TABLE 9A-1: EMISSIONS CALCULATIONS - LNG TERMINAL OPERATING EMISSIONS
Sparrows Point LNG Terminal
Hot Water Heaters Emissions

Parameter	Value
Fuel	Nat. Gas
MMBtu/hr, MCR, ea. Heater	345
Btu/CF	1,000
CF/hr Nat. Gas	345,000
CF/yr Nat. Gas	3.0E+9
Max. hrs/yr	8,760
MMBtu/yr ea. Heater @ MCR	3,022,200
Stack Temp., deg. F	275
Flue gas rate ea. heater, ACFM	96,500
Flue gas rate ea. boiler, DSCFM	57,100
Stack Height, ft.	100
Stack diameter (ea. flue[1]), ft.	4.5
Stack exit velocity, ft/s	101.1

Pollutant	Emission Factor	Emission Factor Units	Emssion Factor Source	1 HW Heater @ 100% MCR[2], lb/hr (1-hr to 24-hr avg.)	3 Boilers[3] @ 100% MCR, TPY	Catalyst Malfunctions[4] TPY	Startup Emissions[5], TPY	Total HW Heaters, TPY
NOX	3	ppmvd @ 3% O_2	Mfg. guarantee	1.24	16.29	1.79	0.011	18.09
CO	10	ppmvd @ 3% O_3	Mfg. guarantee	2.52	33.11	1.81	0.011	34.94
VOC	10	ppmvd @ 3% O_4	Mfg. guarantee	1.44	18.92			18.92
PM-10/PM-2.5	2.60	lb/hr	Mfg. guarantee	2.60	34.16			34.16
SOX	0.07	ppmvd @ 3% O_3	Mfg. guarantee	0.04	0.50			0.50
NH3	5	ppmvd @ 3% O_3	Mfg. guarantee	0.76	9.99			9.99
POM/PAH	8.8E-05	lb/MMSCF	AP-42, T1.4-3 (7/98)	3.0E-05	4.0E-04			4.0E-04
Benzene	2.1E-03	lb/MMSCF	AP-42, T1.4-3 (7/98)	7.2E-04	9.5E-03			9.5E-03
Dichlorobenzene	1.2E-03	lb/MMSCF	AP-42, T1.4-3 (7/98)	4.1E-04	5.4E-03			5.4E-03
Formaldehyde	7.5E-02	lb/MMSCF	AP-42, T1.4-3 (7/98)	2.6E-02	3.4E-01			3.4E-01
Hexane	1.8	lb/MMSCF	AP-42, T1.4-3 (7/98)	6.2E-01	8.2E+00			8.2E+00
Naphthalene	6.1E-04	lb/MMSCF	AP-42, T1.4-3 (7/98)	2.1E-04	2.8E-03			2.8E-03
Toluene	3.4E-03	lb/MMSCF	AP-42, T1.4-3 (7/98)	1.2E-03	1.5E-02			1.5E-02
Arsenic	2.00E-04	lb/MMSCF	AP-42, T1.4-4 (7/98)	6.9E-05	9.1E-04			9.1E-04
Beryllium	1.20E-05	lb/MMSCF	AP-42, T1.4-4 (7/98)	4.1E-06	5.4E-05			5.4E-05
Cadmium	1.10E-03	lb/MMSCF	AP-42, T1.4-4 (7/98)	3.8E-04	5.0E-03			5.0E-03
Chromium	1.40E-03	lb/MMSCF	AP-42, T1.4-4 (7/98)	4.8E-04	6.3E-03			6.3E-03
Cobalt	8.40E-05	lb/MMSCF	AP-42, T1.4-4 (7/98)	2.9E-05	3.8E-04			3.8E-04
Lead	5.00E-04	lb/MMSCF	AP-42, T1.4-2 (7/98)	1.7E-04	2.3E-03			2.3E-03
Manganese	3.80E-04	lb/MMSCF	AP-42, T1.4-4 (7/98)	1.3E-04	1.7E-03			1.7E-03
Mercury	2.60E-04	lb/MMSCF	AP-42, T1.4-4 (7/98)	9.0E-05	1.2E-03			1.2E-03
Nickel	2.10E-03	lb/MMSCF	AP-42, T1.4-4 (7/98)	7.2E-04	9.5E-03			9.5E-03
Selenium	2.40E-05	lb/MMSCF	AP-42, T1.4-4 (7/98)	8.3E-06	1.1E-04			1.1E-04

Total HAPs 8.6E+00

Notes:
1. Two stacks serving 4 HW Heaters, independent (per boiler basis) flues within shared stack
2. Annual emissions based on 100% of Maximum Capacity Rating (MCR) @ 8,760 hr/yr.
3. Assumes spare (4th) heater is kept in hot standby using a heating coil, not by firing gas at low load. Also assumes all heaters are rotated once per week to obtain even run time throughout the year.
4. Two SCR and/or oxidation catalyst malfunctions per year, per heater times 3 heaters, 48 hours duration each malfunction. Only NOX and CO emissions are controlled and, therefore, would be increased as a result of control system malfunction.
5. Three cold iron startups per year per heater at average 15% load, uncontrolled for duration of 1 hour per startup.

TABLE 9A-2: EMISSIONS CALCULATIONS - LNG TERMINAL OPERATING EMISSIONS
Sparrows Point LNG Terminal
Diesel Fire Water Pump (Fresh Water) Emissions

Parameter	Value
Fuel	Diesel
Number of Units	1
BHP, MCR	375
MMBtu/hr[1]	2.625
Diesel Sulfur content, wt. %	0.0015
Max. hrs/yr	60
Stack Temp., deg. F[2]	800
Exhaust Rate, ACFM[2]	1,969
Stack Height, ft.	25.0
Stack diameter, ft.[2]	0.58
Stack exit velocity, ft/s	122.8

Pollutant	Emission Factor	Emission Factor Units	Emssion Factor Source	100% Load, lb/hr (1-hr to 24-hr avg.)	TPY
NOX	5.08	g/hp-hr	Mfg. data[4]	4.20	1.3E-01
CO	0.36	g/hp-hr	Mfg. data[4]	0.30	8.9E-03
VOC	0.10	g/hp-hr	Mfg. data[4]	0.08	2.5E-03
PM-10/PM-2.5	0.08	g/hp-hr	Mfg. data[4]	0.07	2.0E-03
SOX	4.65E-03	g/hp-hr	AP-42, T3.3-1(10/96)	0.0038	1.2E-04
NH3	6.62	lb/1000 gal	3	0.12	3.7E-03
Pb	1.08E-05	lb/MMBtu	AP-42 T 1.3-11	2.8E-05	8.5E-07
Acetaldehyde	7.67E-04	lb/MMBtu	AP-42, T 3.3-2(10/96)	2.0E-03	6.0E-05
Acrolein	9.25E-05	lb/MMBtu	AP-42, T 3.3-2(10/96)	2.4E-04	7.3E-06
Benzene	9.33E-04	lb/MMBtu	AP-42, T 3.3-2(10/96)	2.4E-03	7.3E-05
1,3-Butadiene	3.91E-05	lb/MMBtu	AP-42, T 3.3-2(10/96)	1.0E-04	3.1E-06
Formaldehyde	1.18E-03	lb/MMBtu	AP-42, T 3.3-2(10/96)	3.1E-03	9.3E-05
Naphthalene	8.48E-05	lb/MMBtu	AP-42, T 3.3-2(10/96)	2.2E-04	6.7E-06
POM/PAH	1.68E-04	lb/MMBtu	AP-42, T 3.3-2(10/96)	4.4E-04	1.3E-05
Toluene	4.09E-04	lb/MMBtu	AP-42, T 3.3-2(10/96)	1.1E-03	3.2E-05
Xylene	2.85E-04	lb/MMBtu	AP-42, T 3.3-2(10/96)	7.5E-04	2.2E-05
Total HAPs					3.1E-04

Notes:
1. Estimated - 7,000 Btu/hp-hr
2. Estimated from typical diesel engine manufacturer's specifications (Caterpillar, Inc.). Exhaust volume rate estimated from 105 cfm/gph based on review of specifications.
3. EPA Emission Inventory Improvement Program, "Estimating Ammonia Emissions from Anthropogenic Nonagricultural Sources - Draft Final Report", April 2004.
4. Based on maximum of emission factors for similar size engines obtained from Caterpillar, Inc. specification sheets, (www.cat.com).

TABLE 9A-3: EMISSIONS CALCULATIONS - LNG TERMINAL OPERATING EMISSIONS
Sparrows Point LNG Terminal
Diesel Fire Water Pump (Salt Water) Emissions

Parameter	Value
Fuel	Diesel
Number of units	6
BHP, MCR	700
MMBtu/hr[1]	4.9
Diesel Sulfur content, wt. %	0.0015
Max. hrs/yr	60
Stack Temp., deg. F[2]	800
Exhaust Rate, ACFM[2]	3,675
Stack Height, ft.	25.0
Stack diameter, ft.[2]	0.7
Stack exit velocity, ft/s	175.5

Pollutant	Emission Factor	Emission Factor Units	Emssion Factor Source	100% Load, lb/hr (1-hr to 24-hr avg.)	1 Engine, TPY	6 Engines, TPY
NOX	5.77	g/hp-hr	Mfg. data[4]	8.90	0.27	1.60
CO	0.39	g/hp-hr	Mfg. data[4]	0.60	0.02	0.11
VOC	0.12	g/hp-hr	Mfg. data[4]	0.19	0.006	0.033
PM-10/PM-2.5	0.033	g/hp-hr	Mfg. data[4]	0.051	0.002	0.009
SOX	5.50E-03	g/hp-hr	AP-42, T3.3-1(10/96)	0.008	2.55E-04	0.002
NH3	6.62	lb/1000 gal	3	0.23	5.7E-04	3.4E-03
Pb	1.08E-05	lb/MMBtu	AP-42 T 1.3-11	5.3E-05	1.6E-06	9.5E-06
Benzene	7.76E-04	lb/MMBtu	AP-42 T 3.4-3 (10/96)	3.8E-03	1.1E-04	6.8E-04
Toluene	2.81E-04	lb/MMBtu	AP-42 T 3.4-3 (10/96)	1.4E-03	4.1E-05	2.5E-04
Xylene	1.93E-04	lb/MMBtu	AP-42 T 3.4-3 (10/96)	9.5E-04	2.8E-05	1.7E-04
Formaldehyde	7.89E-05	lb/MMBtu	AP-42 T 3.4-3 (10/96)	3.9E-04	1.2E-05	7.0E-05
Acetaldehyde	2.52E-05	lb/MMBtu	AP-42 T 3.4-3 (10/96)	1.2E-04	3.7E-06	2.2E-05
Acrolein	7.88E-06	lb/MMBtu	AP-42 T 3.4-3 (10/96)	3.9E-05	1.2E-06	7.0E-06
Naphthalene	1.30E-04	lb/MMBtu	AP-42 T 3.4-4 (10/96)	6.4E-04	1.9E-05	1.1E-04
POM/PAH	2.57E-07	lb/MMBtu	AP-42 T 3.4-4 (10/96)	1.3E-06	3.8E-08	2.3E-07
Total HAPs						1.3E-03

Notes:
1. Estimated - 7,000 Btu/hp-hr
2. Estimated from typical diesel engine manufacturer's specifications (Caterpillar, Inc.). Exhaust volume rate estimated from 105 cfm/gph based on review of specifications.
3. EPA Emission Inventory Improvement Program, "Estimating Ammonia Emissions from Anthropogenic Nonagricultural Sources - Draft Final Report", April 2004.
4. Based on maximum of emission factors for similar size engines obtained from Caterpillar, Inc. specification sheets, (www.cat.com).

TABLE 9A-4: EMISSIONS CALCULATIONS - LNG TERMINAL OPERATING EMISSIONS
Sparrows Point LNG Terminal
Standby Generator Emissions

Parameter	Value
Fuel	Diesel
Number of units	1
BHP, MCR	2937
MMBtu/hr[1]	20.559
Diesel Sulfur content, wt. %	0.0015
Max. hrs/yr	60
Stack Temp., deg. F[2]	762
Exhaust Rate, ACFM[2]	15,136
Stack Height, ft.	25.0
Stack diameter, ft.[2]	0.7
Stack exit velocity, ft/s	722.7

Pollutant	Emission Factor	Emission Factor Units	Emssion Factor Source	100% Load, lb/hr (1-hr to 24-hr avg.)	1 Engine, TPY
NOX	6.47	g/hp-hr	Mfg. data[4]	41.87	1.26
CO	0.53	g/hp-hr	Mfg. data[4]	3.43	0.10
VOC	0.14	g/hp-hr	Mfg. data[4]	0.91	0.03
PM-10/PM-2.5	0.04	g/hp-hr	Mfg. data[4]	0.23	0.01
SOX	5.50E-03	lb/hp-hr	AP-42, T3.4-1	0.04	1.07E-03
NH3	6.62	lb/1000 gal	3	0.97	1.0E-02
Pb	1.08E-05	lb/MMBtu	AP-42 T 1.3-11	2.2E-04	6.7E-06
Benzene	7.76E-04	lb/MMBtu	AP-42 T 3.4-3 (10/96)	1.6E-02	4.8E-04
Toluene	2.81E-04	lb/MMBtu	AP-42 T 3.4-3 (10/96)	5.8E-03	1.7E-04
Xylene	1.93E-04	lb/MMBtu	AP-42 T 3.4-3 (10/96)	4.0E-03	1.2E-04
Formaldehyde	7.89E-05	lb/MMBtu	AP-42 T 3.4-3 (10/96)	1.6E-03	4.9E-05
Acetaldehyde	2.52E-05	lb/MMBtu	AP-42 T 3.4-3 (10/96)	5.2E-04	1.6E-05
Acrolein	7.88E-06	lb/MMBtu	AP-42 T 3.4-3 (10/96)	1.6E-04	4.9E-06
Naphthalene	1.30E-04	lb/MMBtu	AP-42 T 3.4-4 (10/96)	2.7E-03	8.0E-05
POM/PAH	2.57E-07	lb/MMBtu	AP-42 T 3.4-4 (10/96)	5.3E-06	1.6E-07
Total HAPs					9.2E-04

Notes:
1. Estimated - 7,000 Btu/hp-hr
2. Estimated from typical diesel engine manufacturer's specifications (Caterpillar, Inc.). Exhaust volume rate estimated from 105 cfm/gph based on review of specifications.
3. EPA Emission Inventory Improvement Program, "Estimating Ammonia Emissions from Anthropogenic Nonagricultural Sources - Draft Final Report", April 2004.
4. Based on maximum of emission factors for similar size engines obtained from Caterpillar, Inc. specification sheets, (www.cat.com).

TABLE 9A-5: EMISSIONS CALCULATIONS - LNG TERMINAL OPERATING EMISSIONS
Sparrows Point LNG Terminal
Vent Stack Heater Emissions

Parameter	Value
Fuel	Nat. Gas
MMBtu/hr, MCR, ea. Boiler	5.5
Btu/CF	1,000
CF/hr Nat. Gas	5,500
CF/yr Nat. Gas	48.2E+6
Max. hrs/yr	50
MMBtu/yr ea. Boiler @ MCR	48,180
Stack Temp., deg. F	-100
Flue gas rate, ACFM	29,167
Stack Height, ft.	179.5
Stack diameter, ft.	2.0
Stack exit velocity, ft/s	154.7

Pollutant	Emission Factor	Emission Factor Units	Emssion Factor Source	100% Load, lb/hr (1-hr to 24-hr avg.)	TPY
NOX	0.005	lb/MMBtu	Mfg. data	0.03	6.9E-04
CO	0.025	lb/MMBtu	Mfg. data	0.14	3.4E-03
VOC	0.025	lb/MMBtu	Mfg. data	0.14	3.4E-03
PM-10/PM-2.5	0.01	lb/MMBtu	Mfg. data	0.06	1.4E-03
SOX	0.01	lb/MMBtu	Mfg. data	0.04	9.6E-04
POM/PAH	8.8E-05	lb/MMSCF	AP-42, T1.4-3 (7/98)	4.9E-07	1.2E-08
NH3	3.2E+00	lb/MMSCF	1	1.8E-02	4.4E-04
Benzene	2.1E-03	lb/MMSCF	AP-42, T1.4-3 (7/98)	1.2E-05	2.9E-07
Dichlorobenzene	1.2E-03	lb/MMSCF	AP-42, T1.4-3 (7/98)	6.6E-06	1.7E-07
Formaldehyde	7.5E-02	lb/MMSCF	AP-42, T1.4-3 (7/98)	4.1E-04	1.0E-05
Hexane	1.8	lb/MMSCF	AP-42, T1.4-3 (7/98)	9.9E-03	2.5E-04
Naphthalene	6.1E-04	lb/MMSCF	AP-42, T1.4-3 (7/98)	3.4E-06	8.4E-08
Toluene	3.4E-03	lb/MMSCF	AP-42, T1.4-3 (7/98)	1.9E-05	4.7E-07
Arsenic	2.00E-04	lb/MMSCF	AP-42, T1.4-4 (7/98)	1.1E-06	2.8E-08
Beryllium	1.20E-05	lb/MMSCF	AP-42, T1.4-4 (7/98)	6.6E-08	1.7E-09
Cadmium	1.10E-03	lb/MMSCF	AP-42, T1.4-4 (7/98)	6.1E-06	1.5E-07
Chromium	1.40E-03	lb/MMSCF	AP-42, T1.4-4 (7/98)	7.7E-06	1.9E-07
Cobalt	8.40E-05	lb/MMSCF	AP-42, T1.4-4 (7/98)	4.6E-07	1.2E-08
Lead	5.00E-04	lb/MMSCF	AP-42, T1.4-2 (7/98)	2.8E-06	6.9E-08
Manganese	3.80E-04	lb/MMSCF	AP-42, T1.4-4 (7/98)	2.1E-06	5.2E-08
Mercury	2.60E-04	lb/MMSCF	AP-42, T1.4-4 (7/98)	1.4E-06	3.6E-08
Nickel	2.10E-03	lb/MMSCF	AP-42, T1.4-4 (7/98)	1.2E-05	2.9E-07
Selenium	2.40E-05	lb/MMSCF	AP-42, T1.4-4 (7/98)	1.3E-07	3.3E-09
Total HAPs					7.0E-04

1. EPA Emission Inventory Improvement Program, "Estimating Ammonia Emissions from Anthropogenic Nonagricultural Sources - Draft Final Report", April 2004.

TABLE 9A-6: EMISSIONS CALCULATIONS - LNG TERMINAL OPERATING EMISSIONS
Sparrows Point LNG Terminal
LNG Tanker Ship Unloading Operations Emissions

Shipping Assumptions used for air quality impact dispersion modeling:

Background:

AES reviewed available information from the Maritime Institute of Technology and Graduate Studies (MITAGS) and Maritime Business Strategies, LLC website (http://www.coltoncompany.com/shipbldg/worldsbldg/gas.htm) to obtain data on the existing world fleet of LNG carriers as well as LNG carriers under construction and on order. Based on this information, AES determined that there are 182 ships currently in the fleet that fall into the range of 125,000 cubic meters (cum) to 217,000 cum, with the largest currently in operation being 147,000 cum. Of these ships, AES has reviewed the availability and the likelihood that these vessels could deliver LNG to AES's facility and determined that there is a potential for 114 of these 182 ships that fall into this category. All of these vessels run on steam power plants for both propulsion and auxiliary power and can be run on heavy fuel oil (HFO) or boil-off gas.

There are currently 117 ships on order or in construction within AES's design envelope that potentially could deliver to AES's facility. These consist of 61 (52%) steam powered ships, 30 slow speed diesels, 27 medium speed diesels. This gives us a total of 52% steam power driven and 48% are diesel driven – for the assumptions and calculations summarized below a 50 / 50 ratio was used to add a small degree of conservatism. The diesel ships typically run on HFO with an average global 2.7% sulfur content. They have auxiliary diesel generator sets that can be run while in port to supply the unloading pumps. These diesel engines have the capability of burning low sulfur diesel fuel (typically 1- 1.5% global average) while in port. Twenty nine of the newer vessels on order are also set up to run these auxiliary generator sets on dual fuel (90% gas / 10% low sulfur distillate) – this is roughly 24% of the ships under construction. An assumption of 20% was used in the calculations to add a level of conservatism.

Based on the AES LNG Terminal system design, the head required at the ship unloading flange is 60 m. Based on an anticipated average unloading rate of 11,500 cum / hour this translates to 1147 kw / hour of auxiliary power required for the unloading pumps. For steam ships this would require 4.09 MW of heat input assuming a 28% steam cycle efficiency and for diesel generators this would require 2.44 MW of heat input assuming a 47% efficiency.

The capacity throughput of the LNG Terminal on a daily and annual basis is 1.5 BSCFD / 547 BSCFY. Using the standard conversion of 1 cubic meter of LNG equals 20,631 cubic feet of gas a 217,000 cum vessel would last 2.98 days at 1.5 BCFD and using only 217,000 cum vessels to supply the facility would require approximately 123 ships / year. If using 125,000 cum vessels, 215 ships / year would be required. Average unloading time for a 217,000 cum vessel at 12,000 cum/hr is 18 hours and for a 125,000 cum vessel at 10,500 cum/hr is 12 hours.

Assumptions to use for Modeling Input:

If the maximum number of vessels per year was assumed (i.e., assuming all 125,000 cum vessels), this would not be the worst-case emission scenario because all of these can be operated on natural gas while in port. Therefore, a mix of the various types of ships was assumed. In order to provide for a reasonable number of vessels burning fuel oil into this mix, it was assumed that 40% of the ships on an annual basis will be the larger 217,000 cum vessels and the remainder (60%) would be the smaller 125,000 cum vessels on average for the life of the facility. This translates into 50 ships / year of the 217,000 cum capacity and 130 ships / year of the 125,000 cum capacity. This is believed to a conservatively high estimate with respect to emissions and impacts.

The assumptions for ship power and fuel by ship class are further categorized as follows:

<u>217,000 cum vessels – [50 Total]</u>

- 50 x 50% = 25 ships are powered by steam and only use natural gas while in port for auxiliary power generation (for offloading and hoteling).
- 50 x 50%x 20% = 5 ships will use dual-fueled auxiliary engine generators.
- 50 x 50%x 80% = 20 ships will use diesel engine powered auxiliary generators fired with distillate (1.5% sulfur) oil.
- Ships will take 18 hours to unload.

25 of the 50 ships will transit up the bay and maneuver to the port while burning HFO 2.7% sulfur. The other 25 will transit burning 90% gas and 10% pilot oil (2.7% sulfur). Transit times remain the same as previous assumptions. While the ship is moving up the channel and in the turning circle it is entirely under assist tug power with its engines in standby and steam boilers on hot standby (i.e., ship engines are not used for propulsion in the turning circle and safety & security zone). Three assist tugs and two security vessels will also be operating within the 500 yard safety & security zone.

<u>125,000 cum vessels – [130 total]</u>

All 130 ships will be steam powered and operate on only on natural gas while at berth and unloading. Ships will take 12 hours to unload.

All 130 ships will transit up the bay and maneuver with a dual fuel mix of 90% gas, 10% distillate oil (1.5% sulfur) for safety purposes. Transit times remain the same as previous assumptions. While the ship is moving up the channel and in the turning circle it is under tug power with its steam boilers in hot standby. Three assist tugs and two security vessels will also be operating within the 500 yard safety & security zone.

