Trucks	1	300	224		75 days	10 hrs/day	750	hours	1.4	0.1	0.2	0.5	0.1	0.1	133	0.0
	Bore/Drill Rigs	1	300	224		75 days	10 hrs/day	750	hours	1.8	0.1	0.2	0.6	0.1	0.1	131	0.0
HDD Boring	HDD Drill Rig	1	300	224		20 days	10 hrs/day	200	hours	0.5	0.0	0.0	0.2	0.0	0.0	35	0.0
Concrete Casting of Ductbank	Cement Mixer	1	300	224		75 days	10 hrs/day	750	hours	1.8	0.2	0.2	0.6	0.1	0.1	131	0.0
Install Manholes	Front End Loaders	1	300	224		75 days	10 hrs/day	750	hours	1.2	0.1	0.2	0.4	0.1	0.1	133	0.0
Backfill Ductbank	Excavators	1	300	224		75 days	10 hrs/day	750	hours	1.1	0.1	0.2	0.3	0.1	0.1	133	0.0
	Backhoes	1	100	75		75 days	10 hrs/day	750	hours	0.6	0.2	0.1	0.7	0.1	0.1	57	0.0
	Dump Trucks	1	300	224		75 days	10 hrs/day	750	hours	1.4	0.1	0.2	0.5	0.1	0.1	133	0.0
	Graders	1	300	224		75 days	10 hrs/day	750	hours	1.2	0.1	0.2	0.3	0.1	0.1	133	0.0
Fugitive Emissions	All Types/Activities					1 acre	5 months	5	acre-months	0.0	0.0	0.0	0.0	0.6	0.1	0.0	0.0
Delivery of Supplies	Heavy-Duty Trucks	2		-		150 days	60 mi/day	18,000	miles	0.2	0.0	0.0	0.1	0.0	0.0	0	0.0
Worker Transport	Pick-up Trucks	10		-		150 days	120 mi/day	180,000	miles	2.4	3.2	0.0	31.1	0.0	0.0	0	0.0
Subtotal										**18.6**	**4.7**	**2.1**	**37.4**	**1.8**	**1.4**	**1,552**	**0.0**
115kV Transmission Line Installation																	
Cable Pulling	Heavy-Duty Trucks	1		-		75 days	10 mi/day	750	miles	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0
	Winch	1	300	224		75 days	10 hrs/day	750	hours	1.7	0.3	0.0	0.7	0.2	0.2	129	0.0
Power Pole Installation	Bore/Drill Rigs	1	300	224		2 days	10 hrs/day	20	hours	0.0	0.0	0.0	0.0	0.0	0.0	4	0.0
	Crane	1	400	298		2 days	10 hrs/day	20	hours	0.1	0.0	0.0	0.0	0.0	0.0	5	0.0
	Heavy-Duty Trucks	1		-		2 days	10 mi/day	750	miles	0.0	0.0	0.0	0.0	0.0	0.0	0	0.0
Fugitive Emissions	All Types/Activities					1 acre	5 months	5	acre-months	0.0	0.0	0.0	0.0	0.6	0.1	0	0.0
Delivery of Supplies	Heavy-Duty Trucks	2		-		150 days	60 mi/day	18,000	total miles	0.2	0.0	0.0	0.1	0.0	0.0	0	0.0
Worker Transport	Pick-up Trucks	10		-		150 days	120 mi/day	180,000	total miles	2.4	3.2	0.0	31.1	0.0	0.0	0	0.0
Subtotal										**4.4**	**3.5**	**0.0**	**32.0**	**0.8**	**0.4**	**137**	**0.0**
TOTAL Emissions Over Construction Duration										**23.0**	**8.2**	**2.1**	**69.4**	**2.7**	**1.8**	**1689.4**	**0.0**

All operating hours will be metered to track actual emissions.

Revised July 2009 as directed by EPA & MMS

Cape Wind Energy Project
Construction Emissions Outside of 25 miles and in RI Waters

Note: All trips are one-way (not round trips).

