Northeast Gateway Energy Bridge™ Deepwater Port Project

Northeast Gateway, L.L.C.

Minor Source Air Permit Application

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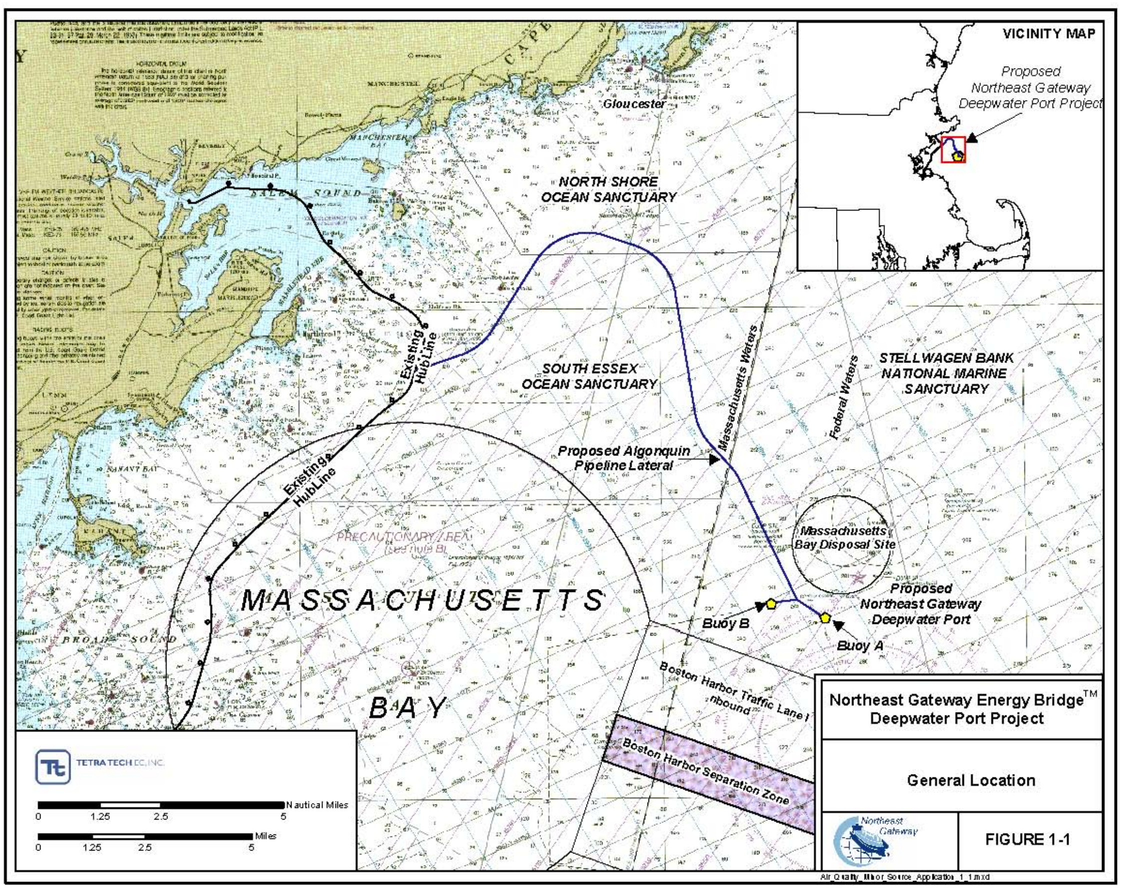
SECTION 1 INTRODUCTION

Northeast Gateway Energy Bridge, L.L.C. (Northeast Gateway) is proposing to construct, own, and operate the Northeast Gateway Energy Bridge™ Deepwater Port (Northeast Port or Port) to import liquefied natural gas (LNG) into the New England region. The Northeast Gateway Energy Bridge™ is a project that will allow LNG to be delivered in a reliable, safe and environmentally friendly manner, without the need for an on-shore terminal, near-shore ship traffic, or an offshore platform. The Port, which will be located in Massachusetts Bay, will consist of two submerged buoy systems to moor LNG carriers approximately 13 miles (21 kilometers) offshore in federal waters (see Figure 1-1). This facility will deliver regasified LNG to onshore markets via pipeline facilities owned and operated by Algonquin Gas Transmission, LLC (Algonquin). Algonquin will build and operate a pipeline lateral (Pipeline Lateral) to interconnect the Port to Algonquin's existing offshore pipeline system called the HubLine. Together, the Port and Pipeline Lateral form the Northeast Gateway Deepwater Port Project (Project). Carriers will typically remain moored for approximately 7-8 days while regasifying LNG into the Port and Pipeline Lateral. This same technology is already in use at a similar deepwater port, the Gulf Gateway Energy Bridge™, (Gulf Gateway) located in the Gulf of Mexico.

Figure 1-1. General Location



Northeast Gateway will be required to obtain a license to own and operate the Port from the United States Department of Transportation (USDOT) which has delegated this responsibility to USDOT's Maritime Administration (MARAD) and to the U.S. Coast Guard (USCG) within the Department of Homeland Security. The Pipeline Lateral will require a Certificate of Public Convenience and Necessity from the Federal Energy Regulatory Commission (FERC). The FERC is responsible for the review and approval of interstate natural gas pipelines under the Natural Gas Act. Amendments by the Maritime Transportation Security Act of 2002 extended the definition of deepwater ports under the Deep Water Port Act (DWPA) to include natural gas facilities. The Secretary of Transportation must designate as an "adjacent state" any coastal state that is either: connected by pipeline to the deepwater port or would be located within 15 miles of the deepwater port. Massachusetts meets the criteria for designation as the nearest adjacent state.

While the Port is located outside Massachusetts state waters, much of the interconnecting Pipeline Lateral is in state territorial waters. The Port and the Pipeline Lateral are being reviewed together in the same environmental impact review documents. The Project is undergoing the National Environmental Policy Act (NEPA) and Massachusetts Environmental Policy Act (MEPA) review in one combined Environmental Impact Statement (EIS) to allow for a more efficient evaluation of the overall Project. The Massachusetts Executive Office of Environmental Affairs has already agreed to have the Project reviewed together under MEPA and to have the federal EIS also serve as the state Environmental Impact Report (EIR).

1.1 Purpose of this Application

Although the LNG carriers are marine vessels, and emissions from marine vessels (even when moored) are included in the mobile source portion of the Massachusetts DEP's emissions inventory, the U.S. Environmental Protection Agency (EPA) has made a determination to subject the carriers to stationary source emissions regulations, as will be described in more detail in Section 1.3. Northeast Gateway does not agree with EPA's jurisdictional determination. Nevertheless, Northeast Gateway has cooperated fully with EPA to develop this application.

In the original DWPA application for this Project, submitted in June of 2005, the Project's potential emissions were presented as large enough to classify the Port as a major air pollution source subject to Federal Nonattainment New Source Review and Prevention of Significant Deterioration regulations. However in December of 2005, after months of analysis, reengineering and redesign and at substantial additional cost, Northeast Gateway announced that the Port emissions will be below the major source thresholds, and that all vessels using the Northeast Gateway facility would adopt innovative air pollution control equipment and procedures. As is described in detail in Section 5 of this application, this will involve the first application of innovative pollution control techniques to boilers on a marine vessel and their implementation will truly advance the state-of-the-art of marine vessel air pollution control. With the reduced emissions and operating restrictions, the Port will not be subject to federal Clean Air Act permitting requirements. However, in accordance with direction from EPA, the Project is still subject to the air quality regulations of Massachusetts (the nearest adjacent state).

The purpose of this application is to provide all information required by the Massachusetts regulations for a minor stationary source permit and to demonstrate compliance with all applicable federal and state regulations, thus allowing for the granting of a minor source permit by EPA.

1.2 General Project Description

1.2.1 Project Need

The Project will provide additional natural gas supplies to Massachusetts and New England, at an average annual baseload send out rate of approximately 400 million cubic feet per day (MMcfd, or 11 million cubic meters) with a peak send out of 800 MMcfd (22 million cubic meters). The Project will provide a reliable and timely supply of clean-burning natural gas through a portal into the natural gas transmission system for Massachusetts and New England that minimizes environmental impacts, mitigates safety concerns, and increases energy diversity for the onshore infrastructure and the communities that it serves.

Natural gas use for electricity generation in the New England market has continued to increase. Since 1998, electric power companies have added 23 new power plants representing over 9,000 megawatts (MW) of new summertime generating capability in the New England market. Much of this generation capacity in New England is fired by natural gas on either a single-fuel or a dual-fuel basis. In Massachusetts alone, nearly 4,000 MW of new gas-fired capacity has come on line since 1998. Between 2005 and 2025, U.S. Department of Energy (DOE) estimates that demand for natural gas associated with electric generation in New England will grow from approximately 320,000 MMcf to about 500,000 MMcf (DOE/EIA 2005). As a positive consequence of this growth in use of gas for electric generation, the air emission rates of the newer, more-efficient gas-fired plants and repowering with natural gas will be very low relative to emission rates of New England's less-efficient non-gas fossil-fueled generators, thus ensuring that as demand for power increases in Massachusetts and New England, the generation of the increased power can be achieved with lower emissions. It has been estimated in the ER contained in the DWPA application for the Project that just half of the Project's 400 million standard cubic feet per day of natural gas could offset enough power plant coal and oil consumption to reduce up to thousands of tons of each criteria air pollutant emitted in the New England region annually.

The Project provides incremental natural gas supplies to the region by interconnecting a new high-pressure supply source at the eastern end of the Algonquin pipeline system, reducing the need for additional new pipeline facilities to be added to the existing natural gas trunklines into the region. New England has virtually no known native sources of natural gas, and almost no capacity for storing gas in large geologic repositories (such as salt caverns or depleted natural gas reservoirs). The New England region is, in effect, at the end of the major natural gas pipeline systems from the Gulf of Mexico region, the western United States, and Western Canadian sources that serve natural gas demand in Massachusetts and the New England region. These factors make the task of meeting New England's growing demand for natural gas more difficult. Massachusetts consumers, along with those in the rest of New England, will benefit from having a nearby gas supply portal provided by the Port, thereby partially offsetting the impact of being the "last stop" on long-distance pipeline networks.

1.2.2 Northeast Port and Energy Bridge Regasification Vessels (EBRVs)

The Port will consist of two subsea Submerged Turret Loading™ (STL™) buoys, each with a flexible riser assembly and a manifold connecting the riser assembly, via a flow line, to the subsea Pipeline Lateral. Northeast Gateway will utilize a fleet of specially designed Energy Bridge™ Regasification Vessels (EBRVs) to deliver LNG to the Port. EBRVs are purpose-built LNG tankers that incorporate onboard equipment for the vaporization of LNG and delivery of high-pressure natural gas. Two EBRVs (*Excelsior* and *Excellence*) are already operational at the Gulf Gateway facility and a third (*Excelerate*) will be operational later this year. Each of these "first generation" vessels is capable of transporting approximately 2.9 billion cubic feet of natural gas condensed to approximately 4.9 million cubic feet (approximately 138,000 cubic meters) of LNG. The first generation EBRVs include three fossil fuel fired combustion units (two main boilers, each with a heat input capacity of 224 MMBtu per hour and a 3650 kW auxiliary generator) to provide energy for the regasification process. While the boilers produce steam for steam turbines which operate to propel the vessels through the water, they are also used to vaporize the LNG while the vessels are moored. The generators are auxiliary equipment for power when one or more of the steam turbines are out of service

The first of a second generation of vessels, the *Explorer*, has been ordered and is scheduled for commissioning in March 2008, shortly after the Port is expected to become operational.. These second generation vessels will have additional transport capacity (approximately 3.2 billion cubic feet of natural gas condensed to approximately 5.4 million cubic feet (approximately 151,000 cubic meters). The second generation vessels will also have a fourth fossil fuel fired combustion unit (a 100 MMBtu per hour auxiliary boiler) allowing an increased regasification rate. It is the fossil fuel fired combustion equipment on first and second generation EBRVs that are the subject of this permit application as is described further in the following paragraphs.

Although these first two generations of vessels are the only ones known to be able to regasify at the Port (and the only vessels doing so for the first few years of Port operation), the mooring system is designed to handle other and potentially larger LNG vessels that may come into service in the future. However, total annual emissions from all operations at Northeast Gateway would be limited to the totals shown in this application. The EBRVs will moor at the STL™ buoys, which in turn will serve as both the single-point mooring system for the vessels and the delivery conduit for natural gas.

Natural gas that has been chilled to -260 ºF (-162 ºC) at atmospheric pressure changes from a gaseous state to a more stable liquid state referred to as LNG. LNG will be transported on the specially designed EBRVs from international sources to the proposed Port. The EBRVs are designed for safe and efficient operation, with maximum operational performance and minimum downtime risks.

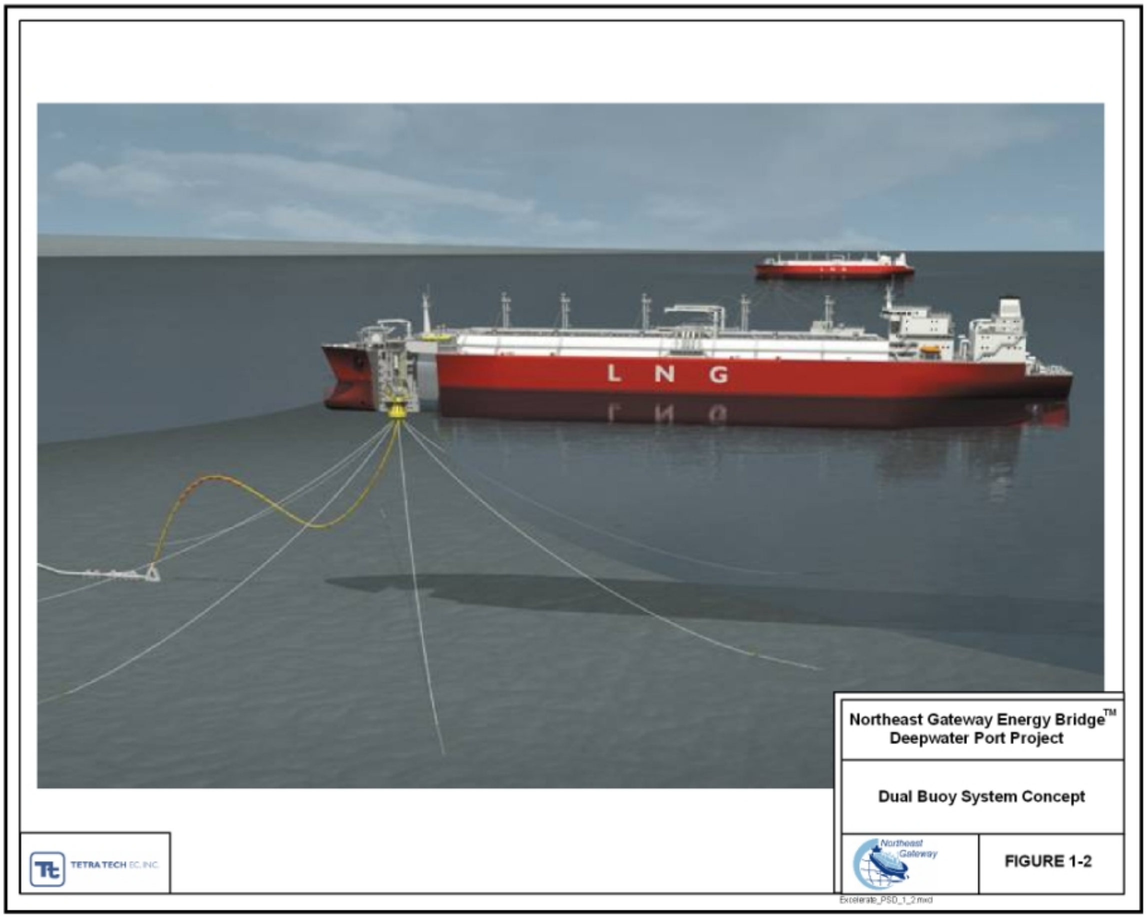
The vessels are capable of loading in the same manner as standard LNG tankers at traditional liquefaction terminals, and also retain the flexibility to discharge liquid at conventional onshore LNG receiving terminals. The on-board regasification process will utilize a freshwater-based, closed-loop warming system to vaporize the LNG. As part of the vessel's normal propulsion and auxiliary systems, seawater will be used for condensing exhaust steam in the main condenser and for a variety of cooling water functions. The typical seawater demand required by the EBRVs to operate these systems, plus ballast water intake, is approximately 56 million gallons per day (mgd). This seawater demand is typical of most LNG vessels and most large crude carriers (oil tankers over 200,000 dead weight tons [dwt]) that are currently in service today. However, while at Port, Northeast Gateway will be significantly reducing the amount of seawater used while the EBRV is in the regasification mode by implementing seawater heat exchangers in the vessel seawater piping system that will enable the vessel to operate under the innovative closed-loop heat recovery and exchange mode during the regasification process. Operating under the closed-loop heat recovery and exchange mode, will reduce average daily water use while at a steady-state send-out of LNG at the Port from approximately 56 mgd to only 2.77 mgd.

The regasification system will allow the average delivery of approximately 400 million cubic feet per day (MMcfd) (11 million cubic meters per day) of natural gas at pipeline pressure. Higher rates will be achievable, particularly on the second generation EBRVs. To deliver a continuous base load supply of natural gas into the natural gas grid, Northeast Gateway will continuously operate at least one EBRV on location as LNG is regasified and delivered into the pipeline system. As such, a new cargo of LNG will be delivered approximately every 6 to 7 days.

When an EBRV arrives at the Port, it will retrieve one of the two permanently anchored submerged STL™ buoys. Once moored at the buoy, the EBRV will vaporize the LNG into its gaseous state using the onboard regasification system. As the LNG is regasified, the resulting natural gas is transferred off the EBRV at pipeline pressures through the STL™ buoy and flexible riser via a subsea flow line leading to the connecting Pipeline Lateral. Other than the connecting Pipeline Lateral, no other pipeline, storage, or related ancillary facilities will be required to deliver the natural gas to Massachusetts and New England markets, with the exception of minor onshore metering facility modifications to properly measure the delivered volumes of natural gas, already described in the DWPA application.

Northeast Gateway has begun initial detailed design tasks and will begin long-lead procurement for the Port facilities in the next few months, including STL™ buoy fabrication and pipe purchases. It is anticipated that off-site fabrication of the STL™ buoy will take approximately 9 months, and the on-site construction and installation of the STL™ buoy and the remaining components that comprise the Port will take approximately 5 months. Following construction, Northeast Gateway will conduct tests to ensure the system is ready to operate safely. Northeast Gateway plans to be operational and ready to receive its first delivery of regasified LNG by the fourth quarter of 2007 to meet the 2007/2008 winter heating season. Figure 1-2 illustrates the Port's dual buoy system concept.

Figure 1-2. Dual Buoy System Concept



1.2.3 Pipeline Lateral

As shown in Figure 1-1, the Pipeline Lateral will begin at the existing HubLine in waters approximately 3 miles (4.8 kilometers) to the east of Marblehead Neck in Marblehead, Massachusetts. From this point (milepost [MP] 0.0), the Pipeline Lateral route extends towards the northeast for approximately 6.3 miles (10.1 kilometers). At MP 6.3 the Pipeline Lateral route curves to the east and southeast entering waters regulated by the Commonwealth. The Pipeline Lateral route continues to the south/southeast for approximately 6.2 miles (10.0 kilometers) to MP 12.5, where it exits state waters and enters federal waters. The Pipeline Lateral route then extends to the south for another approximately 3.9 miles (6.3 kilometers), terminating near the Port. Construction of the Pipeline Lateral will take approximately 9 months. There are no operational air quality emissions from the pipeline itself.

1.3 Air Quality Regulatory Interpretations

Permitting of the Port under air quality stationary source preconstruction permitting regulations and procedures raises a number of significant issues, which are discussed briefly in this subsection.

1.3.1 *Stationary Source Regulatory Issues for the Port Generally*

The Clean Air Act provides fundamentally different approaches to the regulation of stationary sources and mobile sources. For example, New Source Performance Standards (NSPS) for **stationary sources** are addressed in Section 111 of the Act, and standards for nonroad engines (including marine engines) are addressed in Title II of the Act. Section 111(a)(3) specifically states that "nothing in Title II of this Act relating to nonroad engines shall be construed to apply to stationary internal combustion engines" and Section 216(10) of Title II specifically states that "the term 'nonroad engines' means an internal combustion engine...that is not subject to standards promulgated under section 111". In general, states are allowed to set their own requirements for stationary source controls, but are more restricted with regard to the regulation of mobile sources, in part because it is not feasible for sources traveling from one jurisdiction to another to be able to track or comply with all of the different requirements that different states may set. In the case of marine vessels, travel is not just interstate but also international. For example, the International Maritime Organization (IMO) recently developed regulations for air pollution from ships (Annex VI of MARPOL 73/78) and the United States is a signatory to those regulations. EPA's Tier 1 NO_x regulations for new marine engines (40 CFR 94, developed under Title II of the Act) also match the IMO regulations.

Regulations for stationary sources have been developed for facilities with well-defined boundaries under common ownership and control; the number of pieces of equipment on-site is fixed, and permits are required for new sources to be added. The regulations differ in the degree of stringency based on the air quality in the area where the new source proposes to locate. For example, more stringent emission limits are required if the proposed source is located in an area designated non-attainment for a pollutant for which the source would be a major source. An emissions source may be required to install advanced pollution control technology in order to get a permit to locate in these areas whereas the same source type might be permitted in less sensitive areas with less sophisticated and more economically feasible air pollution control technology. The stationary source permitting program in part therefore manages air quality by encouraging new sources to locate in less sensitive areas.

The **mobile source** program is designed for sources that are not under common control and are not fixed in one place, which is the case with the Project. States are required to set emissions budgets for all mobile source activity in their area, and projects involving mobile sources are required to demonstrate that they conform to those budgets. Conformity is typically demonstrated not by controlling individual sources but may involve other types of emissions controls and classes of sources (for example, highway projects that increase PM emissions may pave unpaved roads to generate emissions credits).

Typically, vessel emissions are subject to conformity regulations for mobile sources of air pollution, rather than permitting regulations for stationary sources of air pollution (which specifically exempt mobile sources).[1] However, this stationary source permit application has been requested by the U.S. Environmental Protection Agency (EPA), which is proposing to regulate the emissions associated with regasification operations from the moored LNG vessels as a stationary source.

With regard to the applicability of state regulations outside state territorial waters, the federal Deepwater Port Act states that the "law of the nearest adjacent coastal state...is declared to be the law of the United States, and shall apply to any deepwater port...to the extent applicable and not inconsistent with any provision or regulation under this Act or other Federal laws and regulations" [§19(b)]. Massachusetts regulations specific to marine vessels (such as those for opacity, as will be discussed in Section 4) logically could be applied to the vessels moored at the Port.