TABLE 9A-7: EMISSIONS CALCULATIONS - LNG TERMINAL OPERATING EMISSIONS
Sparrows Point LNG Terminal
LNG Tanker Ship Unloading Operations Emissions

ASSUMPTIONS:

	217,000 m³ LNG Carrier Capacity Steam Turbine Power Plant			125,000 m³ LNG Carrier Capacity Steam Turbine Power Plant			217,000 m³ LNG Carrier Capacity Auxiliary Engine (Diesel-Electric) Powered Pumps			125,000 m³ LNG Carrier Capacity Auxiliary Engine (Diesel-Electric) Powered Pumps		
Fuel	Residual Oil	Marine Diesel Oil	Natural Gas	Residual Oil	Marine Diesel Oil	Natural Gas	Residual Oil	Marine Diesel Oil	Marine Gas Oil	Residual Oil	Marine Diesel Oil	Marine Gas Oil
NO. of ship calls assumed for potential emissions and modeling purposes			25			130		20	5			
Sulfur content, % wt.	2.7	1.5		2.7	1.5		2.7	1.5	0.5	2.7	1.5	0.5
LNG plant capacity, BSCF/yr	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5
LNG unloading rate, m³/hr	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000
NO. of annual ships/yr	123	123	123	215	215	215	123	123	123	215	215	215
Total pump power requirement for LNG offloading, kW	1147	1147	1147	1147	1147	1147	1147	1147	1147	1147	1147	1147
Boiler MMBtu/hr input for offloading operation	14.0	14.0	14.0	14.0	14.0	14.0	---	---	---	---	---	---
Btu/gal	154,225	140,000	---	154,225	140,000	---	154,225	140,000	---	154,225	140,000	---
Btu/CF nat. gas	---	---	1,000	---	---	1,000	---	---	1,000	---	---	1,000
Total propulsion power, Bhp output	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000
NO. of propulsion boilers/engines	2	2	2	2	2	2	2	2	2	2	2	2
Auxiliary Engine Rated Power, kW	N/A	N/A	N/A	N/A	N/A	N/A	3,750	3,750	3,750	3,750	3,750	3,750
Operating Load for 1 boiler/engine due to unloading[2]	0.08	0.08	0.08	0.08	0.08	0.08	0.31	0.31	0.31	0.31	0.31	0.31
Operating Load for 1 boiler/engine due to hoteling[2]	0.13	0.13	0.13	0.13	0.13	0.13	0.53	0.53	0.53	0.53	0.53	0.53
Hours per offload	18	18	18	12	12	12	18	18	18	12	12	12
Annual operating hours[3]	2,214	2,214	2,214	2,580	2,580	2,580	2,214	2,214	2,214	2,580	2,580	2,580
gal/hr oil, 1 unit while unloading (1 - 12 hr avg.)	90.7	99.9	---	90.7	99.9	---	---	---	---	---	---	---
gal/hr oil, 1 unit while unloading (24 hr avg.)	68.0	74.9	---	45.3	50.0	---	---	---	---	---	---	---
gal/yr oil, total offloading	200,790.3	221,192.0	---	233,983.2	257,757.6	---	---	---	---	---	---	---
CF/hr Nat. Gas, 1 Boiler while unloading (1 - 12 hr avg.)	---	---	13,987	---	---	13,987	---	---	---	---	---	---
CF/hr Nat. Gas, 1 Boiler while unloading (24-hr avg.)	---	---	10,490	---	---	6,993	---	---	---	---	---	---
CF/yr Nat. Gas, total offloading	---	---	30,966,876	---	---	36,086,062	---	---	---	---	---	---
Stack Temp., deg. F	350	350	350	350	350	350	900	900	800	900	900	800
Stack Temp., deg. K	450	450	450	450	450	450	755	755	700	755	755	700
Exhaust rate, ACFM[1]	10,667	10,667	11,298	10,667	10,667	11,298	15,429	16,997	29,119	15,429	16,997	29,119
Exhaust rate, m³/sec	5.04	5.04	5.33	5.04	5.04	5.33	7.28	8.02	13.74	7.28	8.02	13.74
Stack Height, ft.	131	131	131	131	131	131	131	131	131	131	131	131
Stack Height, m.	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
Stack diameter, ft.	5.5	5.5	5.5	5.5	5.5	5.5	2.0	2.0	2.0	2.0	2.0	2.0
Stack diameter, m.	1.7	1.7	1.7	1.7	1.7	1.7	0.6	0.6	0.6	0.6	0.6	0.6
Stack exit velocity, ft/s	7.5	7.5	7.9	7.5	7.5	7.9	81.9	90.2	154.5	81.9	90.2	154.5
Stack exit velocity, m/s	2.3	2.3	2.4	2.3	2.3	2.4	24.9	27.5	47.1	24.9	27.5	47.1

	Marine Residual Oil-Fired Steam Boiler Emissions - One Boiler								
			217,000 m³ Ship (lb/hr)			125,000 m³ Ship (lb/hr)			
Pollutant	Emission Factor lb/1000 gal[4]	Emission Factor lb/MMBtu	1-12 hr avg.	24-hr avg.	annual avg.	1-12 hr avg.	24-hr avg.	annual avg.	Emission Factor Source
TSP	28.0	0.18	2.54	1.91	0.64	2.54	1.27	0.75	AP-42 T 1.3-1
PM-10	28.0	0.18	2.54	1.91	0.64	2.54	1.27	0.75	AP-42 T 1.3-1
SO_x	423.9	2.75	38.44	28.83	9.72	38.44	19.22	11.32	AP-42 T 1.3-1
NOX	47	0.30	4.26	3.20	1.08	4.26	2.13	1.26	AP-42 T 1.3-1
VOC	0.76	0.005	0.07	0.05	0.02	0.07	0.03	0.020	AP-42 T 1.3-3
CO	5	0.03	0.45	0.34	0.11	0.45	0.23	0.13	AP-42 T 1.3-1
NH3	0.8	0.01	0.07	0.05	0.02	0.07	0.04	0.02	5
CO2	24,400	158	2,213	1,660	559	2,213	1106	652	AP-42 T 1.3-12
Pb	1.51E-03	9.79E-06	1.37E-04	1.03E-04	3.46E-05	1.37E-04	6.85E-05	4.03E-05	AP-42 T 1.3-11
POM/PAH	1.30E-03	8.43E-06	1.18E-04	8.84E-05	2.98E-05	1.18E-04	5.89E-05	3.47E-05	AP-42 T1.3-8
1,1,1-Trichloroethane	2.36E-04	1.53E-06	2.14E-05	1.61E-05	5.41E-06	2.14E-05	1.07E-05	6.30E-06	AP-42 T1.3-9
Benzene	2.14E-04	1.39E-06	1.94E-05	1.46E-05	4.91E-06	1.94E-05	9.70E-06	5.72E-06	AP-42 T1.3-9
Ethylbenzene	6.36E-05	4.12E-07	5.77E-06	4.33E-06	1.46E-06	5.77E-06	2.88E-06	1.70E-06	AP-42 T1.3-9
Formaldehyde	6.10E-02	3.96E-04	5.53E-03	4.15E-03	1.40E-03	5.53E-03	2.77E-03	1.63E-03	AP-42 T1.3-8
Naphthalene	1.13E-03	7.33E-06	1.02E-04	7.69E-05	2.59E-05	1.02E-04	5.12E-05	3.02E-05	AP-42 T1.3-9
Toluene	6.20E-03	4.02E-05	5.62E-04	4.22E-04	1.42E-04	5.62E-04	2.81E-04	1.66E-04	AP-42 T1.3-9
Xylene	1.09E-04	7.07E-07	9.89E-06	7.41E-06	2.50E-06	9.89E-06	4.94E-06	2.91E-06	AP-42 T1.3-9
Antimony	5.25E-03	3.40E-05	4.76E-04	3.57E-04	1.20E-04	4.76E-04	2.38E-04	1.40E-04	AP-42 T1.3-11
Arsenic	1.32E-03	8.56E-06	1.20E-04	8.98E-05	3.03E-05	1.20E-04	5.99E-05	3.53E-05	AP-42 T1.3-11
Beryllium	2.78E-05	1.80E-07	2.52E-06	1.89E-06	6.37E-07	2.52E-06	1.26E-06	7.43E-07	AP-42 T1.3-11
Cadmium	3.98E-04	2.58E-06	3.61E-05	2.71E-05	9.12E-06	3.61E-05	1.80E-05	1.06E-05	AP-42 T1.3-11
Chromium	8.45E-04	5.48E-06	7.66E-05	5.75E-05	1.94E-05	7.66E-05	3.83E-05	2.26E-05	AP-42 T1.3-11
Cobalt	6.02E-03	3.90E-05	5.46E-04	4.09E-04	1.38E-04	5.46E-04	2.73E-04	1.61E-04	AP-42 T1.3-11
Lead	1.51E-03	9.79E-06	1.37E-04	1.03E-04	3.46E-05	1.37E-04	6.85E-05	4.03E-05	AP-42 T1.3-11
Manganese	3.00E-03	1.95E-05	2.72E-04	2.04E-04	6.88E-05	2.72E-04	1.36E-04	8.01E-05	AP-42 T1.3-11
Mercury	1.13E-04	7.33E-07	1.02E-05	7.69E-06	2.59E-06	1.02E-05	5.12E-06	3.02E-06	AP-42 T1.3-11
Nickel	8.45E-02	5.48E-04	7.66E-03	5.75E-03	1.94E-03	7.66E-03	3.83E-03	2.26E-03	AP-42 T1.3-11
Selenium	6.83E-04	4.43E-06	6.19E-05	4.65E-05	1.57E-05	6.19E-05	3.10E-05	1.82E-05	AP-42 T1.3-11

	Marine Distillate Oil-Fired Steam Boiler Emissions - One Boiler								
			217,000 m³ Ship (lb/hr)			125,000 m³ Ship (lb/hr)			
Pollutant	Emission Factor lb/1000 gal³	Emission Factor lb/MMBtu	1-12 hr avg.	24-hr avg.	annual avg.	1-12 hr avg.	24-hr avg.	annual avg.	Emission Factor Source
TSP	17.0	0.12	1.54	1.16	0.39	1.54	0.77	0.45	AP-42 T 1.3-1
PM-10	17.0	0.12	1.54	1.16	0.39	1.54	0.77	0.45	AP-42 T 1.3-1
SO_2	235.5	1.68	21.36	16.02	5.40	21.36	10.68	6.29	AP-42 T 1.3-1
NOX	47	0.34	4.26	3.20	1.08	4.26	2.13	1.26	AP-42 T 1.3-1
VOC	0.76	0.005	0.07	0.05	0.02	0.07	0.03	0.020	AP-42 T 1.3-2
CO	5	0.04	0.45	0.34	0.11	0.45	0.23	0.13	AP-42 T 1.3-1
NH3	0.8	0.01	0.07	0.05	0.02	0.07	0.04	0.02	5
CO2	25,000	179	2,267	1,700	573	2,267	1134	668	AP-42 T 1.3-12
Pb	1.51E-03	1.08E-05	1.37E-04	1.03E-04	3.46E-05	1.37E-04	6.85E-05	4.03E-05	AP-42 T 1.3-11
POM/PAH	1.30E-03	9.29E-06	1.18E-04	8.84E-05	2.98E-05	1.18E-04	5.89E-05	3.47E-05	AP-42 T1.3-8
1,1,1-Trichloroethane	2.36E-04	1.69E-06	2.14E-05	1.61E-05	5.41E-06	2.14E-05	1.07E-05	6.30E-06	AP-42 T1.3-9
Benzene	2.14E-04	1.53E-06	1.94E-05	1.46E-05	4.91E-06	1.94E-05	9.70E-06	5.72E-06	AP-42 T1.3-9
Ethylbenzene	6.36E-05	4.54E-07	5.77E-06	4.33E-06	1.46E-06	5.77E-06	2.88E-06	1.70E-06	AP-42 T1.3-9
Formaldehyde	6.10E-02	4.36E-04	5.53E-03	4.15E-03	1.40E-03	5.53E-03	2.77E-03	1.63E-03	AP-42 T1.3-8
Naphthalene	1.13E-03	8.07E-06	1.02E-04	7.69E-05	2.59E-05	1.02E-04	5.12E-05	3.02E-05	AP-42 T1.3-9
Toluene	6.20E-03	4.43E-05	5.62E-04	4.22E-04	1.42E-04	5.62E-04	2.81E-04	1.66E-04	AP-42 T1.3-9
Xylene	1.09E-04	7.79E-07	9.89E-06	7.41E-06	2.50E-06	9.89E-06	4.94E-06	2.91E-06	AP-42 T1.3-9
Antimony	5.25E-03	3.75E-05	4.76E-04	3.57E-04	1.20E-04	4.76E-04	2.38E-04	1.40E-04	AP-42 T1.3-11
Arsenic	1.32E-03	9.43E-06	1.20E-04	8.98E-05	3.03E-05	1.20E-04	5.99E-05	3.53E-05	AP-42 T1.3-11
Beryllium	2.78E-05	1.99E-07	2.52E-06	1.89E-06	6.37E-07	2.52E-06	1.26E-06	7.43E-07	AP-42 T1.3-11
Cadmium	3.98E-04	2.84E-06	3.61E-05	2.71E-05	9.12E-06	3.61E-05	1.80E-05	1.06E-05	AP-42 T1.3-11
Chromium	8.45E-04	6.04E-06	7.66E-05	5.75E-05	1.94E-05	7.66E-05	3.83E-05	2.26E-05	AP-42 T1.3-11
Cobalt	6.02E-03	4.30E-05	5.46E-04	4.09E-04	1.38E-04	5.46E-04	2.73E-04	1.61E-04	AP-42 T1.3-11
Lead	1.51E-03	1.08E-05	1.37E-04	1.03E-04	3.46E-05	1.37E-04	6.85E-05	4.03E-05	AP-42 T1.3-11
Manganese	3.00E-03	2.14E-05	2.72E-04	2.04E-04	6.88E-05	2.72E-04	1.36E-04	8.01E-05	AP-42 T1.3-11
Mercury	1.13E-04	8.07E-07	1.02E-05	7.69E-06	2.59E-06	1.02E-05	5.12E-06	3.02E-06	AP-42 T1.3-11
Nickel	8.45E-02	6.04E-04	7.66E-03	5.75E-03	1.94E-03	7.66E-03	3.83E-03	2.26E-03	AP-42 T1.3-11
Selenium	6.83E-04	4.88E-06	6.19E-05	4.65E-05	1.57E-05	6.19E-05	3.10E-05	1.82E-05	AP-42 T1.3-11

	Natural Gas Fired Steam Boiler Emissions - One Boiler								
			217,000 m³ Ship (lb/hr)			125,000 m³ Ship (lb/hr)			
Pollutant	Emission Factor lb/MMSCF³	Emission Factor lb/MMBtu	1-12 hr avg.	24-hr avg.	annual avg.	1-12 hr avg.	24-hr avg.	annual avg.	Emission Factor Source
TSP	1.9	0.0019	0.03	0.02	0.01	0.03	0.01	0.01	AP-42 T 1.4-2
PM-10	1.9	0.0019	0.03	0.02	0.01	0.027	0.01	0.008	AP-42 T 1.4-2
SO_2	0.6	0.0006	0.008	0.006	0.002	0.008	0.004	0.002	AP-42 T 1.4-2
NOX	280	0.28	3.92	2.94	0.99	3.92	1.96	1.153	AP-42 T 1.4-1
VOC	5.5	0.0055	0.08	0.06	0.02	0.08	0.04	0.023	AP-42 T 1.4-2
CO	84	0.084	1.17	0.88	0.30	1.17	0.59	0.346	AP-42 T 1.4-1
NH3	3.2	0.0032	0.04	0.03	0.01	0.04	0.02	0.013	5
CO2	120,000	120	1678.42	1258.82	424.20	1,678	839	494	AP-42 T 1.4-2
Pb	5.00E-04	5.00E-07	6.99E-06	5.25E-06	1.77E-06	6.99E-06	3.50E-06	2.06E-06	AP-42 T1.4-2
POM/PAH	8.82E-05	8.82E-08	1.23E-06	9.25E-07	3.12E-07	1.23E-06	6.17E-07	3.63E-07	AP-42 T1.4-3
Benzene	2.10E-03	2.10E-06	2.94E-05	2.20E-05	7.42E-06	2.94E-05	1.47E-05	8.65E-06	AP-42 T1.4-3
Dichlorobenzene	1.20E-03	1.20E-06	1.68E-05	1.26E-05	4.24E-06	1.68E-05	8.39E-06	4.94E-06	AP-42 T1.4-3
Formaldehyde	7.50E-02	7.50E-05	1.05E-03	7.87E-04	2.65E-04	1.05E-03	5.25E-04	3.09E-04	AP-42 T1.4-3
Hexane	1.8	1.80E-03	2.52E-02	1.89E-02	6.36E-03	2.52E-02	1.26E-02	7.41E-03	AP-42 T1.4-3
Naphthalene	6.10E-04	6.10E-07	8.53E-06	6.40E-06	2.16E-06	8.53E-06	4.27E-06	2.51E-06	AP-42 T1.4-3
Toluene	3.40E-03	3.40E-06	4.76E-05	3.57E-05	1.20E-05	4.76E-05	2.38E-05	1.40E-05	AP-42 T1.4-3
Arsenic	2.00E-04	2.00E-07	2.80E-06	2.10E-06	7.07E-07	2.80E-06	1.40E-06	8.24E-07	AP-42 T1.4-4
Beryllium	1.20E-05	1.20E-08	1.68E-07	1.26E-07	4.24E-08	1.68E-07	8.39E-08	4.94E-08	AP-42 T1.4-4
Cadmium	1.10E-03	1.10E-06	1.54E-05	1.15E-05	3.89E-06	1.54E-05	7.69E-06	4.53E-06	AP-42 T1.4-4
Chromium	1.40E-03	1.40E-06	1.96E-05	1.47E-05	4.95E-06	1.96E-05	9.79E-06	5.77E-06	AP-42 T1.4-4
Cobalt	8.40E-05	8.40E-08	1.17E-06	8.81E-07	2.97E-07	1.17E-06	5.87E-07	3.46E-07	AP-42 T1.4-4
Lead	5.00E-04	5.00E-07	6.99E-06	5.25E-06	1.77E-06	6.99E-06	3.50E-06	2.06E-06	AP-42 T1.4-2
Manganese	3.80E-04	3.80E-07	5.32E-06	3.99E-06	1.34E-06	5.32E-06	2.66E-06	1.57E-06	AP-42 T1.4-4
Mercury	2.60E-04	2.60E-07	3.64E-06	2.73E-06	9.19E-07	3.64E-06	1.82E-06	1.07E-06	AP-42 T1.4-4
Nickel	2.10E-03	2.10E-06	2.94E-05	2.20E-05	7.42E-06	2.94E-05	1.47E-05	8.65E-06	AP-42 T1.4-4
Selenium	2.40E-05	2.40E-08	3.36E-07	2.52E-07	8.48E-08	3.36E-07	1.68E-07	9.89E-08	AP-42 T1.4-4

	Residual Oil-Fired MSD Auxiliary Engine Emissions - One Engine								
			217,000 m³ Ship (lb/hr)			125,000 m³ Ship (lb/hr)			
Pollutant	Emission Factor g/kWh *output*	Emission Factor lb/MMBtu *(input)*	1-12 hr avg.	24-hr avg.	annual avg.	1-12 hr avg.	24-hr avg.	annual avg.	Emission Factor Source
TSP	1.11		2.81	2.11	0.71	2.81	1.40	0.83	EPA/ICF[6]
PM-10	1.11		2.81	2.11	0.71	2.81	1.40	0.827	EPA/ICF[6]
SO_2	11.1		28.07	21.05	7.09	28.07	14.03	8.27	EPA/ICF[6]
NOX	14.7		37.17	27.88	9.39	37.17	18.59	10.95	EPA/ICF[6]
VOC	0.4		1.01	0.76	0.26	1.01	0.51	0.30	EPA/ICF[6]
CO	1.1		2.78	2.09	0.70	2.78	1.39	0.82	EPA/ICF[6]
NH3		0.043	0.36	0.27	0.090	0.36	0.18	0.11	5
CO2		165	1795	1031	347	1,375	687	405	AP-42 T3.4-1
Pb		1.08E-05	1.17E-04	6.75E-05	2.27E-05	9.00E-05	4.50E-05	2.65E-05	AP-42 T1.3-11
POM/PAH		2.57E-07	2.80E-06	1.61E-06	5.41E-07	2.14E-06	1.07E-06	6.31E-07	AP-42 T3.4-4
Acetaldehyde		2.52E-05	2.74E-04	1.57E-04	5.31E-05	2.10E-04	1.05E-04	6.18E-05	AP-42 T3.4-3
Acrolein		7.88E-06	8.57E-05	4.92E-05	1.66E-05	6.57E-05	3.28E-05	1.93E-05	AP-42 T3.4-3
Benzene		7.76E-04	8.44E-03	4.85E-03	1.63E-03	6.47E-03	3.23E-03	1.90E-03	AP-42 T3.4-3
Formaldehyde		7.89E-05	8.58E-04	4.93E-04	1.66E-04	6.57E-04	3.29E-04	1.94E-04	AP-42 T3.4-3
Naphthalene		1.30E-04	1.41E-03	8.12E-04	2.74E-04	1.08E-03	5.42E-04	3.19E-04	AP-42 T3.4-4
Toluene		2.81E-04	3.06E-03	1.76E-03	5.92E-04	2.34E-03	1.17E-03	6.90E-04	AP-42 T3.4-3
Xylene		1.93E-04	2.10E-03	1.21E-03	4.06E-04	1.61E-03	8.04E-04	4.74E-04	AP-42 T3.4-3
Lead		1.08E-05	1.17E-04	6.75E-05	2.27E-05	9.00E-05	4.50E-05	2.6504E-05	AP-42 T1.3-11

Marine Diesel Oil-Fired MSD Auxiliary Engine Emissions - One Engine									
	Emission Factor g/kWh output	Emission Factor lb/MMBtu (input)	217,000 m³ Ship (lb/hr)			125,000 m³ Ship (lb/hr)			Emission Factor Source
Pollutant			1-12 hr avg.	24-hr avg.	annual avg.	1-12 hr avg.	24-hr avg.	annual avg.	
TSP	0.71		1.80	1.35	0.45	1.80	0.90	0.53	EPA/ICF[6]
PM-10	0.71		1.80	1.35	0.45	1.80	0.90	0.529	EPA/ICF[6]
SO_X	6.2		15.58	11.68	3.94	15.58	7.79	4.59	EPA/ICF[6]
NOX	13.9		35.15	26.36	8.88	35.15	17.57	10.35	EPA/ICF[6]
VOC	0.4		1.01	0.76	0.26	1.01	0.51	0.30	EPA/ICF[6]
CO	1.1		2.78	2.09	0.70	2.78	1.39	0.82	EPA/ICF[6]
NH3		0.047	0.39	0.30	0.100	0.39	0.20	0.12	5
CO2		165	1375	1031	347	1,375	687	405	AP-42 T3.4-1
Pb		1.08E-05	9.00E-05	6.75E-05	2.27E-05	9.00E-05	4.50E-05	2.65E-05	AP-42 T1.3-11
POM/PAH		2.57E-07	2.14E-06	1.61E-06	5.41E-07	2.14E-06	1.07E-06	6.31E-07	AP-42 T3.4-4
Acetaldehyde		2.52E-05	2.10E-04	1.57E-04	5.31E-05	2.10E-04	1.05E-04	6.18E-05	AP-42 T3.4-3
Acrolein		7.88E-06	6.57E-05	4.92E-05	1.66E-05	6.57E-05	3.28E-05	1.93E-05	AP-42 T3.4-3
Benzene		7.76E-04	6.47E-03	4.85E-03	1.63E-03	6.47E-03	3.23E-03	1.90E-03	AP-42 T3.4-3
Formaldehyde		7.89E-05	6.57E-04	4.93E-04	1.66E-04	6.57E-04	3.29E-04	1.94E-04	AP-42 T3.4-3
Naphthalene		1.30E-04	1.08E-03	8.12E-04	2.74E-04	1.08E-03	5.42E-04	3.19E-04	AP-42 T3.4-4
Toluene		2.81E-04	2.34E-03	1.76E-03	5.92E-04	2.34E-03	1.17E-03	6.90E-04	AP-42 T3.4-3
Xylene		1.93E-04	1.61E-03	1.21E-03	4.06E-04	1.61E-03	8.04E-04	4.74E-04	AP-42 T3.4-3
Lead		1.08E-05	9.00E-05	6.75E-05	2.27E-05	9.00E-05	4.50E-05	2.6504E-05	AP-42 T1.3-11

Marine Gas Oil-Fired MSD Auxiliary Engine Emissions - One Engine									
	Emission Factor g/kWh output	Emission Factor lb/MMBtu (input)	217,000 m³ Ship (lb/hr)			125,000 m³ Ship (lb/hr)			Emission Factor Source
Pollutant			1-12 hr avg.	24-hr avg.	annual avg.	1-12 hr avg.	24-hr avg.	annual avg.	
TSP	0.38		0.96	0.72	0.24	0.96	0.48	0.28	EPA/ICF[6]
PM-10	0.38		0.96	0.72	0.24	0.96	0.48	0.283	EPA/ICF[6]
SO_X	2.1		5.18	3.89	1.31	5.18	2.59	1.53	EPA/ICF[6]
NOX	13.9		35.15	26.36	8.88	35.15	17.57	10.35	EPA/ICF[6]
VOC	0.4		1.01	0.76	0.26	1.01	0.51	0.30	EPA/ICF[6]
CO	1.1		2.78	2.09	0.70	2.78	1.39	0.82	EPA/ICF[6]
NH3		0.047	0.39	0.30	0.100	0.39	0.20	0.12	5
CO2		110	917	687	232	917	458	270	AP-42 T3.4-1
Pb		1.08E-05	9.00E-05	6.75E-05	2.27E-05	9.00E-05	4.50E-05	2.65E-05	AP-42 T1.3-11
POM/PAH		2.57E-07	2.14E-06	1.61E-06	5.41E-07	2.14E-06	1.07E-06	6.31E-07	AP-42 T3.4-4
Acetaldehyde		2.52E-05	2.10E-04	1.57E-04	5.31E-05	2.10E-04	1.05E-04	6.18E-05	AP-42 T3.4-3
Acrolein		7.88E-06	6.57E-05	4.92E-05	1.66E-05	6.57E-05	3.28E-05	1.93E-05	AP-42 T3.4-3
Benzene		7.76E-04	6.47E-03	4.85E-03	1.63E-03	6.47E-03	3.23E-03	1.90E-03	AP-42 T3.4-3
Formaldehyde		7.89E-05	6.57E-04	4.93E-04	1.66E-04	6.57E-04	3.29E-04	1.94E-04	AP-42 T3.4-3
Naphthalene		1.30E-04	1.08E-03	8.12E-04	2.74E-04	1.08E-03	5.42E-04	3.19E-04	AP-42 T3.4-4
Toluene		2.81E-04	2.34E-03	1.76E-03	5.92E-04	2.34E-03	1.17E-03	6.90E-04	AP-42 T3.4-3
Xylene		1.93E-04	1.61E-03	1.21E-03	4.06E-04	1.61E-03	8.04E-04	4.74E-04	AP-42 T3.4-3
Lead		1.08E-05	9.00E-05	6.75E-05	2.27E-05	9.00E-05	4.50E-05	2.6504E-05	AP-42 T1.3-11

Emissions (lbs/ship call)														Composite Annual Emissions Based on Ship Call Assumptions (TPY)
	217,000 m³ LNG Carrier Capacity Steam Turbine Power Plant			125,000 m³ LNG Carrier Capacity Steam Turbine Power Plant			217,000 m³ LNG Carrier Capacity Auxiliary Engine (Diesel-Electric) Powered Pumps			125,000 m³ LNG Carrier Capacity Auxiliary Engine (Diesel-Electric) Powered Pumps				
Pollutant	Residual Oil	Marine Diesel Oil	Natural Gas	Residual Oil	Marine Diesel Oil	Natural Gas	Residual Oil	Marine Diesel Oil	Marine Gas Oil	Residual Oil	Marine Diesel Oil	Marine Gas Oil		
TSP	45.76	27.76	0.48	30.51	18.51	0.32	50.52	32.32	17.30	33.68	21.54	11.53		0.39
PM-10	45.76	27.76	0.48	30.51	18.51	0.32	50.52	32.32	17.30	33.68	21.54	11.53		0.39
SO_X	691.99	384.44	0.15	461.33	256.29	0.10	505.23	280.38	93.31	336.82	186.92	62.21		3.05
NOX	76.72	76.72	70.49	51.15	51.15	47.00	669.08	632.67	632.67	446.06	421.78	421.78		11.84
VOC	1.24	1.24	1.38	0.83	0.83	0.92	18.21	18.21	18.21	12.14	12.14	12.14		0.30
CO	8.16	8.16	21.15	5.44	5.44	14.10	50.07	50.07	50.07	33.38	33.38	33.38		1.81
NH3	1.31	1.31	0.81	0.87	0.87	0.54	6.44	7.09	7.09	4.29	4.73	4.73		0.13
CO2	39,832	40,811	30,212	26,554	27,207	20,141	24,748	24,748	16,499	16,499	16,499	10,999		1,976
Pb	2.46E-03	2.46E-03	1.26E-04	1.64E-03	1.64E-03	8.39E-05	1.62E-03	1.62E-03	1.62E-03	1.08E-03	1.08E-03	1.08E-03		2.73E-05
POM/PAH	2.12E-03	2.12E-03	2.22E-05	1.41E-03	1.41E-03	1.48E-05	3.85E-05	3.85E-05	3.85E-05	2.57E-05	2.57E-05	2.57E-05		1.72E-06
1,1,1-Trichloroethane	3.85E-04	3.85E-04		2.57E-04	2.57E-04									
Benzene	3.49E-04	3.49E-04	5.29E-04	2.33E-04	2.33E-04	3.52E-04	1.16E-01	1.16E-01	1.16E-01	7.76E-02	7.76E-02	7.76E-02		1.48E-03
Dichlorobenzene			3.02E-04			2.01E-04								1.69E-05
Ethylbenzene	1.04E-04	1.04E-04		6.92E-05	6.92E-05									
Formaldehyde	9.96E-02	9.96E-02	1.89E-02	6.64E-02	6.64E-02	1.26E-02	1.18E-02	1.18E-02	1.18E-02	7.89E-03	7.89E-03	7.89E-03		1.20E-03
Hexane			4.53E-01			3.02E-01								2.53E-02
Naphthalene	1.84E-03	1.84E-03	1.54E-04	1.23E-03	1.23E-03	1.02E-04	1.95E-02	1.95E-02	1.95E-02	1.30E-02	1.30E-02	1.30E-02		2.52E-04
Toluene	1.01E-02	1.01E-02	8.56E-04	6.75E-03	6.75E-03	5.71E-04	4.21E-02	4.21E-02	4.21E-02	2.81E-02	2.81E-02	2.81E-02		5.75E-04
Xylene	1.78E-04	1.78E-04		1.19E-04	1.19E-04		2.89E-02	2.89E-02	2.89E-02	1.93E-02	1.93E-02	1.93E-02		3.62E-04
Antimony	8.57E-03	8.57E-03		5.71E-03	5.71E-03									
Arsenic	2.15E-03	2.15E-03	5.04E-05	1.44E-03	1.44E-03	3.36E-05								2.81E-06
Beryllium	4.54E-05	4.54E-05	3.02E-06	3.03E-05	3.03E-05	2.01E-06								1.69E-07
Cadmium	6.50E-04	6.50E-04	2.77E-04	4.33E-04	4.33E-04	1.85E-04								1.55E-05
Chromium	1.38E-03	1.38E-03	3.52E-04	9.20E-04	9.20E-04	2.35E-04								1.97E-05
Cobalt	9.83E-03	9.83E-03	2.11E-05	6.55E-03	6.55E-03	1.41E-05								1.18E-06
Lead	2.46E-03	2.46E-03	1.26E-04	1.64E-03	1.64E-03	8.39E-05	1.62E-03	1.62E-03	1.62E-03	1.08E-03	1.08E-03	1.08E-03		2.73E-05
Manganese	4.90E-03	4.90E-03	9.57E-05	3.26E-03	3.26E-03	6.38E-05								5.34E-06
Mercury	1.84E-04	1.84E-04	6.55E-05	1.23E-04	1.23E-04	4.36E-05								3.65E-06
Nickel	1.38E-01	1.38E-01	5.29E-04	9.20E-02	9.20E-02	3.52E-04								2.95E-05
Selenium	1.11E-03	1.11E-03	6.04E-06	7.43E-04	7.43E-04	4.03E-06								3.37E-07