Emission Factors from EPA's "Current Methodologies and Best Practices in Preparing Port Emission Inventories", April 2009

Diesel Fuel Sulfur Content:	500 ppm

Emission Factors - Ocean Going Vessel Main Engines, Medium-Speed Diesel, Marine Diesel Oil, g/kWh (Table 2-9)								
Engine	NOx	VOC (HC)	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
MSD & MDO	13.2	0.50	0.20	1.10	0.47	0.43	646.08	0.00635

Emission Factors - Harbor Craft, Tier 0, g/kWh (Table 3-8)								
Engine Power	NOx	VOC (HC)	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
225 - 449 kW (Cat. 1)	10.0	0.27	0.043	1.50	0.30	0.29	690.00	0.0161
450 - 559 kW (Cat. 1)	10.0	0.27	0.043	1.50	0.30	0.29	690.00	0.0161
560 - 999 kW (Cat. 1)	10.0	0.27	0.043	1.50	0.30	0.29	690.00	0.00635
1,000 kW (Cat. 1)	13.0	0.27	0.043	2.50	0.30	0.29	690.00	0.00635
1,000 - 3,000 kW (Cat. 2)	13.2	0.50	0.043	1.10	0.72	0.70	690.00	0.00635

Category 1 vessels are defined by EPA as small harbor craft and recreational propulsion (<1,000 kW)
Category 2 vessels are defined by EPA as OGV auxiliary engines, harbor craft, and smaller OGV propulsion (1,000-3,000 kW)
Category 3 vessels are defined by EPA as OGV propulsion engines (>3,000 kW)
HAP emission factors are from AP-42 (Sections 3.3 & 3.4)
Load Factors are from Table 3-4 of the EPA Port Emissions Guidance Document
Emissions (tons) = Engine Power Rating (kW) x Load Factor (%) x Activity (hrs) x Emission Factor (g/KWh) x (1 lb/454 g) x (1 ton/2000 lb) x (# of sources)

Activity Type	Vessel Type/ Emission Source	Number of Sources	Equipment Size (HP)	Equipment Size (kW)	Activity	Count	Duration (hrs/trip)	Operating Hours (per unit)	Assumptions	Load Factor	Auxiliary Engine Power Adjustment	Emissions (tons) NOx	VOC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
Construction Period - Activities beyond 25 Miles of the Project and in RI Waters																			
Move jack up barge	attendant tug	1	3,000	2,237	Trips to/fr Quonset Point, RI	4 trips	2	10		0.31	1.100	0.11	0.00	0.00	0.01	0.01	0.01	5.51	0.00
Transport piles & transition pieces	tow tug	1	6,000	4,474	Trips to/fr Quonset Point, RI	86 trips	2	204	avg. 3 piles per trip, 130 piles	0.68	1.100	9.94	0.38	0.15	0.83	0.35	0.32	486.38	0.00
Move scour installation equipment	attendant tug	1	3,000	2,237	Trips to/fr Quonset Point, RI	4 trips	2	10	This is done twice (once per year)	0.31	1.100	0.11	0.00	0.00	0.01	0.01	0.01	5.51	0.00
Transport rock armor barges	tow tug	1	6,000	4,474	Trips to/fr Quonset Point, RI	276 trips	2	656	Spd. 8 knts	0.68	1.100	31.89	1.21	0.48	2.66	1.14	1.04	1560.95	0.02
Transport filler material barges	tow tug	1	6,000	4,474	Trips to/fr Quonset Point, RI	370 trips	2	879	Spd. 8 knts	0.68	1.100	42.75	1.62	0.64	3.56	1.52	1.39	2092.58	0.02
Subtotal												**84.8**	**3.2**	**1.3**	**7.1**	**3.0**	**2.8**	**4,151**	**0.0**