1.3.2 Stationary Source Permitting of Regasification Process Emissions Only

In the Gulf Gateway determination, EPA stated that "*Emissions related to re-gasification and transfer of gas at the port will be included in the CAA operating and preconstruction permit applicability determinations without regard to whether those emissions originated on the metering platforms or the EPEBVs.*"[2,3] In that same letter, EPA stated, "*However, we believe that these statutory definitions do not require EPA to include "to and fro" emissions from marine vessels powered by external combustion engines, or the vessels' "hotelling" emissions not directly associated with the activities of the part as port of the emissions attributable to the port facility.*"

While EPA Region I has indicated concurrence with these prior interpretations by EPA Region VI, they have cautioned Northeast Gateway with regard to "hotelling" emissions due to a unique definition in the Massachusetts Nonattainment New Source Review Regulations. Specifically, EPA Region I initially interpreted Massachusetts' nonattainment New Source Review (NSR) regulations for stationary sources as meaning that "*all regulated air pollutant emissions from LNG vessels moored to the buoy system – i.e., both regasification and "hotelling" emissions – are subject to major source NNSR requirements*."[4] However, Massachusetts DEP emissions inventory staff have clarified that although the regulatory wording (310 CMR 7.00 Appendix A) still states that "any marine vessel is part of a facility while docked at the facility," vessel "hotelling" emissions were reclassified from being stationary area source emissions to being non-road mobile source emissions in the mid-1990s and are currently explicitly included within

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[1] For example, the definition of "Stationary Source" in Massachusetts stationary source permitting regulations (310 CMR 7.00, Appendix A) states that "A stationary source does not include...tailpipe emissions from any source regulated under title II of the [Clean Air] Act"; marine engines (and other mobile source engines) are regulated under title II of the Clean Air Act.

[2] Letter from Charles J. Sheehan, Regional Counsel of EPA Region VI, to Michael Cathey, Managing Director of El Paso Energy Bridge Gulf of Mexico, L.L.C., October 28, 2003.

[3] EPEBV was the term used previously for EBRV.

[4] L. Murphy (US EPA Region I), letter to Rob Bryngelson (Excelerate Energy) "Re: Clean Air Act and Clean Water Act Permit Applications for the Proposed Northeast Gateway Energy Bridge, LLC, Deepwater Port," September 16, 2005.

the non-road mobile source emissions inventory[5] in Massachusetts' State Implementation Plan (SIP).[6] Northeast Gateway is not proposing, and does not believe, that this minor equipment associated with "hotelling" be included in the air permit; emissions from this minor equipment is included in this application solely in response to EPA Region I's initial interpretation associated with 310 CMR 7.00 Appendix A. The minor equipment is discussed only in Sections 2 and 3 of this application related to emissions and solely to demonstrate that even using the Massachusetts definitions in Appendix A that the Port would not be a major source of a nonattainment pollutant.

Emissions from in-transit LNG vessels and "hotelling" emissions would still be subject to conformity regulations. In summary, this "stationary source" application addresses only emissions directly associated with regasification operations while the EBRVs are moored, consistent with the Gulf Gateway air permit. The conformity analysis previously submitted to the U. S. Coast Guard (included in this application as Appendix D) includes the regasification emissions as well. That analysis also addresses the in-transit and "hotelling" emissions (as well as other support vessel emissions and construction emissions).

1.4 Application Organization

Section 2 of the application provides a more detailed description of the project, particularly the equipment and operating conditions that are considered stationary sources for the purpose of this application. Maximum potential emissions of the facility for determination of pollutant-specific applicability to various permitting requirements are provided in Section 3. As described in the prior subsection, Section 3 includes a presentation of emissions from non-regasification ("hotelling") sources as well as the main regasification emissions. This allows for a confirmation that the Port would be classified as a minor source even under the definition of stationary source included in Massachusetts Nonattainment NSR Regulations. Section 4 identifies the applicable federal and Massachusetts regulations based on the facility's design characteristics and potential emissions and compliance with these regulatory requirements is demonstrated. A determination of best available control technology (BACT), one of the key Massachusetts regulatory requirements, is presented in Section 5 with consideration provided to account for the "marine vessel" nature of the emission sources. Section 6 presents the air quality impact assessment (dispersion modeling) to demonstrate the maximum impact of project emissions relative to national ambient air quality standards (NAAQS) and PSD increments. Appendix A contains application forms (Northeast Gateway has selected the Massachusetts DEP Plan Approval application forms). Appendix B contains vendor specification and design data for the regasification process fuel burning equipment and air pollution control equipment. Appendix C provides supporting emissions calculations while Appendix D contains a copy of the Support Document for a General Conformity Determination submitted to the U.S. Coast Guard. Appendix E contains dispersion modeling input and output files.

[5] Massachusetts DEP, "Massachusetts Periodic Emission Inventories 1999 - VOC, NOx and CO," April 2003 (Section 5.3 e-mailed from Ken Santlal, Massachusetts DEP, to Todd Tamura, Tetra Tech EC, Inc., May 2005).
[6] K. Santlal (Massachusetts DEP), e-mail message to Todd Tamura (Tetra Tech EC, Inc.), April 29, 2005.

SECTION 2 PROJECT DESCRIPTION

The proposed Northeast Gateway Deepwater Port Project consists of the construction and operation of two major components: 1) The Northeast Port consisting of two STL™ buoy systems, each with its own flexible riser, pipeline end manifold (PLEM), and flow line; and 2) a Pipeline Lateral to be constructed and operated by Algonquin connecting both flow lines to the existing HubLine. Figure 1-1 in the prior section shows the location of the Northeast Port (STL™ buoy locations "A" and "B") and connecting Pipeline Lateral in Massachusetts Bay.

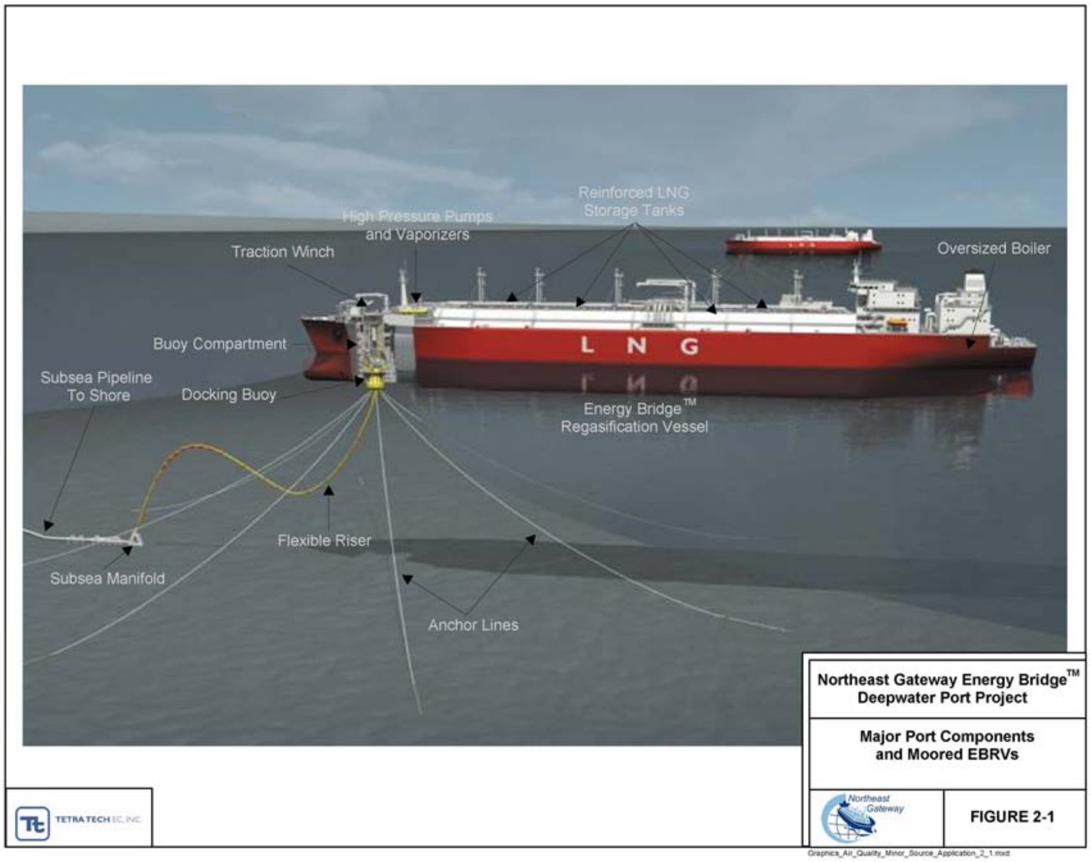
This project description provides an overview of project components and activities that are not necessarily closely related to the regasification operations. As noted in Section 1, the focus of this application is on the air emissions sources from the EBRVs associated with regasification operations. Therefore, Section 3 and future sections of this application focus in on only the project components and activities that are closely related to the regasification operations.

2.1 Port Facilities

The LNG will be transported on an EBRV from various foreign locations to the Port. The Port will be located in federal waters in Massachusetts Bay in a water depth of approximately 270 to 290 feet (82 to 88 meters). The location is 13 miles (21 kilometers) south of Gloucester, Massachusetts. Thus, Massachusetts is the nearest "adjacent state", the significance of which to air quality regulatory programs was introduced in the prior section and is described further in Section 4. Among other things, significant is that the attainment status with respect to ambient air quality standards of nearest adjacent state is considered the attainment status of the Port. Therefore, based on Massachusetts status, the Port site area is considered non-attainment for ozone and attainment or unclassified for all other pollutants.

Each component of the Port was developed and designed to have minimal environmental impact and to ensure a continuous and reliable supply capability. In addition, the Port provides complete redundancy for components offshore from the Pipeline Lateral by utilizing a two STL™ buoy system, each with its own flexible riser, PLEM, and flow line. Figure 2-1 shows major Port components and a moored EBRV.

Figure 2-1. Major Port Components and Moored EBRVs



2.1.1 *Energy Bridge Regasification Vessels (EBRVs)*

Developed by the Northeast Gateway's parent company Excelerate Energy, L.L.C., EBRVs are standard LNG tankers that are purpose-built to carry equipment for the vaporization of LNG and delivery of natural gas. The first generation of these EBRVs includes the Excelsior and Excellence—which are currently operational and serving the Gulf Gateway Energy Bridge™ located in the Gulf of Mexico—and the *Excelerate*, which is under construction and expected to be commissioned in October 2006. The Explorer and the Express are second-generation EBRVs that are scheduled for delivery in March 2008 and spring 2009 respectively.

Figure 2-2. EBRV Excelsior

Figure 2-2 shows the EBRV *Excelsior*, which began commercial operation in January 2005. Table 2-1 provides dimensions of the first generation and second generation EBRVs. The Port mooring system is designed to handle other and potentially large vessels with capacities up to 250,000 cubic meters.

The EBRVs will moor at the Northeast Port at one of two STL™ buoys. When moored, the buoy serves as the anchor system for the vessel, allowing it to weathervane (rotate) to minimize ambient environmental forces (wind, waves, and currents) on the ship. After docking with the STL™ buoy, an EBRV will commence regasification by utilizing its deck-mounted shell-and-tube vaporizers and high-pressure pumps to deliver natural gas at pipeline pressure (up to about 100 bar or 1,440 pounds per square inch [psi]) pressure. The regasified natural gas will flow from the EBRV through the STL™ buoy and associated subsea components to Algonquin's proposed Pipeline Lateral to the existing HubLine. The emissions sources addressed in this application are all related to providing the steam for regasification operation of the shell-and-tube vaporizers. These sources during regasification operations consist of two gas-fired boilers, each with a heat input capacity of 224 million Btu per hour and a 3650 kilowatt diesel or dual-fuel fired generator. Second generation EBRVs will also include a 100 million Btu per hour auxiliary boiler. The use of this equipment for on-board regasification is described in Section 2.4.5.

Table 2-1. EBRV Dimensions and Capacities (First Generation - Second Generation)

Vessel Dimensions	Standard Units	Metric Units
Length	909 – 955 feet	277 – 291 meters
Beam	142.4 feet (both 1st and 2nd generation)	43.4 meters (both 1st and 2nd generation)
Capacity	2.9 – 3.2 Bcf of natural gas	138,000 – 150,900 cubic meters of LNG
Draft	40.4 – 40.7 feet	12.3 - 12.4 meters

On each EBRV, three steam turbine generators are fitted, with one being used for vessel electrical generation both during periods of vessel propulsion and all three being used during periods of LNG regasification when the vessels are moored. Steam is primarily provided by two identical dual-fuel fuel boilers, capable of firing any combination of marine fuel oil, LNG boil-off gas (i.e., vapors in the headspace above the LNG), and regasified LNG, although the marine fuel oil will not be used during regasification operations. These boilers are manufactured by Mitsubishi Heavy Industries (MHI), and each has a maximum heat input rate of approximately 224 million British thermal units per hour (MMBtu/hr).[7] Northeast Gateway is committing to designing second-generation EBRVs with selective catalytic reduction (SCR) technology for reducing boiler NO_x emissions during regasification operations, and will retrofit any first-generation EBRV used at the Northeast Port with SCR; the EBRVs' SCR systems will represent the first installation of SCR on marine boilers in history. Second-generation EBRVs will be equipped with an additional 100 MMBtu/hr boiler—fired only with boil-off gas or regasified LNG—that will enable the vessels to regasify LNG at a higher discharge rate, where such rates are required. The baseload design criteria discharge rate of 400 million standard cubic feet of natural gas per day (MMscfd) can be met without the auxiliary boiler, with a heat input rate of approximately 197 MMBtu/hr in each of the main boilers.

Each EBRV is also equipped with a single 3650 kW auxiliary generator, for use in the event of power loss in a steam generator. Each first-generation EBRV's auxiliary generator is driven by a MAN/B&W 8L32/40 diesel engine, firing 0.5% sulfur oil; each second-generation EBRV's auxiliary generator is driven by a Wärtsilä 12V32DF dual-fueled engine, fueled primarily with boil-off gas or regasified LNG. When a steam generator is offline, the baseload design criteria discharge rate of 400 MMscfd can be met by operating the auxiliary generator at a load of only 2880 kW.

Aside from the boilers and auxiliary generators mentioned above, the only other fuel-burning equipment onboard each EBRV (both first generation and second generation) consists of:

- a small incinerator used for routine disposal of trash and sludge, rated for 730,000 kcal/hr (2.9 MMBtu/hr), that would run for approximately 60 minutes each day;
- a small (620 kW) emergency generator, fueled with marine fuel oil, that is tested once per week for approximately 30 minutes but otherwise only started if power is lost;

[7] Unless noted otherwise, all references to MMBtu in this report refer to Higher Heating Values (HHV).

- a lifeboat (two 29 hp engines) and rescue boat (one 144 hp engine), each of which is fueled with marine fuel oil and needs to have its engines tested once per week for approximately 30 minutes; and
- an inert gas generator only used within 25 miles of shore for training, maintenance or emergency operations for approximately one (1) hour per month, and then only if such training and maintenance has not been done at sea.

As described in Section 1.3 of this application, these other smaller fuel burning sources are not considered a part of the regasification process and thus are not the subject of this air quality permit application except to the extent that their emissions for NO_x and VOC are included in Section 3 to demonstrate that the Port is not a major source under Massachusetts non-attainment regulations (310 CMR 7.00, Appendix A).

2.1.2 STL™ Buoy and Mooring System

The Project is proposed with two STL™ buoys to accommodate continuous delivery of natural gas from multiple EBRVs. To accomplish this, deliveries of natural gas from the vessels will be scheduled consecutively. As delivery into one of the two buoys is finishing, a second vessel will arrive and attach to the other buoy to commence discharge of its cargo. At a maximum, two EBRVs will be simultaneously moored no more than 10% of the time (876 hours/year).

Separation between the two buoys will be approximately 1 nautical mile (1,850 meters) to allow two vessels to weathervane without interference when moored simultaneously, while providing sufficient room for maneuvering. Each buoy is approximately 35 feet (11 meters) in height and 26 feet (8 meters) wide and weighs approximately 181 tons (165 metric tons). The proposed mooring system design will use eight mooring lines to hold each buoy in place. In service, the wind, wave, and current loads on the EBRV are transmitted through the buoy and into the mooring anchors. The vessel is permitted to weathervane and in doing so, naturally finds a heading that minimizes the overall loading on the system. While moored and connected to the buoy, the EBRV requires no power to maintain station. When not in use, the buoy descends to an equilibrium position at a depth of approximately 82 feet (25 meters) below the water surface, and maintains that position until retrieved by the EBRV.

2.1.3 Connections to Pipeline Lateral

The PLEMs are the riser base and connect it to the flow lines. When the EBRV is connected to the STL™ buoy, two ESD valves on the PLEM are operated through a control umbilical that is installed in parallel with the riser. If the umbilical loses integrity for any reason, the surface-controlled valves on the PLEMs will close. These types of valves are called Fail-Safe Closed (FSC) because they require power at all times to remain open, and if power is interrupted, they close. In addition to providing the FSC connection between the riser and the subsea pipeline, the PLEM will host manual valves and pigging equipment used during installation as well as valve position indicating and pressure sensors. The PLEM will be located on the seafloor.

The natural gas sent out from the EBRV will flow through each of the STL™ buoys and into 14-inch (0.36-meter) inner diameter flexible risers. This flexible riser section will extend from the top of the STL™ buoy down through the buoy to the PLEM on the ocean floor. The riser will have sufficient flexibility to allow the STL™ buoy to move within the design range allowed by the moorings. An 18-inch (0.46-meter) flow line will traverse the distance between each tie-in point along the Pipeline Lateral, through the area of the mooring pattern, to its respective PLEM. The flow line is connected to the Pipeline Lateral by a curved steel pipeline called a spool piece. The spool piece is made up of flanges and fittings that allow the connection of the flow line and Pipeline Lateral. A similar connection is made between the flow line and the PLEM.

2.2 Pipeline Lateral Facilities

Algonquin will build and operate the Pipeline Lateral to interconnect the Northeast Port to Algonquin's existing offshore HubLine and make modifications at two existing meter stations. To support offshore construction, one or more onshore loading areas will be required. The proposed Pipeline Lateral consists of approximately 16.4 (26.4 kilometers) miles of 24-inch (61-centimeter) outside diameter natural gas pipeline. The maximum allowable operating pressure of the Pipeline Lateral is 1,440 psi. The Pipeline Lateral originates at the existing HubLine (MP 0.0) and terminates at the proposed flow line connection to Buoy A (MP 16.4). The tie-in with the HubLine is located in waters approximately 3 miles (4.8 kilometers) to the east of Marblehead Neck.

2.3 Construction

2.3.1 Construction Workforce

The construction workforce for the Port will be hired to work in 28-day shifts on board the construction vessels. The 96-person peak workforce for each shift will live full-time on the construction vessels. An additional 12 people will work with the restoration vessel, which completes the restoration of the site after the larger workforce has departed. This makes a total workforce of 204 for the Port. For the Pipeline Lateral, Algonquin would hire a total of about 475 people during the 9-month construction period for the Pipeline Lateral. This construction workforce would also be hired to work in generally 28-day shifts. All members of the workforce would live full-time on board the construction vessels.

2.3.2 Construction Vessel Traffic

Construction activities associated with Port construction will involve four types of vessels on station and making trips between the Northeast Port and local ports during a 4-month construction period. These activities and total number of trips during the construction period include:

- **Anchor Handling Vessel (AHV) -** The AHV is used to deploy anchors, typically over a stern roller, and has both provisions for winching wire rope and chain.
- **Diving Support Vessel (DSV) -** The DSV is dynamically positioned and supports saturation diving operations. It has crane capacity sufficient for construction support, deck space for rigging lift items,

and often will have additional multi-service features such as reels for wire rope and flexible pipe installation, and chain lockers for deployment of mooring components. Approximately five round trips are anticipated.

- **Crew Boat -** The Crew Boat supports crew changes and brings some supplies to the DSV and AHVs. Approximately 12 round trips are anticipated.
- **Restoration Vessel -** The Restoration Vessel will likely be dynamically positioned and will be equipped to deposit sand or other fill materials through a placement tube observed by ROV. Approximately four round trips are anticipated.

Construction activities associated with the Pipeline Lateral construction will also involve various vessels with specialized construction capabilities. These vessels will generally remain in the field performing construction activities. Smaller support vessels will ferry personnel and materials from landside facilities to the construction vessels on site.

2.4 Project Operation

This section provides an overview of Port operations.

2.4.1 General Port Operations

The EBRVs are designed for safe and efficient operation, with maximum operational performance and minimal downtime risks. The first EBRV, the *Excelsior*, began commercial operations in January 2005 and the second, the *Excellence*, went into commercial operation in May 2005. The EBRVs are fully approved and certified by Bureau Veritas (BV), a major international Classification Society, and will be issued USCG Certificates of Compliance for foreign flag vessels upon first entering U.S. waters (as has occurred with the *Excelsior* and the *Excellence*). All aspects of Port operations will be conducted in accordance with specifications and procedures detailed in an Operations Manual that the Project will submit for the USCG's review and approval prior to the commencement of operations.

Approximately 30 to 34 licensed and certificated personnel will operate aboard the EBRV as it transports LNG and moors at the Port. All shipboard officers will be licensed by the flag state of the EBRV and all officers and crew will be trained specifically in EBRV operations. The training that these individuals will receive will meet or exceed federal and international standards. Prior to the EBRV mooring operation, two Port personnel, known as Persons In Charge (PICs), will board the vessel to direct, monitor, and assist with cargo transfer from the EBRV to the Port. The Port Operator will also direct and control operations to convey the natural gas from the ship to the PLEM. Each PIC advises the vessel Master when to discontinue cargo transfer operations and depart the Port should safety or weather criteria at the Port become of concern. In addition to the PICs, permanent staff will be employed by Northeast Gateway with responsibilities covering management, administration, and warehousing. Activities typically associated with the arrival and offload of an EBRV include transfer of the Northeast Port's PICs to the EBRV, mooring the EBRV to the STL™ buoy, transfer of gas from the EBRV through the Port, coordination with downstream pipeline gas control, unmooring the EBRV from the STL™ buoy, and transferring the Northeast Gateway PIC off the EBRV prior to departure.

2.4.2 Energy Bridge™ Regasification Vessel (EBRV) and Port Reliability

The LNG containment system in the EBRV is designed to withstand the forces encountered due to liquid cargo sloshing during transportation and unloading as a result of partially loaded tanks. The integrity of the reinforced insulation boxes, structural reinforcement of the cargo inner hull, and strengthened cargo pump towers have been verified by laboratory testing, and have been approved by BV and Gas Transport and Technigaz for unrestricted liquid levels during vessel operations.