1. Based on ship information provided by AES, 1147 kW needed for pump power / (0.28 steam cycle efficiency factor for thermal heat input to electrical power output) x 3414.4 Btu/kW-hr = 14.0 MMBtu/hr total fuel heat input. Assumes 1 boiler operating.
2. Approximate operating load fraction of 1 boiler or engine capacity - used for purposes of estimating realistic total exhaust volume rate and stack velocity for modeling purposes. For steam boiler power plant case, assumes 1 of 2 boilers is operating to provide total power needs while ship is at berth. For auxiliary engine power cases, assumes 1 engine provides all auxiliary power needs while at berth for LNG pumping and hotelling. Auxiliary power needs for hotelling based on 2,000 kW, based on information obtained from Tables 2-4 and 2-7 of ICF Final Report prepared for EPA, "Current Methodologies and Best Practices in Preparing Port Emission Inventories", January 5, 2006.
3. Based on number of ship calls/yr x hrs/offload operation, assuming exclusive use of respective ship size and power plant type. Does not represent assumed mix of ship sizes and power plants on annual basis.
4. Emission factors based on EPA AP-42, Section 1.3 (No. 6 residual fuel oil) and Section 1.4 (nat. gas combustion). TSP and PM-10 emissions are total filterable particulate matter and assumed to all be less than 10 microns. PM-2.5 is conservatively estimated as 100% of PM-10 emissions.
5. EPA Emission Inventory Improvement Program, "Estimating Ammonia Emissions from Anthropogenic Nonagricultural Sources - Draft Final Report", April 2004.
6. Based on emission factors for auxiliary engines in Table 2-10 of ICF Final Report prepared for EPA, "Current Methodologies and Best Practices in Preparing Port Emission Inventories", January 5, 2006.
7. Based on exclusive use of respective LNG ship size and power plant type for deliveries to AES LNG Terminal (does not represent assumed mix of ship sizes and power plants on annual basis).
8. Boiler exhaust volume rate calculated from fuel consumption and 15% excess air, assuming 1 of 2 boilers operating at part load for all activities while ship is at berth. Diesel engine exhaust volume estimated based on 6300 cf/gal diesel consumed. Dual-fuel engine exhaust volume rate estimated based on 6.9 cfm/BHp.

TABLE 9A-8: EMISSIONS CALCULATIONS - LNG TERMINAL OPERATING EMISSIONS
Sparrows Point LNG Terminal
LNG Terminal Stationary Source Emissions Summary

	Potential Emissions (tons/year)							
Pollutant	**Hot Water Heaters**	**Fire Pump (Fresh Water)**	**6 Fire Pumps (Salt Water)**	**Emergency Standby Generator**	**Stack Vent Heater**	**LNG Ship Offloading**	**Total LNG Terminal**	**Major Source Threshold**
NOX	18.1	0.1	1.6	1.3	0.0007	11.84	32.9	25
CO	34.9	0.009	0.1	0.1	0.003	1.8	37.0	100
VOC	18.9	0.002	0.03	0.03	0.003	0.30	19.3	25
PM-10	34.2	0.002	0.009	0.007	0.001	0.393	34.6	100
SOX	0.5	0.000	0.00	0.00	0.001	3.05	3.6	100
NH3	10.0	0.004	0.003	0.01	0.0004	0.13	10.1	
POM/PAH	4.0E-04	1.3E-05	2.3E-07	1.6E-07	1.2E-08	1.7E-06	4.2E-04	10
1,1,1-Trichloroethane								
Acetaldehyde		6.0E-05	2.2E-05	1.6E-05			9.8E-05	10
Acrolein		7.3E-06	7.0E-06	4.9E-06			1.9E-05	10
Antimony								
Benzene	9.5E-03	7.3E-05	6.8E-04	4.8E-04	2.9E-07	1.5E-03	1.2E-02	10
1,3-Butadiene		3.1E-06					3.1E-06	10
Dichlorobenzene	5.4E-03				1.7E-07	1.7E-05	5.5E-03	10
Ethylbenzene								
Formaldehyde	3.4E-01	9.3E-05	7.0E-05	4.9E-05	1.0E-05	1.2E-03	3.4E-01	10
Hexane	8.2E+00				2.5E-04	2.5E-02	8.2E+00	10
Naphthalene	2.8E-03	6.7E-06	1.1E-04	8.0E-05	8.4E-08	2.5E-04	3.2E-03	10
Toluene	1.5E-02	3.2E-05	2.5E-04	1.7E-04	4.7E-07	5.7E-04	1.6E-02	10
Xylene		2.2E-05	1.7E-04	1.2E-04		3.6E-04	6.7E-04	10
Arsenic	9.1E-04				2.8E-08	2.8E-06	9.1E-04	10
Beryllium	5.4E-05				1.7E-09	1.7E-07	5.5E-05	10
Cadmium	5.0E-03				1.5E-07	1.5E-05	5.0E-03	10
Chromium	6.3E-03				1.9E-07	2.0E-05	6.4E-03	10
Cobalt	3.8E-04				1.2E-08	1.2E-06	3.8E-04	10
Lead	2.3E-03				6.9E-08	2.7E-05	2.3E-03	10
Manganese	1.7E-03				5.2E-08	5.3E-06	1.7E-03	10
Mercury	1.2E-03				3.6E-08	3.7E-06	1.2E-03	10
Nickel	9.5E-03				2.9E-07	3.0E-05	9.5E-03	10
Selenium	1.1E-04				3.3E-09	3.4E-07	1.1E-04	10
Total HAPs							8.6	25

TABLE 9A-9: EMISSIONS CALCULATIONS - LNG TERMINAL OPERATING EMISSIONS
Sparrows Point LNG Terminal
LNG Tanker Ship Unloading Operations - Ship Boiler Exhaust Volume Calculation

TYPICAL GAS VOLUME CALCULATION, 100% LOAD - Heavy Oil Fired Boiler

Total ship power	40,000	hp (output)
NO. of boilers	2	
ea. Boiler heat input	169.8	MMBtu/hr (based on 30% steam cycle efficiency, 2546.4 Btu/hp-hr)

Fuel Data :	NO. 6 Fuel Oil					
HHV Consumption =	169.8	MMBtu/hr				
Fuel Consumption =	169.8	MMBtu/hr /	0.01864	MMBtu/lb=	9107.30	lb/hr
Excess Air =	15	%				
Relative Humidity =	60	%				
Stack Exhaust Temp. =	350	deg. F				

Fuel Composition	Wt. %	lb/hr	O2 (lb/hr) Consumed	H2O(lb/hr) Produced	CO2 (lb/hr) Produced
C	85.7	7805.0	-20813.2	0.0	28618.2
H2	10.5	956.3	-7650.1	8606.4	0.0
	96.20	8761.2	-28463.3	8606.4	28618.2

Exhaust Composition

Component	From Fuel Combustion	From Air lb/hr	Total lb/hr	Wt. %	Moles/hr	Vol. %
O2	-28463.33619	32732.83662	4269.5	2.85	133.42	2.60
H2O	8606.39485		8606.4	5.74	477.87	9.31
CO2	28618.16023		28618.2	19.09	650.26	12.67
N2		108398.1557	108398.2	72.32	3869.98	75.42
Ar			0.0	0.00	0.00	0.00
	8761.218884	141130.9924	149892.2112	100.00	5131.53	100.00

Total Exhaust Vol. Rate = 5131.534967 moles/hr x 385.3 cu.ft./mole / 60min/hr = 32953 scfm
29884 dscfm
50553 acfm

TABLE 9A-10: EMISSIONS CALCULATIONS - LNG TERMINAL OPERATING EMISSIONS
Sparrows Point LNG Terminal
LNG Tanker Ship Unloading Operations - Ship Boiler Exhaust Volume Calculations

TYPICAL GAS VOLUME CALCULATION, 100% LOAD - Natural Gas Fired Boiler

Total ship power	40,000	hp (output)
NO. of boilers	2	
ea. Boiler heat input	169.8	MMBtu/hr (based on 30% steam cycle efficiency, 2546.4 Btu/hp-hr)

Fuel Data :	Natural Gas				
HHV Consumption =	169.760	MMBtu/hr			
Fuel Consumption =	169.760	MMBtu/hr /	0.02331	MMBtu/lb=	7282.71 lb/hr
Excess Air =	15	%			
Relative Humidity =	60	%			
Exhaust Temperatue =	350	deg. F			

Fuel Composition	Wt. %	lb/hr	O2 (lb/hr) Consumed	H2O(lb/hr) Produced	CO2 (lb/hr) Produced
C	75.32	5485.3	-14627.6	0.0	20112.9
H2	24.68	1797.4	-14379.0	16176.4	0.0
	100.00	7282.7	-29006.6	16176.4	20112.9

Exhaust Composition

Component	From Fuel Combustion	From Air lb/hr	Total lb/hr	Wt. %	Moles/hr	Vol. %
O2	-29006.55352	33357.53655	4351.0	2.88	135.97	2.50
H2O	16176.3583		16176.4	10.71	898.19	16.53
CO2	20112.90651		20112.9	13.31	457.01	8.41
N2		110466.9138	110466.9	73.11	3943.84	72.56
Ar			0.0	0.00	0.00	0.00
	7282.711283	143824.4504	151107.1617	100.00	5435.00	100.00

Total Exhaust Vol. Rate = 5435.001853 moles/hr x 385.3cu.ft./mole / 60min/hr = 34902 scfm
29134 dscfm
53542 acfm

TABLE 9A-11: EMISSIONS CALCULATIONS - LNG TERMINAL OPERATING EMISSIONS
Sparrows Point LNG Terminal
LNG Tanker Ship Hoteling and Transit Operations Emissions Within Safety & Security Zone[4]

ASSUMPTIONS:

	217,000 m³ LNG Carrier Capacity Steam Turbine Power Plant			125,000 m³ LNG Carrier Capacity Steam Turbine Power Plant			217,000 m³ LNG Carrier Capacity Auxiliary Engine (Diesel-Electric) Powered Pumps			125,000 m³ LNG Carrier Capacity Auxiliary Engine (Diesel-Electric) Powered Pumps		
Fuel	Residual Oil	Marine Diesel Oil	Natural Gas	Residual Oil	Marine Diesel Oil	Natural Gas	Residual Oil	Marine Diesel Oil	Marine Gas Oil	Residual Oil	Marine Diesel Oil	Marine Gas Oil
NO. of ship calls assumed for potential emissions and modeling purposes			25			130		20	5			
Sulfur content, % wt.	2.7	1.5		2.7	1.5		2.7	1.5	0.5	2.7	1.5	0.5
LNG plant capacity, BSCF/yr	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5	547.5
LNG unloading rate, m³/hr	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000	12,000
NO. of annual ships/yr	123	123	123	215	215	215	123	123	123	215	215	215
Total power requirement for hoteling, kW	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000
Boiler MMBtu/hr input for hoteling[1]	24.4	24.4	24.4	24.4	24.4	24.4	---	---	---	---	---	---
Btu/gal	154,225	140,000	---	154,225	140,000	---	154,225	140,000	---	154,225	140,000	---
Btu/CF nat. gas	---	---	1,000	---	---	1,000	---	---	1,000	---	---	1,000
Total propulsion power, Bhp output	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000	40,000
NO. of propulsion boilers/engines	2	2	2	2	2	2	2	2	2	2	2	2
Auxiliary Engine Rated Power, kW	N/A	N/A	N/A	N/A	N/A	N/A	3,750	3,750	3,750	3,750	3,750	3,750
Operating Load for 1 boiler/engine due to hoteling[2]	0.13	0.13	0.13	0.13	0.13	0.13	0.53	0.53	0.53	0.53	0.53	0.53
Hours hoteling per ship call	6	6	6	12	12	12	6	6	6	12	12	12
Annual operating hours[3]	738	738	738	2,580	2,580	2,580	738	738	738	2,580	2,580	2,580
gal/hr oil, 1 unit while hoteling (1 - 12 hr avg.)	158.1	174.2	---	158.1	174.2	---	---	---	---	---	---	---
gal/hr oil, 1 unit while hoteling (24 hr avg.)	39.5	43.6	---	79.1	87.1	---	---	---	---	---	---	---
gal/yr oil, total hoteling	116,704.6	128,562.6	---	407,991.7	449,446.5	---	---	---	---	---	---	---
CF/hr Nat. Gas, 1 Boiler while hoteling (1 - 12 hr avg.)	---	---	24,389	---	---	24,389	---	---	---	---	---	---
CF/hr Nat. Gas, 1 Boiler while hoteling (24-hr avg.)	---	---	6,097	---	---	12,194	---	---	---	---	---	---
CF/yr Nat. Gas, total hoteling	---	---	17,998,766	---	---	62,922,514	---	---	---	---	---	---
Stack Temp., deg. F	350	350	350	350	350	350	900	900	800	900	900	800
Stack Temp., deg. K	450	450	450	450	450	450	755	755	700	755	755	700
Exhaust rate, ACFM[5]	6,779	6,779	7,180	6,779	6,779	7,180	9,806	10,802	18,506	9,806	10,802	18,506
Exhaust rate, m³/sec	3.20	3.20	3.39	3.20	3.20	3.39	4.63	5.10	8.74	4.63	5.10	8.74
Stack Height, ft.	131	131	131	131	131	131	131	131	131	131	131	131
Stack Height, m.	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0	40.0
Stack diameter, ft.	5.5	5.5	5.5	5.5	5.5	5.5	2.0	2.0	2.0	2.0	2.0	2.0
Stack diameter, m.	1.7	1.7	1.7	1.7	1.7	1.7	0.6	0.6	0.6	0.6	0.6	0.6
Stack exit velocity, ft/s	4.8	4.8	5.0	4.8	4.8	5.0	52.0	57.3	98.2	52.0	57.3	98.2
Stack exit velocity, m/s	1.4	1.4	1.5	1.4	1.4	1.5	15.9	17.5	29.9	15.9	17.5	29.9

	Marine Residual Oil-Fired Steam Boiler Emissions - One Boiler								
			217,000 m³ Ship (lb/hr)			125,000 m³ Ship (lb/hr)			
Pollutant	Emission Factor lb/1000 gal[4]	Emission Factor lb/MMBtu	1-12 hr avg.	24-hr avg.	annual avg.	1-12 hr avg.	24-hr avg.	annual avg.	Emission Factor Source
TSP	28.0	0.18	4.43	1.11	0.37	4.43	2.22	1.31	AP-42 T 1.3-1
PM-10	28.0	0.18	4.43	1.11	0.37	4.43	2.22	1.31	AP-42 T 1.3-1
SO_X	423.9	2.75	67.03	16.76	5.65	67.03	33.52	19.74	AP-42 T 1.3-1
NOX	47	0.30	7.43	1.86	0.63	7.43	3.72	2.19	AP-42 T 1.3-1
VOC	0.76	0.005	0.12	0.03	0.01	0.12	0.06	0.035	AP-42 T 1.3-3
CO	5	0.03	0.79	0.20	0.07	0.79	0.40	0.23	AP-42 T 1.3-1
NH3	0.8	0.01	0.13	0.03	0.01	0.13	0.06	0.04	5
CO2	24,400	158	3,859	965	325	3,859	1929	1136	AP-42 T 1.3-12
Pb	1.51E-03	9.79E-06	2.39E-04	5.97E-05	2.01E-05	2.39E-04	1.19E-04	7.03E-05	AP-42 T 1.3-11
POM/PAH	1.30E-03	8.43E-06	2.06E-04	5.14E-05	1.73E-05	2.06E-04	1.03E-04	6.05E-05	AP-42 T1.3-8
1,1,1-Trichloroethane	2.36E-04	1.53E-06	3.73E-05	9.33E-06	3.14E-06	3.73E-05	1.87E-05	1.10E-05	AP-42 T1.3-9
Benzene	2.14E-04	1.39E-06	3.38E-05	8.46E-06	2.85E-06	3.38E-05	1.69E-05	9.97E-06	AP-42 T1.3-9
Ethylbenzene	6.36E-05	4.12E-07	1.01E-05	2.51E-06	8.47E-07	1.01E-05	5.03E-06	2.96E-06	AP-42 T1.3-9
Formaldehyde	6.10E-02	3.96E-04	9.65E-03	2.41E-03	8.13E-04	9.65E-03	4.82E-03	2.84E-03	AP-42 T1.3-8
Naphthalene	1.13E-03	7.33E-06	1.79E-04	4.47E-05	1.51E-05	1.79E-04	8.93E-05	5.26E-05	AP-42 T1.3-9
Toluene	6.20E-03	4.02E-05	9.80E-04	2.45E-04	8.26E-05	9.80E-04	4.90E-04	2.89E-04	AP-42 T1.3-9
Xylene	1.09E-04	7.07E-07	1.72E-05	4.31E-06	1.45E-06	1.72E-05	8.62E-06	5.08E-06	AP-42 T1.3-9
Antimony	5.25E-03	3.40E-05	8.30E-04	2.08E-04	6.99E-05	8.30E-04	4.15E-04	2.45E-04	AP-42 T1.3-11
Arsenic	1.32E-03	8.56E-06	2.09E-04	5.22E-05	1.76E-05	2.09E-04	1.04E-04	6.15E-05	AP-42 T1.3-11
Beryllium	2.78E-05	1.80E-07	4.40E-06	1.10E-06	3.70E-07	4.40E-06	2.20E-06	1.29E-06	AP-42 T1.3-11
Cadmium	3.98E-04	2.58E-06	6.29E-05	1.57E-05	5.30E-06	6.29E-05	3.15E-05	1.85E-05	AP-42 T1.3-11
Chromium	8.45E-04	5.48E-06	1.34E-04	3.34E-05	1.13E-05	1.34E-04	6.68E-05	3.94E-05	AP-42 T1.3-11
Cobalt	6.02E-03	3.90E-05	9.52E-04	2.38E-04	8.02E-05	9.52E-04	4.76E-04	2.80E-04	AP-42 T1.3-11
Lead	1.51E-03	9.79E-06	2.39E-04	5.97E-05	2.01E-05	2.39E-04	1.19E-04	7.03E-05	AP-42 T1.3-11
Manganese	3.00E-03	1.95E-05	4.74E-04	1.19E-04	4.00E-05	4.74E-04	2.37E-04	1.40E-04	AP-42 T1.3-11
Mercury	1.13E-04	7.33E-07	1.79E-05	4.47E-06	1.51E-06	1.79E-05	8.93E-06	5.26E-06	AP-42 T1.3-11
Nickel	8.45E-02	5.48E-04	1.34E-02	3.34E-03	1.13E-03	1.34E-02	6.68E-03	3.94E-03	AP-42 T1.3-11
Selenium	6.83E-04	4.43E-06	1.08E-04	2.70E-05	9.10E-06	1.08E-04	5.40E-05	3.18E-05	AP-42 T1.3-11

	Marine Distillate Oil-Fired Steam Boiler Emissions - One Boiler								
			217,000 m³ Ship (lb/hr)			125,000 m³ Ship (lb/hr)			
Pollutant	Emission Factor lb/1000 gal[3]	Emission Factor lb/MMBtu	1-12 hr avg.	24-hr avg.	annual avg.	1-12 hr avg.	24-hr avg.	annual avg.	Emission Factor Source
TSP	17.0	0.12	2.69	0.67	0.23	2.69	1.34	0.79	AP-42 T 1.3-1
PM-10	17.0	0.12	2.69	0.67	0.23	2.69	1.34	0.79	AP-42 T 1.3-1
SO_X	235.5	1.68	37.24	9.31	3.14	37.24	18.62	10.97	AP-42 T 1.3-1
NOX	47	0.34	7.43	1.86	0.63	7.43	3.72	2.19	AP-42 T 1.3-1
VOC	0.76	0.005	0.12	0.03	0.01	0.12	0.06	0.035	AP-42 T 1.3-2
CO	5	0.04	0.79	0.20	0.07	0.79	0.40	0.23	AP-42 T 1.3-1
NH3	0.8	0.01	0.13	0.03	0.01	0.13	0.06	0.04	5
CO2	25,000	179	3,953	988	333	3,953	1977	1164	AP-42 T 1.3-12
Pb	1.51E-03	1.08E-05	2.39E-04	5.97E-05	2.01E-05	2.39E-04	1.19E-04	7.03E-05	AP-42 T 1.3-11
POM/PAH	1.30E-03	9.29E-06	2.06E-04	5.14E-05	1.73E-05	2.06E-04	1.03E-04	6.05E-05	AP-42 T1.3-8
1,1,1-Trichloroethane	2.36E-04	1.69E-06	3.73E-05	9.33E-06	3.14E-06	3.73E-05	1.87E-05	1.10E-05	AP-42 T1.3-9
Benzene	2.14E-04	1.53E-06	3.38E-05	8.46E-06	2.85E-06	3.38E-05	1.69E-05	9.97E-06	AP-42 T1.3-9
Ethylbenzene	6.36E-05	4.54E-07	1.01E-05	2.51E-06	8.47E-07	1.01E-05	5.03E-06	2.96E-06	AP-42 T1.3-9
Formaldehyde	6.10E-02	4.36E-04	9.65E-03	2.41E-03	8.13E-04	9.65E-03	4.82E-03	2.84E-03	AP-42 T1.3-8
Naphthalene	1.13E-03	8.07E-06	1.79E-04	4.47E-05	1.51E-05	1.79E-04	8.93E-05	5.26E-05	AP-42 T1.3-9
Toluene	6.20E-03	4.43E-05	9.80E-04	2.45E-04	8.26E-05	9.80E-04	4.90E-04	2.89E-04	AP-42 T1.3-9
Xylene	1.09E-04	7.79E-07	1.72E-05	4.31E-06	1.45E-06	1.72E-05	8.62E-06	5.08E-06	AP-42 T1.3-9
Antimony	5.25E-03	3.75E-05	8.30E-04	2.08E-04	6.99E-05	8.30E-04	4.15E-04	2.45E-04	AP-42 T1.3-11
Arsenic	1.32E-03	9.43E-06	2.09E-04	5.22E-05	1.76E-05	2.09E-04	1.04E-04	6.15E-05	AP-42 T1.3-11
Beryllium	2.78E-05	1.99E-07	4.40E-06	1.10E-06	3.70E-07	4.40E-06	2.20E-06	1.29E-06	AP-42 T1.3-11
Cadmium	3.98E-04	2.84E-06	6.29E-05	1.57E-05	5.30E-06	6.29E-05	3.15E-05	1.85E-05	AP-42 T1.3-11
Chromium	8.45E-04	6.04E-06	1.34E-04	3.34E-05	1.13E-05	1.34E-04	6.68E-05	3.94E-05	AP-42 T1.3-11
Cobalt	6.02E-03	4.30E-05	9.52E-04	2.38E-04	8.02E-05	9.52E-04	4.76E-04	2.80E-04	AP-42 T1.3-11
Lead	1.51E-03	1.08E-05	2.39E-04	5.97E-05	2.01E-05	2.39E-04	1.19E-04	7.03E-05	AP-42 T1.3-11
Manganese	3.00E-03	2.14E-05	4.74E-04	1.19E-04	4.00E-05	4.74E-04	2.37E-04	1.40E-04	AP-42 T1.3-11
Mercury	1.13E-04	8.07E-07	1.79E-05	4.47E-06	1.51E-06	1.79E-05	8.93E-06	5.26E-06	AP-42 T1.3-11
Nickel	8.45E-02	6.04E-04	1.34E-02	3.34E-03	1.13E-03	1.34E-02	6.68E-03	3.94E-03	AP-42 T1.3-11
Selenium	6.83E-04	4.88E-06	1.08E-04	2.70E-05	9.10E-06	1.08E-04	5.40E-05	3.18E-05	AP-42 T1.3-11