Activity Type	Vessel Type/ Emission Source	Number of Sources	Equipment Size (HP)	Equipment Size (kW)	Activity	Count	Duration	Operating Hours (per unit)	Assumptions			Emissions (tons) NOx	VOC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
Cable laying																			
115 kV Cable laying barge	tow tug	1	1,500	1,119	Trips to/fr Quonset Point, RI	4 trips	2	10		0.31	1.100	0.05	0.00	0.00	0.00	0.00	0.00	2.75	0.00
33 kV Cable laying barge	tow tug	1	1,500	1,119	Trips to/fr Quonset Point, RI	26 trips	2	62	13 round trips	0.31	1.100	0.34	0.01	0.00	0.03	0.02	0.02	17.90	0.00
Move Crane barge to cofferdam location	tow tug	1	1,500	1,119	Trips to/fr Quonset Point, RI	4 trips	2	10		0.31	1.100	0.05	0.00	0.00	0.00	0.00	0.00	2.75	0.00
Subtotal												**0.4**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**23**	**0.0**
Turbine installation																			
Turbines	one specialized vessel	1	6,000	4,474	Trips to/fr Quonset Point, RI	86 trips	2	204		0.83	1.100	12.13	0.46	0.18	1.01	0.43	0.40	593.67	0.01
Subtotal												**12.1**	**0.5**	**0.2**	**1.0**	**0.4**	**0.4**	**594**	**0.0**
ESP Installation																			
Crane barge towing	tow tug	1	3,000	2,237	Trips to/fr Quonset Point, RI	2 trips	2	5		0.31	1.100	0.05	0.00	0.00	0.00	0.00	0.00	2.75	0.00
Pile Installation barge towing	tow tug	1	3,000	2,237	Trips to/fr Quonset Point, RI	2 trips	2	5		0.31	1.100	0.05	0.00	0.00	0.00	0.00	0.00	2.75	0.00
ESP deck to wind farm	tow tug	1	6,000	4,474	Trips to/fr Quonset Point, RI	2 trips	2	5		0.68	1.100	0.23	0.01	0.00	0.02	0.01	0.01	11.31	0.00
Crane barge towing	tow tug	1	3,000	2,237	Trips to/fr Quonset Point, RI	2 trips	2	5		0.31	1.100	0.05	0.00	0.00	0.00	0.00	0.00	2.75	0.00
Subtotal												**0.4**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**20**	**0.0**
TOTAL Construction Emissions Over 2-year Construction Duration												**97.8**	**3.7**	**1.5**	**8.1**	**3.5**	**3.2**	**4,788**	**0.0**

- Quonset Point to RI Border = 19 Miles
- Miles are nautical milles
A vessel speed of 8 knots was assumed to determine the duration for each trip
All operating hours will be metered to track actual emissions.

Revised July 2009 as directed by EPA & MMS

Cape Wind Energy Project
Construction Emissions Outside of 25 miles and in MA Waters

Note: All trips are one-way (not round trips).

Emission Factors from EPA's "Current Methodologies and Best Practices in Preparing Port Emission Inventories", April 2009

Diesel Fuel Sulfur Content:	500 ppm

Emission Factors - Ocean Going Vessel Main Engines, Medium-Speed Diesel, Marine Diesel Oil, g/kWh (Table 2-9)								
Engine	**NOx**	**VOC (HC)**	**SO_2**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**HAPs**
MSD & MDO	13.2	0.50	0.20	1.10	0.47	0.43	646.08	0.00635

Emission Factors - Harbor Craft, Tier 0, g/kWh (Table 3-8)								
Engine Power	**NOx**	**VOC (HC)**	**SO_2**	**CO**	**PM_{10}**	**$PM_{2.5}$**	**CO_2**	**HAPs**
225 - 449 kW (Cat. 1)	10.0	0.27	0.043	1.50	0.30	0.29	690.00	0.0161
450 - 559 kW (Cat. 1)	10.0	0.27	0.043	1.50	0.30	0.29	690.00	0.0161
560 - 999 kW (Cat. 1)	10.0	0.27	0.043	1.50	0.30	0.29	690.00	0.00635
1,000 kW (Cat. 1)	13.0	0.27	0.043	2.50	0.30	0.29	690.00	0.00635
1,000 - 3,000 kW (Cat. 2)	13.2	0.50	0.043	1.10	0.72	0.70	690.00	0.00635