The STL™ buoy system, designed by APL, is the same as the one in operation for the Gulf Gateway and has proven safe and efficient in the harsh North Sea environment. Eight similar APL installations have been installed worldwide, with over 1,000 oil tanker shuttle loadings in the North Sea. All of the elements of the STL™ system in use in the Gulf Gateway and proposed for the Northeast Port are similar in these installations, including STL™ buoy, mooring system, gas riser, gas delivery swivel and connector; and shipboard components.

The design condition for the Northeast Port is the 100-year storm condition at the Port location in Massachusetts Bay. This condition is estimated to produce a significant wave height of 30 feet (9.1 meters). In addition, the maximum condition allowable for connection to the buoy is established at 16.4 feet (5.0 meters). The maximum design discharge criterion (unloading) for the EBRVs themselves is 39 feet (12 meters). However, the Port will stop discharging and disconnect at a lesser state as dictated by its severe weather plan in the USCG approved Operations Manual.

2.4.3 Energy Bridge Regasification Vessel (EBRV) Approach/Departure Routes and Mooring

The EBRVs will approach the Port in a manner and at speeds consistent with safe navigation, taking into consideration environmental factors, vessel traffic density, and other concerns that impact the safety of the vessel and the environment. For maximum ship maneuvering capability, each EBRV is equipped with two bow thrusters at 1,500 kW each, and one 2,000-kW stern thruster. In addition, a Maneuvering Assistance and Positioning System (MAPS) provides automatic heading and direction of the thrusters and main propulsion, and controls EBRV position within 10 feet (3 meters) during buoy retrieval operations. The primary fuel for the EBRV propulsion system while the vessel is at sea is an Intermediate Fuel Oil. This, in combination with the boil off gas from the LNG cargo, provides the energy for steam propulsion at sea. After the EBRV maneuvers to the STL™ buoy, recovers the buoy, and is locked in place prior to regasification operations, the EBRV will stop the supply of fuel oil to the boilers and burn only natural gas. The maneuvering equipment and operations described above will not be used once regasification begins and thus are not the subject of this application.

As the EBRV approaches the STL™ buoy, a small line with a grapple hook is used to retrieve the STL™ messenger line and marker buoy floating on the surface of the water. The messenger line is then attached to a traction winch located on the bow of the EBRV adjacent to and above the STL™ buoy compartment. The STL™ buoy is then winched into the turret compartment and locked in place. Following regasification and cargo discharge, the buoy is unlocked and lowered until it achieves neutral buoyancy at a depth of approximately 82 feet (25 meters) below the surface of the water.

2.4.4 Safety Zones and Navigation Areas

The safety of navigation and unloading of the EBRVs while they are approaching, maneuvering, docking, and departing the Port mooring buoy area requires the establishment of zones around the buoys. Concentric areas of surface waters around the Project site will be restricted during these procedures as described below, as will specific areas of the seafloor where fixed elements of the Port will require exclusions from some uses. In addition, a general cautionary designation on navigation charts for the Port is expected in order to provide general notice to mariners that an EBRV may be moored to one or both of the buoys at any time and that they should exercise additional caution when navigating in the area. Regulations under the DWPA and the International Maritime Organization (IMO) envision a designated Safety Zone, a No Anchoring Area, an Area To Be Avoided, and a Watch Zone as described below as they relate to the Port.

A Safety Zone is limited by international law to 1,640 feet (500 meters) around an object, which for the Port would result in a Safety Zone of up to 0.54 nautical miles (1 kilometer) in diameter around each of the two STL™ buoys. Only EBRVs, support vessels, and law enforcement vessels would be allowed in this area. This area would be restricted at all times – regardless of whether an EBRV is present – and is mandated by the DWPA. As described in Section 6 of this application, no modeling receptors have been considered within this safety zone since it is restricted access to the public and thus is not considered ambient air.

Northeast Gateway also has requested from USCG and the IMO the establishment of an Area to Be Avoided (ATBA) of approximately 1.4 nautical miles (2,500 meters) in diameter around each of the STL™ buoys. Although not a restricted area, the ATBA would be indicated on nautical charts to provide a warning to vessesls operating in the vicinity as to the operational area of the Northeast Port.

Northeast Gateway will also request a No Anchoring Area around each STL™ buoy in order to protect its underwater facilities. This area will provide the means for avoiding damage to the mooring buoys, risers, and anchors used for this deepwater port. Northeast Gateway anticipates that a No Anchoring Area approximately 1.1 nautical miles (2,000 meters) in diameter will be established around each of the STL™ buoys, and that these areas may exclude anchoring, lobster trap sets, and bottom dragging to protect each buoy's anchor array.

2.4.5 Regasification

Each EBRV has regasification capabilities integrated into its shipboard cargo handling system. At full capacity, the current first generation EBRV design can store 4.9 million cubic feet (138,000 cubic meters) of LNG, which is the equivalent of approximately 2.9 Bcf of natural gas. The second generation EBRV design is for approximately a 10% greater capacity. The EBRV also can be used as a conventional LNG ship for offloading at land-based terminals. The regasification system can operate in (i) open-loop mode where seawater is used for the vaporization of LNG, (ii) closed-loop mode where a recirculating stream of water is heated and used for the vaporization of LNG, or (iii) in a combined open-loop and closed-loop mode. Only the closed-loop mode is proposed for this Project. In the closed-loop mode, steam from the two main EBRV steam boilers (each with heat input capacity of 224 million Btu per hour) will be routed forward to the regasification plant. Steam produced by the gas-fired boilers is also used to produce the electricity necessary to meet the needs of the vessel. Part of the steam produced is used in the three turbine generators fitted in the vessel for this purpose. Second generation EBRVs include a 100 MMBtu/hr gas fired auxiliary boiler. Performance data for the boilers are included in Appendix B of this application. An auxiliary diesel generator (3650 kilowatts) is available for use when one of the turbine generators is off line for maintenance or repair. The auxiliary generator on first generation EBRVs are fueled by 0.5% sulfur diesel fuel oil while the generators on second generation EBRVs are dual fuel fired (boil off gas with a small percentage of diesel oil). Engine performance data for both types of generator and compliance certification for a first generation generator with respect to MARPOL 73/78 Annex VI is included in Appendix B.

The steam will be used to heat fresh water circulated in a closed loop through shell-and-tube vaporizers in the regasification plant. LNG will be pumped from cargo tanks to a set of high pressure LNG pumps which are used to inject the LNG, at high pressure, into the vaporizers. The output of the vaporizer is natural gas, which is routed to the STL™ buoy and downstream delivery pipeline. There is no seawater intake or discharge used specifically for the regasification process in the closed-loop mode. Natural gas used by the EBRV during the closed-loop regasification process will be approximately 2.5 percent of regasified natural gas output.

The EBRVs are not designed to flare natural gas, and are engineering, constructed, and operated in compliance with the International Convention on the Construction and Operation of Gas Carriers. During operation, regasified LNG can be discharged up to 100 bar (1,440 psi) pressure through the buoy, riser, and PLEM depending on the receiving pipeline requirements. As such, a fully loaded vessel will be able to discharge its cargo in about 7 days, depending on operating conditions.

The auxiliary generator operation will be limited to 14 days annually (336 hours) at a single buoy. For the second buoy, to account for periods during which both buoys may be in operation, 10% of the emissions from the first buoy are assumed and added to the emissions from the first buoy to represent total EBRV regasification emissions. In essence, this represents a Port-wide restriction of 370 hours for the auxiliary generators. Port-wide main boiler operation will not exceed 19,272 "boiler-hours" (110% of full year operation for each of two main boilers). Port-wide auxiliary boiler operation will not exceed 9636 "boiler-hours" (110% of full year operation for one boiler). Lastly, depending on the degree of auxiliary generator usage, the mix of first and second generation vessels, and actual emissions as measured, some minimal further annual restriction on boiler operation may be necessary to maintain NO_x and CO emissions at less than 49 and 99 tons per year, respectively. See Section 3.4 for additional discussion of these permit restrictions and suggested compliance assurance measures on a conceptual basis.

Maximum short term emissions presented in Section 3 and modeled in Section 6 are based on maximum boiler and generator operation of both buoys simultaneously. Annual maximum emissions are based however on full year round operation at one buoy and the 10% capacity for the second of the two buoys as well as the 370 hour restriction on auxiliary generator usage.

2.4.6 Operations Vessel Traffic

As anticipated, there will be between 55 and 65 EBRV arrivals per year at the Port subject to a variety of variables, including distance traveled to/from the LNG supply source, EBRV capacity, and discharge rate over the life of the Project. For the conformity analysis conducted for this project (see Appendix D), 65 EBRV arrivals were used as the conservative base case.

Prior to the arrival of an EBRV at the individual Port buoy locations, an inspection of the STL™ messenger line and marker buoys will be conducted by either an offshore service vessel (OSV) or by helicopter. The planned maintenance requirements of the Port also will require a weekly inspection of surface components of the Port facility. This will be accomplished by either a shore-based OSV, transporting personnel to attend to specific needs of the Port or by a helicopter. Based on this requirement, Northeast Gateway expects an OSV will make approximately one trip per EBRV arrival from a base of operations at a location to be determined on the main land. There will be no pilot or tug requirements associated with the routine operation of the Port.

2.5 Construction Schedule

Construction of the Northeast Port and the Pipeline Lateral is scheduled to begin February of 2007 with completion in September of 2007 to be in operation for the 2007/2008 winter heating season.

The following are some of the construction activity milestones.

- February 2007 – Start of Pipeline Construction
- April 2007 – Start of Anchors/Mooring System Construction
- July 2007 – Completion of Pipeline Construction
- September 2007 – Completion of Anchors/Mooring System Construction

Actual implementation of the planned construction durations and sequence for the Project will depend upon several factors. Establishment of the final Pipeline Lateral route and anchor locations and of the final engineering designs are currently ongoing and may result in scope changes that would revise the above sequence and/or durations. Also, the timing of the appropriate regulatory approvals and availability of construction equipment may impact the start dates and the sequence of work.

SECTION 3 EMISSIONS

Air emissions result solely from the use of equipment onboard the vessels; there are no emissions from the buoys. As described in Section 2, EBRVs will be regasifying LNG using three steam generators, for which steam is provided by two identical dual-fuel boilers (second generation EBRVs will also have a smaller auxiliary boiler which will allow for LNG to be regasified at higher rates over the short term); hourly emissions from these boilers are described in Section 3.1. In the event of power loss in a steam generator, each EBRV is also equipped with an auxiliary generator. Hourly emissions from the auxiliary generator are described in Section 3.2.

Section 3.3 identifies emissions from minor sources onboard the EBRVs that are not associated with regasification activities, and are thus outside the scope of the minor source permit. These sources are characteristic of equipment on other commercial marine vessels that currently dock at Massachusetts ports, and were excluded from the Gulf Gateway air permit issued by EPA Region VI. As described in Section 1.3 of this application, emissions from this minor equipment is included in this application solely in response to EPA Region I's initial interpretation that these emissions should be included relative to the Massachusetts Nonattainment New Source Review regulations in 310 CMR Appendix A, and the minor equipment emissions are not discussed in any other portion of this application.

Section 3.4 identifies long-term emissions from the EBRVs. Over the long term, emissions from regasification activities at the Port will depend on the degree to which first-generation or second-generation vessels are used, the discharge rate, and the degree to which the auxiliary boilers and generators need to be used; however, emissions will be tracked, and operations will be restricted so that total emissions of nitrogen oxides (NOx) from the operation of the Project will not exceed 49 tons per year (TPY) and total emissions of carbon monoxide (CO) from the operation of the Project will not exceed 99 tons per year (TPY).

3.1 Boilers

On each EBRV, steam is provided by two identical Mitsubishi Heavy Industries (MHI) marine boilers, each with a maximum heat input rate of approximately 224 million British thermal units per hour (MMBtu/hr).[7] The boilers are capable of firing any combination of marine fuel oil, LNG boil-off gas (i.e., vapors in the headspace above the LNG), and regasified LNG while underway, but will only fire LNG boil-off gas or regasified LNG when moored at the Port.

To control emissions from the boilers, Northeast Gateway is committing to retrofitting any first-generation EBRV used at the Port with selective catalytic reduction (SCR) technology for reducing NO_x emissions during regasification operations. Northeast Gateway is also committing to designing all second-generation EBRVs (and beyond) with new low-NO_x "Volcano" burners in addition to SCR. The EBRVs' SCR systems will represent the first installation of SCR on marine boilers in history; because exhaust temperatures from the boilers are relatively low, the SCR systems will need to be installed upstream of the boilers' economizers. The SCR systems will be provided by Argillon LLC, which has extensive experience applying the proprietary SINOx® SCR technology (developed by Siemens) to marine vessel diesel engines in Europe and has provided an exhaust emissions guarantee of 15 ppmvd NO_x at 3% (dry) O_2. Appendix B includes specification sheets for the first-generation EBRV boilers and second-generation EBRV boilers, Argillon's experience list for applying SINOx® SCR technology to marine diesels, and Argillon's proposal for applying SINOx® SCR technology to the main boilers.

During regasification activities, each main boiler will have an operating range of 40% to 100% of maximum load, and will be able to meet its baseload design criteria discharge rate (400 MMscfd, as identified in Section 2) at approximately 88% of maximum load (i.e., a heat input rate of approximately 197 MMBtu/hr in each of the two main boilers). Hourly emissions are identified in Table 3-1. However, each second-generation EBRV will also be equipped with an auxiliary 100 MMBtu/hr boiler—fired only with boil-off gas or regasified LNG—that will enable the vessels to regasify LNG at a higher discharge rate over the short-term, where such rates are required. The auxiliary boiler is smaller than the main boilers and has lower emissions, but emissions will still be controlled with SCR. Specifications for the auxiliary boiler and the proposal for the auxiliary boiler's SCR system are included in Appendix B. Hourly emissions from the auxiliary boiler are summarized in Table 3-2. Detailed calculations of the values shown in Table 3-1 and Table 3-2 are provided in Appendix C.

Table 3 -1. Hourly Emissions from Each Main Boiler.
(All values expressed in lb/hr)

	Minimum Load (40% of maximum)	Base Load (88% of maximum)	Maximum Load (100%)
NO_x (as NO_2)	1.6	3.6	4.0
CO	3.9	8.7	9.8
VOC	0.5	1.1	1.2
PM	0.7	1.5	1.7
SO_2	0.05	0.12	0.13
Total HAP	0.17	0.37	0.41

Table 3 -2. Hourly Emissions from Second-Generation EBRV Auxiliary Boiler.
(All values expressed in lb/hr)

	Maximum Load (100%)
NO_x (as NO_2)	1.8
CO	4.4
VOC	0.5
PM	0.7
SO_2	0.06
Total HAP	0.19

3.2 Auxiliary Generators

The auxiliary generators are rated at 3650 kW and are driven by compression-ignition reciprocating internal combustion engines. Each first-generation EBRV auxiliary generator is driven by a MAN/B&W 8L32/40 diesel engine, firing marine fuel oil; each second-generation EBRV auxiliary generator is driven by a Wärtsilä 12V32DF dual-fueled engine, fueled primarily with boil-off gas or regasified LNG (marine fuel is needed to start the dual-fueled engine—i.e., for approximately 5-10 minutes—but is less than 1% of the fuel mixture thereafter, when it is needed solely for ignition purposes). Fuel oil used by the auxiliary generators during regasification will be separate from other fuel oil used for transoceanic travel, and will contain no more than 0.5% sulfur by weight. Specification sheets for each of these engines are included in Appendix B. Hourly emissions are summarized in Table 3-3; detailed calculations are provided in Appendix C.

Table 3 -3. Hourly Emissions from Each Auxiliary Generator.
(All values expressed in lb/hr)

	1st Generation EBRV		2nd Generation EBRV	
	Base Load (75% of maximum)	Maximum Load	Base Load (75% of maximum)	Maximum Load
NO_x (as NO_2)	76.8	97.4	10.2	10.5
CO	21.2	26.9	13.3	15.3
VOC	8.0	10.2	5.1	6.5
PM	2.7	3.4	Negligible[a]	Negligible[a]
SO_2	15.6	19.8	0.8	1.0
Total HAP	0.09	0.12	0.09	0.11

3.3 Minor Emissions Sources Not Associated with Regasification Activities

In addition to the boilers and auxiliary generators mentioned above, each EBRV (first generation and second generation) includes the following minor emissions sources that are not associated with regasification activities (and which should not be subject to the permit):

- a small incinerator used for routine disposal of trash and sludge, rated for 730,000 kcal/hr (2.9 MMBtu/hr), that would run for approximately 60 minutes each day;
- a small (620 kW) emergency generator, fueled with marine fuel oil, that is tested once per week for approximately 30 minutes but otherwise only started if power is lost;
- a lifeboat (two 29 hp engines) and rescue boat (one 144 hp engine), each of which is fueled with marine fuel oil and needs to have its engines tested once per week for approximately 30 minutes;
- an inert gas generator, which is only used for approximately one (1) hour per month for training, maintenance or emergency operations, and would only be used at Northeast Gateway if such training and maintenance had not been done at sea; and

- ten storage tanks (including overflow, sludge, and drain tanks) for marine fuel oil and waste oil, with a combined storage volume of 8,344 m^3 (approximately 1.1 million gallons); the only emissions from these tanks are those associated with volatization during tank breathing, and the volatility of the marine (residual) fuel oil is low (the EPA/API emissions model TANKS4.0 identifies a vapor pressure of approximately 0.000035 psia at the average liquid surface temperature of 55 ^oF).

Massachusetts' Nonattainment NSR regulations only apply to emissions of NO_x and VOC. Emissions of these pollutants have been described in the "Support Document for Clean Air Act General Conformity Determination," which Northeast Gateway submitted to the U.S. Coast Guard (and EPA) in December 2005, and are summarized in Table 3-4. The incinerator is designed and will be operated in accordance with International Maritime Organization (IMO) Regulations for the Prevention of Air Pollution from Ships, Regulation 16 (Shipboard incineration).[8]

Table 3 -4. Annual Emissions from Minor Sources Not Associated with Regasification Activities.
(Single buoy; all values expressed in lb/hr)

	Incinerator	Oil-Burning Sources (Total)	Inert Gas Generator	Oil Storage Tanks
NO_x (as NO_2)	0.2	0.69	0.025	0.000
VOC	1.1	0.07	<0.023	0.002

3.4 Long-Term Emissions

As stated previously, potential emissions are based on full year round operation (8760 hr/yr) at one buoy and 10% capacity (876 hr/yr) at the other buoy, with all boilers operating at maximum load (100%) and the auxiliary generators limited to 370 hr/yr of operation (total, at both buoys), with the additional restriction that long-term emissions from Northeast Gateway will be restricted to no more than 49 TPY NO_x and 99 TPY CO.

There are a variety of potential scenarios for complying with the operating restrictions. For the base case—i.e., design criteria discharge of 400 MMscfd for 365 days/year at one buoy and for 36.5 days/year at the other, assuming no need for the auxiliary generators—emissions are those from the two boilers operating at 88% load, as shown in Table 3-5. If only first-generation vessels were to moor at Northeast Gateway, the auxiliary generators were required for the maximum duration (370 hours/year), and all sources were operating at maximum capacity at the maximum allowable emissions rates, main boiler operations would need to be restricted to 7664 hours/year (for each main boiler) in order to meet the 49 TPY NO_x limit, as shown in Table 3-6. Similarly, if only second-generation vessels were to moor at

[8] The Regulations for the Prevention of Air Pollution from Ships are in the Protocol of 1997, and are Annex VI to the International Convention for the Prevention of Pollution from Ships, 1973, as Modified by the Protocol of 1978 (MARPOL 73/78), which entered into force on May 19, 2005.

Northeast Gateway, the auxiliary generators were required for the maximum duration (370 hours/year), and all sources were operating at maximum capacity at the maximum allowable emissions rates, boiler operations would need to be restricted to 8003 hours/year (for each main boiler and the auxiliary boiler) in order to meet the 99 TPY CO limit, as shown in Table 3-7.

Table 3 -5. Annual Emissions from Base Case Operations.
(all values expressed in tons/year)

	Emissions at Buoy Operating 365 days/yr	Emissions at Buoy Operating 36.5 days/yr	Total Emissions, Both Buoys
NO_x (as NO_2)	31.5	3.2	34.7
CO	76.2	7.6	83.8
VOC	9.6	1.0	10.6
PM	13.1	1.3	14.5
SO_2	1.1	0.1	1.2
Total HAP	3.5	0.4	3.9

Table 3 -6. Annual Emissions from First Generation EBRVs at Maximum Load.
(all values expressed in tons/year)

	Emissions from Auxiliary Generator, 370 hrs/yr @ 3650 kW	Emissions from Boilers, 7664 hr/yr	Total Emissions
NO_x (as NO_2)	18.0	31.0	49.0
CO	5.0	75.4	80.4
VOC	1.9	9.2	11.1
PM	0.6	12.8	13.4
SO_2	3.7	1.0	4.7
Total HAP	0.02	3.2	3.2

Table 3 -7. Annual Emissions from Second Generation EBRVs at Maximum Load.
(all values expressed in tons/year)

	Emissions from Auxiliary Generator, 370 hrs/yr @ 3650 kW	Emissions from Main Boilers and Aux. Boiler, 8003 hr/yr	Total Emissions
NO_x (as NO_2)	1.9	39.5	41.4
CO	2.8	96.2	99.0
VOC	1.2	11.8	13.0
PM	0.0	16.3	16.3
SO_2	0.2	1.3	1.5
Total HAP	0.02	4.1	4.1

Actual operations over the course of a year will typically involve scenarios somewhere in between the cases presented here: e.g., a mixture of first-generation and second-generation EBRVs, probably operating with auxiliary generators for more than zero hours but less than the 370-hour maximum, and probably with the auxiliary boiler on the second-generation EBRVs operating fewer hours than the main boilers.

Potential emissions of NO_x and CO are restricted to 49 TPY and 99 TPY, respectively; potential emissions of the other pollutants are calculated based on (8760+876 =) 9636 hours per year of boiler operations at 100% load and 370 hours per year of auxiliary generator operations, at the maximum allowable emissions rates (shown in Table 3-8).

Table 3 -8. Potential Emissions.
(all values expressed in tons/year)

	Emissions from Auxiliary Generator	Emissions from Main Boilers and Aux. Boiler	Total Emissions
NO_x (as NO_2)	(varies)	(varies)	49.0
CO	(varies)	(varies)	99.0
VOC	1.9	14.2	16.1
PM	0.6	20.0	20.6
SO_2	3.7	1.2	4.9
Total HAP	0.02	4.8	4.8

Northeast Gateway proposes to demonstrate compliance with these operating restrictions by tracking the number of hours spent regasifying, the fuel usage for the boilers during those hours, the operating hours for the generators during those hours, and the corresponding emissions. Emissions would be tracked using the maximum allowable emission factors (calculated as per Appendix C) or results of actual emissions testing or monitoring data, to the degree that valid data are collected.