	Natural Gas Fired Steam Boiler Emissions - One Boiler								
			217,000 m³ Ship (lb/hr)			125,000 m³ Ship (lb/hr)			
Pollutant	Emission Factor lb/MMSCF[3]	Emission Factor lb/MMBtu	1-12 hr avg.	24-hr avg.	annual avg.	1-12 hr avg.	24-hr avg.	annual avg.	Emission Factor Source
TSP	1.9	0.0019	0.05	0.01	0.00	0.05	0.02	0.01	AP-42 T 1.4-2
PM-10	1.9	0.0019	0.05	0.01	0.00	0.046	0.02	0.014	AP-42 T 1.4-2
SO_X	0.6	0.0006	0.015	0.004	0.001	0.015	0.007	0.004	AP-42 T 1.4-2
NOX	280	0.28	6.83	1.71	0.58	6.83	3.41	2.011	AP-42 T 1.4-1
VOC	5.5	0.0055	0.13	0.03	0.01	0.13	0.07	0.040	AP-42 T 1.4-2
CO	84	0.084	2.05	0.51	0.17	2.05	1.02	0.603	AP-42 T 1.4-1
NH3	3.2	0.0032	0.08	0.02	0.01	0.08	0.04	0.023	5
CO2	120,000	120	2926.63	731.66	246.56	2,927	1463	862	AP-42 T 1.4-2
Pb	5.00E-04	5.00E-07	1.22E-05	3.05E-06	1.03E-06	1.22E-05	6.10E-06	3.59E-06	AP-42 T 1.4-2
POM/PAH	8.82E-05	8.82E-08	2.15E-06	5.38E-07	1.81E-07	2.15E-06	1.08E-06	6.34E-07	AP-42 T1.4-3
Benzene	2.10E-03	2.10E-06	5.12E-05	1.28E-05	4.31E-06	5.12E-05	2.56E-05	1.51E-05	AP-42 T1.4-3
Dichlorobenzene	1.20E-03	1.20E-06	2.93E-05	7.32E-06	2.47E-06	2.93E-05	1.46E-05	8.62E-06	AP-42 T1.4-3
Formaldehyde	7.50E-02	7.50E-05	1.83E-03	4.57E-04	1.54E-04	1.83E-03	9.15E-04	5.39E-04	AP-42 T1.4-3
Hexane	1.8	1.80E-03	4.39E-02	1.10E-02	3.70E-03	4.39E-02	2.19E-02	1.29E-02	AP-42 T1.4-3
Naphthalene	6.10E-04	6.10E-07	1.49E-05	3.72E-06	1.25E-06	1.49E-05	7.44E-06	4.38E-06	AP-42 T1.4-3
Toluene	3.40E-03	3.40E-06	8.29E-05	2.07E-05	6.99E-06	8.29E-05	4.15E-05	2.44E-05	AP-42 T1.4-3
Arsenic	2.00E-04	2.00E-07	4.88E-06	1.22E-06	4.11E-07	4.88E-06	2.44E-06	1.44E-06	AP-42 T1.4-4
Beryllium	1.20E-05	1.20E-08	2.93E-07	7.32E-08	2.47E-08	2.93E-07	1.46E-07	8.62E-08	AP-42 T1.4-4
Cadmium	1.10E-03	1.10E-06	2.68E-05	6.71E-06	2.26E-06	2.68E-05	1.34E-05	7.90E-06	AP-42 T1.4-4
Chromium	1.40E-03	1.40E-06	3.41E-05	8.54E-06	2.88E-06	3.41E-05	1.71E-05	1.01E-05	AP-42 T1.4-4
Cobalt	8.40E-05	8.40E-08	2.05E-06	5.12E-07	1.73E-07	2.05E-06	1.02E-06	6.03E-07	AP-42 T1.4-4
Lead	5.00E-04	5.00E-07	1.22E-05	3.05E-06	1.03E-06	1.22E-05	6.10E-06	3.59E-06	AP-42 T1.4-2
Manganese	3.80E-04	3.80E-07	9.27E-06	2.32E-06	7.81E-07	9.27E-06	4.63E-06	2.73E-06	AP-42 T1.4-4
Mercury	2.60E-04	2.60E-07	6.34E-06	1.59E-06	5.34E-07	6.34E-06	3.17E-06	1.87E-06	AP-42 T1.4-4
Nickel	2.10E-03	2.10E-06	5.12E-05	1.28E-05	4.31E-06	5.12E-05	2.56E-05	1.51E-05	AP-42 T1.4-4
Selenium	2.40E-05	2.40E-08	5.85E-07	1.46E-07	4.93E-08	5.85E-07	2.93E-07	1.72E-07	AP-42 T1.4-4

	Residual Oil-Fired MSD Auxiliary Engine Emissions - One Engine								
			217,000 m³ Ship (lb/hr)			125,000 m³ Ship (lb/hr)			
Pollutant	Emission Factor g/kWh output	Emission Factor lb/MMBtu (input)	1-12 hr avg.	24-hr avg.	annual avg.	1-12 hr avg.	24-hr avg.	annual avg.	Emission Factor Source
TSP	1.11		4.89	1.22	0.41	4.89	2.45	1.44	EPA/ICF[6]
PM-10	1.11		4.89	1.22	0.41	4.89	2.45	1.441	EPA/ICF[6]
SO_X	11.1		48.94	12.24	4.12	48.94	24.47	14.41	EPA/ICF[6]
NOX	14.7		64.81	16.20	5.46	64.81	32.41	19.09	EPA/ICF[6]
VOC	0.4		1.76	0.44	0.15	1.76	0.88	0.52	EPA/ICF[6]
CO	1.1		4.85	1.21	0.41	4.85	2.43	1.43	EPA/ICF[6]
NH3		0.043	0.62	0.16	0.053	0.62	0.31	0.18	5
CO2		165	3130	599	202	2,397	1199	706	AP-42 T3.4-1
Pb		1.08E-05	2.05E-04	3.92E-05	1.32E-05	1.57E-04	7.85E-05	4.62E-05	AP-42 T1.3-11
POM/PAH		2.57E-07	4.88E-06	9.34E-07	3.15E-07	3.73E-06	1.87E-06	1.10E-06	AP-42 T3.4-4
Acetaldehyde		2.52E-05	4.78E-04	9.15E-05	3.08E-05	3.66E-04	1.83E-04	1.08E-04	AP-42 T3.4-3
Acrolein		7.88E-06	1.49E-04	2.86E-05	9.65E-06	1.14E-04	5.72E-05	3.37E-05	AP-42 T3.4-3
Benzene		7.76E-04	1.47E-02	2.82E-03	9.50E-04	1.13E-02	5.64E-03	3.32E-03	AP-42 T3.4-3
Formaldehyde		7.89E-05	1.50E-03	2.87E-04	9.66E-05	1.15E-03	5.73E-04	3.38E-04	AP-42 T3.4-3
Naphthalene		1.30E-04	2.47E-03	4.72E-04	1.59E-04	1.89E-03	9.44E-04	5.56E-04	AP-42 T3.4-4
Toluene		2.81E-04	5.33E-03	1.02E-03	3.44E-04	4.08E-03	2.04E-03	1.20E-03	AP-42 T3.4-3
Xylene		1.93E-04	3.66E-03	7.01E-04	2.36E-04	2.80E-03	1.40E-03	8.26E-04	AP-42 T3.4-3
Lead		1.08E-05	2.05E-04	3.92E-05	1.32E-05	1.57E-04	7.85E-05	4.6215E-05	AP-42 T1.3-11

Marine Diesel Oil-Fired MSD Auxiliary Engine Emissions - One Engine									
	Emission Factor	Emission Factor	217,000 m³ Ship (lb/hr)			125,000 m³ Ship (lb/hr)			
Pollutant	g/kWh output	lb/MMBtu (input)	1-12 hr avg.	24-hr avg.	annual avg.	1-12 hr avg.	24-hr avg.	annual avg.	Emission Factor Source
TSP	0.71		3.13	0.78	0.26	3.13	1.57	0.92	EPA/ICF[6]
PM-10	0.71		3.13	0.78	0.26	3.13	1.57	0.922	EPA/ICF[6]
SO_x	6.2		27.16	6.79	2.29	27.16	13.58	8.00	EPA/ICF[6]
NOX	13.9		61.29	15.32	5.16	61.29	30.64	18.05	EPA/ICF[6]
VOC	0.4		1.76	0.44	0.15	1.76	0.88	0.52	EPA/ICF[6]
CO	1.1		4.85	1.21	0.41	4.85	2.43	1.43	EPA/ICF[6]
NH3		0.047	0.69	0.17	0.058	0.69	0.34	0.20	5
CO2		165	2397	599	202	2,397	1199	706	AP-42 T3.4-1
Pb		1.08E-05	1.57E-04	3.92E-05	1.32E-05	1.57E-04	7.85E-05	4.62E-05	AP-42 T1.3-11
POM/PAH		2.57E-07	3.73E-06	9.34E-07	3.15E-07	3.73E-06	1.87E-06	1.10E-06	AP-42 T3.4-4
Acetaldehyde		2.52E-05	3.66E-04	9.15E-05	3.08E-05	3.66E-04	1.83E-04	1.08E-04	AP-42 T3.4-3
Acrolein		7.88E-06	1.14E-04	2.86E-05	9.65E-06	1.14E-04	5.72E-05	3.37E-05	AP-42 T3.4-3
Benzene		7.76E-04	1.13E-02	2.82E-03	9.50E-04	1.13E-02	5.64E-03	3.32E-03	AP-42 T3.4-3
Formaldehyde		7.89E-05	1.15E-03	2.87E-04	9.66E-05	1.15E-03	5.73E-04	3.38E-04	AP-42 T3.4-3
Naphthalene		1.30E-04	1.89E-03	4.72E-04	1.59E-04	1.89E-03	9.44E-04	5.56E-04	AP-42 T3.4-4
Toluene		2.81E-04	4.08E-03	1.02E-03	3.44E-04	4.08E-03	2.04E-03	1.20E-03	AP-42 T3.4-3
Xylene		1.93E-04	2.80E-03	7.01E-04	2.36E-04	2.80E-03	1.40E-03	8.26E-04	AP-42 T3.4-3
Lead		1.08E-05	1.57E-04	3.92E-05	1.32E-05	1.57E-04	7.85E-05	4.6215E-05	AP-42 T1.3-11

Marine Gas Oil-Fired MSD Auxiliary Engine Emissions - One Engine									
	Emission Factor	Emission Factor	217,000 m³ Ship (lb/hr)			125,000 m³ Ship (lb/hr)			
Pollutant	g/kWh output	lb/MMBtu (input)	1-12 hr avg.	24-hr avg.	annual avg.	1-12 hr avg.	24-hr avg.	annual avg.	Emission Factor Source
TSP	0.38		1.68	0.42	0.14	1.68	0.84	0.49	EPA/ICF[6]
PM-10	0.38		1.68	0.42	0.14	1.68	0.84	0.493	EPA/ICF[6]
SO_x	2.1		9.04	2.26	0.76	9.04	4.52	2.66	EPA/ICF[6]
NOX	13.9		61.29	15.32	5.16	61.29	30.64	18.05	EPA/ICF[6]
VOC	0.4		1.76	0.44	0.15	1.76	0.88	0.52	EPA/ICF[6]
CO	1.1		4.85	1.21	0.41	4.85	2.43	1.43	EPA/ICF[6]
NH3		0.047	0.69	0.17	0.058	0.69	0.34	0.20	5
CO2		110	1598	400	135	1,598	799	471	AP-42 T3.4-1
Pb		1.08E-05	1.57E-04	3.92E-05	1.32E-05	1.57E-04	7.85E-05	4.62E-05	AP-42 T1.3-11
POM/PAH		2.57E-07	3.73E-06	9.34E-07	3.15E-07	3.73E-06	1.87E-06	1.10E-06	AP-42 T3.4-4
Acetaldehyde		2.52E-05	3.66E-04	9.15E-05	3.08E-05	3.66E-04	1.83E-04	1.08E-04	AP-42 T3.4-3
Acrolein		7.88E-06	1.14E-04	2.86E-05	9.65E-06	1.14E-04	5.72E-05	3.37E-05	AP-42 T3.4-3
Benzene		7.76E-04	1.13E-02	2.82E-03	9.50E-04	1.13E-02	5.64E-03	3.32E-03	AP-42 T3.4-3
Formaldehyde		7.89E-05	1.15E-03	2.87E-04	9.66E-05	1.15E-03	5.73E-04	3.38E-04	AP-42 T3.4-3
Naphthalene		1.30E-04	1.89E-03	4.72E-04	1.59E-04	1.89E-03	9.44E-04	5.56E-04	AP-42 T3.4-4
Toluene		2.81E-04	4.08E-03	1.02E-03	3.44E-04	4.08E-03	2.04E-03	1.20E-03	AP-42 T3.4-3
Xylene		1.93E-04	2.80E-03	7.01E-04	2.36E-04	2.80E-03	1.40E-03	8.26E-04	AP-42 T3.4-3
Lead		1.08E-05	1.57E-04	3.92E-05	1.32E-05	1.57E-04	7.85E-05	4.6215E-05	AP-42 T1.3-11

Emissions (lbs/ship call)														Composite Annual Emissions Based on Ship Call Assumptions (TPY)
	217,000 m³ LNG Carrier Capacity Steam Turbine Power Plant			125,000 m³ LNG Carrier Capacity Steam Turbine Power Plant			217,000 m³ LNG Carrier Capacity Auxiliary Engine (Diesel-Electric) Powered Pumps			125,000 m³ LNG Carrier Capacity Auxiliary Engine (Diesel-Electric) Powered Pumps				
Pollutant	Residual Oil	Marine Diesel Oil	Natural Gas	Residual Oil	Marine Diesel Oil	Natural Gas	Residual Oil	Marine Diesel Oil	Marine Gas Oil	Residual Oil	Marine Diesel Oil	Marine Gas Oil		
TSP	26.60	16.13	0.28	53.20	32.27	0.56	29.37	18.78	10.05	58.73	37.57	20.11		0.25
PM-10	26.60	16.13	0.28	53.20	32.27	0.56	29.37	18.78	10.05	58.73	37.57	20.11		0.25
SO_x	402.20	223.45	0.09	804.41	446.89	0.18	293.65	162.96	54.23	587.30	325.93	108.47		1.78
NOX	44.59	44.59	40.97	89.19	89.19	81.95	388.89	367.72	367.72	777.78	735.45	735.45		10.44
VOC	0.72	0.72	0.80	1.44	1.44	1.61	10.58	10.58	10.58	21.16	21.16	21.16		0.25
CO	4.74	4.74	12.29	9.49	9.49	24.58	29.10	29.10	29.10	58.20	58.20	58.20		2.12
NH3	0.76	0.76	0.47	1.52	1.52	0.94	3.74	4.12	4.12	7.48	8.24	8.24		0.12
CO2	23,151	23,720	17,560	46,302	47,441	35,120	14,384	14,384	9,589	28,768	28,768	19,179		2,670
Pb	1.43E-03	1.43E-03	7.32E-05	2.87E-03	2.87E-03	1.46E-04	9.42E-04	9.42E-04	9.42E-04	1.88E-03	1.88E-03	1.88E-03		2.22E-05
POM/PAH	1.23E-03	1.23E-03	1.29E-05	2.47E-03	2.47E-03	2.58E-05	2.24E-05	2.24E-05	2.24E-05	4.48E-05	4.48E-05	4.48E-05		2.12E-06
1,1,1-Trichloroethane	2.24E-04	2.24E-04		4.48E-04	4.48E-04									
Benzene	2.03E-04	2.03E-04	3.07E-04	4.06E-04	4.06E-04	6.15E-04	6.76E-02	6.76E-02	6.76E-02	1.35E-01	1.35E-01	1.35E-01		8.89E-04
Dichlorobenzene			1.76E-04			3.51E-04								2.50E-05
Ethylbenzene	6.03E-05	6.03E-05		1.21E-04	1.21E-04									
Formaldehyde	5.79E-02	5.79E-02	1.10E-02	1.16E-01	1.16E-01	2.19E-02	6.88E-03	6.88E-03	6.88E-03	1.38E-02	1.38E-02	1.38E-02		1.65E-03
Hexane			2.63E-01			5.27E-01								3.75E-02
Naphthalene	1.07E-03	1.07E-03	8.93E-05	2.14E-03	2.14E-03	1.79E-04	1.13E-02	1.13E-02	1.13E-02	2.27E-02	2.27E-02	2.27E-02		1.54E-04
Toluene	5.88E-03	5.88E-03	4.98E-04	1.18E-02	1.18E-02	9.95E-04	2.45E-02	2.45E-02	2.45E-02	4.90E-02	4.90E-02	4.90E-02		3.77E-04
Xylene	1.03E-04	1.03E-04		2.07E-04	2.07E-04		1.68E-02	1.68E-02	1.68E-02	3.37E-02	3.37E-02	3.37E-02		2.10E-04
Antimony	4.98E-03	4.98E-03		9.96E-03	9.96E-03									
Arsenic	1.25E-03	1.25E-03	2.93E-05	2.50E-03	2.50E-03	5.85E-05								4.17E-06
Beryllium	2.64E-05	2.64E-05	1.76E-06	5.28E-05	5.28E-05	3.51E-06								2.50E-07
Cadmium	3.78E-04	3.78E-04	1.61E-04	7.55E-04	7.55E-04	3.22E-04								2.29E-05
Chromium	8.02E-04	8.02E-04	2.05E-04	1.60E-03	1.60E-03	4.10E-04								2.92E-05
Cobalt	5.71E-03	5.71E-03	1.23E-05	1.14E-02	1.14E-02	2.46E-05								1.75E-06
Lead	1.43E-03	1.43E-03	7.32E-05	2.87E-03	2.87E-03	1.46E-04	9.42E-04	9.42E-04	9.42E-04	1.88E-03	1.88E-03	1.88E-03		2.22E-05
Manganese	2.85E-03	2.85E-03	5.56E-05	5.69E-03	5.69E-03	1.11E-04								7.92E-06
Mercury	1.07E-04	1.07E-04	3.80E-05	2.14E-04	2.14E-04	7.61E-05								5.42E-06
Nickel	8.02E-02	8.02E-02	3.07E-04	1.60E-01	1.60E-01	6.15E-04								4.38E-05
Selenium	6.48E-04	6.48E-04	3.51E-06	1.30E-03	1.30E-03	7.02E-06								5.00E-07

* Within USCG Security & Safety Zone, LNG ships are assumed not to be using ship power for propulsion (i.e., entirely under tug power). However boilers/engines are in standby mode and total load is same as for hoteling operation while ship is at berth and during USCG inspections. LNG ship transit emissions within the Safety & Security Zone were not modeled to avoid double-counting of emissions (e.g., modeling conservatively assumes 1 ship offloading and 1 ship hoteling at the same time).

1. Based on ship information provided by ABS, 2000 kW needed for pump power / (0.28 steam cycle efficiency factor for thermal heat input to electrical power output) x 3414.4 Btu/kW-hr = 24.4 MMBtu/hr total fuel heat input. Assumes 1 boiler operating.
2. Approximate operating load fraction of 1 boiler or engine capacity - used for purposes of estimating realistic total exhaust volume rate and stack velocity for modeling purposes. For steam boiler power plant case, assumes 1 of 2 boilers is operating to provide total power needs while ship is at berth. For auxiliary engine power cases, assumes 1 engine provides all auxiliary power needs while at berth for LNG pumping and hotelling. Auxiliary power needs for hotelling based on 2,000 kW, based on information obtained from Tables 2-4 and 2-7 of ICF Final Report prepared for EPA, "Current Methodologies and Best Practices in Preparing Port Emission Inventories", January 5, 2006.
3. Based on number of ship calls/yr x hrs hotelling operation/ship call, assuming exclusive use of respective ship size and power plant type. Does not represent assumed mix of ship sizes and power plants on annual basis.
4. Emission factors based on EPA AP-42, Section 1.3 (No. 6 residual fuel oil) and Section 1.4 (nat. gas combustion). TSP and PM-10 emissions are total filterable particulate matter and assumed to all be less than 10 microns. PM-2.5 is conservatively estimated as 100% of PM-10 emissions.
5. EPA Emission Inventory Improvement Program, "Estimating Ammonia Emissions from Anthropogenic Nonagricultural Sources - Draft Final Report", April 2004.
6. Based on emission factors for auxiliary engines in Table 2-10 of ICF Final Report prepared for EPA, "Current Methodologies and Best Practices in Preparing Port Emission Inventories", January 5, 2006.
7. Based on exclusive use of respective LNG ship size and power plant type for deliveries to ABS LNG Terminal (does not represent assumed mix of ship sizes and power plants on annual basis).
8. Boiler exhaust volume rate calculated from fuel consumption and 15% excess air, assuming 1 of 2 boilers operating at part load for all activities while ship is at berth. Diesel engine exhaust volume estimated based on 6300 cf/gal diesel consumed. Dual-fuel engine exhaust volume rate estimated based on 6.9 cfm/BHp.

TABLE 9A-12: EMISSIONS CALCULATIONS - LNG TERMINAL OPERATING EMISSIONS
Sparrows Point LNG Terminal
Assist Tug Emissions

Scenario	Assisting LNG Ship Transit/Berthing Within Safety & Security Zone (SSZ)	Assisting During LNG Ship Transit Outside SSZ
Type of engine (propulsion and aux.)	MSD	MSD
Tug propulsion engine rating, kW ea. Tug[1]	1532	1532
Aux. power rating, kW[1]	82	82
Total power, kW	1614	1614
Number of tugs working	3	2
Working time per LNG ship call, hrs.	2	3
Idling time per LNG ship call, hrs.	12	0
Power factor - working	0.6	0.6
Power factor - idling	0.1	0.1
LNG ship calls per year	180	180
Fuel Btu/gal	140,000	140,000
Stack Height, ft	35	35
Stack diameter, ft.	1.5	1.5
Exhaust volume rate, ACFM	5,230	5,230
Stack Temp., deg. F	900	900
Exhaust velocity, ft/s	49	49

Assist Tugs Within SSZ - Marine Diesel Oil-Fired MSD Engine Emissions

Pollutant	Emission Factor g/kWh output[2]	Emission Factor lb/MMBtu (input)	Each Assist Tug (lb/hr) 1-hr avg.	3-hr avg.	8-hr avg.	24-hr avg.	annual avg.	Total TPY (All Tugs)	Emission Factor Source
TSP	0.72		1.54	1.11	0.58	0.36	0.18	2.35	EPA/ICF
PM-10	0.72		1.54	1.11	0.58	0.36	0.18	2.35	EPA/ICF
SO_X[3]	0.21		0.45	0.32	0.17	0.11	0.05	0.69	EPA/ICF
NOX	13.2		28.18	20.35	10.57	6.65	3.28	43.12	EPA/ICF
VOC	0.5		1.07	0.77	0.40	0.25	0.12	1.63	EPA/ICF
CO	1.1		2.35	1.70	0.88	0.55	0.27	3.59	EPA/ICF
NH3		0.047	0.55	0.40	0.21	0.13	0.065	0.848	4
CO2		165	1935	1397	725	457	225	2960	AP-42 T3.4-1
Pb		1.08E-05	1.27E-04	9.15E-05	4.75E-05	2.99E-05	1.47E-05	1.94E-04	AP-42 T1.3-11
POM/PAH		2.57E-07	3.01E-06	2.18E-06	1.13E-06	7.11E-07	3.51E-07	4.61E-06	AP-42 T3.4-4
Acetaldehyde		2.52E-05	2.95E-04	2.13E-04	1.11E-04	6.98E-05	3.44E-05	4.52E-04	AP-42 T3.4-3
Acrolein		7.88E-06	9.24E-05	6.67E-05	3.46E-05	2.18E-05	1.08E-05	1.41E-04	AP-42 T3.4-3
Benzene		7.76E-04	9.10E-03	6.57E-03	3.41E-03	2.15E-03	1.06E-03	1.39E-02	AP-42 T3.4-3
Formaldehyde		7.89E-05	9.25E-04	6.68E-04	3.47E-04	2.18E-04	1.08E-04	1.42E-03	AP-42 T3.4-3
Naphthalene		1.30E-04	1.52E-03	1.10E-03	5.72E-04	3.60E-04	1.77E-04	2.33E-03	AP-42 T3.4-4
Toluene		2.81E-04	3.29E-03	2.38E-03	1.24E-03	7.78E-04	3.84E-04	5.04E-03	AP-42 T3.4-3
Xylene		1.93E-04	2.26E-03	1.63E-03	8.49E-04	5.34E-04	2.63E-04	3.46E-03	AP-42 T3.4-3

Assist Tugs During LNG Ship Transit Outside SSZ - Marine Diesel Oil-Fired MSD Engine Emissions

Pollutant	Emission Factor g/kWh output[2]	Emission Factor lb/MMBtu (input)	Each Assist Tug (lb/hr) 1-hr avg.	3-hr avg.	8-hr avg.	24-hr avg.	annual avg.	Total TPY (All Tugs)	Emission Factor Source
TSP	0.72		1.54	1.54	0.74	0.42	0.14	1.80	EPA/ICF
PM-10	0.72		1.54	1.54	0.74	0.42	0.14	1.80	EPA/ICF
SO_X[3]	0.21		0.45	0.45	0.21	0.12	0.04	0.52	EPA/ICF
NOX	13.2		28.18	28.18	13.50	7.63	2.51	32.97	EPA/ICF
VOC	0.5		1.07	1.07	0.51	0.29	0.10	1.25	EPA/ICF
CO	1.1		2.35	2.35	1.13	0.64	0.21	2.75	EPA/ICF
NH3		0.047	0.55	0.55	0.27	0.15	0.049	0.649	4
CO2		165	1935	1935	927	524	172	2264	AP-42 T3.4-1
Pb		1.08E-05	1.27E-04	1.27E-04	6.07E-05	3.43E-05	1.13E-05	1.48E-04	AP-42 T1.3-11
POM/PAH		2.57E-07	3.01E-06	3.01E-06	1.44E-06	8.16E-07	2.68E-07	3.53E-06	AP-42 T3.4-4
Acetaldehyde		2.52E-05	2.95E-04	2.95E-04	1.42E-04	8.00E-05	2.63E-05	3.46E-04	AP-42 T3.4-3
Acrolein		7.88E-06	9.24E-05	9.24E-05	4.43E-05	2.50E-05	8.23E-06	1.08E-04	AP-42 T3.4-3
Benzene		7.76E-04	9.10E-03	9.10E-03	4.36E-03	2.46E-03	8.10E-04	1.06E-02	AP-42 T3.4-3
Formaldehyde		7.89E-05	9.25E-04	9.25E-04	4.43E-04	2.51E-04	8.24E-05	1.08E-03	AP-42 T3.4-3
Naphthalene		1.30E-04	1.52E-03	1.52E-03	7.30E-04	4.13E-04	1.36E-04	1.78E-03	AP-42 T3.4-4
Toluene		2.81E-04	3.29E-03	3.29E-03	1.58E-03	8.92E-04	2.93E-04	3.85E-03	AP-42 T3.4-3
Xylene		1.93E-04	2.26E-03	2.26E-03	1.08E-03	6.13E-04	2.01E-04	2.65E-03	AP-42 T3.4-3

1. Based on data for "Assist tug", Table 2-13 of ICF Final Report prepared for EPA, "Current Methodologies and Best Practices in Preparing Port Emission Inventories", January 5, 2006.
2. Category 2 harbor craft emission factors from Table 2-16 of ICF Final Report prepared for EPA, "Current Methodologies and Best Practices in Preparing Port Emission Inventories", January 5, 2006.
3. Based on 0.05% diesel sulfur content required by 40 CFR 80, Subpart I, beginning June 1, 2007. Beginning, June 1, 2012, the applicable sulfur content limit wil be further reduced to 0.0015%.
4. EPA Emission Inventory Improvement Program, "Estimating Ammonia Emissions from Anthropogenic Nonagricultural Sources - Draft Final Report", April 2004.