Category 1 vessels are defined by EPA as small harbor craft and recreational propulsion (<1,000 kW)
Category 2 vessels are defined by EPA as OGV auxiliary engines, harbor craft, and smaller OGV propulsion (1,000-3,000 kW)
Category 3 vessels are defined by EPA as OGV propulsion engines (>3,000 kW)
HAP emission factors are from AP-42 (Sections 3.3 & 3.4)
Load Factors are from Table 3-4 of the EPA Port Emissions Guidance Document
Emissions (tons) = Engine Power Rating (kW) x Load Factor (%) x Activity (hrs) x Emission Factor (g/KWh) x (1 lb/454 g) x (1 ton/2000 lb) x (# of sources)

Activity Type	Vessel Type/ Emission Source	Number of Sources	Equipment Size (HP)	Equipment Size (kW)	Activity	Count	Duration (hrs/trip)	Operating Hours (per unit)	Assumptions	Load Factor	Auxiliary Engine Power Adjustment	Emissions (tons)							
												NOx	VOC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
Construction Period - Activities beyond 25 Miles of the Project and in MA Waters																			
Move jack up barge	attendant tug	1	3,000	2,237	Trips to/fr Quonset Point, RI	4 trips	1	4		0.31	1.100	0.04	0.00	0.00	0.00	0.00	0.00	2.12	0.00
Transport piles and transition pieces	tow tug	1	6,000	4,474	Trips to/fr Quonset Point, RI	86 trips	1	78	avg. 3 piles per trip, 130 piles	0.68	1.100	3.82	0.14	0.06	0.32	0.14	0.12	186.87	0.00
Move scour installation equipment	attendant tug	1	3,000	2,237	Trips to/fr Quonset Point, RI	4 trips	1	4	This is done twice (once per year)	0.31	1.100	0.04	0.00	0.00	0.00	0.00	0.00	2.12	0.00
Transport rock armor barges	tow tug	1	6,000	4,474	Trips to/fr Quonset Point, RI	276 trips	1	252	Spd. 8 knts	0.68	1.100	12.25	0.46	0.18	1.02	0.44	0.40	599.74	0.01
Transport filler material barges	tow tug	1	6,000	4,474	Trips to/fr Quonset Point, RI	370 trips	1	338	Spd. 8 knts	0.68	1.100	16.43	0.62	0.25	1.37	0.58	0.54	803.99	0.01
Subtotal												**32.6**	**1.2**	**0.5**	**2.7**	**1.2**	**1.1**	**1,595**	**0.0**

Activity Type	Vessel Type/ Emission Source	Number of Sources	Equipment Size (HP)	Equipment Size (kW)	Activity	Count	Duration	Operating Hours (per unit)	Assumptions			Emissions (tons)							
												NOx	VOC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
Cable laying																			
115 kV Cable laying barge	tow tug	1	1,500	1,119	Trips to/fr Quonset Point, RI	4 trips	1	4		0.31	1.100	0.02	0.00	0.00	0.00	0.00	0.00	1.06	0.00
33 kV Cable laying barge	tow tug	1	1,500	1,119	Trips to/fr Quonset Point, RI	26 trips	1	24	13 round trips	0.31	1.100	0.13	0.00	0.00	0.01	0.01	0.01	6.88	0.00
Move Crane barge to cofferdam location	tow tug	1	1,500	1,119	Trips to/fr Quonset Point, RI	4 trips	1	4		0.31	1.100	0.02	0.00	0.00	0.00	0.00	0.00	1.06	0.00
Subtotal												**0.2**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**9**	**0.0**
Turbine installation																			
Turbines	one specialized vessel	1	6,000	4,474	Trips to/fr Quonset Point, RI	86 trips	1	78		0.83	1.100	4.66	0.18	0.07	0.39	0.17	0.15	228.10	0.00
Subtotal												**4.7**	**0.2**	**0.1**	**0.4**	**0.2**	**0.2**	**228**	**0.0**
ESP Installation																			
Crane barge towing	tow tug	1	3,000	2,237	Trips to/fr Quonset Point, RI	2 trips	1	2		0.31	1.100	0.02	0.00	0.00	0.00	0.00	0.00	1.06	0.00
Pile Installation barge towing	tow tug	1	3,000	2,237	Trips to/fr Quonset Point, RI	2 trips	1	2		0.31	1.100	0.02	0.00	0.00	0.00	0.00	0.00	1.06	0.00
ESP deck to wind farm	tow tug	1	6,000	4,474	Trips to/fr Quonset Point, RI	2 trips	1	2		0.68	1.100	0.09	0.00	0.00	0.01	0.00	0.00	4.35	0.00
Crane barge towing	tow tug	1	3,000	2,237	Trips to/fr Quonset Point, RI	2 trips	1	2		0.31	1.100	0.02	0.00	0.00	0.00	0.00	0.00	1.06	0.00
Subtotal												**0.1**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**8**	**0.0**
TOTAL Construction Emissions Over 2-year Construction Duration												**37.6**	**1.4**	**0.6**	**3.1**	**1.3**	**1.2**	**1,839**	**0.0**