SECTION 4 REGULATORY FRAMEWORK

A deepwater port must be licensed by the Secretary of Transportation who has delegated the processing of deepwater port applications to the Coast Guard and the Maritime Administration (MARAD). Issuance of a Deepwater Port license requires the Secretary to determine “that the deepwater port will be constructed and operated using the best available technology, so as to prevent or minimize adverse impact on the marine environment” [§4(c)(5)]. The Project must also conform to all provisions of the Clean Air Act, and the Governor of the adjacent coastal state must approve of the project.

4.1 National Ambient Air Quality Standards and Visibility Protection

National Ambient Air Quality Standards (NAAQS) have been established for each of the criteria air pollutants. Standards are designated as primary or secondary. Primary standards are set at a level designed to protect public health. Secondary standards are set to protect welfare values such as vegetation, visibility, and property values. State Implementation Plans (SIPs) present the regulatory framework for a state to follow to demonstrate it will achieve and maintain the NAAQS. State and federal permitting programs require that new sources demonstrate the ability to meet all NAAQS. The NAAQS are summarized in Table 4-1.

TABLE 4-1

National Ambient Air Quality Standards

Pollutant	Averaging Time	NAAQS	PSD Increments	
			Class I	Class II
PM_{10}	24-Hour	150 µg/m^3	8 µg/m^3	30 µg/m^3
	Annual	50 µg/m^3	4 µg/m^3	17 µg/m^3
$PM_{2.5}$ [a]	24-Hour	65 µg/m^3	N/A	N/A
	Annual	15 µg/m^3		
Sulfur Dioxide (SO_2)	3-Hour	.50 ppm (1300 µg/m^3) [b]	25 µg/m^3	512 µg/m^3
	24-Hour	.14 ppm (365 µg/m^3)	5 µg/m^3	91 µg/m^3
	Annual	.03 ppm (80 µg/m^3)	2 µg/m^3	20 µg/m^3
Ozone (O_3)	1-Hour [c/]	0.120 ppm (235 µg/m^3)	N/A	N/A
	8-Hour [d/]	0.08 ppm (157 µg/m^3)	N/A	N/A
Nitrogen Dioxide (NO_2)	Annual Arithmetic Mean	0.053 ppm (100 µg/m^3)	2.5 µg/m^3	25 µg/m^3
Lead (Pb)	24-Hour	N/A	N/A	N/A
	Calendar Quarter	1.5 µg/m^3		
Carbon Monoxide (CO)	1-Hour	35 ppm (40 mg/m^3)	N/A	N/A
	8-Hour	9 ppm (10 mg/m^3)	N/A	N/A

a/ EPA adopted a new fine particulate standard (particulate smaller than 2.5 microns in diameter) on 7/17/97, but retained existing PM_{10} standards. This standard was not enforceable pending court challenges; however, the court upheld the standards and the State of Massachusetts has recommended that the entire State be designated Attainment/Unclassifiable.

b/ Set as a secondary standard

c/ Statistically estimated number of exceedances. The 1-hour standard is met when the daily maximum 1-hour concentration does not exceed 0.12 ppm at any one monitor on more than 3 days over any 3-year period.

d/ EPA adopted new 8-hour ozone standard on 7/17/97 and vacated the existing 1-hour standard. The 1-hour standard was re-instated in June of 2000, pending resolution of the legal challenges to the 8-hour standard. The 8-hour standard is now in effect. Compliance with the 8-hour standard is based on the 3-year average of the 4th highest daily maximum 8-hour ozone concentrations. EPA designated Massachusetts as "moderate nonattainment" for the 8-hour ozone standard effective June 15, 2004.

On December 20, 2005, the EPA Administrator signed a proposed change to the NAAQS for particulate matter. The proposal would reduce the PM2.5 standard from 65 ug/m^3 to 35 ug/m^3 for the 24-hour averaging period and retain the current standard of 15 ug/m^3 as the annual standard. In addition, the proposal would adopt a new standard for "inhalable course particles" comprised of particles that are smaller than 10 microns in diameter but larger than 2.5 microns. The proposed standard for particles in the PM_{10} to $PM_{2.5}$ size range is 70 ug/m^3. EPA is accepting comments on the proposed changes and is expected to adopt final standards by September 27, 2006. In addition to its basis as a public health standard, the $PM_{2.5}$ standard is also intended to reduce regional haze attributed to the light scattering property of the fine particulate matter.

Compliance of the Project with all applicable NAAQS (as well as the PSD increments shown in Table 1) is demonstrated in Section 6 of this application.

On July 1, 1999, EPA adopted its final regional haze regulation for protection of Class I areas. The regulations, at 40 CFR Part 51, sets forth a national goal for visibility, specifically, the "prevention of any future, and the remedying of any existing, impairment to visibility in Class I areas which impairment results from manmade air pollution". The rule requires states to set goals and adopt implementation plans to reduce regional haze. However, as a minor source, the Port would not be subject to any additional requirements related to visibility protection; in fact, the natural gas supplied to the region will help EPA and the states in the northeast region to reduce regional haze.

4.2 Existing Air Quality

The air quality at the project location—i.e., approximately 13 miles off the Massachusetts coast, outside the state territorial boundary—has not been classified. Counties along the Massachusetts coast are in attainment with all ambient air quality standards except that for ozone, which is formed by emissions of volatile organic compounds (VOC) and oxides of nitrogen (NO_x).

Carbon monoxide (CO) is a more localized pollutant; although nine Boston area cities—Boston, Cambridge, Chelsea, Everett, Malden, Medford, Quincy, Revere, and Somerville—were previously designated as nonattainment areas; the surrounding portions of their counties (Middlesex, Norfolk, and Suffolk) were not. Those nine cities were redesignated as attainment areas on January 30, 1996 (61 FR 2918); the term "maintenance area" applies to all such areas previously designated as nonattainment that have been redesignated to attainment.

4.3 General Conformity with State Implementation Plans for Air Quality

For projects in nonattainment areas and maintenance areas, if air emissions exceed thresholds identified in U.S. Environmental Protection Agency (EPA) general conformity regulations (40 CFR 51 and 40 CFR 93 Subpart B), Federal agencies are required to demonstrate that those emissions are generally in conformity with SIPs prior to approving those projects. For this project, the U.S. Coast Guard (USCG) has the responsibility of determining the applicability of conformity regulations and demonstrating conformity where necessary. Northeast Gateway submitted a support document for the general conformity determination to USCG in December 2005 and made slight revisions to this document in January 2006; the revised document is included in Appendix D to this application. As shown in the support document, emissions of VOC and CO are low enough to not trigger the need for a conformity determination. NOx emissions are high enough to trigger a determination, but worst-case NOx emissions (which are due to project construction rather than project operation) are only 3.1 tpd, which is very low compared to the 2007 attainment emissions inventory of 605.3 tpd—especially considering that in 2007, on-road mobile sources alone are projected to have an 18.8 tpd margin of compliance with their emissions budget of 226.4 tpd. Therefore, NO_x emissions associated with the Northeast Gateway project will not cause the emissions budgets identified in the ozone SIP to be exceeded, and the project conforms to the ozone SIP.

4.4 Regulations Applicable to Marine Vessels

In 1997, the International Maritime Organization (IMO) approved Regulations for the Prevention of Air Pollution from Ships (Annex VI of MARPOL 73/78). These regulations include NO_x standards for all marine diesels (except those in lifeboats and other equipment only used for emergency) manufactured since January 1, 2000 (which apply to the auxiliary generators on all of the EBRVs), a sulfur content for fuel oil used on board ships, and design standards for shipboard incinerators. As stated in Section 3, the NO_x standard is 12.1 g/kWh for the auxiliary engines (identical to the EPA NOx standard for marine diesels at 40 CFR 94, developed under Title II of the Clean Air Act). A certificate of compliance for the auxiliary diesel generators (on the first generation vessels) is included in Appendix B; as shown in Section 3, the auxiliary dual-fuel generators (on the second generation vessels) will comply with this standard by a very wide margin. The maximum sulfur content limit for fuel oil is 4.5% by weight, but the Northeast Gateway will only be allowing the use of LNG boil-off or regasified LNG as a fuel in the boilers while vessels are moored and regasifying LNG, and the fuel oil used by the auxiliary generators will contain no more than 0.5% sulfur by weight. (Furthermore, the dual-fuel auxiliary generators on the second generation vessels will be fueled with a mixture of at least 99% gas and less than 1% oil.) The shipboard incinerator is also compliant with the MARPOL regulation; emissions are described in the technical support document for general conformity (Appendix D of this application).

Massachusetts has opacity regulations for marine vessels which limit opacity to no more than 40% at any instant in time and no more than 20% for periods in excess of two minutes in any hour [310 CMR 7.06(3)]. Although the Massachusetts regulations identifies these requirements as only being applicable within certain coastal air districts, the EBRVs will comply with these limits.

4.5 Stationary Source Regulations

As stated in Section 1, Northeast Gateway does not believe that stationary source regulations apply to marine vessels (moored or otherwise), especially those located outside state territorial boundaries. However, regulations that would be applicable to stationary boilers and engines with heat input rates identical to those of the EBRV boilers and auxiliary engines are identified in this section for purposes of illustration. Since the project is outside Massachusetts' state waters, the EPA would be the permitting authority.

4.5.1 Federal Stationary Source Regulations

Stationary sources classified as "major" are required to obtain preconstruction permits in accordance with EPA regulations for non-attainment New Source Review (NSR) and/or the Prevention of Significant Deterioration (PSD), depending on whether the local air quality is classified as being "attainment" or "nonattainment" with the National Ambient Air Quality Standards (NAAQS) for each pollutant. Table 4-2 compares the NSR and PSD major source thresholds to the PTE for the Port (derived in Section 3.4). The values in this table demonstrate that potential emissions from the moored EBRVs would not be a major source of any criteria pollutant with respect to either NSR or PSD regulations.

Table 4 -2. Comparison of Potential Emissions from Moored EBRVs to NSR/PSD Permit Thresholds (All values expressed in TPY)

	PTE from moored EBRVs	NSR Major Source Threshold[a]	PSD Major Source Threshold[b]
NO_x	49	50	100
CO	99	NA (attainment area)	100
VOC	16.1	50	NA (nonattainment area)
SO_2	4.9	NA (attainment area)	100
PM_{10}	20.6	NA (attainment area)	100
$PM_{2.5}$	20.6	NA (attainment area)	100

[a]From 310 CMR 7.00, Appendix A.

[b]From 40 CFR 52.21(b)(1)(i); these thresholds apply to fossil-fuel boilers (or combinations thereof) totaling more than 250 MMBtu/hr heat input.

Additional requirements can also be triggered for sources that are "major" sources of hazardous air pollutants (HAPs)—i.e., those with the potential to emit 25 TPY of HAP, or 10 TPY or any individual HAP (42 U.S.C. § 7412(a)(1)). However, as shown in Section 3, the potential emissions from the moored EBRVs are too low for the source to be considered "major" for either criteria pollutants or hazardous air pollutants. Emissions are therefore not high enough to trigger National Emissions Standards for Hazardous Air Pollutants (NESHAPs)/Maximum Achievable Control Technology (MACT) requirements for stationary boilers (40 CFR 63, Subpart DDDDD) and stationary engines (40 CFR 63, Subpart ZZZZ).

Because emissions are not major for NSR/PSD and not major for HAP, they are also not considered "major" for purposes of the Title V Operating Permit Program, and therefore that program does not apply. (310 CMR 7.00 APP(2))

Stationary boilers with heat input rates greater than 100 million Btu/hr and constructed after June 19, 1984 are subject to Federal New Source Performance Standards (NSPS) (40 CFR 60, Subpart Db) promulgated under Section 111 of the Clean Air Act. For boilers that are the size of the EBRV boilers, the NSPS sets an emission limit of 0.20 lb NO_x/MMBtu for boilers with high heat release rates (i.e., over 70,000 Btu/hr-ft^3). The main boilers have heat release rates of approximately 120,000 Btu/hr-ft^3 while the auxiliary boiler has a heat release rate of approximately 82,000 Btu/hr-ft^3. Therefore, all of the EBRV boilers would be classified as high heat release boilers. The NO_x emissions identified in Appendix C demonstrate that emissions from all boilers would be well within the NSPS regulatory limit.

4.5.2 State Stationary Source Regulations

As stated previously, the project is not located within state territorial waters. The Deepwater Port Act does require "The law of the nearest adjacent coastal state...is declared to be the law of the United States, and shall apply to any deepwater port...to the extent applicable and not inconsistent with any provision or regulation under this Act or other Federal laws and regulations" [§19(b)] but as pointed out previously, the extension of stationary source regulations to mobile sources in general is inconsistent with the Clean Air Act. Regulations pertaining to the Massachusetts' air quality program are codified in 310 CMR 6.00

to 8.00. This section identifies the state regulations which would potentially be applicable to the proposed project if it were a stationary source within an air district.

310 CMR 7.02 – Minor Source Permitting Regulation (Plan Approvals)

Massachusetts' approved SIP includes regulations at 310 CMR 7.02 with respect to permitting requirements for new minor sources. This section requires a permit (plan approval) for fuel burning equipment (gaseous fuel) with a heat input capacity of greater than 10 MMBtu/hr and internal combustion engines with an input capacity of greater than 3 MMBtu/hr. Plan approvals are divided into limited plan approvals and comprehensive plan approvals (CPA). Under this program, the Northeast Gateway Project would require a CPA because a CPA is required for fuel burning equipment with an input capacity of greater than 40 MMBtu/hr (gaseous fuel) or internal combustion engine greater than 3 MMBtu/hr. However, internal combustion engines regulated by EPA as a non-road engine under 40 CFR Parts 89, 90, 91, or 92 are not required to submit an application.

This section of the Massachusetts regulations includes a particulate matter emission limit of 0.10 lbs/MMBtu for fossil fuel utilization equipment in the size range of 3-250 MMBtu/hr (310 CMR 7.02(8)(h)). Appendix C of this application (emissions calculations) demonstrates that all emissions units at the Port would easily meet this limit.

Applications are submitted on prescribed forms and the CPA must be received before a proposed new facility may commence construction. In many respects, the criteria for obtaining a CPA are similar to those for major sources, a demonstration that ambient air quality standards will not be exceeded and demonstration that emissions comply with all applicable emission standards including a demonstration that all emissions are controlled by best available control technology (BACT) (310 CMR 7.02(8)(a)). The BACT demonstration for this project is made in Section 5 of this application.

310 CMR 7.04 – Fuel Utilization Equipment

This section requires that all oil or solid fuel fired equipment with a capacity equal to or greater than 40 MMBtu/hr must be equipped with a smoke density meter and establishes requirements for the burning of used oil. While the proposed boilers are dual-fuel capable, during the time when the boilers are used for regasification only natural gas will be burned; therefore this provision does not apply.

310 CMR 7.05 – Fuels – All Districts

The sulfur content of fuels is regulated by 310 CMR 7.05. Section 7.05(1) establishes a sulfur content limit of 0.28 lb sulfur/MMBtu (equivalent to approximately 0.5% sulfur content) in Boston and other nearby cities, and 0.55 lb/MMBtu (equivalent to approximately 1.0% sulfur content) in the remainder of the Metropolitan Boston Air Pollution Control District. The auxiliary generators will be using 0.5% sulfur oil so they would comply with this requirement.

310 CMR 7.09 – Dust, Odor – Construction and Demolition

This provision prohibits the handling, storage or transportation of any material to be used in construction to be handled in a way that results in a "condition of air pollution". All land-based construction lay-down areas will be managed to prevent fugitive dust emissions.

310 CMR 7.10 – Noise

This section prohibits unnecessary emissions of noise from construction equipment and other activities or to operate such equipment without enclosures or methods to suppress sound in order to prevent "sound that may cause noise". The Port will comply with this regulation.

310 CMR 7.22 – Sulfur Dioxide Emission Reductions for the Purpose of Reducing Acid Rain

This section requires any fuel burning facility with an input capacity of greater than 100 MMBtu/hr to limit its emissions of sulfur dioxide to an annual average emission rate of 1.2 lbs/MMBtu. Burning natural gas in the EBRV boilers will insure that SO_2 emissions are below 1.2 lbs/MMBtu.

310 CMR 7.24 – Organic Material Storage and Distribution

This section imposes requirements for tank design for organic liquid storage tanks greater than 40,000 gallons in capacity and which store an organic liquid having a vapor pressure of 1.5 psia or greater under actual storage conditions. Methane, the predominant component of LNG, has a vapor pressure of 100 mm Hg = 1.9 psia at -181.4 ^{o}C but freezes at -182 ^{o}C,[9] so it is likely that the LNG has a vapor pressure greater than 1.5 psia at actual storage conditions. However, because the boil-off is burned in the boilers, the boilers would meet the requirement for "a vapor recovery system which collects all of the organic vapors emitted from the tank, and a vapor control system which reduces emissions of vapors to the atmosphere by at least 95% over every three hour period" (310 CMR 7.24(1)(b)(2)).

310 CMR 7.26 - Industry Performance Standards for Engines and Turbines

In September 2005, the MA DEP amended its regulations to set emission standards and other requirements for new stationary reciprocating internal combustion engines (and turbines) constructed after March 23, 2006 (310 CMR 7.26(40) through (44)), where a "stationary reciprocating internal combustion engine" is defined (in 310 CMR 7.00) as "any reciprocating internal combustion engine that is not self propelled". Stationary engines larger than 50 kW installed before January 1, 2008 are subjected to a NO_x emissions limitation of 0.6 lb/MWh = 0.27 g/kWh (as well as other requirements), with the exception that "emergency or standby" engines larger than 37 kW are required to meet EPA nonroad engine regulations at 40 CFR 89.105, which identifies an emissions limit of 6.4 g/kWh for the sum of NO_x and nonmethane hydrocarbon emissions (as well as other requirements).

[9] CRC Handbook of Chemistry and Physics, 62nd ed. (1982).

The auxiliary generators are capable of self-propulsion, and therefore would not meet the definition of "stationary reciprocating internal combustion engine". Although they would not be used for self-propulsion while the EBRVs are moored, the same is true of engines used for hotelling all vessels that dock in Boston Harbor and other ports, and DEP is not assuming that 310 CMR 7.26 applies to those engines (none would likely meet these requirements). Additionally, the first-generation EBRV generators will have all been constructed prior to March 23, 2006, and the second-generation EBRV generators would likely be classifiable as "emergency or standby" under 310 CMR 7.26(42) and would meet the emissions limitation for emergency engines.

310 CMR 7.27 - NOx Allowance Program

The Massachusetts' NOx allowance program requires any person who owns or operates a "budget unit" to have a number of NOx allowances in the units compliance account equal to the total tons of NOx emitted from May 1 through September 30 of that year. A NOx budget unit is defined as a fossil fuel fired boiler with an input capacity of equal to or greater than 250 MMBtu/hr. The EBRV boilers are all below the threshold for the allowance program.

310 CMR 7.29 – Emission Standards for Power Plants

In December 2005, the MA DEP proposed revisions to 310 CMR 7.29, *Emission Standards for Power Plants*, to include emission limits of carbon dioxide (CO_2) from six identified facilities. The proposed Northeast Gateway boilers would not be subject to the proposed rules, but could provide a valuable source of alternative natural gas to assist the affected sources to develop a compliance plan. Additionally, Massachusetts adopted a Climate Action Plan in the spring of 2004. The goal of the plan is to reduce emissions of greenhouse gases (predominately carbon dioxide – CO_2) to the level of the 1990 emissions by the year 2010 and to achieve a 10% reduction of greenhouse gases by 2020. The availability of natural gas from the Northeast Gateway Project may represent an important milestone in helping Massachusetts to achieve its goal.

310 CMR 8.0 – Prevention and Abatement of Emergency Episodes

This section provides emergency powers to the Massachusetts DEP to take actions if/when ambient concentrations reach levels defined as presenting imminent and substantial danger to public health. The requirements specify steps for the DEP to declare an emergency and initiate actions to reduce emissions; however, since endangerment levels have never been approached, it is unlikely that this section will impact the operation of the proposed project. The Northeast Gateway project would comply with actions required by the DEP in the case of an air pollution emergency.

SECTION 5 BEST AVAILABLE CONTROL TECHNOLOGY ANALYSIS

As discussed in Section 4.2, new and modified stationary sources of air pollution are subject to a requirement to apply Best Available Control Technology (BACT), where BACT is determined on a case-by-case basis. The EBRVs are mobile marine vessels, and the first-generation EBRVs are neither new nor modified. However, this section describes the case-by-case analyses of BACT as if the requirement were applicable to the EBRV boilers and auxiliary generators. An overview of BACT requirements is provided in Section 5.1; Section 5.2 describes the BACT evaluations for the EBRV boilers, and Section 5.3 describes the BACT evaluations for the EBRV auxiliary generators. Conclusions of the control technology analyses are summarized in Section 5.4.

5.1 Definition and Determination of BACT

The Federal Clean Air Act defines BACT as

> "an emissions limitation based on the maximum degree of reduction of each pollutant subject to regulation...which the permitting authority, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such facility..." [§169(3)][10]

There are several key energy and environmental impact considerations for this project. The Northeast Gateway Energy Bridge™ is a project that will allow liquefied natural gas (LNG) to be delivered to Massachusetts in a reliable, safe and environmentally friendly manner, without the need for an on-shore terminal, near-shore ship traffic, or a visible platform. Excelerate Energy, L.L.C. is the only company to have proven this technology in practice, and the PSD-permitted Gulf Gateway facility in the Gulf of Mexico was even able to provide natural gas to shore during Hurricane Katrina, when many other energy facilities were required to shut down.

EPA's New Source Review Workshop Manual (NSR Manual)[11] recommends that BACT be determined using a five-step "top-down" procedure:

Step 1—Identify all control technologies, including demonstrated and transferable technologies

Step 2—Eliminate technically infeasible options

Step 3—Rank remaining control technologies by control effectiveness

Step 4—Evaluate most effective controls and document results

Step 5—Select BACT

[10] BACT is defined similarly in Federal regulations at 40 CFR 52.21(b)(12) and Massachusetts regulations at 310 CMR 7.00.

[11] US EPA, "New Source Review Workshop Manual," Draft, Research Triangle Park, NC: EPA Office of Air Quality Planning and Standards, October 1990.

Because BACT assessments are source-specific, the two types of emissions sources for this project (the boilers and generator on each ship) are addressed separately in Sections 5.2 and 5.3.