TABLE 9A-13: EMISSIONS CALCULATIONS - LNG TERMINAL OPERATING EMISSIONS
Sparrows Point LNG Terminal
Security and Escort Boat Emissions

Scenario	Within Safety & Security Zone (SSZ)	During LNG Ship Transit Outside SSZ
Type of engine (propulsion and aux.)	Gasoline Outboard Engines	Gasoline Outboard Engines
Total propulsion engine rating, kW ea. Boat[1]	298.3	298.3
Aux. power rating, kW[1]		
Total power, kW	298.3	298.3
Number of boats working	2	2
Working time per LNG ship call, hrs.	1	10
Idling time per LNG ship call, hrs.	12	2
Power factor - working	0.6	0.8
Power factor - idling	0.2	0.2
LNG ship calls per year	180	180
Fuel Btu/gal	136,000	136,000
Stack Height, ft	0	0
Stack diameter, ft.	0.25	0.25
Exhaust volume rate, ACFM	995	1,327
Stack Temp., deg. F	900	900
Exhaust velocity, ft/s	338	450

Security and Escort Boats Within SSZ - Gasoline Outboard Engines Emissions

Pollutant	Emission Factor g/kWh output[2]	Emission Factor lb/MMBtu (input)	Each Boat (lb/hr) 1-hr avg.	3-hr avg.	8-hr avg.	24-hr avg.	annual avg.	Total TPY (All Boats)	Emission Factor Source
TSP	0.060		0.02	0.01	0.01	0.01	0.003	0.04	EPA/NONROAD
PM-10	0.060		0.02	0.01	0.01	0.01	0.003	0.04	EPA/NONROAD
SO_X	0.021		0.01	0.00	0.00	0.00	0.001	0.01	EPA/NONROAD
NOX	5.820		2.30	1.28	0.96	0.83	0.27	3.58	EPA/NONROAD
VOC	3.530		1.39	0.77	0.58	0.50	0.17	2.17	EPA/NONROAD
CO	120.310		47.47	26.37	19.78	17.14	5.64	74.05	EPA/NONROAD
NH3			0.00	0.00	0.00	0.00	0.000	0.000	
CO2			0	0	0	0	0	0	
Pb			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
POM/PAH			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Acetaldehyde			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Acrolein			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Benzene			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Formaldehyde			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Naphthalene			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Toluene			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Xylene			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	

Security and Escort Boats During LNG Ship Transit Outside SSZ - Gasoline Outboard Engines Emissions

Pollutant	Emission Factor g/kWh output[2]	Emission Factor lb/MMBtu (input)	Each Boat (lb/hr) 1-hr avg.	3-hr avg.	8-hr avg.	24-hr avg.	annual avg.	Total TPY (All Tugs)	Emission Factor Source
TSP	0.060		0.03	0.03	0.03	0.02	0.01	0.08	EPA/NONROAD
PM-10	0.060		0.03	0.03	0.03	0.02	0.01	0.08	EPA/NONROAD
SO_X[3]	0.021		0.01	0.01	0.01	0.01	0.00	0.03	EPA/NONROAD
NOX	5.820		3.06	3.06	3.06	1.72	0.57	7.44	EPA/NONROAD
VOC	3.530		1.86	1.86	1.86	1.04	0.34	4.51	EPA/NONROAD
CO	120.310		63.29	63.29	63.29	35.60	11.70	153.80	EPA/NONROAD
NH3			0.00	0.00	0.00	0.00	0.000	0.000	
CO2			0	0	0	0	0	0	
Pb			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
POM/PAH			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Acetaldehyde			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Acrolein			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Benzene			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Formaldehyde			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Naphthalene			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Toluene			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	
Xylene			0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	

1. Based on two 200 hp outboard engines x 0.7457 kW/hp
2. Emission factors from EPA NONROAD model emission factors for gasoline-fueled 4-stroke direct injection outboard marine engine (EPA/420-R-05-019, Dec. 2005).

TABLE 9A-14: EMISSIONS CALCULATIONS - LNG TERMINAL OPERATING EMISSIONS
Sparrows Point LNG Terminal
LNG Tanker Ship Transit Emissions Outside Safety & Security Zone in MD and VA Waters

Scenario	LNG Ship Transit in MD	LNG Ship Transit in VA
Total power rating, hp	40,000	40,000
Total power rating, kW	29,828	29,828
Transit Time, ea. way, hrs.	10	10
Power factor - transit	0.8	0.8
LNG ship calls per year	180	180

Development of Maximum and Annual Composite Emission Factors Based on Assumed Mix of LNG Ship Propulsion

	Steam Turbine Power Plant			Medium Speed Diesel Engines				
Fuel	Residual Oil	Marine Diesel Oil	Natural Gas	Residual Oil	Marine Diesel Oil	Marine Gas Oil	Maximum Emission Factor	Composite Emission Factor
NO. of ship calls assumed for potential emissions and modeling purposes	25		117		13	25		
Sulfur content, % wt.	2.7	1.5		2.7	1.5	0.5		
Emission Factors, g/kW-hr output								
TSP	1.01	0.67	0.01	1.11	0.71	0.38	1.01	0.25
PM-10	1.01	0.67	0.01	1.11	0.71	0.38	1.01	0.25
SO_x	15.20	9.30	0.003	11.10	6.16	2.05	15.20	2.84
NOX	1.69	1.86	1.55	14.70	13.90	13.90	13.90	4.18
VOC	0.03	0.03	0.03	0.40	0.40	0.40	0.40	0.11
CO	0.18	0.20	0.46	1.10	1.10	1.10	1.10	0.56
NH3	0.03	0.03	0.02	0.14	0.16	0.16	0.16	0.05
CO2	875.12	987.74	663.76	543.72	543.72	362.48	875.12	642.60
Pb	5.42E-05	5.97E-05	2.77E-06	3.56E-05	3.56E-05	3.56E-05	5.42E-05	1.08E-05
POM/PAH	4.66E-05	5.14E-05	4.88E-07	8.47E-07	8.47E-07	8.47E-07	4.66E-05	6.97E-06
1,1,1-Trichloroethane	8.46E-06	9.32E-06					8.46E-06	1.18E-06
Benzene	7.68E-06	8.46E-06	1.16E-05	2.56E-03	2.56E-03	2.56E-03	2.56E-03	5.48E-04
Dichlorobenzene			6.64E-06				6.64E-06	4.31E-06
Ethylbenzene	2.28E-06	2.51E-06					2.28E-06	3.17E-07
Formaldehyde	2.19E-03	2.41E-03	4.15E-04	2.60E-04	2.60E-04	2.60E-04	2.19E-03	6.28E-04
Hexane			9.96E-03				9.96E-03	6.47E-03
Naphthalene	4.05E-05	4.46E-05	3.37E-06	4.28E-04	4.28E-04	4.28E-04	4.28E-04	9.83E-05
Toluene	2.22E-04	2.45E-04	1.88E-05	9.26E-04	9.26E-04	9.26E-04	9.26E-04	2.39E-04
Xylene	3.91E-06	4.31E-06		6.36E-04	6.36E-04	6.36E-04	6.36E-04	1.35E-04
Antimony	1.88E-04	2.07E-04					1.88E-04	2.62E-05
Arsenic	4.73E-05	5.22E-05	1.11E-06				4.73E-05	7.29E-06
Beryllium	9.97E-07	1.10E-06	6.64E-08				9.97E-07	1.82E-07
Cadmium	1.43E-05	1.57E-05	6.08E-06				1.43E-05	5.04E-06
Chromium	3.03E-05	3.34E-05	7.74E-06				3.03E-05	9.24E-06
Cobalt	2.16E-04	2.38E-04	4.65E-07				2.16E-04	3.03E-05
Lead	5.42E-05	5.97E-05	2.77E-06	3.56E-05	3.56E-05	3.56E-05	5.42E-05	1.68E-05
Manganese	1.08E-04	1.19E-04	2.10E-06				1.08E-04	1.63E-05
Mercury	4.05E-06	4.46E-06	1.44E-06				4.05E-06	1.50E-06
Nickel	3.03E-03	3.34E-03	1.16E-05				3.03E-03	4.28E-04
Selenium	2.45E-05	2.70E-05	1.33E-07				2.45E-05	3.49E-06

LNG Tanker Ship Transit Emissions - Maryland Waters

Pollutant	Maximum Emission Factor g/kWh output[2]	Annual Avg. Emission Factor g/kWh	Each LNG Tanker Ship (lb/hr) 1-hr avg.	3-hr avg.	8-hr avg.	24-hr avg.	annual avg.	Total TPY (All Ships)
TSP	1.01	0.25	52.89	52.89	52.89	22.04	5.42	23.72
PM-10	1.01	0.25	52.89	52.89	52.89	22.04	5.42	23.72
SO_x	15.20	2.84	799.80	799.80	799.80	333.25	61.47	269.24
NOX	13.90	4.18	731.23	731.23	731.23	304.68	90.27	395.37
VOC	0.40	0.11	21.04	21.04	21.04	8.77	2.33	10.23
CO	1.10	0.56	57.87	57.87	57.87	24.11	12.09	52.95
NH3	0.16	0.05	8.20	8.20	8.20	3.42	1.046	4.582
CO2	875.12	642.60	46037	46037	46037	19182	13893	60849
Pb	5.42E-05	1.08E-05	2.85E-03	2.85E-03	2.85E-03	1.19E-03	3.64E-04	1.59E-03
POM/PAH	4.66E-05	6.97E-06	2.45E-03	2.45E-03	2.45E-03	1.02E-03	1.53E-04	6.68E-04
1,1,1-Trichloroethane	8.46E-06	1.18E-06	4.45E-04	4.45E-04	4.45E-04	1.86E-04	2.54E-05	1.11E-04
Benzene	2.56E-03	5.48E-04	1.35E-01	1.35E-01	1.35E-01	5.61E-02	1.19E-02	5.19E-02
Dichlorobenzene	6.64E-06	4.31E-06	3.49E-04	3.49E-04	3.49E-04	1.45E-04	9.33E-05	4.09E-04
Ethylbenzene	2.28E-06	3.17E-07	1.20E-04	1.20E-04	1.20E-04	5.00E-05	6.85E-06	3.00E-05
Formaldehyde	2.19E-03	6.28E-04	1.15E-01	1.15E-01	1.15E-01	4.80E-02	1.36E-02	5.95E-02
Hexane	9.96E-03	6.47E-03	5.24E-01	5.24E-01	5.24E-01	2.18E-01	1.40E-01	6.13E-01
Naphthalene	4.28E-04	9.83E-05	2.25E-02	2.25E-02	2.25E-02	9.39E-03	2.12E-03	9.30E-03
Toluene	9.26E-04	2.39E-04	4.87E-02	4.87E-02	4.87E-02	2.03E-02	5.16E-03	2.26E-02
Xylene	6.36E-04	1.35E-04	3.35E-02	3.35E-02	3.35E-02	1.39E-02	2.91E-03	1.28E-02
Antimony	1.88E-04	2.62E-05	9.91E-03	9.91E-03	9.91E-03	4.13E-03	5.65E-04	2.48E-03
Arsenic	4.73E-05	7.29E-06	2.49E-03	2.49E-03	2.49E-03	1.04E-03	1.58E-04	6.91E-04
Beryllium	9.97E-07	1.82E-07	5.25E-05	5.25E-05	5.25E-05	2.19E-05	3.93E-06	1.72E-05
Cadmium	1.43E-05	5.04E-06	7.51E-04	7.51E-04	7.51E-04	3.13E-04	1.28E-04	5.62E-04
Chromium	3.03E-05	9.24E-06	1.59E-03	1.59E-03	1.59E-03	6.64E-04	2.00E-04	8.75E-04
Cobalt	2.16E-04	3.03E-05	1.14E-02	1.14E-02	1.14E-02	4.73E-03	6.55E-04	2.87E-03
Lead	5.42E-05	1.68E-05	2.85E-03	2.85E-03	2.85E-03	1.19E-03	3.64E-04	1.59E-03
Manganese	1.08E-04	1.63E-05	5.66E-03	5.66E-03	5.66E-03	2.36E-03	3.53E-04	1.54E-03
Mercury	4.05E-06	1.50E-06	2.13E-04	2.13E-04	2.13E-04	8.88E-05	3.24E-05	1.42E-04
Nickel	3.03E-03	4.28E-04	1.59E-01	1.59E-01	1.59E-01	6.64E-02	9.20E-03	4.00E-02
Selenium	2.45E-05	3.49E-06	1.29E-03	1.29E-03	1.29E-03	5.37E-04	7.54E-05	3.30E-04

LNG Tanker Ship Transit Emissions - Virginia Waters

Pollutant	Maximum Emission Factor g/kWh output[2]	Annual Avg. Emission Factor g/kWh	Each LNG Tanker Ship (lb/hr) 1-hr avg.	3-hr avg.	8-hr avg.	24-hr avg.	annual avg.	Total TPY (All Ships)
TSP	1.01	0.25	52.89	52.89	52.89	22.04	5.42	23.72
PM-10	1.01	0.25	52.89	52.89	52.89	22.04	5.42	23.72
SO_x	15.20	2.84	799.80	799.80	799.80	333.25	61.47	269.24
NOX	13.90	4.18	731.23	731.23	731.23	304.68	90.27	395.37
VOC	0.40	0.11	21.04	21.04	21.04	8.77	2.33	10.23
CO	1.10	0.56	57.87	57.87	57.87	24.11	12.09	52.95
NH3	0.16	0.05	8.20	8.20	8.20	3.42	1.046	4.582
CO2	875.12	642.60	46037	46037	46037	19182	13893	60849
Pb	5.42E-05	1.08E-05	2.85E-03	2.85E-03	2.85E-03	1.19E-03	3.64E-04	1.59E-03
POM/PAH	4.66E-05	6.97E-06	2.45E-03	2.45E-03	2.45E-03	1.02E-03	1.53E-04	6.68E-04
1,1,1-Trichloroethane	8.46E-06	1.18E-06	4.45E-04	4.45E-04	4.45E-04	1.86E-04	2.54E-05	1.11E-04
Benzene	2.56E-03	5.48E-04	1.35E-01	1.35E-01	1.35E-01	5.61E-02	1.19E-02	5.19E-02
Dichlorobenzene	6.64E-06	4.31E-06	3.49E-04	3.49E-04	3.49E-04	1.45E-04	9.33E-05	4.09E-04
Ethylbenzene	2.28E-06	3.17E-07	1.20E-04	1.20E-04	1.20E-04	5.00E-05	6.85E-06	3.00E-05
Formaldehyde	2.19E-03	6.28E-04	1.15E-01	1.15E-01	1.15E-01	4.80E-02	1.36E-02	5.95E-02
Hexane	9.96E-03	6.47E-03	5.24E-01	5.24E-01	5.24E-01	2.18E-01	1.40E-01	6.13E-01
Naphthalene	4.28E-04	9.83E-05	2.25E-02	2.25E-02	2.25E-02	9.39E-03	2.12E-03	9.30E-03
Toluene	9.26E-04	2.39E-04	4.87E-02	4.87E-02	4.87E-02	2.03E-02	5.16E-03	2.26E-02
Xylene	6.36E-04	1.35E-04	3.35E-02	3.35E-02	3.35E-02	1.39E-02	2.91E-03	1.28E-02
Antimony	1.88E-04	2.62E-05	9.91E-03	9.91E-03	9.91E-03	4.13E-03	5.65E-04	2.48E-03
Arsenic	4.73E-05	7.29E-06	2.49E-03	2.49E-03	2.49E-03	1.04E-03	1.58E-04	6.91E-04
Beryllium	9.97E-07	1.82E-07	5.25E-05	5.25E-05	5.25E-05	2.19E-05	3.93E-06	1.72E-05
Cadmium	1.43E-05	5.04E-06	7.51E-04	7.51E-04	7.51E-04	3.13E-04	1.28E-04	5.62E-04
Chromium	3.03E-05	9.24E-06	1.59E-03	1.59E-03	1.59E-03	6.64E-04	2.00E-04	8.75E-04
Cobalt	2.16E-04	3.03E-05	1.14E-02	1.14E-02	1.14E-02	4.73E-03	6.55E-04	2.87E-03

TABLE 9A-15: EMISSIONS CALCULATIONS - LNG TERMINAL OPERATING EMISSIONS
Sparrows Point LNG Terminal
Summary of Marine Vessel Emissions from LNG Ship Transit, Tug Boats and Security Boats

Total Emissions, TPY					
Pollutant	**LNG Ship Hoteling**	**Assit Tug Boats**	**Security and Escort Boats**	**LNG Ship Transit**	**Total Marine Vessel Emissions**
NOX	10.44	76.09	11.02	790.73	888.28
CO	2.12	6.34	227.85	105.89	342.20
VOC (as CH4)	0.25	2.88	6.69	20.45	30.27
SOX	1.78	1.21	0.04	538.49	541.51
PM-10/PM-2.5	0.25	4.15	0.11	47.45	51.96
NH3	0.12	1.50E+00		9.16	10.78

Total Emissions in MD, TPY					
Pollutant	**LNG Ship Hoteling**	**Assit Tug Boats**	**Security and Escort Boats**	**LNG Ship Transit**	**Total Marine Vessel Emissions**
NOX	10.44	76.09	11.02	395.37	492.91
CO	2.12	6.34	227.85	52.95	289.25
VOC (as CH4)	0.25	2.88	6.69	10.23	20.04
SOX	1.78	1.21	0.04	269.24	272.27
PM-10/PM-2.5	0.25	4.15	0.11	23.72	28.24
NH3	0.12	1.50E+00		4.58	6.20

Total Emissions In VA, TPY					
Pollutant	**LNG Ship Hoteling**	**Assit Tug Boats**	**Security and Escort Boats**	**LNG Ship Transit**	**Total Marine Vessel Emissions**
NOX				395.37	395.37
CO				52.95	52.95
VOC (as CH4)				10.23	10.23
SOX				269.24	269.24
PM-10/PM-2.5				23.72	23.72
NH3				4.58	4.58

	In MD Waters	In VA Waters
Total LNG Ship One-way transit distance	147	124

	Baltimore & Anne Arundel Counties, MD (AQCR 115)	Kent & Queen Anne's Counties, MD (AQCR 114)	Calvert Co., MD (AQCR 116)	Norfolk-Virginia Beach-Newport News (Hampton Roads) VA (AQCR 223)
LNG Ship Transit One-way Distances by Nonattainment Area	66	30	45	53
Fraction of total distance in MD	0.45	0.20	0.31	

TABLE 9A-16: EMISSIONS CALCULATIONS - LNG TERMINAL OPERATING EMISSIONS
LNG Terminal Maintenance Dredging Activities
Onshore Processing and Stockpiling Activities

Description	Onshore Processing Equip.
NO. of Units	2 water trucks, 2 backhoes, 2 dozers, 6 excavators, 4 loaders, 6 trucks, 1 broom sweeper and 2 skid steers
BSFC, lb/hp-hr	0.367
% S in Fuel	0.05
Engine Type	Diesel compression ignition
Avg. Load Factor	0.5
Operating hrs/day	12

	2 Water Trucks				2 Backhoes				2 Dozers				6 Excavator			
	300 Bhp, each unit				85 Bhp, each unit				185 Bhp, each unit				300 Bhp, each unit			
Pollutant	Em. Factor[1] g/Bhp-hr	In-use Adj. Factor[2]	Ea. Unit g/sec	Total g/sec	Em. Factor[1] g/Bhp-hr	In-use Adj. Factor[2]	Ea. Unit g/sec	Total g/sec	Em. Factor[1] g/Bhp-hr	In-use Adj. Factor[2]	Ea. Unit g/sec	Total g/sec	Em. Factor[1] g/Bhp-hr	In-use Adj. Factor[2]	Ea. Unit g/sec	Total g/sec
PM	0.33	2.07	0.057	0.114	0.33	2.07	0.016	0.032	0.33	1.29	0.022	0.044	0.33	1.29	0.035	0.213
NOX	8.38	1.05	0.733	1.467	8.38	1.05	0.208	0.416	8.38	0.98	0.422	0.844	8.38	0.98	0.684	4.106
SO_2	0.16	1.16	0.016	0.031	0.16	1.16	0.004	0.009	0.16	0.99	0.008	0.016	0.16	0.99	0.013	0.080
CO	2.7	2.66	0.599	1.197	2.7	2.66	0.170	0.339	2.7	1.5	0.208	0.416	2.7	1.5	0.338	2.025
HC	0.68	2.23	0.126	0.253	0.68	2.23	0.036	0.072	0.68	0.88	0.031	0.062	0.68	0.88	0.050	0.299

	4 Loaders				6 Trucks				1 Sweeper				2 Skid Steers			
	300 Bhp, each unit				355 Bhp, each unit				200 Bhp, each unit				80 Bhp, each unit			
Pollutant	Em. Factor[1] g/Bhp-hr	In-use Adj. Factor[2]	Ea. Unit g/sec	Total g/sec	Em. Factor[1] g/Bhp-hr	In-use Adj. Factor[2]	Ea. Unit g/sec	Total g/sec	Em. Factor[1] g/Bhp-hr	In-use Adj. Factor[2]	Ea. Unit g/sec	Total g/sec	Em. Factor[1] g/Bhp-hr	In-use Adj. Factor[2]	Ea. Unit g/sec	Total g/sec
PM	0.33	2.07	0.057	0.114	0.33	2.07	0.016	0.032	0.33	2.07	0.035	0.070	0.33	1.74	0.048	0.287
NOX	8.38	1.05	0.733	1.467	8.38	1.05	0.208	0.416	8.38	1.05	0.452	0.904	8.38	0.95	0.663	3.981
SO_2	0.16	1.16	0.016	0.031	0.16	1.16	0.004	0.009	0.16	1.16	0.010	0.019	0.16	1.09	0.015	0.088
CO	2.7	2.66	0.599	1.197	2.7	2.66	0.170	0.339	2.7	2.66	0.369	0.738	2.7	1.83	0.412	2.471
HC	0.68	2.23	0.126	0.253	0.68	2.23	0.036	0.072	0.68	2.23	0.078	0.156	0.68	1.49	0.084	0.507

Pollutant	Total g/sec	Daily Avg. Load Fact.	Total Tons per day @ 12 hr/day	Total TPY @ max. 30 days/yr[5]
PM	0.906	0.5	0.02	0.6
NOX	13.599	0.5	0.32	9.7
SO_2	0.285	0.5	0.01	0.2
CO	8.722	0.5	0.21	6.2
HC	1.672	0.5	0.04	1.2

Notes:
1 Emission factors from "Exhaust Emission Factors for Nonroad Engine Modeling --Compression-Ignition", Report No. NR-009A, revised June 15, 1998, US EPA Office of Mobile Sources. Steady-state emission factors for CI engines obtained from Table 1, assuming 1988-99 model year engines, not subject to Tier 1 or Tier 2 controls. SO2 emission factor based on brake-specific fuel consumption (BSFC) given in Table 1 and assuming default sulfur content (0.05%) required for the construction year in nonroad diesel fuel.
2 In-use adjustment factors obtained from "Exhaust Emission Factors for Nonroad Engine Modeling --Compression-Ignition", Report No. NR-009A, revised April 2004, US EPA Office of Mobile Sources.
3 Sizes of construction equipment diesel engines provided by Clean Earth Technologies, Inc.
4 Period of Construction Activites Used for Calculation: Dredging Process Activities occur March 2008-May 2010 (27 months)
5. Expected to occur approximately one month every 3 years.

TABLE 9A-17: EMISSIONS CALCULATIONS - LNG TERMINAL OPERATING EMISSIONS
LNG Terminal Maintenance Dredging Activities
Offshore - Dredging and Marine Vessel Emissions

Description	Off-shore Start-Up Const. Equip.
NO. of Units	1 Dredge, 1 Tug, 1 Work/Survey boat, 1 Crew boat, 1
BSFC, lb/hp-hr	0.367
% S in Fuel	0.05
Engine Type	Diesel compression ignition
# Operating Days	1
Operating hrs/day	12

	1 Dredge					1 Tug					1 Survey/Work Boat				
	1800 Bhp, each unit					2400 Bhp, each unit					250 Bhp, each unit				
Pollutant	Factor based on Fractional Load	Emissions Factor, g/kw-hr	kwhrs/day	Ea. Unit g/day	Total g/day	Factor based on Fractional Load	Emissions Factor, g/kw-hr	kwhrs/day	Ea. Unit g/day	Total g/day	Factor based on Fractional Load	Emissions Factor, g/kw-hr	kwhrs/day	Ea. Unit g/day	Total g/day
PM	1	0.261	16113.6	4206	4206	0.5	0.272	21485	5839	5839	0.5	0.272	2238	608	608
NOX	1	10.575	16113.6	170403	170403	0.5	10.805	21485	232134	232134	0.5	10.805	2238	24181	24181
SO_2	1	0.16	16113.6	2578	2578	0.50	0.16	21485	3438	3438	0.16	0.642	2238	1437	1437
CO	1	0.0059	16113.6	95	95	0.5	0.017	21485	359	359	0.5	0.017	2238	37	37
HC	1	0.0067	16113.6	108	108	0.5	0.019	21485	407	407	0.5	0.019	2238	42	42

	1 Crew Boat					1 Inspecting/Contracting Vessel				
	200 Bhp, each unit					684 Bhp, each unit				
Pollutant	Factor based on Fractional Load	Emissions Factor, g/kw-hr	kwhrs/day	Ea. Unit g/day	Total g/day	Factor based on Fractional Load	Emissions Factor, g/kw-hr	kwhrs/day	Ea. Unit g/day	Total g/day
PM	0.5	0.272	1790	487	487	0.5	0.272	6123	1664	1664
NOX	0.5	10.805	1790	19344	19344	0.5	10.805	6123	66158	66158
SO_2	0.50	0.160	1790	286	286	0.50	0.160	6123	980	980
CO	0.5	0.017	1790	30	30	0.5	0.017	6123	102	102
HC	0.5	0.019	1790	34	34	0.5	0.019	6123	116	116

Pollutant	Total g/day	Total Tons per day @ 12 hr/day	Total TPY @ max. 30 days per year[3]
PM	12804	0.01	0.42
NOX	512220	0.56	16.94
SO_2	8719	0.01	0.29
CO	623	0.001	0.02
HC	707	0.001	0.02

Notes:
1. Emission factors from "Analysis of Commercial Marine Vessels Emissions and Fuel Consumption Data" EPA guidance report, February 2000, Office of Air and radiation.
2. Equipment list provided by Han Padron, Inc. and Clean Earth Technologies, Inc.
3. Expected to occur approximately one month every 3 years.