- MA Border to 25-mile limit = 7.3 Miles
- Miles are nautical miles
A vessel speed of 8 knots was assumed to determine the duration for each trip
All operating hours will be metered to track actual emissions.

Revised July 2009 as directed by EPA & MMS

Cape Wind Energy Project
Total Construction Emissions Outside of 25 miles

Note: All trips are one-way (not round trips).

Emission Factors from EPA's "Current Methodologies and Best Practices in Preparing Port Emission Inventories", April 2009

Emission Factors - Ocean Going Vessel Main Engines, Medium-Speed Diesel, Marine Diesel Oil, g/kWh (Table 2-9)								
Engine	NOx	VOC (HC)	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
MSD & MDO	13.2	0.50	0.20	1.10	0.47	0.43	646.08	0.00535

Emission Factors - Harbor Craft, Tier 0, g/kWh (Table 3-8)								
Engine Power	NOx	VOC (HC)	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
225 - 449 kW (Cat. 1)	10.0	0.27	0.043	1.50	0.30	0.29	690.00	0.0161
450 - 559 kW (Cat. 1)	10.0	0.27	0.043	1.50	0.30	0.29	690.00	0.0161
560 - 999 kW (Cat. 1)	10.0	0.27	0.043	1.50	0.30	0.29	690.00	0.00635
1,000 kW (Cat. 1)	13.0	0.27	0.043	2.50	0.30	0.29	690.00	0.00635
1,000 - 3,000 kW (Cat. 2)	13.2	0.50	0.043	1.10	0.72	0.70	690.00	0.00635

Diesel Fuel Sulfur Content:	500 ppm

Category 1 vessels are defined by EPA as small harbor craft and recreational propulsion (<1,000 kW)
Category 2 vessels are defined by EPA as OGV auxiliary engines, harbor craft, and smaller OGV propulsion (1,000-3,000 kW)
Category 3 vessels are defined by EPA as OGV propulsion engines (>3,000 kW)
HAP emission factors are from AP-42 (Sections 3.3 & 3.4)
Load Factors are from Table 3-4 of the EPA Port Emissions Guidance Document
Emissions (tons) = Engine Power Rating (kW) x Load Factor (%) x Activity (hrs) x Emission Factor (g/KWh) x (1 lb/454 g) x (1 ton/2000 lb) x (# of sources)