5.2 EBRV Boilers

As described in Section 3.1, the primary fuel-burning sources on each EBRV are the two main 224 MMBtu/hr MHI marine boilers, and the second-generation EBRVs are equipped with an auxiliary 100 MMBtu/hr marine boiler. Although the boilers are capable of firing any combination of marine fuel oil, LNG boil-off gas, and regasified LNG, they will be restricted to firing only LNG boil-off gas or regasified LNG when moored at the Port.

Marine vessel boilers differ from stationary boilers in several respects, principally as a result of space constraints on the vessels: i.e., boilers need to be relatively compact and fuel-efficient, and therefore have very high heat release rates (heat release rate is defined as the heat input rate divided by the furnace volume). EPA has recognized that high heat release rates can have an adverse effect on NO_x emissions: for example, as noted in Section 4.1, the New Source Performance Standard (NSPS) for NO_x is 0.20 lb/MMBtu for stationary gas-fired boilers with heat release rates over 70,000 Btu/hour-ft^3 and 0.10 lb/MMBtu for stationary gas-fired boilers with heat release rates less than or equal to 70,000 Btu/hour-ft^3. (The main EBRV boilers have heat release rates of approximately 120,700 Btu/hour-ft^3 and the auxiliary EBRV boiler has a heat release rate of approximately 81,500 Btu/hour-ft^3.) However, marine boilers are still generally a lower-emitting form of marine vessel propulsion than marine diesel generators: Table 5-1 illustrates the emission factors estimated by the Massachusetts Department of Environmental Protection (DEP) for oil-fired marine diesel generators and oil-fired marine boilers in its nonroad mobile source emissions inventory (because gas-fired marine generators and marine boilers are relatively uncommon, DEP does not have emission factors for gas-fired marine sources). Most existing LNG tankers (including those that currently travel to the LNG terminal in Everett, Massachusetts) utilize boilers rather than diesel generators for propulsion.

Table 5-1. Emission Factors for Vessel Propulsion Systems while Docked or Moored.

	Dockside marine vessel emission factor used in Massachusetts DEP mobile source emission inventories[a]				Gas-Fired Boilers (see Section 3)
	Diesel generators		Oil-fired boilers		
	lb/1000 gal	lb/MMBtu	lb/1000 gal	lb/MMBtu	lb/MMBtu
NO_x	364	2.6	36.4	0.24	0.186
CO	44	0.31	(NA)	(NA)	0.084
VOC	59	0.42	3.2	0.021	0.0055

[a]lb/1000 gal factors were obtained from Kenneth Santlal, Massachusetts DEP, for conformity pollutants (NO_x, CO, VOC); diesels were listed as being fueled with distillate fuel, boilers were listed as being fueled with residual fuel. lb/MMBtu factors were calculated based on EPA default heating values of 140 MMBtu/1000 gal for distillate fuel and 150 MMBtu/1000 gal for residual fuel. (DEP provided a CO emission factor of zero for oil-fired boilers.)

5.2.1 BACT for NO_x Emissions

5.2.1.1 Step 1 – Identify all Control Options

Step 1 of the BACT determination often begins with searching EPA's RACT/BACT/LAER Clearinghouse (RBLC) for emissions control technologies applicable to this source type. However, no listings were found in the RBLC for marine boilers prior to this application, and the only known instance in which marine boilers have been subjected to stationary source permitting requirements and BACT determinations is Gulf Gateway, where the first-generation EBRVs *Excelsior* and *Excellence* are already operational (the first-generation EBRV *Excelerate* is due to be operational later this year). EPA Region VI issued a preconstruction permit for Gulf Gateway in June 2004, and approved BACT for NO_x as an emissions limit of 41.88 lb/hr for each EBRV boiler. This limit corresponds to an emissions rate of 0.186 lb/MMBtu and can be met by both the existing first-generation EBRV boilers and the new second-generation EBRV boilers without installing air pollution control equipment, as long as the boilers are restricted to using LNG boil-off gas or regasified LNG as a fuel.

To find any State Implementation Plan (SIP) emission limits that might exist for marine boilers, Federal SIP approval regulations (40 CFR 52) were accessed on the internet and searched for the term "marine". Although 13 states include the word "marine" in their SIPs, none regulate emissions from marine vessel propulsion systems; all SIP regulations for marine sources were limited to regulation of marine vessel cleaning, coating, or vapor recovery for marine vessel loading operations.

EPA guidance for BACT states that regulatory agencies may consider technology transfer from similar sources; therefore, in spite of the differences between marine boilers and stationary boilers noted in Section 5.2, the RBLC was searched for recent BACT determinations for stationary gas-fired boilers (see Table 5-2). The only control technologies used at the facilities listed in Table 5-2 were low-NO_x burners (LNB), flue gas recirculation (FGR), selective catalytic reduction (SCR), good combustion practices (GCP), and usage restrictions.

In addition to the technologies listed, other NO_x reduction technologies exist but are still under development and have not been demonstrated in a commercial application on identical or similar emission units. These are classified as "innovative technologies" by the NSR manual and are not required to be considered in the BACT analysis, but have been considered in this case. These innovative add-on technologies include:

- Direct catalysts to simultaneously reduce NO_x and oxidize CO without reagents
- NOx adsorbers, such as EmeraChem's EMx™ technology (formerly known as SCONOx™)
- Processes in which NO_x is reacted with ozone to form a water-soluble nitrogen oxide, and this oxide is then removed with a scrubber (Thermal Energy International's ThermaLoNOx™ process and BOC Gases' LoTOx™ process)
- A technology proposed by Specialized Process Technologies BV (SPT) / DPS (Bristol) Limited that cools, compresses, and reacts the exhaust with a proprietary "Monochem" reagent
- Selective Noncatalytic Reduction (SNCR).

Table 5-2. EPA RBLC NO_x Data for Stationary Natural Gas Boilers 100-250 MMBtu/hr (Process Code 12.310), Jan. 1999 – Jan. 2006

RBLC ID	Name	Size (MMBtu/hr)	Permit Date	NO_x Limit (lb/MMBtu)	Control Technology
OR-0046	TURNER ENERGY CENTER, LLC	139	1/6/05	0.011 (3-hr avg)	SCR, LTD. USE
PA-0193	MERCK AND COMPANY - WEST POINT	249	8/26/99	0.012	LNB, FGR, AND SCR
IN-0085	PSEG LAWRENCEBURG ENERGY	125	6/7/01	0.036	LNB, LTD. USE
NJ-0036	AES RED OAK LLC	120	10/24/01	0.036	LTD. OPERATION
NJ-0043	LIBERTY GENERATING STATION	200	3/28/02	0.036	SCR, LTD. USE
CO-0052	ROCKY MOUNTAIN ENERGY CTR	129	8/11/02	0.037	LNB, FGR, AND GCP
SC-0049	SKYGEN	230	12/2/99	0.038	LNB, LTD. USE
AR-0057	TENASKA ARKANSAS PARTNERS, LP	122	10/9/01	0.04	LNB, FGR, AND GCP; LTD. USE
TX-0386	AMELLA ENERGY CENTER	155	3/26/02	0.04	FGR
TX-0411	AMELIA ENERGY CENTER	155	3/26/02	0.04	
MN-0062	HEARTLAND CORN PRODUCTS	198	12/22/05	0.04	
ID-0015	J R SIMPLOT COMPANY - DON SIDING	175	4/5/04	0.04	
IA-0050	CARGILL-EDDYVILLE	182	4/22/99	0.04 (30-day avg)	LNB
AL-0128	ALABAMA POWER - THEODORE COGEN	220	3/16/99	0.05	LNB AND FGR
MS-0069	DUPONT DELISLE FACILITY	231	6/8/04	0.053	LNB AND FGR
TX-0414	ATOFINA PORT ARTHUR COMPLEX	227	4/22/99	0.058	LNB AND FGR
FL-0251	OKEELANTA CORP SUGAR MILL	211	10/29/01	0.06	GCP
TN-0153	WILLIAMS REFINING & MARKETING	180	4/3/02	0.06	LNB, FGR, AND GCP
NE-0024	CARGILL - BLAIR PLANT	198	6/22/04	0.06	LTD. USE
GA-0096	SOUTHERN LNG, INC. ELBA ISLAND	121	2/17/03	0.07	LNB AND FGR
GA-0103	ELBA ISLAND, LNG TERMINAL	121	2/17/03	0.08	WI AND GCP
VA-0278	VCU EAST PLANT	151	3/31/03	0.08	WI
MS-0069	DUPONT DELISLE FACILITY	231	6/8/04	0.08	LNB, FGR, AND GCP; LTD. USE
MS-0069	DUPONT DELISLE FACILITY	231	6/8/04	0.09	LNB AND FGR
WI-0204	UWGP - FUEL GRADE ETHANOL PLANT	140	8/14/03	0.09	LNB AND FGR
WV-0023	MAIDSVILLE	225	3/2/04	0.095	LNB
WV-0015	E.I. DUPONT - WASHINGTON WORKS	181	1/2/02	0.098 (3-hr avg)	LNB, GCP, AND LTD. USE
VA-0270	VCU EAST PLANT	150	3/31/03	0.1	LNB, FGR, AND GCP
NC-0101	FORSYTH ENERGY PLANT	110	9/29/05	0.1	LNB, FGR, AND GCP
PA-0170	SUNOCO INC. (R&M)	245	8/2/01	0.137 (3-hr avg)	LNB AND GCP
PA-0170	SUNOCO INC. (R&M)	245	8/2/01	0.25	FOUR SPUD BURNERS
NJ-0042	ROCHE VITAMINS	118	2/5/99	0.25	FOUR SPUD BURNERS
NJ-0042	ROCHE VITAMINS	134	2/5/99	0.28	NONE LISTED
NJ-0042	ROCHE VITAMINS	152	2/5/99	0.28	NONE LISTED
DE-0017	SPI POLYOLS, INC.	115	10/26/01	0.28	NONE LISTED
OH-0241	MILLER BREWING CO - TRENTON	238	5/27/04	0.28	ANNUAL TUNE-UP, EXCESS O2 LIMIT

5.2.1.2 Step 2 – Eliminate Technically Infeasible Options

Several of the controls identified in the preceding section are technically infeasible. Combustion controls—including flue gas recirculation (FGR) and low-NO_x burners (LNB)—had been evaluated in the past by the boiler vendor (MHI). For FGR, MHI stated:

> "FGR requires significant space requirements for added fans and duct work and requires added furnace volume to be effective. We are aware from our prior efforts to increase the current boilers to 71 tons per hour, that insufficient space is available to retrofit FGR. If the added FGR components could be accommodated within the current shipboard space limitation and existing furnace volume, the steam output capacity of the regasification vessel boilers would be reduced by approximately 20%."[12]

For LNB, MHI noted that

> "...we would be especially concerned about flame stability of LNB during rapid load changes commonly experienced on marine boilers. If steam atomizing is also introduced for LNB, we would also question the ability of the vessel to meet the added water demand for steam atomizing, which could be as much as 40 tons per day on the regasification vessels. An extensive research and development program would be required before we could consider application of LNB to current marine boilers on your regasification vessels."

These statements were also supported by information obtained separately from Combustion Components Associates (Monroe, CT), a firm which specializes in combustion controls and has extensive experience with stationary boilers as well as experience with marine boilers (increasing efficiency and decreasing particulate emissions). CCA stated that although substantial NO_x reductions are sometimes obtainable from stationary boilers, the problem is much more difficult for marine boilers because of the short furnaces, and they have not yet embarked on a project to reduce NO_x from dual-fueled marine boilers.[13]

This having been said, Northeast Gateway will ensure that the second-generation EBRV main boilers are equipped with MHI "Volcano" burners designed to emit lower emissions of NO_x. Even though MHI has only limited experience with these burners and cannot provide any emissions guarantees, test data has shown that they are likely to reduce NO_x emissions and they will provide additional assurance that the outlet emissions provided in this application based on SCR can be met. Excelerate may also take the steam air heaters of the main boilers off-line, resulting in lower temperatures at the burner inlets and subsequently reduced energy efficiency but also reduced NO_x. For the auxiliary boiler (on each second-generation EBRV), Excelerate will be utilizing Hamworthy low-NO_x dual fuel DFL type register burners,

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[12] T. Yuki, Manager, Turbo & Marine Machin. Design Department, Marine Boiler Design Section, MHI, letter to Al Nierenberg, Excelerate Energy, letter #NMB-0313, 10 June 2005.
[13] Giff Broderick (CCA), telephone conversation with Todd Tamura (Tetra Tech EC), September 1, 2005.

which the vendor does not provide a performance guarantee for but predicts will emit lower levels of NO_x (72 ppm at 3% O_2 ≈ 0.087 lb/MMBtu) than standard burners.

Based on its research, Northeast Gateway made the following determinations regarding the various innovative add-on technologies:

- The direct reagentless catalysts are still essentially a research project at an educational institution.
- EMx™ had no operational experience with similar source types and is extremely sulfur-sensitive; as such, it would not have been able to withstand exhaust from the boilers when firing marine diesel during transoceanic voyages, and there was insufficient room available for a bypass.
- Thermal Energy's ThermaLoNOx™ utilizes elemental phosphorus to generate ozone, has only been tried on a coal-fired boiler, and was considered to be too much of a safety risk. BOC's LoTOx™ has been used in limited stationary gas-fired boiler applications and utilizes compressed oxygen to generate ozone, but a large quantity of compressed oxygen would have been required; in addition, the amount of space needed for the reaction chamber to oxidize the NO_x was more than what was available. (The scrubbers in both of these technologies also had the drawback of creating a waste byproduct that would need to be handled.)
- The vendors of the SPT process have been unable to fully establish the veracity of their results, and there are insufficient data to support the vendor's claims of emissions control.
- SNCR has limited use on stationary gas-fired utility boilers, and even in those applications there is a need for very hot temperatures, careful urea injection lance placement in the furnace, and computational fluid dynamics modeling. (The furnace geometry of the marine boilers is substantially different from that of utility boilers.)

SCR typically requires temperatures above 300 ^{o}C, well above the boilers' maximum exhaust temperatures of 180 ^{o}C; however, the potential for locating SCR upstream of the economizer was evaluated. MHI, the boiler vendor, is also an SCR vendor; however, MHI stated that

> "SCR...has added space and weight requirements. Most importantly, current SCR technology is not compatible with the sulphur content of fuel oils when [the boilers are] not in the gas burning mode and added complexity and space for [a] SCR bypass would be required, otherwise [the] catalyst is required to [be] replace[d] every two years at [the] shortest....we regret that we are not currently in the position to offer any proven emission reduction technology for your regasification vessels, which can maintain the 71 tons per hour required capacity and fit within the current engine room space restraints."[3]

Excelerate developed a Request For Proposal (RFP) for SCR, and obtained proposals from both MHI and Argillon LLC, which has provided the SINOx® SCR technology (developed by Siemens) for several marine engines but no marine boilers. Only Argillon was willing to provide a NO_x performance guarantee—15 ppmvd @ 3% O_2 (0.018 lb/MMBtu)—for both the main boilers and the auxiliary boiler.

In modifying the marine boilers and inserting SCR upstream of the economizers, Excelerate has gone above and beyond what is typically required for BACT analysis. This type of configuration has never been tried previously (let alone proven in practice) for marine applications and therefore should not be considered BACT.

5.2.1.3 Step 3 – Rank Remaining Controls by Control Effectiveness

Clearly, the SCR at 0.018 lb/MMBtu is the most effective control, although it is innovative and not proven in practice. Without SCR, the best guaranteed emissions performance for the main boilers is still 0.186 lb/MMBtu, as was accepted by EPA Region VI for the Gulf Gateway project. For the auxiliary boiler without SCR, the best guaranteed emissions performance is unknown, but is probably higher than the 0.087 lb/MMBtu unguaranteed estimate identified in Section 5.2.1.2.

5.2.1.4 Step 4 – Evaluate Most Effective Controls and Document Results

As discussed in Section 5.2.1.4, the most effective control—SCR, located upstream of the relocated boiler economizers—is not demonstrated in practice and should not be considered BACT, but will be installed on both the main boilers and the auxiliary boiler of any EBRV mooring at Northeast Gateway.

5.2.1.5 Step 5 – Select BACT

If BACT were applied to the boilers, it would still be 0.186 lb/MMBtu for the main boilers and somewhat above 0.072 lb/MMBtu for the auxiliary boiler. However, as stated previously, the proposed project is committed to installing SCR—with a vendor-guaranteed emissions specification of 0.018 lb/MMBtu—on both the main boilers and the auxiliary boiler of any EBRV mooring at Northeast Gateway.

5.2.2 BACT for CO Emissions

5.2.2.1 Step 1 – Identify all Control Options

As was the case with the BACT determination for NO_x, no CO controls are identified in the RBLC or in SIPs for marine boilers, and the only known instance of marine boilers being subjected to stationary source permitting requirements and BACT determinations is Gulf Gateway, for which EPA Region VI approved BACT for CO as an emissions limit of 18.52 lb/hr for each EBRV boiler. This corresponds to a CO emissions rate of 0.082 lb/MMBtu, and can be met by both the existing first-generation EBRV boilers and the new second-generation EBRV boilers without installing air pollution control equipment, as long as the boilers are restricted to using LNG boil-off gas or regasified LNG as a fuel.

Table 5-3 shows the results of an RBLC search for transferable technologies from stationary natural gas-fired boilers. The only control technologies used at the facilities listed in Table 5-3 were good combustion practices (GCP), catalysts, and usage restrictions.

Table 5-3. EPA RBLC CO Data for Stationary Natural Gas Boilers 100-250 MMBtu/hr (Process Code 12.310), Jan. 1999 – Jan. 2006

RBLC ID	Name	Size (MMBtu/hr)	Permit Date	CO Limit (lb/MMBtu)	Control Technology
OR-0046	TURNER ENERGY CENTER, LLC	139	1/6/05	0.038	CATALYST, LTD. USE
CO-0052	ROCKY MOUNTAIN ENERGY CENTER	249	8/26/99	0.039	GCP
MN-0062	HEARTLAND CORN PRODUCTS	181	1/2/02	0.04	NOT LISTED
NJ-0042	ROCHE VITAMINS	125	6/7/01	0.04	NOT LISTED
NJ-0042	ROCHE VITAMINS	120	10/24/01	0.04	NONE LISTED
NJ-0042	ROCHE VITAMINS	200	3/28/02	0.04	NONE LISTED
WV-0023	MAIDSVILLE	129	8/11/02	0.04 (3-hr avg)	GCP, LTD. USE
LA-0131	CLECO EVANGELINE LLC	230	12/2/99	0.05	GCP
NJ-0036	AES RED OAK LLC	122	10/9/01	0.05	GCP
SC-0049	SKYGEN	155	3/26/02	0.06	GCP, LTD. USE
TX-0414	ATOFINA PORT ARTHUR COMPLEX	155	3/26/02	0.07	GCP
TX-0386	AMELLA ENERGY CENTER	198	12/22/05	0.08	
IN-0085	PSEG LAWRENCEBURG ENERGY	175	4/5/04	0.082	GCP, LTD. USE
AR-0055	NUCOR YAMATO STEEL (ARMOREL)	182	4/22/99	0.0824	
NC-0101	FORSYTH ENERGY PLANT	220	3/16/99	0.0824	LNB AND GCP
OH-0241	MILLER BREWING COMPANY - TRENTON	231	6/8/04	0.084	
NJ-0043	LIBERTY GENERATING STATION	227	4/22/99	0.087	CATALYST, LTD. USE
VA-0270	VCU EAST PLANT	211	10/29/01	0.1	GCP
VA-0278	VCU EAST PLANT	180	4/3/02	0.1	GCP, LTD. USE
AR-0057	TENASKA ARKANSAS PARTNERS, LP	198	6/22/04	0.11	GCP
WI-0204	UWGP - FUEL GRADE ETHANOL PLANT	121	2/17/03	0.13	
GA-0096	SOUTHERN LNG, INC. ELBA ISLAND	121	2/17/03	0.164	GCP
GA-0103	ELBA ISLAND, LNG TERMINAL	151	3/31/03	0.164	GCP
AL-0128	ALABAMA POWER COMPANY - THEODORE COGEN	231	6/8/04	0.165	GCP
OH-0245	REPUBLIC TECHNOLOGIES INTL	231	6/8/04	0.175	
TN-0153	WILLIAMS REFINING & MARKETING	140	8/14/03	0.18	LTD. USE
PA-0193	MERCK AND COMPANY - WEST POINT	225	3/2/04	0.37	GCP

5.2.2.2 Step 2 – Eliminate Technically Infeasible Options

Although the exhaust temperatures required by CO oxidation catalysts are typically 400 ^{o}C and higher—i.e., well above the exhaust temperatures of the EBRV boilers—the SCR reactors inserted upstream of the boiler economizers are at an elevated temperature and it appears that there is at least limited space for some CO catalyst. There are significant safety concerns with using CO catalysts in this environment: in particular, the potential for high concentrations of methane in the exhaust—for example, from a tube leak—could present a safety risk across the CO catalyst. The most recent Suez Distrigas expansion project in Everett did not use CO catalysts for this reason. CO catalysts are therefore likely to be technically infeasible, but were also analyzed in subsequent steps of this analysis to illustrate that they are also economically infeasible.

5.2.2.3 Step 3 – Rank Remaining Controls by Control Effectiveness

In general, the use of a CO catalyst will result in lower emissions (have higher control effectiveness) than the use of GCP alone. However, it needs to be recognized that the difference in emissions may not be practicably measurable. The majority of the CO exhaust concentration data that has been collected from the main boilers in the Gulf Gateway project has shown CO concentrations as being 0 ppm, which is consistent with EPA findings for oil-fired marine boilers: i.e., for purposes of mobile source emissions inventories, EPA has identified CO emissions from oil-fired marine boilers as "negligible" during hotelling and as only 3.5 lb/1000 gal (≈ 0.023 lb/MMBtu) during transit,[14] and Massachusetts DEP uses these same assumptions in its mobile source emissions inventory.[15] Hamworthy, the vendor for the low-NO_x DFL burners on the auxiliary boiler for the second-generation EBRVs, has stated that "[CO] emissions for a boiler/burning operating at its design conditions (e.g., clean, etc.) will be extremely low and of the order of 10-20 ppm" (see Appendix B). This having been said, neither MHI nor Hamworthy provides a performance guarantee for CO, and Gulf Gateway project has also found indications that CO concentrations from the main boilers may occasionally be elevated; it is for these reasons that the proposed emissions limit for the Northeast Gateway boilers is no more stringent than 60 ppmvd @ 3% O_2 = 0.044 lb/MMBtu.[16]

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[14] US EPA, "Procedures for Emission Inventory Preparation, Volume IV: Mobile Sources," EPA-450/4-81-026d (revised), July 1989, pp. 7-11 and 7-12.