TABLE 9A-18: EMISSIONS CALCULATIONS - LNG TERMINAL OPERATING EMISSIONS
LNG Terminal Maintenance Dredging Activities
Indirect Emissions from Haul Trucks and Workers Commuting

				PM			NH3			NOX			VOC			CO		
Vehicle Type	Vehicle Trips per Day	Days per Year	Round Trip Miles	Emissions Factor (g/mile)	Tons/day	Tons/Year	Emissions Factor (g/mile)	Tons/day	Tons/Year	Emissions Factor (g/mile)	Tons/day	Tons/Year	Emissions Factor (g/mile)	Tons/day	Tons/Year	Emissions Factor (g/mile)	Tons/day	Tons/Year
Spoils Haul Trucks (HDDV)	218	30	20	0.3	1.44E-03	0.04	0.02704	1.30E-04	3.90E-03	12.69	6.10E-02	1.83	1.56	7.50E-03	0.22	6.87	3.30E-02	0.99
Additive Supply Trucks (HDDV	27	30	20	0.3	1.79E-04	0.005	0.02704	1.61E-05	4.83E-04	12.69	7.55E-03	0.23	1.56	9.29E-04	0.03	6.87	4.09E-03	0.12
Workers Commuting (LDGV)	15	30	30	0.02	9.92E-06	0.0003	0.01513	7.50E-06	2.25E-04	1.86	9.23E-04	0.03	1.22	6.05E-04	0.02	14.72	7.30E-03	0.22
Workers Commuting (LDGT)	15	30	30	0.02	9.92E-06	0.0003	0.01513	7.50E-06	2.25E-04	2.31	1.15E-03	0.03	1.82	9.03E-04	0.03	22.24	1.10E-02	0.33
Total					1.64E-03	0.0492		1.61E-04	4.83E-03		7.06E-02	2.1183		9.93E-03	0.2980		5.54E-02	1.6632

Notes:

Emission factors for NOX, VOC and CO obtained from USEPA AP-42, Appendix J (1998), with the following assumptions - 35 mph, 1995 model year, 50% cold start and 50% stabilized operation, low altitude, 100°F ambient temperature.

Total days of operation = approximately 12 months x 23 days/month = 276 days @ 2years = 552 Days

Emission factors for Ammonia obtained from Table III-3 of USEPA report, "Estimating Ammonia Emissions from Anthropogenic Nonagricultural Sources", April 2004.

TABLE 9A-19: EMISSIONS CALCULATIONS - LNG TERMINAL OPERATING EMISSIONS
LNG Terminal Maintenance Dredging Activities
Summary of Total Emissions from Dredging Activities

Total Tons/Year - Maintenance Dredging Activities				
Pollutant	Onshore Processing - Total Tons/Yr	Offshore Marine Vessels and Dredging - Total Tons/Yr	Indirect Emissions from Commuting Workers and Haul Trucks, Tons/Yr	Total Maintenance Dredging Tons/Yr
PM_{10}	0.65	0.42	0.00	1.07
NOX	9.71	16.94	2.12	28.77
SO_2	0.20	0.29		0.49
CO	6.23	0.02	1.66	7.91
VOC	1.19	0.02	0.30	1.52
NH3**	0.009	0.006	0.005	0.019

** NH3 emissions from nonroad diesel engines calculated using proportionality of emissions factors, PM emissions * (.0044/.33).

0.0044 g/Bhp-hr derived from 1.83E-04 lb NH3/gal / (7 lb/gal diesel) x 0.367 lb diesel/Bhp-hr x 454 g/lb)

1.83E-04 lb/gal emission factor obtained from Table III-6 of USEPA report, "Estimating Ammonia Emissions from Anthropogenice Nonagricultural Sources", April 2004.

NH3 emissions from indirect sources calculated seperately, as noted on respective worksheets, using Table III-3 from above-noted USEPA reference.

TABLE 9A-20: EMISSIONS CALCULATIONS - LNG TERMINAL OPERATING EMISSIONS
Sparrows Point LNG Terminal
Power Plant Scenario 1 - CTG + Fired HRSG Emissions

Parameter	Value[1]
Fuel	Nat. Gas
MMBtu/hr (HHV), MCR, CTG	2314.4
MMBtu/hr (HHV), MCR, HRSG duct Burner (DB)	299.7
Btu/CF	1,000
CF/hr Nat. Gas, CTG	2,314,408
CF/hr Nat. Gas, HRSG	299,714
Max. hrs/yr	8,760
Stack Temp., deg. F	120
Total exhaust gas rate, ACFM	1,005,996
Stack Height, ft.	100.0
Stack diameter, ft.	28.0
Stack exit velocity, ft/s	27.2

Pollutant	Emission Factor, CTG + DB	Emission Factor Units	Emssion Factor Source[1]	CTG/HRSG @ 100% Load, lb/hr	CTG/HRSG, TPY	Catalyst Malfunctions[2], TPY	Startup Emissions[3], TPY	Total CTG + DB, TPY
NOX	2	ppmvd @ 15% O_2	Mfg. guarantee	21.58	94.52	10.36	0.800	105.67
CO	5	ppmvd @ 15% O_2	Mfg. guarantee	32.84	143.83	7.88	2.865	154.58
VOC (as CH4)	0.005	lb/MMBtu	Mfg. guarantee	11.25	49.29		0.818	50.10
PM-10/PM-2.5	16.21	lb/hr	Mfg. guarantee	16.21	71.01		0.093	71.10
SOX	0.30	lb/hr	Mfg. guarantee	0.30	1.33		0.071	1.40
NH3	10	ppmvd @ 15% O_2	Mfg. guarantee	39.84	174.50			174.50

HAPs from CTG

Pollutant	Emission Factor, CTG	Emission Factor Units	Emssion Factor Source	CTG/HRSG @ 100% Load, lb/hr	CTG/HRSG, TPY	Catalyst Malfunctions[2], TPY	Startup Emissions[3], TPY	Total CTG, TPY
PAH	2.2E-06	lb/MMBtu	AP-42, T3.1-3 (4/00)	5.1E-03	2.2E-02			2.2E-02
Acetaldehyde	4.0E-05	lb/MMBtu	AP-42, T3.1-3 (4/00)	9.3E-02	4.1E-01			4.1E-01
Benzene	1.2E-05	lb/MMBtu	AP-42, T3.1-3 (4/00)	2.8E-02	1.2E-01			1.2E-01
1,3-Butadiene	4.3E-07	lb/MMBtu	AP-42, T3.1-3 (4/00)	1.0E-03	4.4E-03			4.4E-03
Ethylbenzene	3.2E-05	lb/MMBtu	AP-42, T3.1-3 (4/00)	7.4E-02	3.2E-01			3.2E-01
Formaldehyde	7.1E-04	lb/MMBtu	AP-42, T3.1-3 (4/00)	1.6E+00	7.2E+00			7.2E+00
Naphthalene	1.3E-06	lb/MMBtu	AP-42, T3.1-3 (4/00)	3.0E-03	1.3E-02			1.3E-02
Toluene	1.3E-04	lb/MMBtu	AP-42, T3.1-3 (4/00)	3.0E-01	1.3E+00			1.3E+00
Xylenes	6.4E-05	lb/MMBtu	AP-42, T3.1-3 (4/00)	1.5E-01	6.5E-01			6.5E-01

HAPs from DB

Pollutant	Emission Factor	Emission Factor Units	Emssion Factor Source	DB @ 100% Load, lb/hr	DB, TPY	Catalyst Malfunctions[2], TPY	Startup Emissions[3], TPY	Total DB, TPY
PAH	8.8E-05	lb/MMSCF	AP-42, T1.4-3 (7/98)	2.6E-08	1.2E-07			1.2E-07
Benzene	2.1E-03	lb/MMSCF	AP-42, T1.4-3 (7/98)	6.3E-07	2.8E-06			2.8E-06
Dichlorobenzene	1.2E-03	lb/MMSCF	AP-42, T1.4-3 (7/98)	3.6E-07	1.6E-06			1.6E-06
Formaldehyde	7.5E-02	lb/MMSCF	AP-42, T1.4-3 (7/98)	2.2E-05	9.8E-05			9.8E-05
Hexane	1.8	lb/MMSCF	AP-42, T1.4-3 (7/98)	5.4E-04	2.4E-03			2.4E-03
Naphthalene	6.1E-04	lb/MMSCF	AP-42, T1.4-3 (7/98)	1.8E-07	8.0E-07			8.0E-07
Toluene	3.4E-03	lb/MMSCF	AP-42, T1.4-3 (7/98)	1.0E-06	4.5E-06			4.5E-06
Arsenic	2.00E-04	lb/MMSCF	AP-42, T1.4-4 (7/98)	6.0E-08	2.6E-07			2.6E-07
Beryllium	1.20E-05	lb/MMSCF	AP-42, T1.4-4 (7/98)	3.6E-09	1.6E-08			1.6E-08
Cadmium	1.10E-03	lb/MMSCF	AP-42, T1.4-4 (7/98)	3.3E-07	1.4E-06			1.4E-06
Chromium	1.40E-03	lb/MMSCF	AP-42, T1.4-4 (7/98)	4.2E-07	1.8E-06			1.8E-06
Cobalt	8.40E-05	lb/MMSCF	AP-42, T1.4-4 (7/98)	2.5E-08	1.1E-07			1.1E-07
Lead	5.00E-04	lb/MMSCF	AP-42, T1.4-2 (7/98)	1.5E-07	6.6E-07			6.6E-07
Manganese	3.80E-04	lb/MMSCF	AP-42, T1.4-4 (7/98)	1.1E-07	5.0E-07			5.0E-07
Mercury	2.60E-04	lb/MMSCF	AP-42, T1.4-4 (7/98)	7.8E-08	3.4E-07			3.4E-07
Nickel	2.10E-03	lb/MMSCF	AP-42, T1.4-4 (7/98)	6.3E-07	2.8E-06			2.8E-06
Selenium	2.40E-05	lb/MMSCF	AP-42, T1.4-4 (7/98)	7.2E-09	3.2E-08			3.2E-08

Total HAPs from CTG + DB			
Pollutant	**CTG, TPY**	**DB, TPY**	**Total TPY**
PAH	2.2E-02	1.2E-07	2.2E-02
Acetaldehyde	4.1E-01		4.1E-01
Acrolein			
Benzene	1.2E-01	2.8E-06	1.2E-01
1,3-Butadiene	4.4E-03		4.4E-03
Dichlorobenzene		1.6E-06	1.6E-06
Ethylbenzene	3.2E-01		3.2E-01
Formaldehyde	7.2E+00	9.8E-05	7.2E+00
Hexane		2.4E-03	2.4E-03
Naphthalene	1.3E-02	8.0E-07	1.3E-02
Propylene			
Toluene	1.3E+00	4.5E-06	1.3E+00
Xylenes	6.5E-01		6.5E-01
Arsenic		2.6E-07	2.6E-07
Beryllium		1.6E-08	1.6E-08
Cadmium		1.4E-06	1.4E-06
Chromium		1.8E-06	1.8E-06
Cobalt		1.1E-07	1.1E-07
Lead		6.6E-07	6.6E-07
Manganese		5.0E-07	5.0E-07
Mercury		3.4E-07	3.4E-07
Nickel		2.8E-06	2.8E-06
Selenium		3.2E-08	3.2E-08
Total HAPs	1.0E+01	2.5E-03	1.0E+01

Notes:
1. Based on worst case of GE 7FA and Siemens SGT6-5000F combustion turbine performance specifications (minimum exhaust volume rate and temperature; maximum heat input and emission rates).
2. Two SCR and/or oxidation catalyst malfunctions per year, 48 hours duration each malfunction. Only NOX and CO emissions are controlled and, therefore, would be increased as a result of control system malfunction.
3. Based on three cold iron startups per year, 300 minutes duration and startup emissions profile data provided by GE for 7FA.

TABLE 9A-21: EMISSIONS CALCULATIONS - LNG TERMINAL OPERATING EMISSIONS
Sparrows Point LNG Terminal
Power Plant Scenario 1 - Hot Water Heaters Emissions

Parameter	Value
Fuel	Nat. Gas
MMBtu/hr, MCR, ea. HW Heater	345
Btu/CF	1,000
CF/hr Nat. Gas	345,000
CF/yr Nat. Gas	3.0E+9
Max. hrs/yr	8,760
MMBtu/yr ea. HW Heater @ MCR	3,022,200
Stack Temp., deg. F	275
Flue gas rate ea. HW Heater, ACFM @ MCR	96,500
Flue gas rate ea. HW Heater, DSCFM	57,100
Stack Height, ft.	100.0
Stack diameter (ea. flue[1]), ft.	4.5
Stack exit velocity, ft/s	101.1

Pollutant	Emission Factor	Emission Factor Units	Emssion Factor Source	1 HW Heater @ 25% Load, lb/hr	1 HW Heater @ 25%, TPY	Catalyst Malfunctions[2], TPY	Startup Emissions[3], TPY	Total HW Heaters, TPY
NOX	3	ppmvd @ 3% O_2	Mfg. guarantee	0.31	1.36	0.15	0.001	1.51
CO	10	ppmvd @ 3% O_2	Mfg. guarantee	0.63	2.76	0.30	0.001	3.06
VOC	10.33	ppmvd @ 3% O_2	Mfg. guarantee	0.36	1.58			1.58
PM-10/PM-2.5	3.50	lb/hr	Mfg. guarantee	0.65	2.85			2.85
SOX	0.07	ppmvd @ 3% O_2	Mfg. guarantee	0.01	0.04			0.04
NH3	5	ppmvd @ 3% O_2	Mfg. guarantee	0.19	0.83			0.83
PAH	8.8E-05	lb/MMSCF	AP-42, T1.4-3 (7/98)	7.6E-06	3.3E-05			3.3E-05
Benzene	2.1E-03	lb/MMSCF	AP-42, T1.4-3 (7/98)	1.8E-04	7.9E-04			7.9E-04
Dichlorobenzene	1.2E-03	lb/MMSCF	AP-42, T1.4-3 (7/98)	1.0E-04	4.5E-04			4.5E-04
Formaldehyde	7.5E-02	lb/MMSCF	AP-42, T1.4-3 (7/98)	6.5E-03	2.8E-02			2.8E-02
Hexane	1.8	lb/MMSCF	AP-42, T1.4-3 (7/98)	1.6E-01	6.8E-01			6.8E-01
Naphthalene	6.1E-04	lb/MMSCF	AP-42, T1.4-3 (7/98)	5.3E-05	2.3E-04			2.3E-04
Toluene	3.4E-03	lb/MMSCF	AP-42, T1.4-3 (7/98)	2.9E-04	1.3E-03			1.3E-03
Arsenic	2.00E-04	lb/MMSCF	AP-42, T1.4-4 (7/98)	1.7E-05	7.6E-05			7.6E-05
Beryllium	1.20E-05	lb/MMSCF	AP-42, T1.4-4 (7/98)	1.0E-06	4.5E-06			4.5E-06
Cadmium	1.10E-03	lb/MMSCF	AP-42, T1.4-4 (7/98)	9.5E-05	4.2E-04			4.2E-04
Chromium	1.40E-03	lb/MMSCF	AP-42, T1.4-4 (7/98)	1.2E-04	5.3E-04			5.3E-04
Cobalt	8.40E-05	lb/MMSCF	AP-42, T1.4-4 (7/98)	7.2E-06	3.2E-05			3.2E-05
Lead	5.00E-04	lb/MMSCF	AP-42, T1.4-2 (7/98)	4.3E-05	1.9E-04			1.9E-04
Manganese	3.80E-04	lb/MMSCF	AP-42, T1.4-4 (7/98)	3.3E-05	1.4E-04			1.4E-04
Mercury	2.60E-04	lb/MMSCF	AP-42, T1.4-4 (7/98)	2.2E-05	9.8E-05			9.8E-05
Nickel	2.10E-03	lb/MMSCF	AP-42, T1.4-4 (7/98)	1.8E-04	7.9E-04			7.9E-04
Selenium	2.40E-05	lb/MMSCF	AP-42, T1.4-4 (7/98)	2.1E-06	9.1E-06			9.1E-06
Total HAPs								7.1E-01

Notes:
1. Two stacks serving 4 boilers, independent (per boiler basis) flues within shared stack
2. Two SCR and/or oxidation catalyst malfunctions per year, per boiler, 48 hours duration each malfunction. Only NOX and CO emissions are controlled and, therefore, would be increased as a result of control system malfunction.
3. Three cold iron startups per year per boiler at average 15% load, uncontrolled for duration of 1 hour per startup.

TABLE 9A-22: EMISSIONS CALCULATIONS - LNG TERMINAL OPERATING EMISSIONS
Sparrows Point LNG Terminal
Power Plant Scenario 2 - CTG + Unfired HRSG (NO Duct Burner Firing) Emissions

Parameter	Value[1]
Fuel	Nat. Gas
MMBtu/hr (HHV), MCR, CTG	2314.4
MMBtu/hr (HHV), MCR, HRSG duct Burner (DB)	
Btu/CF	1,000
CF/hr Nat. Gas, CTG	2,314,408
CF/hr Nat. Gas, HRSG	
Max. hrs/yr	8,760
Stack Temp., deg. F	120
Total exhaust gas rate, ACFM	1,000,985
Stack Height, ft.	100.0
Stack diameter, ft.	28.0
Stack exit velocity, ft/s	27.1

Pollutant	Emission Factor, CTG + DB	Emission Factor Units	Emssion Factor Source[1]	CTG/HRSG @ 100% Load, lb/hr	CTG/HRSG, TPY	Catalyst Malfunctions[2], TPY	Startup Emissions[3], TPY	Total CTG + DB, TPY
NOX	2	ppmvd @ 15% O_2	Mfg. guarantee	19.32	84.63	9.27	0.800	94.71
CO	5	ppmvd @ 15% O_2	Mfg. guarantee	29.40	128.79	7.06	2.865	138.71
VOC (as CH4)	0.005	lb/MMBtu	Mfg. guarantee	3.36	14.72		0.818	15.54
PM-10/PM-2.5	13.21	lb/hr	Mfg. guarantee	13.21	57.87		0.093	57.96
SOX	0.27	lb/hr	Mfg. guarantee	0.27	1.18		0.071	1.25
NH3	10	ppmvd @ 15% O_2	Mfg. guarantee	35.67	156.25			156.25

HAPs from CTG

Pollutant	Emission Factor, CTG	Emission Factor Units	Emssion Factor Source	CTG/HRSG @ 100% Load, lb/hr	CTG/HRSG, TPY	Catalyst Malfunctions[2], TPY	Startup Emissions[3], TPY	Total CTG, TPY
PAH	2.2E-06	lb/MMBtu	AP-42, T3.1-3 (4/00)	5.1E-03	2.2E-02			2.2E-02
Acetaldehyde	4.0E-05	lb/MMBtu	AP-42, T3.1-3 (4/00)	9.3E-02	4.1E-01			4.1E-01
Benzene	1.2E-05	lb/MMBtu	AP-42, T3.1-3 (4/00)	2.8E-02	1.2E-01			1.2E-01
1,3-Butadiene	4.3E-07	lb/MMBtu	AP-42, T3.1-3 (4/00)	1.0E-03	4.4E-03			4.4E-03
Ethylbenzene	3.2E-05	lb/MMBtu	AP-42, T3.1-3 (4/00)	7.4E-02	3.2E-01			3.2E-01
Formaldehyde	7.1E-04	lb/MMBtu	AP-42, T3.1-3 (4/00)	1.6E+00	7.2E+00			7.2E+00
Naphthalene	1.3E-06	lb/MMBtu	AP-42, T3.1-3 (4/00)	3.0E-03	1.3E-02			1.3E-02
Toluene	1.3E-04	lb/MMBtu	AP-42, T3.1-3 (4/00)	3.0E-01	1.3E+00			1.3E+00
Xylenes	6.4E-05	lb/MMBtu	AP-42, T3.1-3 (4/00)	1.5E-01	6.5E-01			6.5E-01

HAPs from DB

Pollutant	Emission Factor	Emission Factor Units	Emssion Factor Source	DB @ 100% Load, lb/hr	DB, TPY	Catalyst Malfunctions[2], TPY	Startup Emissions[3], TPY	Total DB, TPY
PAH	8.8E-05	lb/MMSCF	AP-42, T1.4-3 (7/98)					
Benzene	2.1E-03	lb/MMSCF	AP-42, T1.4-3 (7/98)					
Dichlorobenzene	1.2E-03	lb/MMSCF	AP-42, T1.4-3 (7/98)					
Formaldehyde	7.5E-02	lb/MMSCF	AP-42, T1.4-3 (7/98)					
Hexane	1.8	lb/MMSCF	AP-42, T1.4-3 (7/98)					
Naphthalene	6.1E-04	lb/MMSCF	AP-42, T1.4-3 (7/98)					
Toluene	3.4E-03	lb/MMSCF	AP-42, T1.4-3 (7/98)					
Arsenic	2.00E-04	lb/MMSCF	AP-42, T1.4-4 (7/98)					
Beryllium	1.20E-05	lb/MMSCF	AP-42, T1.4-4 (7/98)					
Cadmium	1.10E-03	lb/MMSCF	AP-42, T1.4-4 (7/98)					
Chromium	1.40E-03	lb/MMSCF	AP-42, T1.4-4 (7/98)					
Cobalt	8.40E-05	lb/MMSCF	AP-42, T1.4-4 (7/98)					
Lead	5.00E-04	lb/MMSCF	AP-42, T1.4-2 (7/98)					
Manganese	3.80E-04	lb/MMSCF	AP-42, T1.4-4 (7/98)					
Mercury	2.60E-04	lb/MMSCF	AP-42, T1.4-4 (7/98)					
Nickel	2.10E-03	lb/MMSCF	AP-42, T1.4-4 (7/98)					
Selenium	2.40E-05	lb/MMSCF	AP-42, T1.4-4 (7/98)					

Total HAPs from CTG + DB			
Pollutant	**CTG, TPY**	**DB, TPY**	**Total TPY**
PAH	2.2E-02		2.2E-02
Acetaldehyde	4.1E-01		4.1E-01
Acrolein			
Benzene	1.2E-01		1.2E-01
1,3-Butadiene	4.4E-03		4.4E-03
Dichlorobenzene			
Ethylbenzene	3.2E-01		3.2E-01
Formaldehyde	7.2E+00		7.2E+00
Hexane			
Naphthalene	1.3E-02		1.3E-02
Propylene			
Toluene	1.3E+00		1.3E+00
Xylenes	6.5E-01		6.5E-01
Arsenic			
Beryllium			
Cadmium			
Chromium			
Cobalt			
Lead			
Manganese			
Mercury			
Nickel			
Selenium			
Total HAPs	1.0E+01		1.0E+01

TABLE 9A-23: EMISSIONS CALCULATIONS - LNG TERMINAL OPERATING EMISSIONS
Sparrows Point LNG Terminal
Power Plant Scenario 2 - Hot Water Heaters Emissions

Parameter	Value
Fuel	Nat. Gas
MMBtu/hr, MCR, ea. HW Heater	345
Btu/CF	1,000
CF/hr Nat. Gas	345,000
CF/yr Nat. Gas	3.022E+9
Max. hrs/yr	8,760
MMBtu/yr ea. HW Heater @ MCR	3,022,200
Stack Temp., deg. F	275
ACFM	96,500
DSCFM	57,100
Stack Height, ft.	100.0
Stack diameter (ea. flue[1]), ft.	4.5
Stack exit velocity, ft/s	101.1

Pollutant	Emission Factor	Emission Factor Units	Emssion Factor Source	1 HW Heater @ 100% Load, lb/hr	1 HW Heater @ 25% Load, lb/hr	1 HW Heater @ 100% + 1 HW Heater @ 25%, TPY	Catalyst Malfunctions[2], TPY	Startup Emissions[3], TPY	Total HW Heaters, TPY
NOX	3	ppmvd @ 3% O_2	Mfg. guarantee	1.24	0.31	6.79	1.19	0.006	7.98
CO	10	ppmvd @ 3% O_2	Mfg. guarantee	2.52	0.63	13.80	1.21	0.006	15.01
VOC	10.33	ppmvd @ 3% O_2	Mfg. guarantee	1.44	0.36	7.88			7.88
PM-10/PM-2.5	3.50	lb/hr	Mfg. guarantee	2.60	0.65	14.24			14.24
SOX	0.07	ppmvd @ 3% O_2	Mfg. guarantee	0.04	0.01	0.21			0.21
NH3	5	ppmvd @ 3% O_2	Mfg. guarantee	0.76	0.19	4.16			4.16
PAH	8.8E-05	lb/MMSCF	AP-42, T1.4-3 (7/98)	3.0E-05	7.6E-06	1.7E-04			1.7E-04
Benzene	2.1E-03	lb/MMSCF	AP-42, T1.4-3 (7/98)	7.2E-04	1.8E-04	4.0E-03			4.0E-03
Dichlorobenzene	1.2E-03	lb/MMSCF	AP-42, T1.4-3 (7/98)	4.1E-04	1.0E-04	2.3E-03			2.3E-03
Formaldehyde	7.5E-02	lb/MMSCF	AP-42, T1.4-3 (7/98)	2.6E-02	6.5E-03	1.4E-01			1.4E-01
Hexane	1.8	lb/MMSCF	AP-42, T1.4-3 (7/98)	6.2E-01	1.6E-01	3.4E+00			3.4E+00
Naphthalene	6.1E-04	lb/MMSCF	AP-42, T1.4-3 (7/98)	2.1E-04	5.3E-05	1.2E-03			1.2E-03
Toluene	3.4E-03	lb/MMSCF	AP-42, T1.4-3 (7/98)	1.2E-03	2.9E-04	6.4E-03			6.4E-03
Arsenic	2.00E-04	lb/MMSCF	AP-42, T1.4-4 (7/98)	6.9E-05	1.7E-05	3.8E-04			3.8E-04
Beryllium	1.20E-05	lb/MMSCF	AP-42, T1.4-4 (7/98)	4.1E-06	1.0E-06	2.3E-05			2.3E-05
Cadmium	1.10E-03	lb/MMSCF	AP-42, T1.4-4 (7/98)	3.8E-04	9.5E-05	2.1E-03			2.1E-03
Chromium	1.40E-03	lb/MMSCF	AP-42, T1.4-4 (7/98)	4.8E-04	1.2E-04	2.6E-03			2.6E-03
Cobalt	8.40E-05	lb/MMSCF	AP-42, T1.4-4 (7/98)	2.9E-05	7.2E-06	1.6E-04			1.6E-04
Lead	5.00E-04	lb/MMSCF	AP-42, T1.4-2 (7/98)	1.7E-04	4.3E-05	9.4E-04			9.4E-04
Manganese	3.80E-04	lb/MMSCF	AP-42, T1.4-4 (7/98)	1.3E-04	3.3E-05	7.2E-04			7.2E-04
Mercury	2.60E-04	lb/MMSCF	AP-42, T1.4-4 (7/98)	9.0E-05	2.2E-05	4.9E-04			4.9E-04
Nickel	2.10E-03	lb/MMSCF	AP-42, T1.4-4 (7/98)	7.2E-04	1.8E-04	4.0E-03			4.0E-03
Selenium	2.40E-05	lb/MMSCF	AP-42, T1.4-4 (7/98)	8.3E-06	2.1E-06	4.5E-05			4.5E-05

Total HAPs 3.6E+00

Notes:
1. Two stacks serving 4 boilers, independent (per boiler basis) flues within shared stack
2. Two SCR and/or oxidation catalyst malfunctions per year, per boiler times 2 boilers, 48 hours duration each malfunction. Only NOX and CO emissions are controlled and, therefore, would be increased as a result of control system malfunction.
3. Three cold iron startups per year per boiler at average 15% load, uncontrolled for duration of 1 hour per startup.