Activity Type	Vessel Type/ Emission Source	Number of Sources	Equipment Size (HP)	Equipment Size (kW)	Activity	Count	Duration (hrs/trip)	Operating Hours (per unit)	Assumptions	Load Factor	Auxiliary Engine Power Adjustment	Emissions (tons) NOx	VOC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
Construction Period - Activities beyond 25 Miles of the Project																			
Move jack up barge	attendant tug	1	3,000	2,237	Trips to/fr Quonset Point, RI	4 trips	4	17		0.31	1.100	0.19	0.01	0.00	0.02	0.01	0.01	10.12	0.00
Transport piles & transition pieces	tow tug	1	6,000	4,474	Trips to/fr Quonset Point, RI	86 trips	4	375	avg. 3 piles per trip, 130 piles	0.68	1.100	18.25	0.69	0.27	1.52	0.65	0.59	893.41	0.01
Move scour installation equipment	attendant tug -	1	3,000	2,237	Trips to/fr Quonset Point, RI	4 trips	4	17	This is done twice (once per year)	0.31	1.100	0.19	0.01	0.00	0.02	0.01	0.01	10.12	0.00
Transport rock armor barges	tow tug	1	6,000	4,474	Trips to/fr Quonset Point, RI	276 trips	4	1,204	Spd. 8 knts	0.68	1.100	58.58	2.22	0.88	4.88	2.09	1.91	2867.23	0.03
Transport filler material barges	tow tug	1	6,000	4,474	Trips to/fr Quonset Point, RI	370 trips	4	1,614	Spd. 8 knts	0.68	1.100	78.53	2.97	1.18	6.54	2.80	2.56	3843.75	0.04
Subtotal												155.8	5.9	2.3	13.0	5.6	5.1	7,625	0.1

Activity Type	Vessel Type/ Emission Source	Number of Sources	Equipment Size (HP)	Equipment Size (kW)	Activity	Count	Duration	Operating Hours (per unit)	Assumptions	Load Factor	Auxiliary Engine Power Adjustment	Emissions (tons) NOx	VOC	SO_2	CO	PM_{10}	$PM_{2.5}$	CO_2	HAPs
Cable laying																			
115 kV Cable laying barge	tow tug	1	1,500	1,119	Trips to/fr Quonset Point, RI	4 trips	4	17		0.31	1.100	0.10	0.00	0.00	0.01	0.01	0.01	5.06	0.00
33 kV Cable laying barge	tow tug	1	1,500	1,119	Trips to/fr Quonset Point, RI	26 trips	4	113	13 round trips	0.31	1.100	0.63	0.02	0.00	0.05	0.03	0.03	32.88	0.00
Move Crane barge to cofferdam location	tow tug	1	1,500	1,119	Trips to/fr Quonset Point, RI	4 trips	4	17		0.31	1.100	0.10	0.00	0.00	0.01	0.01	0.01	5.06	0.00
Subtotal												0.8	0.0	0.0	0.1	0.0	0.0	43	0.0
Turbine Installation																			
Turbines	one specialized vessel	1	6,000	4,474	Trips to/fr Quonset Point, RI	86 trips	4	375		0.83	1.100	22.28	0.84	0.34	1.66	0.79	0.73	1090.49	0.01
Subtotal												22.3	0.8	0.3	1.9	0.8	0.7	1,090	0.0
ESP Installation																			
Crane barge towing	tow tug	1	3,000	2,237	Trips to/fr Quonset Point, RI	2 trips	4	9		0.31	1.100	0.10	0.00	0.00	0.01	0.01	0.01	5.06	0.00
Pile Installation barge towing	tow tug	1	3,000	2,237	Trips to/fr Quonset Point, RI	2 trips	4	9		0.31	1.100	0.10	0.00	0.00	0.01	0.01	0.01	5.06	0.00
ESP deck to wind farm	tow tug	1	6,000	4,474	Trips to/fr Quonset Point, RI	2 trips	4	9		0.68	1.100	0.42	0.02	0.01	0.04	0.02	0.01	20.78	0.00
Crane barge towing	tow tug	1	3,000	2,237	Trips to/fr Quonset Point, RI	2 trips	4	9		0.31	1.100	0.10	0.00	0.00	0.01	0.01	0.01	5.06	0.00
Subtotal												0.7	0.0	0.0	0.1	0.0	0.0	36	0.0
TOTAL Construction Emissions Over 2-year Construction Duration												179.6	6.8	2.7	15.0	6.4	5.9	8,794	0.1

- Quonset Point to 25-mile limit = 34.9 Miles
- Miles are nautical miles
A vessel speed of 8 knots was assumed to determine the duration for each trip
All operating hours will be metered to track actual emissions.