[15] Massachusetts DEP, "Massachusetts Periodic Emission Inventories 1999 - VOC, NOx and CO," April 2003 (Section 5.3 e-mailed from Ken Santlal, Massachusetts DEP, to Todd Tamura, Tetra Tech EC, Inc., May 2005); Massachusetts DEP, "Preliminary Draft MA 2002 Baseline Emission Inventory of VOC, NOx, CO, SO_2, PM & NH_3" (Section 5.3 e mailed from Ken Santlal, Massachusetts DEP, to Todd Tamura, Tetra Tech EC, Inc., November 23, 2005).

[16] The conversion of exhaust concentrations expressed in ppmvd @ 3% O2 to emission factors in lb/MMBtu is described in Appendix C.

5.2.2.4 *Step 4 – Evaluate Most Effective Controls and Document Results*

Despite the fact that CO catalysts have been used on several combustion sources, there is still risk involved with their use. For example, even though CO catalysts have been successfully applied to stationary combustion turbines, there have been instances in which technical problems (such as vibration) have caused complete structural failure of the catalyst. Although risks such as these are not easily quantified and therefore not included in many cost analyses, they are nonetheless real.

In addition, it needs to be recognized that multiple EBRVs will be utilizing the Port. Each individual EBRV needs to travel to the source of the LNG, load, and travel back to the Port; therefore, at a minimum, two EBRVs would be needed to provide a continuous supply of gas to the Port. Because the Port is limited to 99 TPY CO, the average CO emissions from the EBRVs could not exceed 49.5 TPY. Because each of the three boilers on each EBRV has a separate SCR system, control of these emissions by CO catalysts would require three separate CO catalysts that would need to be designed to withstand emissions during residual oil firing which must occur during transoceanic travel; and in addition to the cost associated with the catalysts themselves, compliance would require that the catalysts be periodically replaced, possibly on schedules that are different than those from the SCR catalysts (which would be prohibitively expensive). As a result, the installation of CO catalysts on the boilers is not cost-effective.

5.2.2.5 *Step 5 – Select BACT*

BACT for CO from marine boilers used in LNG regasification operations is selected as being 60 ppmvd @ 3% O_2 = 0.044 lb/MMBtu, which can be met on a continuous basis during those operations when using well-designed marine boilers and clean fuels (LNG boil-off or regasified LNG). This limit is just 53% of the emissions limit approved by EPA Region VI for the Gulf Gateway project and is also comparable to the most stringent BACT emissions determinations that EPA has made for stationary gas-fired boilers (as shown in Table 5-2).

5.2.3 BACT for Other Pollutants

Controls (other than good combustion practices) have not been developed or applied to natural gas-fired boilers for other pollutants. (Although the CO catalysts discussed in Section 5.2.2 do have the potential to reduce VOC and HAP emissions, uncontrolled emissions of these pollutants from marine boilers are very low and the reductions are not likely to be measurable.) BACT for VOC, HAP, SO_2, and PM is the use of natural gas (including natural gas boil-off) as a fuel and good combustion practices.

5.3 EBRV Auxiliary Generators

As described in Section 3.2, the auxiliary generators on first-generation EBRVs are powered by diesel engines and the auxiliary generators on second-generation EBRVs are powered by dual-fuel engines with substantially lower emissions that are capable of firing either primarily gas (i.e., at least 99% gas and no more than 1% oil, after startup) or oil but will be restricted to firing primarily gas when EBRVs are moored at the Port.

As was the case with the boilers, marine engines differ from stationary engines. For example, the auxiliary marine engines proposed here have displacements of greater than 30 L per cylinder and are therefore classified as "Category 3" marine engines. EPA has noted that these engines differ from smaller ("Category 1" and "Category 2") marine engines

> "...in important ways that affect emissions and emission-control technologies....Category 3 engines therefore have the lowest brake-specific fuel consumption rates (BSFC) of any internal-combustion engine (as low as 176 g/kW-hr). Manufacturers achieve this with very high brake mean-effective pressures (up to 2,200 kPa) and low mean piston speeds (7 to 9 m/s)."[17]

In contrast, EPA's AP-42 compilation assumes a BSFC of 221 g/kW-hr for stationary diesels.[18]

5.3.1 BACT for NO_x Emissions

5.3.1.1 Step 1 – Identify all Control Options

As was the case with the BACT determinations for the marine boilers, no NO_x controls for marine generators are identified in the RBLC or in SIPs, and the only known instance of marine generators being subjected to stationary source permitting requirements and BACT determinations is Gulf Gateway, for which EPA Region VI approved BACT for NO_x as an emissions limit of 111.04 lb/hr for a 3,450 kW diesel marine generator (i.e., an emissions rate of 14.6 g/kWh or approximately 10.9 g/hp-hr) allowed to operate 8760 hr/yr.

The US is a signatory to the International Maritime Organization's Regulations for the Prevention of Air Pollution from Ships (Annex VI of MARPOL 73/78), which include NO_x standards for marine diesel engines that are identical to EPA's "Tier 1" NO_x standards for Category 3 marine diesel engines (12.1 g/kWh, for the engines being proposed). EPA's 2003 regulatory support document for the Category 3 emissions rulemaking[17] included information regarding several additional types of emissions controls for this source type that go beyond the Tier 1 standards. These additional control options included:

1. Water introduction into the combustion process
2. SCR
3. Fuel cells
4. Exhaust Gas Recirculation (EGR)
5. Electronic control

[17] US EPA, "Final Regulatory Support Document: Control of Emissions from New Marine Compression-Ignition Engines at or Above 30 Liters per Cylinder," EPA420-R-03-004, January 2003.
[18] US EPA, AP-42 Section 3.4, Table 3.4-1, footnote e identifies a heating value of 0.36 lb/hp-hr, which translates into 221 g/kW-hr.

As was done for the boiler BACT analysis, an RBLC search was conducted for stationary diesel and dual-fuel engines, for purposes of identifying any other technologies for potential technology transfer. Table 5 shows that a wide range of emission limits and control technologies applied to land-based internal combustion engines larger than 500 hp. Most of the technologies are incorporated into the engine design: e.g., so-called "clean burn" technology or dual-fuel technology, the use of turbochargers (TC) and aftercoolers (AC), and electronic controls for air/fuel ratio (A/F). In some cases, the ignition timing is retarded (ITR), and a few stationary engines also use the water injection or SCR technologies mentioned above. In many cases, controls are limited to good combustion practices (GCP) and/or limitations on usage.

Table 5-4. EPA RBLC NO_x Data for Large (> 500 hp) Stationary Diesel and Dual-Fuel Reciprocating Engines (Process Code 17.1), Jan. 2001 – Jan. 2006**

RBLC ID	Name	Size	Permit Date	NO_x Limit (g/bhp-hr)	Control Technology
VA-0276	INGENCO - CHARLES CITY PLANT	550 HP	6/20/03	0.7	LTD USE (500-1200 H/YR)
AK-0059	USAF EARECKSON AIR STATION	3000 KW	9/29/03	1.1	A/F CONTROL, TC, CHARGE AIR COOLING
PA-0209	ORCHARD PARK GENERATING STATION	8086 HP	11/8/02	1.5	SCR
IA-0076	JOHN DEERE PRODUCT ENGRG CENTER	NA	3/23/05	3.7	LEAN BURN, SCR, LOW EMISSION COMB. CONTROL
NM-0049	PHELPS DODGE TYRONE, INC	NA	5/20/02	3.9	GCP, DUAL-FUEL
CA-1012	POWER SYS. ASSOC./JOHNSON POWER	685 HP	7/11/01	4.2	GCP
CA-1013	POWER SYS. ASSOC./JOHNSON POWER	610 HP	7/11/01	4.2	TC, AC
NM-0049	PHELPS DODGE TYRONE, INC	NA	5/20/02	4.6	TC, AC
CA-1014	POWER SYS. ASSOC./JOHNSON POWER	536 HP	7/11/01	4.8	GCP
VA-0288	INGENCO	550 HP	12/17/03	5.1	TC, AC, DUAL-FUEL
WV-0023	MAIDSVILLE	1801 HP	3/2/04	5.3	A/F CONTROL, TC, CHARGE- AIR COOLING, SUPPLEMENTARY COOLING AND OVERSIZED INLET CHARGE AND EXHAUST DUCTS.
NC-0074	BRIDGESTONE/FIRESTONE	624 HP	1/24/03	5.7	GCP
CA-1010	POWER SYS. ASSOC./JOHNSON POWER	764 HP	7/11/01	6.2	ITR
AK-0060	DUTCH HARBOR SEAFOOD PROCESSING	2220 KW	10/10/03	6.5	TC, AC
CA-0988	PACIFIC BELL	2935 HP	2/1/03	6.9	WATER INJECTION, LOW NOX DESIGN
OH-0254	DUKE ENERGY WASHINGTON COUNTY	600 KW	8/14/03	7.0	
OH-0266	UNIVERSITY OF CINCINNATI	2922 BHP	8/15/02	7.1	LOW SULFUR FUEL, COMBUSTION CONTROL
MN-0053	FAIRBAULT ENERGY PARK	670 HP	7/15/04	7.9	
NC-0074	BRIDGESTONE/FIRESTONE	1600 KW	1/24/03	8.6	GCP
OK-0090	DUKE ENERGY STEPHENS, LLC STEPHENS ENERGY	749 HP	3/21/03	8.8	ITR
OK-0072	REDBUD POWER PLT	1818 HP	5/6/02	10.9	ENGINE DESIGN AND LTD USE (<100 H/YR)
IA-0058	GREATER DES MOINES ENERGY CENTER	700 KW	4/10/02	11.0	
MN-0054	MANKATO ENERGY CENTER	1850 HP	12/4/03	12.7	ITR (3-4 DEGREES)
WI-0207	ACE ETHANOL - STANLEY	1850 HP	1/21/04	13.0	GCP
TX-0407	STERNE ELECTRIC GEN. FACILITY	1350 HP	12/6/02	14.0	LTD USE (16.7 HRS/MO, 12 MO. AVG.)
AR-0051	DUKE ENERGY-JACKSON FACILITY	671 HP	4/1/02	14.0	
PA-0244	FIRST QUALITY TISSUE, LLC	575 HP	10/20/04	14.1	GOOD OPERATING PRACTICE

5.3.1.2 *Step 2 – Eliminate Technically Infeasible Options*

For marine engines, EPA identified all five of the technologies listed in Section 5.3.1.1 as "advanced" technologies "under development," and in its cost projections noted that costs needed to "include a substantial time allowance for manufacturers to pursue engine improvements" (p. 6-3) or "reflect technology development and overhead involved for the company manufacturing the components" (p. 6-5, 6-8). EPA's BACT guidance states (p. B.18) that

> "A source would not be required to experience extended time delays or resource penalties to allow research to be conducted on a new technique. Neither is it expected that an applicant would be required to experience extended trials to learn how to apply a technology on a totally new and dissimilar source type. Consequently, technologies in the pilot scale testing states of development would not be considered available for BACT review."

Therefore, each of these options should be identified as technically infeasible. However, because SCR systems are commercially available for marine diesels, this technology was not eliminated at this stage as being technically infeasible. (There are space constraints; however, as discussed in Section 5.3.1.4, this technology is not economically feasible given the proposed operating constraints, and therefore a full evaluation of space constraints was not conducted.)

5.3.1.3 *Step 3 – Rank Remaining Controls by Control Effectiveness*

SCR is the most effective control available: one vendor (Argillon) has achieved NO_x emissions of 1-2 g/kWh (roughly 0.75-1.5 g/hp-hr) in applications on diesel marine generators. The use of the dual-fuel generators on second-generation EBRVs is the next most effective option; vendor data (see Appendix B) shows that emissions from these generators are only 1-2 g/kWh even without SCR. The use of IMO- and EPA Tier 1-compliant marine diesel generators and good combustion practices, as is done on the first-generation EBRVs, is the next most effective option. Although the maximum allowable NO_x emissions (12.1 g/kWh ≈ 9.0 g/hp-hr) have conservatively been assumed for these Tier 1 generators, the MARPOL compliance certificate for this engine family (see Appendix B) has shown that tested emissions were actually slightly lower (11.8 g/kWh ≈ 8.8 g/hp-hr).

5.3.1.4 *Step 4 – Evaluate Most Effective Controls and Document Results*

The most effective control, SCR, is not cost-effective, primarily because engine operations are so limited at Northeast Gateway. As shown in Tables 3-6 and 3-7, total NO_x emissions from all auxiliary generators on all first-generation EBRVs could not be greater than 18 TPY and total emissions from all auxiliary on all second-generation EBRVs could not be greater than 1.9 TPY. As pointed out previously, the control of the potential 18 TPY of emissions from first-generation EBRVs would also necessitate not just the installation of one SCR control system, but the installation of SCR systems on all of the first-generation EBRVs mooring at Northeast Gateway.

5.3.1.5 *Step 5 – Select BACT*

For marine generators limited to a combined total of 370 hr/yr of operation, uncontrolled emissions from dual-fueled generators (1.3 g/kWh at full load) and diesel generators (12.1 g/kWh) are representative of BACT for those respective source categories.

5.3.2 BACT for Other Pollutants

5.3.2.1 *Step 1 – Identify all Control Options*

EPA has not yet addressed controls for CO, PM_{10}, and other pollutants from Category 3 marine diesel engines; they are due to promulgate Tier 2 requirements for Category 3 marine diesels on or before April 27, 2007 [40 CFR 94.8(a)(2)(ii)]. RBLC searches of controls for stationary diesel sources turned up no additional control measures other than good combustion practice/good engine design, diesel particulate filters (which are not applicable to oil-firing units unless ultra low sulfur diesel fuel is available), the use of low-sulfur fuel, and CO oxidation catalysts , which were evaluated by EPA in 2002 when the Agency proposed National Emissions Standards for Hazardous Air Pollutants (NESHAP) for reciprocating internal combustion engines (RICE).[19]

5.3.2.2 *Step 2 – Eliminate Technically Infeasible Options*

CO catalysts may be technically feasible, if space is available; however, given that they are not economically feasible (as will be discussed in Section 5.3.2.4), a detailed analysis of space constraints was not conducted.

Northeast Gateway is committing to utilizing fuel oil with a sulfur content of no more than 0.5% (wt.) sulfur in the auxiliary generators when the EBRVs are moored, which requires fuel oil tanks that are separate from those used by the main boilers during transoceanic travel. Although ultra-low sulfur diesel (0.0015% sulfur by weight) will be available on the US mainland, the EBRVs need to purchase fuel at various ports of call (many of which are international), and it is not technically feasible to continually guarantee a more stringent sulfur content specification.

5.3.2.3 *Step 3 – Rank Remaining Controls by Control Effectiveness*

CO catalysts are the only remaining control, aside from the control strategy of limiting operational hours of the auxiliary generators at Northeast Gateway to 370 hr/yr.

5.3.2.4 *Step 4 – Evaluate Most Effective Controls and Document Results*

The most effective controls, CO catalysts, are not cost-effective, primarily because engine operations are so limited at Northeast Gateway. As shown in Tables 3-6 and 3-7, total CO emissions from all auxiliary generators on all first-generation EBRVs could not be greater than 5.0 TPY and total emissions from all

[19] US EPA, "Regulatory Impact Analysis of the Proposed Reciprocating Internal Combustion Engines NESHAP," Final Report, EPA-452/R-02-012, November 2002.

auxiliary on all second-generation EBRVs could not be greater than 2.8 TPY. EPA has estimated annual control costs for CO oxidation catalysts on diesels as being $10-13 per horsepower per year,[19] which would be equivalent to approximately $36,500-$47,450/yr for each of the EBRV auxiliary generators. These costs would therefore not be cost-effective even if all of the CO emissions were emitted by a single EBRV.

5.3.2.5 Step 5 – Select BACT

For marine generators fueled in foreign countries and limited to a combined total of 370 hr/yr of operation, BACT for diesel generators and dual-fueled generators consists of using modern generators, a fuel oil with a sulfur content of no more than 0.5% by weight, and (for the dual-fueled generator) predominantly natural gas as a fuel.

5.4 Conclusion

It is assumed in this application that BACT requirements are applicable to the EBRVs (see Section 4.2); these requirements are met by both the first-generation EBRVs and second-generation EBRVs as proposed.

For the marine boilers, the innovative proposal to install SCR upstream of the economizers with an exhaust specification of 15 ppmvd NO_x (corrected to 3% O_2) has never before been demonstrated in practice and is therefore beyond what would be considered BACT. The use of modern boilers with clean-burning gas as a fuel and good combustion practices would represent BACT for CO and other pollutants emitted from the boilers, as was approved by EPA Region VI for these source types in 2004, although the emission limits for CO proposed here are substantially more stringent than what was approved by EPA Region VI.

The diesel auxiliary generators on the first-generation EBRVs were approved as BACT by EPA Region VI and the dual-fuel auxiliary generators on the second-generation EBRVs emit substantially fewer emissions, as shown in Table 3-3. Total run-time of auxiliary generators on all EBRVs mooring at Northeast Gateway will also be limited to no more than 370 hours per year, and the auxiliary generators are committed to using marine diesel oil that contains no more than 0.5% sulfur by weight.

SECTION 6 AIR QUALITY IMPACT ASSESSMENT

6.1 Overview

A dispersion modeling analysis was conducted to evaluate potential air quality impacts resulting from the proposed project. The proposed location of the EBRVs while moored at the Port is an area on the high seas, assumed for purposes of air quality modeling to be designated as attainment for SO_2, CO, NO_x, and PM_{10}. Therefore, if the EBRVs are considered stationary sources for these pollutants, the Project would be required to demonstrate compliance with all respective national ambient air quality standards (NAAQS).

Results of the air quality analysis indicate that the emissions from EBRVs discharged while moored at the Port will have modeled insignificant impacts (i.e., the maximum modeled predicted impacts are less than the Significant Impact Levels (SILs)) for all criteria pollutants. Therefore, no NAAQS and increment analyses are required as the NAAQS and PSD increment levels would not be threatened by the Project. (SO_2 was not considered since annual potential emissions are less than the EPA-defined Significant Emission Rate (SER)).

6.2 Vessel Emissions

Emission and stack exhaust parameters are provided in Table 6-1 for each of the main boilers as well as the auxiliary generator and auxiliary boiler. Source data are provided for five different operations scenarios: for each of the two buoys.

1. First Generation Vessels/Minimum Load Case — Both main boilers at 40% load (approximately 90 MMBtu/hr), no other sources.
2. First Generation Vessels/Normal (Base) Load Case — Both main boilers at base load (197 MMBtu/hr), no other sources.
3. First Generation Vessels/Maximum Load Case — Both main boilers at maximum load (224 MMBtu/hr), diesel-fired generator at 3,650 kW load.
4. Second Generation Vessels/Normal (Base) Load Case — Both main boilers at base load (197 MMBtu/hr), auxiliary boiler at maximum load (100 MMBtu/hr), gas-fired generator at 2,880 kW load.
5. Second Generation Vessels/Maximum Load Case — Both main boilers at maximum load (224 MMBtu/hr), auxiliary boiler at maximum load (100 MMBtu/hr), gas-fired generator at maximum load (3,650 kW).

In addition, short term modeling considers that EBRVs will be in operation at the same time at both locations (Buoy A and Buoy B). For annual emission impacts predictions, it is assumed that a vessel is always at Buoy B, since this location is the one nearest to the Massachusetts shoreline and thus providing worst case impacts. Additionally, the second vessel at Buoy A is assumed to be present for 10% of the time (876 hours). Similarly, generator operation is assumed to be limited to 336 hours per year at Buoy B and 34 hours per year at Buoy A.

6.3 Project Site Characteristics

Described in this section are: the Good Engineering Practice stack height analysis (Section 3.1), the meteorological data bases (Section 3.2), and background air quality (Section 3.3).

6.3.1 Good Engineering Practice Stack Height Analysis

Specific guidance for determining Good Engineering Practice (GEP) stack height and for determining whether downwash will occur is provided in the Guidance for Determination of Good Engineering Practice Stack Height (Technical Support Document for the Stack Height Regulations), (U.S. EPA, 1985). GEP stack height is defined as "the height necessary to ensure that emissions from the stack do not result in excessive concentrations of any air pollutant in the immediate vicinity of the source as a result of atmospheric downwash, eddies, and wakes that may be created by the source itself, nearby structures, or nearby terrain obstacles".

The GEP definition is based on the observed phenomenon of atmospheric flow in the immediate vicinity of a structure. It identifies the minimum stack height at which significant adverse aerodynamics (downwash) are avoided.

The U.S. EPA GEP stack height regulations specify that the GEP stack height is calculated in the following manner:

$$H_{GEP} = H_B + 1.5L$$

where:

H_B = the height of adjacent or nearby structures, and

L = the lesser dimension (height or projected width of the adjacent or nearby structures).

The plumes from the boilers and auxiliary generator stacks will be affected by downwash created by the winds blowing over the vessel and the structures on it. The EPA BPIP model was used to conduct the GEP analysis and determine the dimensions for the structures influencing the stack plumes. The controlling structure (the influencing structure that corresponds to the highest calculated GEP stack height) is the wheelhouse.

The height of this structure is 33.2 meters above sea level. Since it is a squat structure (wider than tall), the calculated GEP height is 2.5 times the structure height, or 83.0 meters. Since the actual stack height (37.4 meters) is less than GEP height, downwash effects were evaluated with the dispersion modeling. The BPIP model was used to determine structure dimensions for all directions. However, since the ships are not stationary and the shifting winds can blow across the ship in virtually any orientation, worst case structure dimensions were used to represent all directions for the refined dispersion modeling. A schematic diagram describing the ship structures, along with the BPIP input and output files, are provided in Appendix E.

Note that second generation vessels will be approximately 14 meters longer than the first generation vessels. However, the wheel house will be unchanged and remain the controlling structure. Therefore, the building dimensions used to evaluate downwash will not change.