TABLE 9A-24: EMISSIONS CALCULATIONS - LNG TERMINAL OPERATING EMISSIONS
Sparrows Point LNG Terminal
Power Plant Scenario 1 or 2 - Cooling Tower Emissions

Input Data

Total circulating water (gpm)	53,176
Drift loss (%)	0.001
Cycles of concentration	10
TDS/TSS of Blowdown (ppm)	2131
Number of cells in tower	4
Configuration of cells	1 X 4
Tower height (ft)	49
Tower length (ft)	192
Tower width (ft)	54
Cell diameter (ft)	33
Total tower heat duty (MMBtu/hr)	566
Total ACFM @ ~ 70 deg. F	5,000,273
Total tower air flow (lb/hr)	24,269,222

Estimated PM10/PM2.5 emission rate = 53,176 gpm total circulating water flow x 8.34 lb/gal x 0.001 % drift loss

x 2131 ppm TDS/TSS x 60 min/hr =0.567 lb/hr

Annual Potential Emissions = 0.567 lb/hr x 8,760 hr/yr / 2000 lb/ton = 2.48 TPY

Emissions estimated based on vendor specifications and drift loss provided to AES and mass-balance emission calculation procedure in EPA AP-42, Section 13.4 (1/95).

TDS was estimated from maximum conductivity of 320µS reported in Municipal water data in 2005.

TABLE 9A-25: EMISSIONS CALCULATIONS - LNG TERMINAL OPERATING EMISSIONS
Sparrows Point LNG Terminal
Power Plant Stationary Source Emissions Summary

Scenario 1: CTG + Fired HRSG + 1 HW Heater @ 25% Standby Idle					
Potential Emissions (tons/year)					
Pollutant	CTG + HRSG	Hot Water Heaters	Cooling Tower	Total Power Plant	Major Source Threshold
NOX	105.7	1.5		107.2	25
CO	154.6	3.1		157.6	100
VOC	50.1	1.58		51.68	25
PM-10/PM-2.5	71.1	2.85	2.48	76.43	100
SOX	1.4	0.04		1.44	100
NH3	174.5	0.83		175.33	
PAH	2.2E-02	3.3E-05		2.2E-02	10
Acetaldehyde	4.1E-01			4.1E-01	10
Acrolein					10
Benzene	1.2E-01	7.9E-04		1.2E-01	10
1,3-Butadiene	4.4E-03			4.4E-03	10
Dichlorobenzene	1.6E-06	4.5E-04		4.5E-04	10
Formaldehyde	7.2E+00	2.8E-02		7.2E+00	10
Hexane	2.4E-03	6.8E-01		6.8E-01	10
Naphthalene	1.3E-02	2.3E-04		1.3E-02	10
Toluene	1.3E+00	1.3E-03		1.3E+00	10
Xylenes	6.5E-01			6.5E-01	10
Arsenic	2.6E-07	7.6E-05		7.6E-05	10
Beryllium	1.6E-08	4.5E-06		4.5E-06	10
Cadmium	1.4E-06	4.2E-04		4.2E-04	10
Chromium	1.8E-06	5.3E-04		5.3E-04	10
Cobalt	1.1E-07	3.2E-05		3.2E-05	10
Lead	6.6E-07	1.9E-04		1.9E-04	10
Manganese	5.0E-07	1.4E-04		1.4E-04	10
Mercury	3.4E-07	9.8E-05		9.9E-05	10
Nickel	2.8E-06	7.9E-04		8.0E-04	10
Selenium	3.2E-08	9.1E-06		9.1E-06	10
Total HAPs				10.45	25

Scenario 2: CTG + Unfired HRSG + 1 HW Heater @ 100% + 1 HW Heater @ 25% Standby Idle					
Potential Emissions (tons/year)					
Pollutant	CTG + HRSG	Auxiliary Boilers	Cooling Tower	Total Power Plant	Major Source Threshold
NOX	94.7	8.0		102.7	25
CO	138.7	15.0		153.7	100
VOC	15.5	7.88		23.42	25
PM-10/PM-2.5	58.0	14.24	2.48	74.68	100
SOX	1.2	0.21		1.46	100
NH3	156.3	4.16		160.41	
PAH	2.2E-02	1.7E-04		2.2E-02	10
Acetaldehyde	4.1E-01			4.1E-01	10
Acrolein					10
Benzene	1.2E-01	4.0E-03		1.3E-01	10
1,3-Butadiene	4.4E-03			4.4E-03	10
Dichlorobenzene		2.3E-03		2.3E-03	10
Formaldehyde	7.2E+00	1.4E-01		7.3E+00	10
Hexane		3.4E+00		3.4E+00	10
Naphthalene	1.3E-02	1.2E-03		1.4E-02	10
Propylene					10
Toluene	1.3E+00	6.4E-03		1.3E+00	10
Xylenes	6.5E-01			6.5E-01	10
Arsenic		3.8E-04		3.8E-04	10
Beryllium		2.3E-05		2.3E-05	10
Cadmium		2.1E-03		2.1E-03	10
Chromium		2.6E-03		2.6E-03	10
Cobalt		1.6E-04		1.6E-04	10
Lead		9.4E-04		9.4E-04	10
Manganese		7.2E-04		7.2E-04	10
Mercury		4.9E-04		4.9E-04	10
Nickel		4.0E-03		4.0E-03	10
Selenium		4.5E-05		4.5E-05	10
Total HAPs				13.30	25

TABLE 9A-26: EMISSIONS CALCULATIONS - LNG TERMINAL OPERATING EMISSIONS
Sparrows Point LNG Terminal
Indirect Emissions from Workers Commuting

Sparrows Point

Vehicle Type	Vehicle Trips per Day	Days per Month	Round Trip Miles	PM			NH3			NOX			VOC			CO		
				Emissions Factor (g/mile)	Lbs/day	TPY	Emissions Factor (g/mile)	Lbs/day	TPY	Emissions Factor (g/mile)	Lbs/day	TPY	Emissions Factor (g/mile)	Lbs/day	TPY	Emissions Factor (g/mile)	Lbs/day	TPY
Workers Commuting (LDGV)	20	30	25	0.02	0.02	0.004	0.01513	0.017	0.003	1.86	2.1	0.4	1.22	1.3	0.2	14.72	16.2	2.9
Workers Commuting (LDGT)	20	30	25	0.02	0.02	0.004	0.01513	0.017	0.003	2.31	2.5	0.5	1.82	2.0	0.4	22.24	24.5	4.4
Total					0.04	0.01		0.033	0.006		4.6	0.8		3.4	0.6		40.7	7.3

Notes:

Emissions represent total construction worker commuting for both pipeline constrution spreads and the compressor station.

Total of 200 workers assumed to commute to the project sites each day, 20 days/month, for length of construction period (32 months).

Emission factors for NOX, VOC and CO obtained from USEPA AP-42, Appendix J (1998), with the following assumptions - 35 mph, 1995 model year, 50% cold start and 50% stabilized operation, low altitude.

Workers commuting are divided into half Light Duty Gasoline Vehicles (LDGV) and half Light Duty Gasoline Trucks (LDGT).

Emission factors for Ammonia obtained from Table III-3 of USEPA report, "Estimating Ammonia Emissions from Anthropogenic Nonagricultural Sources", April 2004.

TABLE 9A-27: EMISSIONS CALCULATIONS - LNG TERMINAL OPERATING EMISSIONS
Sparrows Point LNG Terminal
Operating Emissions Summary (Annual Emissions in Tons/Year)

	NOX	CO	VOC	PM-10/2.5	SOX	NH3
LNG Terminal						
Hot Water Heaters w/out Power Plant	18.1	34.9	18.9	34.2	0.5	10.0
1 Fire Pump (Fresh Water)	0.1	0.01	0.002	0.00	0.00	0.004
6 Fire Pumps (Salt Water)	1.6	0.1	0.03	0.01	0.0	0.003
1 Standby Generator	1.3	0.10	0.03	0.007	0.0	0.01
1 Vent Stack Heater	0.001	0.003	0.003	0.001	0.001	0.0004
Total LNG Terminal w/out LNG Ship Offloading (w/out Power Plant)	**21.1**	**35.2**	**19.0**	**34.2**	**0.5**	**10.0**
LNG Ship Offloading Operations	11.8	1.8	0.3	0.4	3.0	0.1
Total LNG Terminal + LNG Ship Offloading (w/out Power Plant)	**32.9**	**37.0**	**19.3**	**34.6**	**3.6**	**10.1**
Power Plant						
CTG + HRSG (Scenario 1)	105.7	154.6	50.1	71.1	1.4	174.5
CTG + HRSG (Scenario 2)	94.7	138.7	15.5	58.0	1.2	156.3
Hot Water Heaters (Scenario 1)	1.5	3.1	1.6	2.8	0.04	0.8
Hot Water Heaters (Scenario 2)	8.0	15.0	7.9	14.2	0.2	4.2
Cooling Tower				2.5		
Total Power Plant (Worst-Case Scenario)	**107.2**	**157.6**	**51.7**	**76.4**	**1.5**	**175.3**
Total Stationary Sources + LNG Ship Offloading (w/ Power Plant)	**122.0**	**159.7**	**52.1**	**76.8**	**4.5**	**175.5**
PSD Thresholds	100	100	100	100	100	NA
NNSR Thresholds	25	NA	25	100	NA	*
Marine Emissions						
LNG Ship Maneuvering/Berthing, hoteling, incl. tugs, security and escort vessels (total)	888.3	342.2	30.3	52.0	541.5	10.78
Total In State of MD Waters	492.9	289.3	20.0	28.2	272.3	6.20
LNG Ships in MD Waters	395.4	52.9	10.2	23.7	269.2	4.58

TABLE 9A-28: EMISSIONS CALCULATIONS - LNG TERMINAL OPERATING EMISSIONS
Sparrows Point LNG Terminal
Operating Emissions Summary - HAPs (Annual Emissions in Tons/Year)

	Total Stationary Sources + LNG Offloading w/out Power Plant	Total Stationary Sources + LNG Offloading w/ Power Plant	Major Source Threshold
PAH	4.2E-04	2.2E-02	10
Acetaldehyde	9.8E-05	4.1E-01	10
Acrolein	1.9E-05	1.9E-05	10
Benzene	1.2E-02	1.3E-01	10
1,3-Butadiene	3.1E-06	4.4E-03	10
Dichlorobenzene	5.5E-03	2.3E-03	10
Formaldehyde	3.4E-01	7.3E+00	10
Hexane	8.2E+00	3.4E+00	10
Naphthalene	3.2E-03	1.5E-02	10
Toluene	1.6E-02	1.3E+00	10
Xylenes	6.7E-04	6.5E-01	10
Arsenic	9.1E-04	3.8E-04	10
Beryllium	5.5E-05	2.3E-05	10
Cadmium	5.0E-03	2.1E-03	10
Chromium	6.4E-03	2.7E-03	10
Cobalt	3.8E-04	1.6E-04	10
Lead	2.3E-03	9.7E-04	10
Manganese	1.7E-03	7.2E-04	10
Mercury	1.2E-03	4.9E-04	10
Nickel	9.5E-03	4.0E-03	10
Selenium	1.1E-04	4.6E-05	10
Total HAPs	8.6	13.3	25

TABLE 9B-1: AIR QUALITY IMPACT ANALYSIS CALCULATIONS AND SUMMARIES - LNG TERMINAL OPERATI
Sparrows Point LNG Terminal
Building/Structure Dimensional Data

Object	Structure/Equipment Description	Height (meters)	Length (meters)	Width (meters)	Base Elev. (meters)
BLD_1	Fabrication Building (HW Heater and Power Plant Bldg.)	20.12	192.33	49.38	4.0
BLD_2	LNG Storage Tank A	51.65	82.30	82.30	3.1
BLD_3	LNG Storage Tank B	52.65	82.30	82.30	3.1
BLD_4	LNG Storage Tank C	53.65	82.30	82.30	3.1
BLD_5	LNG Storage Tank D (Potential future tank)	54.65	82.30	82.30	3.1
BLD_6	LNG Ship A (138,000 m^3)				
	Tier 1	23.0	280.0	42.0	0.0
	Tier 2	35.0	26.0	16.0	0.0
	Tier 3	34.0	31.0	25.0	0.0
	Tier 4	30.0	36.0	24.0	0.0
BLD_7	LNG Ship B (210,000 m^3)				
	Tier 1	23.0	315.0	50.0	0.0
	Tier 2	42.0	30.0	17.0	0.0
	Tier 3	36.0	136.0	19.0	0.0
	Tier 4	30.0	42.0	39.0	0.0
BLD_8	LNG Ship B (210,000 m^3) in Turning Basin				
	Tier 1	23.0	315.0	50.0	0.0
	Tier 2	42.0	30.0	17.0	0.0
	Tier 3	36.0	136.0	19.0	0.0
	Tier 4	30.0	42.0	39.0	0.0

TABLE 9B-2: AIR QUALITY IMPACT ANALYSIS CALCULATIONS AND SUMMARIES - LNG TERMINAL OPERATIONS
Sparrows Point LNG Terminal
Stack Parameters and Emission Rates for Model Input

	Stack #1	Stack #2	Stack #3	Stack #4	Stack #5	Stack #6	Stack #7	Stack #8	Stack #9	Stack #10
Parameter	HW Heater #1	HW Heater #2	HW Heater Malfunction Condition	HW Heater @ 25% Load (Power Plant Scenario)	Fresh Water Fire Pump	Salt Water Fire Pump #1	Salt Water Fire Pump #2	Salt Water Fire Pump #3	Salt Water Fire Pump #4	Salt Water Fire Pump #5
UTM X coord. (NAD27, Zone 18), m	371,009.7	371,009.7	371,005.6	371,005.6	370,911.4	370,814.7	370,810.8	370,806.9	370,802.9	370,799.0
UTM Y coord. (NAD27, Zone 18), m	4,341,708.3	4,341,708.3	4,341,745.1	4,341,745.1	4,341,850.2	4,341,804.3	4,341,804.0	4,341,803.6	4,341,803.2	4,341,802.8
Stack Height, m.	30.48	30.48	30.48	30.48	7.62	7.62	7.62	7.62	7.62	7.62
Stack Temp., deg. K	408.0	408.0	408.0	408.00	699.7	699.7	699.7	699.7	699.7	699.7
Stack diameter, m.	1.37	1.37	1.37	1.37	0.18	0.20	0.20	0.20	0.20	0.20
Stack exit velocity, m/s	30.82	30.82	30.82	7.71	37.42	53.48	53.48	53.48	53.48	53.48
Exhaust rate, m3/sec	45.55	45.55	45.55	11.39	0.93	1.73	1.73	1.73	1.73	1.73
PM10/PM2.5 (24-hr) , g/sec	0.3276	0.3276	0.3276	0.082	0.0083	0.0064	0.0064	0.0064	0.0064	0.0064
PM10/PM2.5 (annual) , g/sec	0.3276	0.3276	0.3276	0.082	5.71E-05	4.39E-05	4.39E-05	4.39E-05	4.39E-05	4.39E-05
SO2 (3-hr) , g/sec	0.0048	0.0048	0.0048	0.0012	0.0005	0.0011	0.0011	0.0011	0.0011	0.0011
SO2 (24-hr) , g/sec	0.0048	0.0048	0.0048	0.0012	0.0005	0.0011	0.0011	0.0011	0.0011	0.0011
SO2 (annual) , g/sec	0.0048	0.0048	0.0048	0.0012	3.32E-06	7.33E-06	7.33E-06	7.33E-06	7.33E-06	7.33E-06
NO2 (annual) , g/sec	0.1735	0.1735	0.1735	0.043	0.0036	0.0077	0.0077	0.0077	0.0077	0.0077
CO (1-hr) , g/sec	0.3175	0.3175	1.5876	0.079	0.0375	0.0758	0.0758	0.0758	0.0758	0.0758
CO (8-hr) , g/sec	0.3175	0.3175	0.3969	0.079	0.0375	0.0758	0.0758	0.0758	0.0758	0.0758
Pb (3-month) , g/sec	2.17E-05	2.17E-05	2.17E-05	5.43E-06	3.57E-06	6.67E-06	6.67E-06	6.67E-06	6.67E-06	6.67E-06

	Stack #11	Stack #12	Stack #13	Stack #14	Stack #15	Stack #16	Stack #17	Stack #18	Stack #19
Parameter	Salt Water Fire Pump #6	Standby Diesel Generator	Vent Stack	LNG Ship Offloading	LNG Ship hoteling	Tug Boats in Security & Safety Zone	USCG Boats in Security & Safety Zone	Power Plant (CTG/HRSG)	Cooling Tower
UTM X coord. (NAD27, Zone 18), m	370,795.1	370,959.8	370,777.4	370,753.2	370,771.6	370,257.4	370,201.9	371,003.7	370,924.9
UTM Y coord. (NAD27, Zone 18), m	4,341,802.4	4,341,861.8	4,341,599.6	4,341,887.2	4,341,955.5	4,341,921.5	4,341,871.1	4,341,886.1	4,341,790.4
Stack Height, m.	7.62	7.62	54.71	40.00	40.00	10.67		30.48	14.94
Stack Temp., deg. K	699.7	678.6	199.7	755.2	755.2	755.22	755.22	321.89	298.00
Stack diameter, m.	0.20	0.20	0.61	0.61	0.61	0.46	0.08	8.53	10.06
Stack exit velocity, m/s	53.48	220.28	47.16	27.48	17.47	15.04	102.97	8.30	7.43
Exhaust rate, m3/sec	1.73	7.14	13.77	8.02	5.10	2.47	0.47	474.84	590.04
PM10/PM2.5 (24-hr) , g/sec	0.0064	0.0290	0.0069	0.17	0.10	0.137	0.0022	2.04	0.071
PM10/PM2.5 (annual) , g/sec	4.39E-05	1.98E-04	3.96E-05	0.057	0.033	0.068	0.0007	2.05	0.071
SO2 (3-hr) , g/sec	0.0011	0.0045	0.0049	1.96	3.42	0.122	0.0012	0.04	
SO2 (24-hr) , g/sec	0.0011	0.0045	0.0049	1.47	0.86	0.040	0.0008	0.04	
SO2 (annual) , g/sec	7.33E-06	3.08E-05	2.77E-05	0.50	0.29	0.020	0.0003	0.04	
NO2 (annual) , g/sec	0.0077	0.0361	0.00002	1.12	0.65	1.240	0.069	3.04	
CO (1-hr) , g/sec	0.0758	0.4322	0.0173	0.35	0.61	0.89	11.96	4.14	
CO (8-hr) , g/sec	0.0758	0.4322	0.0173	0.35	0.61	0.33	4.98	4.14	
Pb (3-month) , g/sec	6.67E-06	2.80E-05	3.47E-07	8.50E-06	4.94E-06	1.13E-05			

TABLE 9B-3: AIR QUALITY IMPACT ANALYSIS CALCULATIONS AND SUMMARIES - LNG TERMINAL OPERATIONS

Sparrows Point LNG Terminal

Source Groups Used in Modeling Analysis

Source Group	Description	Source IDs
1	LNG Terminal stationary sources (without Power Plant), including HW Heaters, emergency fire pumps and generator, and vent stack	1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13
2	LNG Terminal stationary sources (Source Group 1) + LNG Ship Offloading	1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14
3	Emergency Fire Pumps and Standby Generator	5, 6, 7, 8, 9, 10, 11, 12
4	All LNG Terminal stationary sources + LNG ship offloading + hoteling + tugs and USCG security boats in moored safety zone	1, 2, 3, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17
5	LNG Terminal stationary sources (with Power Plant), including CTG/HRSG, HW Heaters (1 @ 25% load), emergency fire pumps and generator, vent stack, and cooling tower	4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 18, 19
6	LNG Terminal with Power Plant stationary sources (Source Group 5) + LNG Ship Offloading	4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 18, 19
7	All LNG Terminal with Power Plant stationary sources + LNG ship offloading + hoteling + tugs and USCG security boats in moored safety zone	4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19

TABLE 9B-4: AIR QUALITY IMPACT ANALYSIS CALCULATIONS AND SUMMARIES - LNG TERMINAL OPERATIONS
Sparrows Point LNG Terminal
Sectors and Site Characteristics Used for AERMET Input

Sector	Staring Azimuth	Ending Azimuth
1	0	30
2	30	60
3	60	90
4	90	120
5	120	150
6	150	180
7	180	210
8	210	240
9	240	270
10	270	300
11	300	330
12	330	360

Site Characteristics by Season and Sector				
Season	Sector	Albedo	Bowen Ration	Surface Roughness (m)
1	1	0.356	1.5	0.998
2	1	0.138	0.962	1.005
3	1	0.157	1.827	1.012
4	1	0.175	1.876	1.003
1	2	0.356	1.5	0.996
2	2	0.138	0.97	1.008
3	2	0.157	1.853	1.017
4	2	0.175	1.899	1.003
1	3	0.377	1.5	0.905
2	3	0.139	0.914	0.914
3	3	0.162	1.761	0.936
4	3	0.177	1.81	0.914
1	4	0.373	1.5	0.928
2	4	0.139	0.916	0.93
3	4	0.161	1.753	0.946
4	4	0.176	1.804	0.932
1	5	0.381	1.5	0.918
2	5	0.137	0.873	0.92
3	5	0.16	1.584	0.941
4	5	0.172	1.677	0.923
1	6	0.384	1.5	0.908
2	6	0.137	0.86	0.91
3	6	0.16	1.547	0.934
4	6	0.171	1.647	0.913

Site Characteristics by Season and Sector				
Season	Sector	Albedo	Bowen Ration	Surface Roughness (m)
1	7	0.366	1.548	0.978
2	7	0.139	0.932	0.981
3	7	0.157	1.662	0.991
4	7	0.172	1.775	0.982
1	8	0.359	1.769	0.993
2	8	0.146	1.057	1.002
3	8	0.16	1.792	1.004
4	8	0.175	2.005	1.002
1	9	0.36	1.631	1.029
2	9	0.139	0.956	1.038
3	9	0.153	1.539	1.045
4	9	0.166	1.746	1.037
1	10	0.368	1.5	1.028
2	10	0.132	0.87	1.079
3	10	0.144	1.293	1.112
4	10	0.156	1.519	1.059
1	11	0.375	1.5	0.975
2	11	0.134	0.876	1.019
3	11	0.15	1.416	1.053
4	11	0.162	1.594	1.002
1	12	0.363	1.5	0.988
2	12	0.137	0.923	0.989
3	12	0.157	1.695	0.998
4	12	0.172	1.772	0.99

TABLE 9B-5: AIR QUALITY IMPACT ANALYSIS CALCULATIONS AND SUMMARIES - LNG TERMINAL OPERATION
Sparrows Point LNG Terminal
Representative Ambient Background Data from Monitoring Stations As Noted[a]

Pollutant	Averaging Period	Representative Ambient Background Concentrations[a]		NAAQS			MDE Air Quality Monitoring Site IDs Used to Represent Background Concentrations	
		AQCR 115	AQCR 114	Standard	Units	Standard Type[b]	AQCR 115	AQCR 114
PM-2.5	24-hour	38.6	33.3	35[c]	$\mu g/m^3$	Primary and Secondary	240053001, 245100008 and 245100035	240150003
	Annual	15.1	13.2	15	$\mu g/m^3$	Primary and Secondary		
PM-10	24-hour	50.7	48.7	150	$\mu g/m^3$	Primary and Secondary	240053001, 245100008 and 245100035	240053001
	Annual	23.3	21.3	50[d]	$\mu g/m^3$	Primary and Secondary		
NO2	Annual	37.6	11.3	100	$\mu g/m^3$	Primary and Secondary	240053001 and 245100040	240259001
SO2	3-hour	172.8	172.8	1300	$\mu g/m^3$	Secondary	240053001	240053001
	24-hour	44.5	44.5	365	$\mu g/m^3$	Primary		
	Annual	13.1	13.1	80	$\mu g/m^3$	Primary		
CO	1-hour	6,755.0	2,862.3	40,000	$\mu g/m^3$	Primary	245100040	240051007
	8-hour	3,091.3	1,831.9	10,000	$\mu g/m^3$	Primary		
Pb	3-Month	ND	ND	1.5	$\mu g/m^3$	Primary and Secondary		
Ozone	1-hour	0.103	0.119	0.12	ppmv	Primary and Secondary	240051007 and 240130001	240251001 and 240259001
	8-hour	0.08	0.089	0.08	ppmv	Primary and Secondary		

Monitoring Site Descriptions

Monitor ID	Pollutants	Monitor Address	City	Urbanized Area	MSA	AQCR	Longitude	Latitude
24-005-1007	CO, O3, PM2.5	Greenspring Dr.	Cockeysville, MD	Baltimore, MD	Baltimore, MD	Metropolitan Baltimore	-76.631111	39.460833
24-005-3001	CO, NO2, O3, PM10, PM2.5, SO2	Woodward And Franklin Roads	Essex. MD	Baltimore, MD	Baltimore, MD	Metropolitan Baltimore	-76.474444	39.310833
24-510-0040	CO, NO2	1100 Hillen Street	Baltimore, MD	Baltimore, MD	Baltimore, MD	Metropolitan Baltimore	-76.604722	39.298056
24-025-9001	NO2, O3	3538 Aldino Road	Churchville, MD	Baltimore, MD	Baltimore, MD	Metropolitan Baltimore	-76.203889	39.563333
24-013-0001	O3	1300 W. Old Liberty Road	Sykesville, MD		Baltimore, MD	Metropolitan Baltimore	-77.041667	39.444167
24-025-1001	O3	Waehli Road Edgewood Army Chem Center	Edgewood, MD	Baltimore, MD	Baltimore, MD	Metropolitan Baltimore	-76.296667	39.41
24-510-0008	PM10, PM2.5	5700 Eastern Ave	Baltimore, MD	Baltimore, MD	Baltimore, MD	Metropolitan Baltimore	-76.547616	39.28768
24-510-0035	PM10, PM2.5	1900 E Patapsco Ave	Baltimore, MD	Baltimore, MD	Baltimore, MD	Metropolitan Baltimore	-76.579722	39.232778
24-015-0003	PM2.5	Rte.273 Fair Hill Ceil Co.	Elkton, MD	Wilmington, DE-NJ-MD-PA	Wilmington-Newark, DE-MD	Eastern Shore	-75.86	39.701111

[a] Three-year average concentrations (2003-2005) from monitoring locations as noted. Short-term values based on second highest monitored values. Annual averages based on maximum values for monitoring location and year.