Table 6-1a: Emission Stack Parameters for the Northeast Gateway Energy Bridge Project

SOURCE	EAST (KM)	NORTH COORD (KM)	BUILDING HEIGHT (M)	STACK TOP HT (M)	STACK DIAM (M)	STACK ANGLE (DEG FROM VERT)	GRD-LVL ELEV. (M)	BLDG WIDTH (M)
SBBOILERB	366,941	4,695,344	33.2	37.4	1.4	45	0	33.25
PORTBOILERB	366,941	4,695,344	33.2	37.4	1.4	45	0	33.25
GENERATORB	366,941	4,695,344	33.2	37.4	0.7	45	0	33.25
SBBOILERA **COORD**	368,973	4,694,752	33.2	37.4	1.4	45	0	33.25
PORTBOILA	368,973	4,694,752	33.2	37.4	1.4	45	0	33.25
GENERATORA	368,973	4,694,752	33.2	37.4	0.7	45	0	33.25
SBBOILERB2	366,941	4,695,344	33.2	37.4	1.4	45	0	33.25
PORTBOILERB2	366,941	4,695,344	33.2	37.4	1.4	45	0	33.25
AUXBOILB2	366,941	4,695,344	33.2	37.4	1.2	45	0	33.25
GENERATORB2	366,941	4,695,344	33.2	37.4	0.7	45	0	33.25
SBBOILERA2	368,973	4,694,752	33.2	37.4	1.4	45	0	33.25
PORTBOILA2	368,973	4,694,752	33.2	37.4	1.4	45	0	33.25
AUXBOILA2	368,973	4,694,752	33.2	37.4	1.2	45	0	33.25
GENERATORA2	368,973	4,694,752	33.2	37.4	0.7	45	0	33.25

Table 6-1b: Emission Stack Parameters for the Northeast Gateway Energy Bridge Project

	STACK TEMPERATURE (K)					EXIT VELOCITY (M/S)				
SOURCE	**Case 1**	**Case 2**	**Case 3**	**Case 4**	**Case 5**	**Case 1**	**Case 2**	**Case 3**	**Case 4**	**Case 5**
SBBOILERB	433	449	453			8.61	18.43	21.22		
PORTBOILERB	433	449	453			8.61	18.43	21.22		
GENERATORB			583					31.27		
SBBOILERA	433	449	453			8.61	18.43	21.22		
PORTBOILA	433	449	453			8.61	18.43	21.22		
GENERATORA			583					31.27		
SBBOILERB2				448	451				18.4	21.1
PORTBOILERB2				448	451				18.4	21.1
AUXBOILB2				694	694				21.4	21.4
GENERATORB2				613	603				22.6	26.0
SBBOILERA2				448	451				18.4	21.1
PORTBOILA2				448	451				18.4	21.1
AUXBOILA2				694	694				21.4	21.4
GENERATORA2				613	603				22.6	26.0

Table 6-1c: Emission Stack Parameters for the Northeast Gateway Energy Bridge Project

	NOX EMISSION RATE (G/S)					CO EMISSION RATE (G/S)					PM EMISSION RATE (G/S)				
SOURCE	**Case 1**	**Case 2**	**Case 3**	**Case 4**	**Case 5**	**Case 1**	**Case 2**	**Case 3**	**Case 4**	**Case 5**	**Case 1**	**Case 2**	**Case 3**	**Case 4**	**Case 5**
SBBOILERB	0.204	0.45	0.51			0.50	1.09	1.24			0.084	0.19	0.21		
PORTBOILERB	0.204	0.45	0.51			0.50	1.09	1.24			0.084	0.19	0.21		
GENERATORB			0.52					3.39					0.43		
SBBOILERA	0.0204	0.0449	0.051			0.50	1.09	1.24			0.084	0.19	0.21		
PORTBOILA	0.0204	0.0449	0.051			0.50	1.09	1.24			0.084	0.19	0.21		
GENERATORA			0.052					3.39					0.43		
SBBOILERB2				0.45	0.51				1.09	1.24				0.19	0.21
PORTBOILERB2				0.45	0.51				1.09	1.24				0.19	0.21
AUXBOILB2				0.23	0.23				0.56	0.56				0.09	0.09
GENERATORB2				0.05	0.06				1.68	1.93				0.00	-
SBBOILERA2				0.045	0.051				1.09	1.24				0.19	0.21
PORTBOILA2				0.045	0.051				1.09	1.24				0.19	0.21
AUXBOILA2				0.023	0.023				0.56	0.56				0.09	0.09
GENERATORA2				0.005	0.006				1.68	1.93				0.00	0.00

Notes: (1) NOx and PM emissions for Buoy site A are annualized and averaged for operation for 10% of the year.

6.3.2 Meteorological Data

The Offshore and Coastal Dispersion (OCD) model uses hourly over-land and over-water meteorological data to simulate the plume transport and dispersion. Data from one land-based National Weather Service monitoring station and one water-based buoy monitoring station were used as input to the OCD model.

According to the EPA's Guideline on Air Quality Models (U.S. EPA, 2003), five years of standard meteorological observations should be used in refined modeling analyses, if on-site meteorological data are not available. Five years of over-land and over-water meteorological have been used in the analysis since Northeast Gateway does not have on-site meteorological data.

6.3.2.1 Hourly Over-land Meteorological Data

Five years (2000-2004) of National Weather Service hourly surface meteorological data were obtained for Boston Logan Airport, and processed with concurrent Gray, ME mixing height data to create the over-land meteorological file required by the OCD model. The over-land meteorological data for the OCD model was QA/QC'd for completeness of the meteorological data as per EPA Guidelines.

An anemometer height of 6.7 meters is used in the OCD model along with the surface roughness length based on the land use types within 3 km of the Boston Logan Airport meteorological monitoring site. A wind rose plot describing the characteristics for this set of wind data is provided in Figure 6-1.

6.3.2.2 Hourly Over-water Meteorological Data

Hourly over-water meteorological data concurrent with the five years (2000-2004) of over-land meteorological data were also used in the modeling analysis. The hourly over-water meteorological data was obtained from the National Data Buoy Center for the Boston, MA buoy (Station 44013 - BOSTON 16 NM East of Boston, MA). The Boston, MA buoy is located approximately 9.7 and 8.4 kilometers southwest of the proposed buoy sites A and B, respectively. Concurrent mixing height data from the Chatham, MA station was used for the over water data set. The over-water meteorological data for the OCD model has also been QA/QC'd for completeness of the meteorological data as per U.S. EPA Guidelines. A wind rose plot describing the characteristics for this set of wind data is provided in Figure 6-2.

Specifications for the buoy station are as follows:

Site elevation:	sea level
Air temp height:	4 meters above site elevation
Anemometer height:	5 meters above site elevation
Barometer elevation:	sea level
Sea temp depth:	0.6 meters below site elevation
Water depth:	55.0 meters
Watch circle radius:	119 meters (130 yards)

Figure 6-1: Wind Rose Plot for Boston, MA (Logan) Wind Data Five-Year Composite (2000 – 2004)

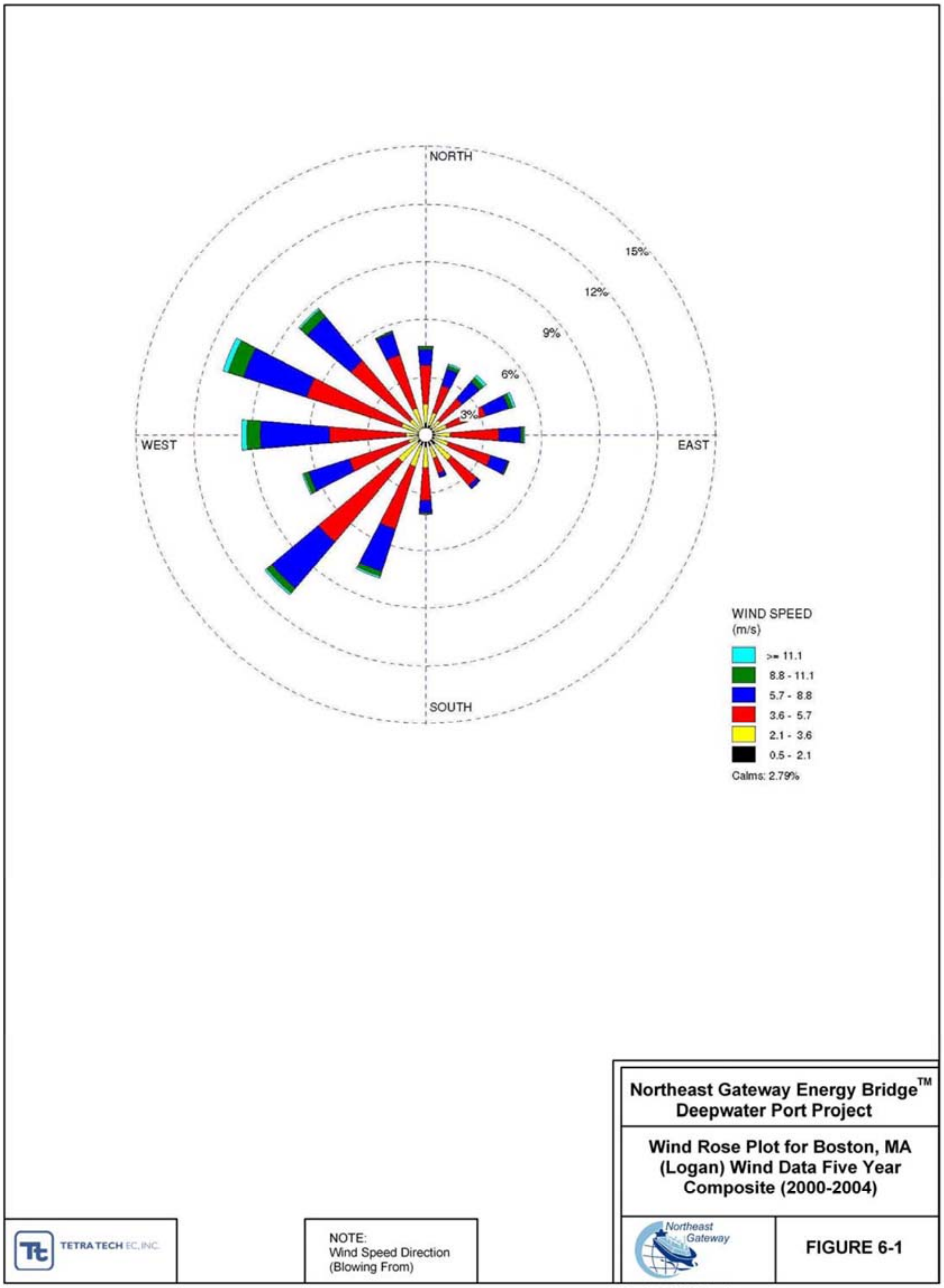
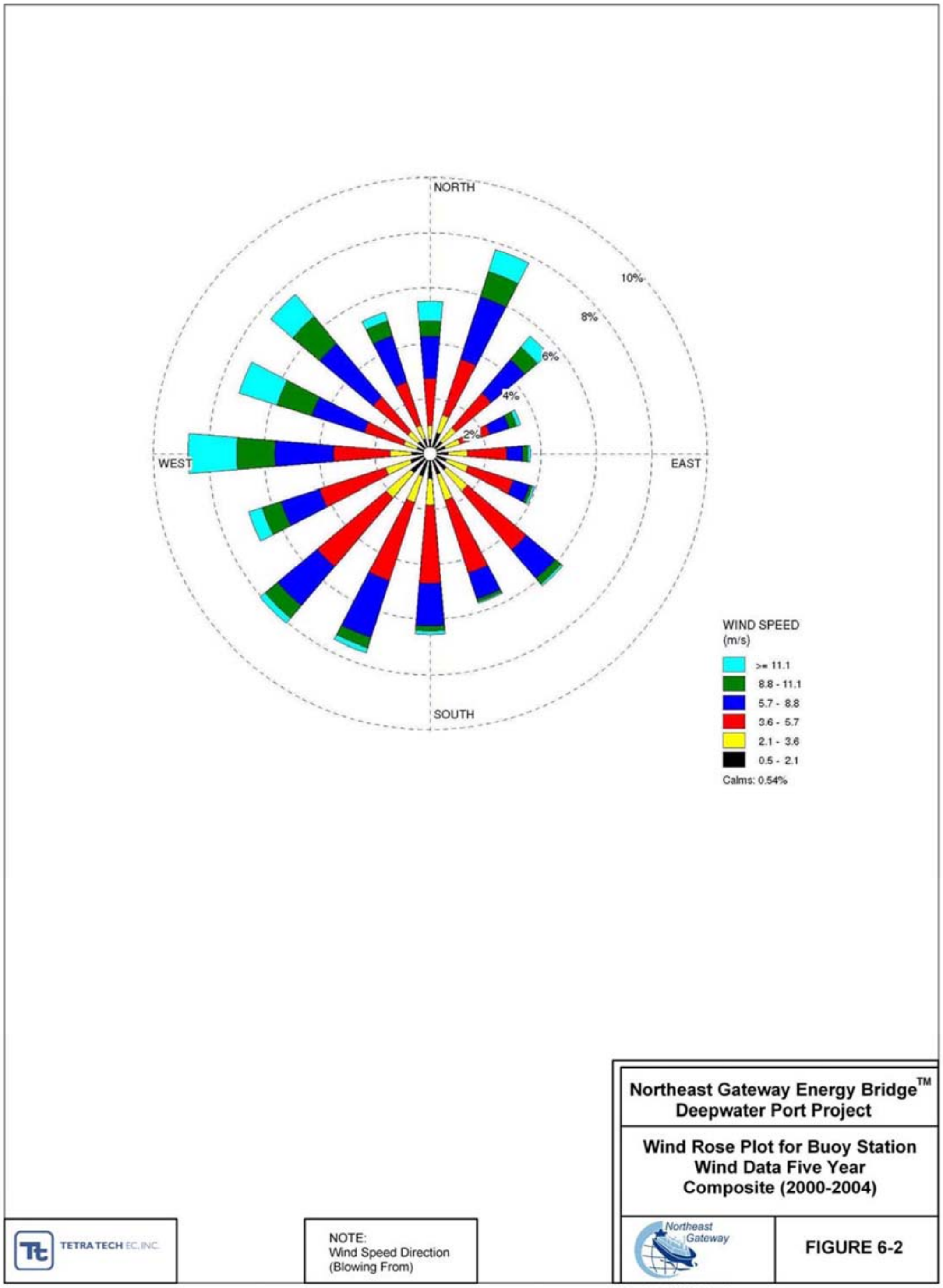


Figure 6-2: Wind Rose Plot for Buoy Station Wind Data Five-Year Composite (2000 – 2004)



6.3.3 Background Air Quality

Massachusetts has been designated as attaining ambient air quality standards (AAQS) for all criteria air pollutants except ozone. Table 6-2 provides a summary of very conservative background air quality data that is representative of the general project area. The table compares the maximum relevant short term concentration and annual average concentration with the Massachusetts and Federal AAQS for each of the most recent three years. The data confirm that with the exception of ozone, the AAQS are being met at even these high activity monitoring sites.

Table 6-2: Ambient Air Monitoring Data Representative of the Project Area

		Concentrations/Number of Exceedances									
						2002		2003		2004	
Pollutant	**Monitor**	**Avg. Time**	**Units**	**NAAQS**	**MA AAQS**	**Conc**	**# > Std**	**Conc**	**# > Std**	**Conc**	**# > Std**
PM_{10}	One City Square, Charlestown/Boston	24-Hr (Max)	μg/m^3	150	150	69	0	61	0	68	0
	One City Square, Charlestown/Boston	Annual	μg/m^3	50	50	30	0	25	0	25	0
$PM_{2.5}$	One City Square, Charlestown/Boston	24-Hr (Max)	μg/m^3	65	65	54	0	48	0	42	0
	One City Square, Charlestown/Boston	Annual	μg/m^3	15	15	13.4	0	12.4	0	12.8	0
SO_2	Long Island Boston Harbor	3-Hour	ppm	0.5	0.5	0.027	0	0.035	0	0.021	0
	Long Island Boston Harbor	24-Hour	ppm	0.14	0.14	0.014	0	0.019	0	0.015	0
	Long Island Boston Harbor	Annual	ppm	0.030	0.030	0.004	0	0.004	0	0.004	0
NO_2	Long Island Hospital Road/Boston	Annual	ppm	0.053	0.053	0.012	0	0.009	0	0.007	0
CO	Kenmore Square Boston	1-Hr (Max)	ppm	35	35	2.8	0	2.1	0	2.2	0
	Kenmore Square Boston	8-Hr (Max)	ppm	9	9	1.6	0	1.7	0	1.3	0
Pb	Kenmore Square Boston	Quarterly Mean	μg/m^3	1.5	1.5	0.02[a]	0	0.04[a]	0	0.02[a]	0
O_3	Long Island Hospital Road/Boston	1-Hr (Max)	ppm	0.12	0.12	0.138	3	0.120	0	0.106	0
	Long Island Hospital Road/Boston	8-Hr (Ave)	ppm	0.08	0.08	0.128	10	0.102	1	0.094	0
	Wastewater Treatment Plant, Lynn	1-Hr (Max)	ppm	0.12	0.12	0.152	2	0.118	0	0.105	0
	Wastewater Treatment Plant, Lynn	8-Hr (Ave)	ppm	0.08	0.08	0.123	13	0.10	3	0.092	2
	Sunset Blvd	1-Hr (Max)	ppm	0.12	0.12	0.148	2	0.117	0	0.100	0

Table 6-2: Ambient Air Monitoring Data Representative of the Project Area

		Concentrations/Number of Exceedances									
Pollutant	Monitor	Avg. Time	Units	NAAQS	MA AAQS	2002 Conc	2002 # > Std	2003 Conc	2003 # > Std	2004 Conc	2004 # > Std
	Newbury Sunset Blvd	8-Hr (Ave)	ppm	0.08	0.08	0.126	9	0.099	2	0.092	2
	Newbury Ocean Ave	1-Hr (Max)	ppm	0.12	0.12	0.136	5	0.109	0	0.104	0
	Kennebunkport, ME Ocean Ave	8-Hr (Ave)	ppm	0.08	0.08	0.121	10	0.093	2	0..86	1
	Kennebunkport, ME										

[1] Lead based on the highest quarterly value for each year

6.4 Air Quality Dispersion Modeling Analysis

According to EPA, separate air quality analyses should be submitted for each regulated pollutant if an applicant proposes to emit the pollutant in a significant amount from a new major stationary source, or proposes to cause a significant net emissions increase from a major modification. Since the proposed emissions associated with the EBRVs are less than the Significant Emission Rates for SO_2 and lead, no modeling was conducted for these pollutants. Because the project will exceed Significant Emission Rate thresholds for NO_x, and PM_{10} /$PM_{2.5}$, air quality analyses were performed for these pollutants, despite the fact that the Port is no longer classified as a major source. In addition, since CO emissions are very close to the Significant Emission Rate, this pollutant was still considered.

The modeling of the NO_x, CO and PM_{10} emissions from the EBRVs was performed in a manner consistent with the procedures described in the USEPA documents: Guideline On Air Quality Models, 40 CFR 51, Ch. I (7–1–03 Edition) Appendix W To Part 51, and New Source Review Workshop Manual [Draft] (U.S. EPA, 1990) and the Screening Procedures for Estimating the Air Quality Impact of Stationary Sources, Revised (EPA-454/R-92-019).

Pursuant to U.S. EPA guidance, the following methodologies have been included in the assessment:

- Determination of air quality concentrations at over-water locations outside the 0.5 kilometer (km) exclusion zone (i.e. over water concentrations only, no land based concentrations calculated);
- Inclusion of condensable particulate matter (PM_{10}/$PM_{2.5}$) in the modeled PM_{10}/$PM_{2.5}$ emission rates; and
- Inclusion of conservative background ambient air quality concentrations in the NAAQS analysis.

Specifically, the maximum modeled concentrations from the EBRV sources have been compared to the significant impact levels, while the highest second high short term concentrations (for 1-, 8-, and 24-hour averaging periods) and maximum annual modeled concentrations due to the EBRV sources have been used to assess compliance with NAAQS and PSD increment levels as is specifically referenced in 40 CFR 51, Appendix W.

Modeling for impacts above the modeling thresholds are first conducted for the EBRV sources to determine if modeled concentrations are significant. Once the maximum impact concentrations are determined, they are compared to the appropriate PSD Class II air quality significance levels, which are shown in Table 6-3 below. The results of significant impact modeling have been used to determine whether additional modeling is necessary. If the significant impact levels are exceeded for a given pollutant, a cumulative air quality impact analysis is performed for that pollutant, with nearby major emission sources added to the analysis. Results from the cumulative air quality impact analysis are then compared with applicable NAAQS. Background ambient air quality concentrations are added to the highest second-highest short-term and maximum annual modeled concentrations for comparison to the NAAQS.

Table 6-3: Significance Levels for Air Quality Impacts in PSD Class II Areas

Pollutant	Annual	24-hour	8-hour	3-hour	1-hour
SO_2	1	5	-	25	-
TSP	1	5	-	-	-
PM_{10}	1	5	-	-	-
NO_x	1	-	-	-	-
CO	-	-	500	-	2,000

6.4.1 Screening Modeling

According to 40 CFR 51, Appendix W, an air quality analysis should begin with a screening model to determine the potential of the proposed source to violate the PSD increment or NAAQS. For traditional stationary sources, EPA guidance specified in EPA-454/R-92-019 should be followed. However, as indicated in the EPA workshop manual, there are situations in which analysis beyond the scope of the document may be required. One of the situations described is that in which pollutant dispersion is significantly affected by nearby terrain features or large bodies of water. The manual states that more refined analytical techniques can be of considerable help in estimating air quality impact. Therefore, a refined approach has been taken to assess impacts from Northeast Gateway Project. This includes the use of the OCD model to determine NAAQS and PSD Increment compliance, and to determine if the predicted concentrations will exceed significant monitoring thresholds for NO_x, CO and PM_{10}.

6.4.2 *Refined Dispersion Modeling Analysis*

6.4.2.1 Offshore and Coastal Dispersion (OCD) Model

The Offshore and Coastal Dispersion (OCD) model has been used to assess the air quality concentrations from the proposed Project. The OCD model can be used to model sources located on the Outer Continental Shelf and it includes meteorological data from both over-land and over-water weather stations. The OCD model can also account for the over-water transport and dispersion and shoreline effects (i.e. development of the thermal internal boundary layer (TIBL), sea breeze, and fumigation).

In the 1980's the OCD model was developed to simulate the impact of emissions from offshore sources on the air quality of shoreline areas. Built on the framework of the U.S. EPA approved MTPER model, the OCD model is an hourly, steady-state Gaussian model with modifications to account for the unique dispersion regime and source characteristics of overwater pollutant releases. The OCD model can account for:

- Overwater plume transport and dispersion;
- Parameterization of the overwater surface boundary layer;
- Treatment of plume dispersion over complex terrain and platform downwash; and
- Changes that occur as the plume crosses the shoreline;
- Evolution of the thermal internal boundary layer (TIBL); and
- Plume fumigation.

Since the regulatory approval of the OCD model, it has been used by the Department of the Interior, MMS, local regulatory agencies, and the oil and gas industry to determine onshore air quality impacts from Outer Continental Shelf sources.

The OCD model has been used to predict maximum pollutant concentrations in ambient air from the EBRV emissions for comparison with PSD Class II significant impact levels and NAAQS. The OCD model was run using all the regulatory default options including use of: stack-tip downwash, buoyancy-induced dispersion, calms processing routines, upper-bound downwash concentrations for super-squat buildings, default wind speed profile exponents, vertical potential temperature gradients, and no use of gradual plume rise. The model was run using rural dispersion coefficients and included local terrain into the calculations.

6.4.2.2 Modeling Domain

The modeling domain is the area for which the OCD model interpolates the shoreline geometry, or the land-sea interface. This information is used to determine the change in plume dispersion characteristics as the plume crosses the internal boundary layer generated at the shoreline. Although the Northeast Gateway Project is not located near the shoreline, the MAKEGEO preprocessing program of the OCD model was used to develop the modeling domain with the shoreline delineation as required by the model.

The modeling domain is defined by the latitude and longitude extents of the shoreline and the number of grid rectangles. One of the criteria for generating the coastline information is that the grid size be small enough so that good shoreline resolution is attained. The OCD model is limited to the number of total grid rectangles: from 60 to 120 in either direction. The closest approach of the project to the shoreline is approximately 20 km in the southwest direction from Buoy B. The modeling domain was selected to cover the Massachusetts shoreline and to include the City of Boston, which is over 30 km to the west. The model extents that were input into the OCD model in longitude and latitude are as follows:

latitude	longitude
42.559194	70.545444
42.225805	71.118888

The OCD model computes the southwest corner of the domain from the input latitude and longitude: UTME = 318.364 and UTMN= 4674.112. The OCD modeling is based on this southwest corner coordinates as the 0, 0 point.

The OCD model generates a map of land/water, model receptors and point sources. The range of x is 0.000 to 50.375 km and the range of y is from 0.000 to 43.312 km. The grid (x,y) lengths are 0.420 km in the x (east) direction and 0.361 in the y (north) direction.

Inland receptor locations have been added as discrete receptors. These were set as eighteen (18) receptor locations that were located every 10° starting from 190° (to the south) to 360° (to the north) and the maximum impact location was determined. The discrete receptors with base and terrain elevations are given in Table 6-4.

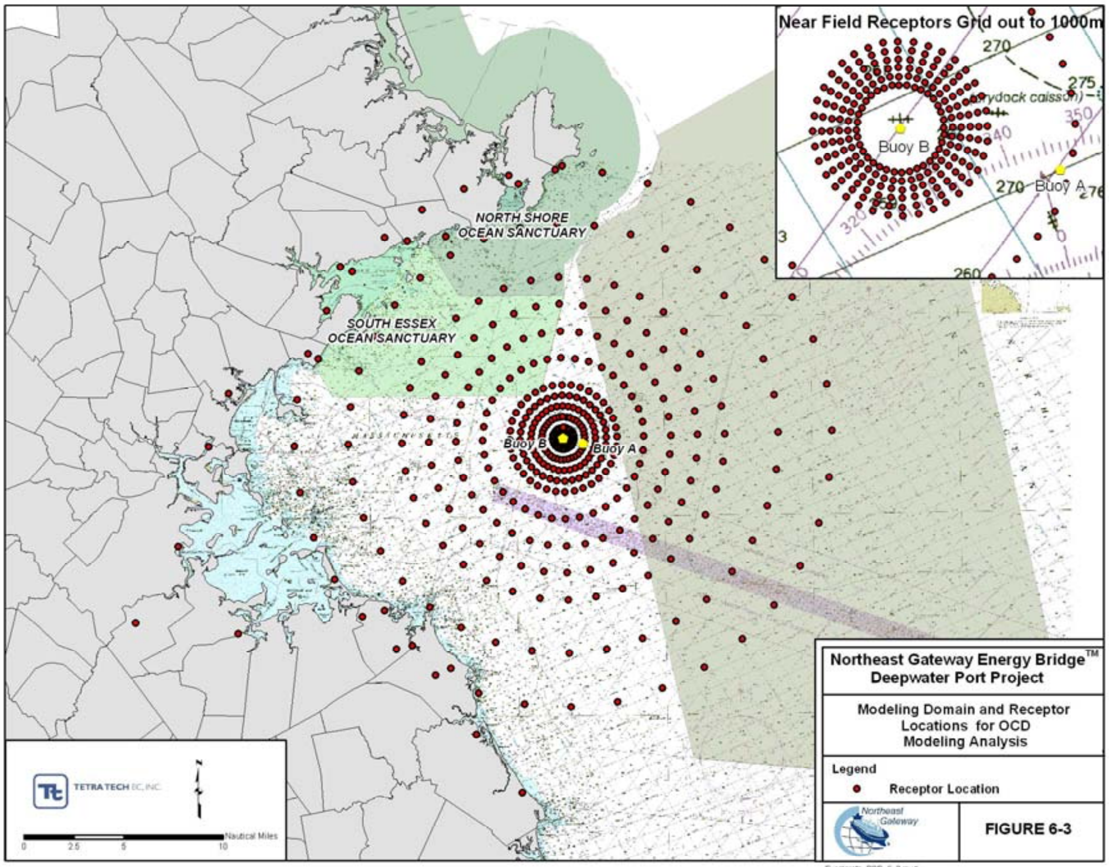
Table 6-4: Shoreline Discrete Receptor Grid

	X (km)	Y (km)	Receptor Elevation, (m)	Terrain Elevation, (m)
190R	44.081	-11.629	0	5
200R	39.964	-6.117	0	10
210R	37.785	0.082	14	20
220R	34.272	2.298	0	10
230R	31.783	5.639	15	20
240R	18.099	3.877	30	30
250R	8.595	5.172	15	50
260R	12.775	12.147	7	50
270R	15.847	21.374	3	50
280R	17.889	26.258	3	50
290R	26.3	29.255	5	30
300R	29.791	32.433	0	20
310R	28.584	37.736	1	45
320R	34.882	39.944	0	40
330R	38.461	40.27	0	35
340R	41.896	40.4	0	50
350R	45.377	44.985	0	20
360R	49.468	46.562	0	25

6.4.2.3 Over-water Receptor Grid

The OCD model requires receptor data consisting of location coordinates, based on the modeling domain coordinates, and ground-level elevations. The receptor grid was centered on the project location (Buoy B) and consisted of a polar receptor grid. The OCD model is limited to a polar grid size of 720 receptors. The grid extent encompasses an area of 25 km from the center point. The grid is depicted on in Figure 6-3. Since no receptors were placed within the 500 meter Safety Zone, the following distances in kilometers from Buoy B define the rings of the polar receptor grid (with receptors spaced every 10 degrees on these rings): 0.5, 0.6, 0.7, 0.8, 0.9, 1.0, 2.0, 3.0, 4.0, 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, 20.0, and 25.0. Most of this receptor grid is over water and has ground elevation of 0 m. At a distance of 25 km terrain elevations have been input where the ring intersects with land.

Figure 6-3: Modeling Domain and Receptor Locations for OCD Modeling Analysis



6.4.2.4 OCD Model Results

Project impacts were predicted by OCD modeling in order to determine if significance levels are exceeded. Tables 6-5, 6-6, and 6-7 present the maximum predicted impact concentrations for CO, PM_{10}/ $PM_{2.5}$ and NO_2. The tables show that all predicted impacts are less than corresponding significant impact levels (SILs). The worst case impact occurs at a distance of 500 meters from the project. Maximum predicted impact concentrations for all three pollutants at the shoreline receptors are well below corresponding SILs. Since maximum predicted impact concentrations for all pollutants are less corresponding SILs, the Project will clearly not cause or contribute to a violation of the NAAQS. Compliance is demonstrated and cumulative modeling with other major emissions sources in the region is not required by normal EPA air quality modeling procedures. However, since cumulative impact data requests have been made previously for this project, cumulative modeling, with other major emission sources of NO_x was conducted for completeness.

A representative OCD output file is provided in Appendix E. A CD containing all of the OCD input and output files will be provided to EPA upon request.

6.4.2.5 Cumulative Source Modeling

As stated above, cumulative modeling with other regional NO_x emission sources was conducted. Since maximum impact concentrations due to Port regasification operations are less than the SILs, cumulative modeling is not required under normal modeling procedures. However, since data requests have requested assessments of cumulative impacts and the NO_x emission source inventory had already been compiled, a cumulative modeling assessment was conducted and is presented here for informational purposes. The Massachusetts Department of Environmental Protection (MA DEP) and the New Hampshire Department of Environmental Services (NH DES) were asked to provide an inventory of major NO_x sources in the region out to 50 km beyond the SIA (57.5 km). There were no major sources in New Hampshire within this distance. Therefore, the MA DEP inventory was used and the nearby Neptune Project was added to the inventory list. The major NO_x sources considered for cumulative impacts are provided in Table 6-8 along with stack parameters for the individual facility stacks.

The results from the multisource impact modeling are presented in Table 6-9. The worst case impact occurs at 500 meters from the facility. The maximum predicted impact for all sources is 2.22 micrograms per cubic meter ($\mu g/m^3$). The monitored NO_2 concentration was 22.6 $\mu g/m^3$ and therefore the combined impact considering the background monitoring and modeled OCD impact sources is 24.8 $\mu g/m^3$, which is well below the 100 $\mu g/m^3$ standard.

Table 6-5: Highest Predicted CO Impacts

Year	Operating Scenario Case	Receptor	Deg	Dist. From Loc B Km	Dist. From Loc A Km	East Coord	North Coord	Averaging Period	Maximum Concentration (Micrograms/M**3)	Significant Impact Level (Micrograms/M**3)
2000	3	5	50	0.5	1.55	48.96	21.55	1- HOUR	160	2000
2001	3	30	300	0.5	2.33	48.15	21.48	8- HOUR	67	500

Table 6-6: Highest Predicted PM10/ PM2.5 Impacts

Year	Operating Scenario Case	Receptor	Deg	Dist. From Loc B Km	Dist. From Loc A Km	East Coord	North Coord	Averaging Period	Maximum Concentration (Micrograms/M**3)	Significant Impact Level (Micrograms/M**3)
2000	3	9	90	0.5	1.41	49.08	21.23	24 HOUR	4.89	5
2001	3	21	210	0.5	2.12	48.33	20.80	ANNUAL	0.39	1

Table 6-7: Highest Predicted NO_2 Impacts

Year	Operating Scenario Case	Receptor	Deg	Dist. From Loc B Km	Dist. From Loc A Km	East Coord	North Coord	Maximum Annual Concentration (Micrograms/M**3)	Significant Impact Level (Micrograms/M**3)
2001	3	21	210	0.5	2.12	48.33	20.80	0.56	1

Table 6-8 NO_x Major Source Inventory

Facility Name	Stack Id	Model Id	UTM-E m	UTM-N m	Distance from Project Site (kilometers)	NOX G/S	Stack Height M	T K	Dia. m	V m/s	Elv. m
NEPTUNE LNG	1	SRVBLR1	368,026	4,704,876	8.0	2.079	45	678.3	1.50	32.6	0
NEPTUNE LNG	2	POWERT1	368,026	4,704,876	8.0	0.601	45	672.2	1.00	22.7	0
NEPTUNE LNG	3	SRVBLR2	367,917	4,701,174	8.0	NA	45	678.3	1.50	32.6	0
NEPTUNE LNG	4	POWER2	367,917	4,701,174	8.0	NA	45	672.2	1.00	22.7	0
BAY STATE PAPER CO	1	BAY1	326,100	4,680,800	45.2	3.28	46.94	588.72	2.44	0.3	12
BOSTON GENERATING MYSTIC I LLC	1	BGM1	329,700	4,695,000	39.3	0.66	102.11	438.72	3.35	25.91	0
BOSTON GENERATING MYSTIC I LLC	2	BGM2	329,700	4,695,000	39.3	0.43	102.11	438.72	3.23	25.91	0
BOSTON GENERATING MYSTIC I LLC	3	BGM3	329,700	4,695,000	39.3	0.26	102.11	438.72	3.2	25.91	0
BOSTON GENERATING MYSTIC I LLC	4	BGM4	329,700	4,695,000	39.3	26.64	152.4	633.16	3.66	25.91	0
BOSTON GENERATING MYSTIC I LLC	5	BGM5	329,700	4,695,000	39.3	0.03	9.14	810.94	3.66	3.05	0
BOSTON GENERATING MYSTIC I LLC	11	BGM11	329,700	4,695,000	39.3	2.85	92.96	368.16	6.25	21.95	0
BOSTON GENERATING MYSTIC I LLC	12	BGM12	329,700	4,695,000	39.3	1.55	92.96	368.16	6.25	21.95	0
BOSTON GENERATING MYSTIC I LLC	15	BGM15	329,700	4,695,000	39.3	2.33	92.96	368.16	6.25	21.95	0
BOSTON GENERATING MYSTIC I LLC	16	BGM16	329,700	4,695,000	39.3	2.91	92.96	368.16	6.22	21.95	0
BRAINTREE ELECTRIC	3	BRAIN3	337,600	4,677,500	35.9	2.82	39.62	444.27	5.18	14.94	16
BRAINTREE ELECTRIC	4	BRAIN4	337,600	4,677,500	35.9	0.03	12.19	449.83	0.61	3.35	16
BRAINTREE ELECTRIC	5	BRAIN5	337,600	4,677,500	35.9	0.09	12.19	699.83	0.55	6.1	16
COVANTA HAVERHILL INCORPORATED	1	COVAN1	326,000	4,736,700	60.1	13.09	87.78	413.72	2.38	18.9	17
COVANTA HAVERHILL INCORPORATED	2	COVAN2	326,000	4,736,700	60.1	13.41	87.78	413.72	2.38	18.59	17
COVANTA HAVERHILL INCORPORATED	8	COVAN8	326,000	4,736,700	60.1	0.03	2.74	683.16	0.15	530.35	17
DOMINION ENERGY SALEM HARBOR LLC	1	DOM1	345,900	4,709,700	27.5	18.78	132.89	436.49	2.74	26.21	0
DOMINION ENERGY SALEM HARBOR LLC	2	DOM2	345,900	4,709,700	27.5	21.83	132.89	431.49	2.74	26.21	0
DOMINION ENERGY SALEM HARBOR LLC	3	DOM3	345,900	4,709,700	27.5	41.28	132.89	422.6	3.84	24.99	0
DOMINION ENERGY SALEM HARBOR LLC	4	DOM4	345,900	4,709,700	27.5	14.47	152.4	433.16	5.67	22.86	0
EASTMAN GELATINE CORP	1	EAST1	340,700	4,709,200	31.8	1.01	49.38	505.38	2.13	5.18	15
EASTMAN GELATINE CORP	2	EAST2	340,700	4,709,200	31.8	0.6	41.76	499.83	1.52	6.1	15
EASTMAN GELATINE CORP	3	EAST3	340,700	4,709,200	31.8	1.35	41.76	488.72	1.52	6.1	15

Table 6-8 NO_x Major Source Inventory

Facility Name	Stack Id	Model Id	UTM-E m	UTM-N m	Distance from Project Site (kilometers)	NOX G/S	Stack Height M	T K	Dia. m	V m/s	Elv. m
EASTMAN GELATINE CORP	4	EAST4	340,700	4,709,200	31.8	0.03	11.28	377.6	0.4	14.94	15
EASTMAN GELATINE CORP	5	EAST5	340,700	4,709,200	31.8	0.03	11.28	377.6	0.4	13.41	15
EXELON FORE RIVER DEVELOPMENT LLC	1	EXEL1	337,800	4,678,300	35.3	0.14	6.4	599.27	1.07	23.47	0
EXELON FORE RIVER DEVELOPMENT LLC	3	EXEL3	337,800	4,678,300	35.3	3.57	77.72	428.16	6.25	25.91	0
EXELON FORE RIVER DEVELOPMENT LLC	4	EXEL4	337,800	4,678,300	35.3	2.36	77.72	428.16	6.25	25.91	0
EXELON NEW BOSTON LLC	1	EXELNEW1	332,300	4,689,200	37.2	2.88	97.54	394.27	2.44	3.05	13
EXELON NEW BOSTON LLC	3	EXELNEW3	332,300	4,689,200	37.2	0.06	76.2	574.83	5.49	3.05	13
EXELON NEW BOSTON LLC	4	EXELNEW4	332,300	4,689,200	37.2	0.03	36.58	810.94	3.05	18.29	13
GENERAL ELECTRIC AIRCRAFT ENGINES	1	GE1	337,700	4,701,700	32.1	0.6	33.53	477.6	1.83	11.28	0
GENERAL ELECTRIC AIRCRAFT ENGINES	2	GE2	337,700	4,701,700	32.1	2.53	41.15	477.6	1.83	11.28	0
GENERAL ELECTRIC AIRCRAFT ENGINES	3	GE3	337,700	4,701,700	32.1	4.57	41.76	477.6	2.44	10.06	0
GENERAL ELECTRIC AIRCRAFT ENGINES	4	GE4	337,700	4,701,700	32.1	1.73	36.58	477.6	2.44	36.27	0
GENERAL ELECTRIC AIRCRAFT ENGINES	5	GE5	337,700	4,701,700	32.1	5.84	10.7	811	0.914	15.2	0
GENERAL ELECTRIC AIRCRAFT ENGINES	6	GE6	337,700	4,701,700	32.1	0.43	53.34	400	1.52	17.98	0
GENERAL ELECTRIC AIRCRAFT ENGINES	14	GE14	337,700	4,701,700	32.1	0.03	9.75	294.27	0.15	0.3	0
GENERAL ELECTRIC AIRCRAFT ENGINES	18	GE18	337,700	4,701,700	32.1	0.03	10.67	477.6	0.15	4.57	0
GILLETTE COMPANY THE	1	GILL1	330,800	4,690,000	38.5	7.02	48.77	433.16	1.95	9.14	2
HARVARD UNIVERSITY	1	HARV1	325,800	4,692,100	43.3	1.64	45.72	469.27	3.66	10.36	3
HARVARD UNIVERSITY	2	HARV2	325,800	4,692,100	43.3	3.08	48.77	435.94	3.05	12.5	3
HAVERHILL PAPERBOARD	1	HAVER1	331,000	4,736,800	56.7	5.75	50.9	487.05	1.1	26.82	7
KRAFT FOODS	2	KRAFT2	326,100	4,704,700	44.1	3.02	45.72	491.49	1.31	18.29	25
KRAFT FOODS	3	KRAFT3	326,100	4,704,700	44.1	1.29	45.72	435.94	1.83	9.14	25
MEDICAL AREA TOTAL ENERGY	1	MATE1	326,300	4,689,100	43.1	37.43	96.01	472.05	2.44	21.34	14
MIRANT - KENDALL LLC	1	MIRANT1	325,700	4,692,200	43.4	3.68	53.34	428	3.05	12.50	1
MIRANT - KENDALL LLC	2	MIRANT2	325,700	4,692,200	43.4	2.22	53.34	461	2.74	9.45	1
MIRANT - KENDALL LLC	3	MIRANT3	325,700	4,692,200	43.4	0.35	53.34	614.27	1.68	15.24	1
MIRANT - KENDALL LLC	4	MIRANT4	325,700	4,692,200	43.4	0.14	10.06	838.72	3.96	39.62	1
MIRANT - KENDALL LLC	5	MIRANT5	325,700	4,692,200	43.4	0.03	9.45	838.72	4.45	9.14	1
MIRANT - KENDALL LLC	10	MIRANT10	325,700	4,692,200	43.4	0.16	76.2	394.27	5.11	23.4	1

Table 6-8 NO_x Major Source Inventory

Facility Name	Stack Id	Model Id	UTM-E m	UTM-N m	Distance from Project Site (kilometers)	NOX G/S	Stack Height M	T K	Dia. m	V m/s	Elv. m
MIT	1	MIT	327,600	4,691,800	41.5	5.12	53.95	483.16	1.83	27.43	1
SEMASS PARTNERSHIP	1	SEMASS1	351,300	4,629,300	67.8	40.94	105.16	416.49	2.29	25.91	0
SEMASS PARTNERSHIP	24	SEMASS24	351,300	4,629,300	67.8	0.03	3.35	533.16	0.12	19.81	0
SEMASS PARTNERSHIP	25	SEMASS25	351,300	4,629,300	67.8	0.06	3.96	533.16	0.09	140.21	0
SEMASS PARTNERSHIP	26	SEMASS26	351,300	4,629,300	67.8	0.03	2.44	533.16	0.09	31.7	0
TAUNTON MUNICIPAL LIGHT - CLEARY FLOOD	1	TAUNT1	325,200	4,636,700	72.8	0.12	23.47	522.05	0.91	6.1	0
TAUNTON MUNICIPAL LIGHT - CLEARY FLOOD	2	TAUNT2	325,200	4,636,700	72.8	4.57	57	477.6	3.05	18.29	0
TAUNTON MUNICIPAL LIGHT - CLEARY FLOOD	3	TAUNT3	325,200	4,636,700	72.8	0.49	57	422.05	2.07	14.33	0
TRIGEN BOSTON ENERGY	1	TRIGEN1	330,400	4,690,400	38.9	7.74	80.77	405.38	3.51	5.49	1
TRIGEN BOSTON ENERGY	2	TRIGEN2	330,400	4,690,400	38.9	6.79	80.77	477.6	3.96	7.62	1
US HANSCOM 66TH SPTG	1	USHANS1	312,400	4,703,200	57.3	1.73	45.72	544.27	2.13	3.96	0
US HANSCOM 66TH SPTG	2	USHANS2	312,400	4,703,200	57.3	1.75	45.72	544.27	2.13	3.96	0
US HANSCOM 66TH SPTG	3	USHANS3	312,400	4,703,200	57.3	0.17	1.52	449.83	0.3	0.61	0
WHEELABRATOR NORTH ANDOVER INCORPORATED	1	WHEEL1	326,300	4,732,400	57.0	20.94	70.1	418.16	2.13	22.86	26
WHEELABRATOR SAUGUS JV	1	WHEELSAG	337,100	4,701,100	32.6	19.3	87.17	416.49	2.16	24.38	0
SUEZ TRACTEBEL LNG IMPORT TERMINAL	1	SUEZ1	330,500	4,695,300	38.5	0.35	9.0	422	0.61	17.7	0
SUEZ TRACTEBEL LNG IMPORT TERMINAL	2	SUEZ2	330,500	4,695,300	38.5	0.32	16.5	386	1.01	10.1	0
SUEZ TRACTEBEL LNG IMPORT TERMINAL	3	SUEZ3	330,500	4,695,300	38.5	0.43	25.0	355	1.22	20.4	0

Table 6-9: Highest NO_2 Multisource Modeling Impact Results

Year	Operating Scenario Case	Receptor	Deg	Dist. From Loc B Km	Dist. From Loc A Km	East Coord	North Coord	Average Annual Concentration (Micrograms/ M**3)
2001	3	585	270R	32.73	34.87	15.85	21.37	2.22