[b] Primary standards set limits to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards set limit to protect public welfare, including protection against decreased visibility, damage to animals, crops, vegetation, and buildings.

[c] Effective December 18, 2006, EPA has revised the 24-hour PM2.5 standard from 65 to 35 $\mu g/m^3$ to provide increased protection of public health and welfare. However, pending EPA rules that will clarify issues such as attainment designation, conformity, and New Source Review during SIP development, compliance with existing PM10 standards are used as a surrogate for PM2.5 compliance.

[d] Effective December 18, 2006, EPA has revoked the annual PM10 standard. However, pending EPA rules that will clarify issues such as attainment designation, conformity, and New Source Review during SIP development, compliance with existing PM10 standards will continue to be evaluated.

TABLE 9B-6: AIR QUALITY IMPACT ANALYSIS CALCULATIONS AND SUMMARIES - LNG TERMINAL OPERATIONS

Sparrows Point LNG Terminal

Summary of AERMOD Modeling Results By Scenario and Model Year

		AERMOD NO2 Impacts, Annual Average (µg/m3) (AAQS = 100, SIL = 1)							UTM Coordinates		Distance from Stack (m)	Azimuth, degrees from N.
Source Group	Description	1990	1991	1992	1993	1994	Max.	Max. Year	East (m)	North (m)		
1	Terminal sources	1.8	1.6	2.0	2.0	2.1	2.1	1994	371,113	4,341,703	115	111
2	Terminal + LNG offloading	3.1	2.9	3.5	3.5	3.7	3.7	1994	371,113	4,341,703	115	111
3	Emergency fire pumps and engine	0.7	0.7	0.6	0.6	0.6	0.7	1991	371,092	4,341,869	151	35
4	All: Terminal+Offloading+Marine	6.2	6.0	5.6	5.7	6.1	6.2	1990	370,960	4,341,930	190	346
5	Terminal + Power Plant	10.5	8.8	11.1	10.9	11.6	11.6	1994	371,143	4,341,825	159	60
6	Terminal + Power Plant + Offload	12.1	10.2	12.8	12.5	13.4	13.4	1994	371,143	4,341,825	159	60
7	All: Terminal+Power Plant+Offloading+Marine	14.7	12.3	15.4	15.0	16.1	16.1	1994	371,143	4,341,825	159	60

		AERMOD SO2 Impacts, Annual Average (µg/m^3) (AAQS = 80, SIL = 1)							UTM Coordinates		Distance from Stack (m)	Azimuth, degrees from N.
Source Group	Description	1990	1991	1992	1993	1994	Max.	Max. Year	East (m)	North (m)		
1	Terminal sources	0.04	0.04	0.04	0.05	0.05	0.05	1994	371,113	4,341,703	115	111
2	Terminal + LNG offloading	0.81	0.94	0.79	0.87	0.94	0.94	1994	371,102	4,341,786	105	67
3	Emergency fire pumps and engine	0.0006	0.0006	0.0005	0.0005	0.0006	0.0006	1994	371,102	4,341,786	105	67
4	All: Terminal+Offloading+Marine	1.24	1.14	1.28	1.36	1.46	1.46	1994	371,102	4,341,786	105	67
5	Terminal + Power Plant	0.13	0.11	0.12	0.99	0.14	0.99	1993	371,143	4,341,825	159	60
6	Terminal + Power Plant + Offload	0.90	0.93	0.90	0.90	1.07	1.07	1994	371,102	4,341,786	105	67
7	All: Terminal+Power Plant+Offloading+Marine	1.32	1.18	1.40	1.48	1.59	1.59	1994	371,102	4,341,786	105	67

		AERMOD SO2 Impacts, 24-Hour Average (µg/m^3) (AAQS = 365, SIL = 5)							UTM Coordinates		Distance from Stack (m)	Azimuth, degrees from N.
Source Group	Description	1990	1991	1992	1993	1994	Max.	Max. Year	East (m)	North (m)		
1	Terminal sources	0.20	0.28	0.28	0.27	0.30	0.30	1994	371,116	4,341,725	112	100
2	Terminal + LNG offloading	15.46	13.45	12.71	15.63	14.46	15.63	1993	370,893	4,341,975	256	334
3	Emergency fire pumps and engine	0.29	0.28	0.28	0.26	0.27	0.29	1990	371,092	4,341,869	151	35
4	All: Terminal+Offloading+Marine	16.50	14.45	14.00	17.06	16.30	17.06	1993	370,909	4,342,022	293	341
5	Terminal + Power Plant	0.81	0.74	0.72	0.70	0.77	0.81	1990	371,143	4,341,825	159	60
6	Terminal + Power Plant + Offload	15.46	13.44	12.71	15.63	14.46	15.63	1993	370,893	4,341,975	256	334
7	All: Terminal+Power Plant+Offloading+Marine	16.50	14.45	14.48	17.06	16.45	17.06	1993	370,909	4,342,022	293	341

		AERMOD SO2 Impacts, 3-Hour Average (µg/m^3) (AAQS = 1,300, SIL = 25)							UTM Coordinates		Distance from Stack (m)	Azimuth, degrees from N.
Source Group	Description	1990	1991	1992	1993	1994	Max.	Max. Year	East (m)	North (m)		
1	Terminal sources	0.58	0.58	0.57	0.51	0.57	0.58	1991	371,092	4,341,869	151	35
2	Terminal + LNG offloading	44.59	43.46	43.60	44.74	42.83	44.74	1993	370,893	4,341,975	256	334
3	Emergency fire pumps and engine	0.58	0.58	0.57	0.51	0.53	0.58	1991	371,092	4,341,869	151	35
4	All: Terminal+Offloading+Marine	82.43	79.53	76.30	74.20	79.12	82.43	1990	371,239	4,341,878	269	60
5	Terminal + Power Plant	1.22	1.16	1.30	1.21	1.27	1.30	1992	371,143	4,341,825	159	60
6	Terminal + Power Plant + Offload	44.59	43.46	43.60	44.74	42.83	44.74	1993	370,893	4,341,975	256	334
7	All: Terminal+Power Plant+Offloading+Marine	82.49	79.53	76.40	74.36	79.46	82.49	1990	371,239	4,341,878	269	60

Source Group	Description	AERMOD PM10/PM2.5 Impacts, Annual Average (µg/m³) (AAQS = 50/15, SIL = 1/0.3)					Max.	Max. Year	UTM Coordinates		Distance from Stack (m)	Azimuth, degrees from N.
		1990	1991	1992	1993	1994			East (m)	North (m)		
1	Terminal sources	2.79	2.38	3.00	3.10	3.24	3.24	1994	371,113	4,341,703	115	111
2	Terminal + LNG offloading	2.85	2.44	3.10	3.18	3.32	3.32	1994	371,113	4,341,703	115	111
3	Emergency fire pumps and engine	0.004	0.004	0.004	0.004	0.004	0.004	1994	371,102	4,341,786	105	67
4	All: Terminal+Offloading+Marine	2.95	2.52	3.20	3.29	3.44	3.44	1994	371,113	4,341,703	115	111
5	Terminal + Power Plant	6.73	5.65	7.10	7.03	7.45	7.45	1994	371,143	4,341,825	159	60
6	Terminal + Power Plant + Offload	6.81	5.72	7.20	7.11	7.56	7.56	1994	371,143	4,341,825	159	60
7	All: Terminal+Power Plant+Offloading+Marine	6.95	5.82	7.40	7.24	7.70	7.70	1994	371,143	4,341,825	159	60

Source Group	Description	AERMOD PM10/PM2.5 Impacts, 24-Hr. Average (µg/m³) (AAQS = 150/35, SIL = 5/2)					Max.	Max. Year	UTM Coordinates		Distance from Stack (m)	Azimuth, degrees from N.
		1990	1991	1992	1993	1994			East (m)	North (m)		
1	Terminal sources	11.2	9.8	11.6	9.7	11.0	11.6	1992	370,788	4,341,417	394	214
2	Terminal + LNG offloading	12.1	10.5	12.8	10.4	11.7	12.8	1992	371,113	4,341,703	115	111
3	Emergency fire pumps and engine	1.0	1.0	0.9	1.0	1.1	1.1	1994	370,960	4,341,930	190	346
4	All: Terminal+Offloading+Marine	12.7	11.4	13.5	10.9	12.5	13.5	1992	371,113	4,341,703	115	111
5	Terminal + Power Plant	31.7	29.1	28.3	27.5	28.0	31.7	1990	371,143	4,341,825	159	60
6	Terminal + Power Plant + Offload	32.2	29.7	28.8	28.4	28.6	32.2	1990	371,143	4,341,825	159	60
7	All: Terminal+Power Plant+Offloading+Marine	32.8	30.5	29.5	29.1	29.5	32.8	1990	371,143	4,341,825	159	60

Source Group	Description	AERMOD CO Impacts, 8-Hour Average (µg/m³) (AAQS = 10,000, SIL = 500)					Max.	Max. Year	UTM Coordinates		Distance from Stack (m)	Azimuth, degrees from N.
		1990	1991	1992	1993	1994			East (m)	North (m)		
1	Terminal sources	72.0	71.0	80.4	74.2	82.4	82.4	1994	371,116	4,341,725	112	100
2	Terminal + LNG offloading	73.3	73.5	82.1	76.4	83.4	83.4	1994	371,116	4,341,725	112	100
3	Emergency fire pumps and engine	39.9	39.7	37.9	35.9	37.7	39.9	1990	371,092	4,341,869	151	35
4	All: Terminal+Offloading+Marine	692.8	645.3	840.8	647.6	682.5	840.8	1992	369,686	4,341,862	1325	275
5	Terminal + Power Plant	97.5	95.1	100.5	98.7	107.8	107.8	1994	371,143	4,341,825	159	60
6	Terminal + Power Plant + Offload	99.2	97.5	103.9	101.5	112.1	112.1	1994	371,143	4,341,825	159	60
7	All: Terminal+Power Plant+Offloading+Marine	693.9	645.3	842.9	647.6	683.4	842.9	1992	369,686	4,341,862	1325	275

Source Group	Description	AERMOD CO Impacts, 1-Hour Average (µg/m³) (AAQS = 40,000, SIL = 2,000)					Max.	Max. Year	UTM Coordinates		Distance from Stack (m)	Azimuth, degrees from N.
		1990	1991	1992	1993	1994			East (m)	North (m)		
1	Terminal sources	113.6	116.4	117.8	114.0	118.4	118.4	1994	371,113	4,341,703	115	111
2	Terminal + LNG offloading	119.0	119.7	120.6	117.8	121.7	121.7	1994	371,113	4,341,703	115	111
3	Emergency fire pumps and engine	65.3	63.7	63.6	64.4	61.8	65.3	1990	371,143	4,341,825	159	60
4	All: Terminal+Offloading+Marine	11532.9	11608.8	12066.1	9812.9	10808.0	12066.1	1992	369,830	4,341,647	1180	265
5	Terminal + Power Plant	147.4	147.0	147.3	151.3	144.4	151.3	1993	371,143	4,341,825	159	60
6	Terminal + Power Plant + Offload	153.1	151.2	151.3	155.6	148.7	155.6	1993	371,143	4,341,825	159	60
7	All: Terminal+Power Plant+Offloading+Marine	11548.6	11609.1	12066.5	9816.7	10808.0	12066.5	1992	369,686	4,341,862	1325	275

Source Group	Description	AERMOD Pb Impacts, 3-Month Average (µg/m³) (AAQS = 1.5, SIL = 0.3)					Max.	Max. Year	UTM Coordinates		Distance from Stack (m)	Azimuth, degrees from N.
		1990	1991	1992	1993	1994			East (m)	North (m)		
1	Terminal sources	0.002	0.002	0.002	0.002	0.002	0.002	1994	371,102	4,341,786	105	67
2	Terminal + LNG offloading	0.002	0.002	0.002	0.002	0.002	0.002	1994	371,102	4,341,786	105	67
3	Emergency fire pumps and engine	0.002	0.002	0.002	0.002	0.002	0.002	1994	371,102	4,341,786	105	67
4	All: Terminal+Offloading+Marine	0.002	0.002	0.002	0.002	0.002	0.002	1994	371,102	4,341,786	105	67
5	Terminal + Power Plant	0.002	0.002	0.002	0.002	0.002	0.002	1994	371,102	4,341,786	105	67
6	Terminal + Power Plant + Offload	0.002	0.002	0.002	0.002	0.002	0.002	1994	371,102	4,341,786	105	67
7	All: Terminal+Power Plant+Offloading+Marine	0.002	0.002	0.002	0.002	0.002	0.002	1994	371,102	4,341,786	105	67

TABLE 9B-7: AIR QUALITY IMPACT ANALYSIS CALCULATIONS AND SUMMARIES - LNG TERMINAL OPERATIONS

Sparrows Point LNG Terminal

Summary of Maximum AERMOD Impacts By Model Scenario

Modeling Results - Source Group 1 - LNG Terminal Stationary Sources (Without Power Plant)

Pollutant	Averaging Period	Max. Impact ($\mu g/m^3$)[1]	Significant Impact Level ($\mu g/m^3$)	Background Conc. ($\mu g/m^3$)[3]	Total Conc. ($\mu g/m^3$)	AAQS ($\mu g/m^3$)	Receptor Location of Maximum Impact				Year
							UTM East (m)	UTM North (m)	Distance from Stack (m)	Azimuth, degrees from N.	
PM10	24-hour average	11.6	5	51	62.3	150	370,788	4,341,417	394	214	1992
	Annual average	3.2	1	23	26.5	50	371,113	4,341,703	115	111	1994
PM2.5	24-hour average	11.6	2	38.6	50.2	35	370,788	4,341,417	394	214	1992
	Annual average	3.24	0.3	15.1	18.3	15	371,113	4,341,703	115	111	1994
NO2	Annual average	2.1	1	37.6	39.7	100	371,113	4,341,703	115	111	1994
SO_2	3-hour average	0.6	25	172.8	173.4	1300	371,092	4,341,869	151	35	1991
	24-hour average	0.3	5	44.5	44.8	365	371,116	4,341,725	112	100	1994
	Annual average	0.05	1	13.1	13.1	80	371,113	4,341,703	115	111	1994
CO	1-hour average	118.4	2,000	6,755	6,873	40,000	371,113	4,341,703	115	111	1994
	8-hour average	82.4	500	3,091	3,174	10,000	371,116	4,341,725	112	100	1994
Pb	3-Month average[2]	0.002	0.3	ND	0.002	1.5	371,102	4,341,786	105	67	1994

Modeling Results - Source Group 2 - LNG Terminal Stationary Sources + LNG Ship Offloading (Without Power Plant)

Pollutant	Averaging Period	Max. Impact ($\mu g/m^3$)[1]	Significant Impact Level ($\mu g/m^3$)	Background Conc. ($\mu g/m^3$)[3]	Total Conc. ($\mu g/m^3$)	AAQS ($\mu g/m^3$)	Receptor Location of Maximum Impact				Year
							UTM East (m)	UTM North (m)	Distance from Stack (m)	Azimuth, degrees from N.	
PM10	24-hour average	12.8	5	51	63.5	150	371,113	4,341,703	115	111	1992
	Annual average	3.3	1	23	26.6	50	371,113	4,341,703	115	111	1994
PM2.5	24-hour average	12.8	2	38.6	51.4	35	371,113	4,341,703	115	111	1992
	Annual average	3.32	0.3	15.1	18.4	15	371,113	4,341,703	115	111	1994
NO2	Annual average	3.7	1	37.6	41.3	100	371,113	4,341,703	115	111	1994
SO_2	3-hour average	44.7	25	172.8	217.6	1300	370,893	4,341,975	256	334	1993
	24-hour average	15.6	5	44.5	60.1	365	370,893	4,341,975	256	334	1993
	Annual average	0.94	1	13.1	14.0	80	371,102	4,341,786	105	67	1994
CO	1-hour average	121.7	2,000	6,755	6,877	40,000	371,113	4,341,703	115	111	1994
	8-hour average	83.4	500	3,091	3,175	10,000	371,116	4,341,725	112	100	1994
Pb	3-Month average[2]	0.002	0.3	ND	0.002	1.5	371,102	4,341,786	105	67	1994

Modeling Results - Source Group 4 - LNG Terminal Stationary Sources + LNG Ship Offloading + Marine Vessels (Without Power Plant)

Pollutant	Averaging Period	Max. Impact ($\mu g/m^3$)[1]	Significant Impact Level ($\mu g/m^3$)	Background Conc. ($\mu g/m^3$)[3]	Total Conc. ($\mu g/m^3$)	AAQS ($\mu g/m^3$)	Receptor Location of Maximum Impact				Year
							UTM East (m)	UTM North (m)	Distance from Stack (m)	Azimuth, degrees from N.	
PM10	24-hour average	13.5	5	51	64.2	150	371,113	4,341,703	115	111	1992
	Annual average	3.4	1	23	26.7	50	371,113	4,341,703	115	111	1994
PM2.5	24-hour average	13.5	2	38.6	52.1	35	371,113	4,341,703	115	111	1992
	Annual average	3.44	0.3	15.1	18.5	15	371,113	4,341,703	115	111	1994
NO2	Annual average	6.2	1	37.6	43.8	100	370,960	4,341,930	190	346	1990
SO_2	3-hour average	82.4	25	172.8	255.2	1300	371,239	4,341,878	269	60	1990
	24-hour average	17.1	5	44.5	61.6	365	370,909	4,342,022	293	341	1993
	Annual average	1.46	1	13.1	14.6	80	371,102	4,341,786	105	67	1994
CO	1-hour average	12066.1	2,000	6,755	18,821	40,000	369,830	4,341,647	1,180	265	1992
	8-hour average	840.8	500	3,091	3,932	10,000	369,686	4,341,862	1,325	275	1992
Pb	3-Month average[2]	0.002	0.3	ND	0.002	1.5	371,102	4,341,786	105	67	1994

Modeling Results - Source Group 5 - LNG Terminal + Power Plant Stationary Sources

Pollutant	Averaging Period	Max. Impact ($\mu g/m^3$)[1]	Significant Impact Level ($\mu g/m^3$)	Background Conc. ($\mu g/m^3$)[3]	Total Conc. ($\mu g/m^3$)	AAQS ($\mu g/m^3$)	Receptor Location of Maximum Impact: UTM East (m)	UTM North (m)	Distance from Stack (m)	Azimuth, degrees from N.	Year
PM10	24-hour average	31.7	5	51	82.4	150	371,143	4,341,825	159	60	1990
	Annual average	7.5	1	23	30.8	50	371,143	4,341,825	159	60	1994
PM2.5	24-hour average	31.7	2	38.6	70.3	35	371,143	4,341,825	159	60	1990
	Annual average	7.45	0.3	15.1	22.6	15	371,143	4,341,825	159	60	1994
NO2	Annual average	11.6	1	37.6	49.2	100	371,143	4,341,825	159	60	1994
SO_2	3-hour average	1.3	25	172.8	174.1	1300	371,143	4,341,825	159	60	1992
	24-hour average	0.8	5	44.5	45.3	365	371,143	4,341,825	159	60	1990
	Annual average	0.99	1	13.1	14.1	80	371,143	4,341,825	159	60	1993
CO	1-hour average	151.3	2,000	6,755	6,906	40,000	371,143	4,341,825	159	60	1993
	8-hour average	107.8	500	3,091	3,199	10,000	371,143	4,341,825	159	60	1994
Pb	3-Month average[2]	0.002	0.3	ND	0.002	1.5	371,102	4,341,786	105	67	1994

Modeling Results - Source Group 6 - LNG Terminal + Power Plant Stationary Sources + LNG Ship Offloading

Pollutant	Averaging Period	Max. Impact ($\mu g/m^3$)[1]	Significant Impact Level ($\mu g/m^3$)	Background Conc. ($\mu g/m^3$)[3]	Total Conc. ($\mu g/m^3$)	AAQS ($\mu g/m^3$)	Receptor Location of Maximum Impact: UTM East (m)	UTM North (m)	Distance from Stack (m)	Azimuth, degrees from N.	Year
PM10	24-hour average	32.2	5	51	82.9	150	371,143	4,341,825	159	60	1990
	Annual average	7.6	1	23	30.9	50	371,143	4,341,825	159	60	1994
PM2.5	24-hour average	32.2	2	38.6	70.8	35	371,143	4,341,825	159	60	1990
	Annual average	7.56	0.3	15.1	22.7	15	371,143	4,341,825	159	60	1994
NO2	Annual average	13.4	1	37.6	51.0	100	371,143	4,341,825	159	60	1994
SO_2	3-hour average	44.7	25	172.8	217.6	1300	370,893	4,341,975	256	334	1993
	24-hour average	15.6	5	44.5	60.1	365	370,893	4,341,975	256	334	1993
	Annual average	1.07	1	13.1	14.2	80	371,102	4,341,786	105	67	1994
CO	1-hour average	155.6	2,000	6,755	6,911	40,000	371,143	4,341,825	159	60	1993
	8-hour average	112.1	500	3,091	3,203	10,000	371,143	4,341,825	159	60	1994
Pb	3-Month average[2]	0.002	0.3	ND	0.002	1.5	371,102	4,341,786	105	67	1994

Modeling Results - Source Group 7 - LNG Terminal + Power Plant Stationary Sources + LNG Ship Offloading + Marine Vessels

Pollutant	Averaging Period	Max. Impact ($\mu g/m^3$)[1]	Significant Impact Level ($\mu g/m^3$)	Background Conc. ($\mu g/m^3$)[3]	Total Conc. ($\mu g/m^3$)	AAQS ($\mu g/m^3$)	Receptor Location of Maximum Impact: UTM East (m)	UTM North (m)	Distance from Stack (m)	Azimuth, degrees from N.	Year
PM10	24-hour average	32.8	5	51	83.5	150	371,143	4,341,825	159	60	1990
	Annual average	7.7	1	23	31.0	50	371,143	4,341,825	159	60	1994
PM2.5	24-hour average	32.8	2	38.6	71.4	35	371,143	4,341,825	159	60	1990
	Annual average	7.70	0.3	15.1	22.8	15	371,143	4,341,825	159	60	1994
NO2	Annual average	16.1	1	37.6	53.7	100	371,143	4,341,825	159	60	1994
SO_2	3-hour average	82.5	25	172.8	255.3	1300	371,239	4,341,878	269	60	1990
	24-hour average	17.1	5	44.5	61.6	365	370,909	4,342,022	293	341	1993
	Annual average	1.59	1	13.1	14.7	80	371,102	4,341,786	105	67	1994
CO	1-hour average	12066.5	2,000	6,755	18,822	40,000	369,686	4,341,862	1,325	275	1992
	8-hour average	842.9	500	3,091	3,934	10,000	369,686	4,341,862	1,325	275	1992
Pb	3-Month average[2]	0.002	0.3	ND	0.002	1.5	371,102	4,341,786	105	67	1994

1. Highest second high modeled concentrations were used to evaluate all short-term impacts (1-hour to 24-hour). Highest modeled concentrations were used to evaluate annual impacts.

TABLE 9B-8: AIR QUALITY IMPACT ANALYSIS CALCULATIONS AND SUMMARIES

Sparrows Point LNG Terminal

List of Model Input and Output Files

Input Files:	Output Files:	Description
AERMOD Refined Modeling Files		
SPNO90.ADI	SPNO90.ADO	NOX, annual average, 1990
SPNO91.ADI	SPNO91.ADO	NOX, annual average, 1991
SPNO92.ADI	SPNO92.ADO	NOX, annual average, 1992
SPNO93.ADI	SPNO93.ADO	NOX, annual average, 1993
SPNO94.ADI	SPNO94.ADO	NOX, annual average, 1994
SPSO390.ADI	SPSO390.ADO	SO2, 3-hr average, 1990
SPSO391.ADI	SPSO391.ADO	SO2, 3-hr average, 1991
SPSO392.ADI	SPSO392.ADO	SO2, 3-hr average, 1992
SPSO393.ADI	SPSO393.ADO	SO2, 3-hr average, 1993
SPSO394.ADI	SPSO394.ADO	SO2, 3-hr average, 1994
SPSO2490.ADI	SPSO2490.ADO	SO2, 24-hr average, 1990
SPSO2491.ADI	SPSO2491.ADO	SO2, 24-hr average, 1991
SPSO2492.ADI	SPSO2492.ADO	SO2, 24-hr average, 1992
SPSO2493.ADI	SPSO2493.ADO	SO2, 24-hr average, 1993
SPSO2494.ADI	SPSO2494.ADO	SO2, 24-hr average, 1994
SPSOA90.ADI	SPSOA90.ADO	SO2, annual average, 1990
SPSOA91.ADI	SPSOA91.ADO	SO2, annual average, 1991
SPSOA92.ADI	SPSOA92.ADO	SO2, annual average, 1992
SPSOA93.ADI	SPSOA93.ADO	SO2, annual average, 1993
SPSOA94.ADI	SPSOA94.ADO	SO2, annual average, 1994
SPPMA90.ADI	SPPMA90.ADO	PM, annual average, 1990
SPPMA91.ADI	SPPMA91.ADO	PM, annual average, 1991
SPPMA92.ADI	SPPMA92.ADO	PM, annual average, 1992
SPPMA93.ADI	SPPMA93.ADO	PM, annual average, 1993
SPPMA94.ADI	SPPMA94.ADO	PM, annual average, 1994
SPPM2490.ADI	SPPM2490.ADO	PM, 24-hr average, 1990
SPPM2491.ADI	SPPM2491.ADO	PM, 24-hr average, 1991
SPPM2492.ADI	SPPM2492.ADO	PM, 24-hr average, 1992
SPPM2493.ADI	SPPM2493.ADO	PM, 24-hr average, 1993
SPPM2494.ADI	SPPM2494.ADO	PM, 24-hr average, 1994
SPCO190.ADI	SPCO190.ADO	CO, 1-hr average, 1990
SPCO191.ADI	SPCO191.ADO	CO, 1-hr average, 1991
SPCO192.ADI	SPCO192.ADO	CO, 1-hr average, 1992
SPCO193.ADI	SPCO193.ADO	CO, 1-hr average, 1993
SPCO194.ADI	SPCO194.ADO	CO, 1-hr average, 1994
SPCO890.ADI	SPCO890.ADO	CO, 8-hr average, 1990
SPCO891.ADI	SPCO891.ADO	CO, 8-hr average, 1991
SPCO892.ADI	SPCO892.ADO	CO, 8-hr average, 1992
SPCO893.ADI	SPCO893.ADO	CO, 8-hr average, 1993
SPCO894.ADI	SPCO894.ADO	CO, 8-hr average, 1994
SPPb2490.ADI	SPPb2490.ADO	Pb, 24-hr average, 1990
SPPb2491.ADI	SPPb2491.ADO	Pb, 24-hr average, 1991
SPPb2492.ADI	SPPb2492.ADO	Pb, 24-hr average, 1992
SPPb2493.ADI	SPPb2493.ADO	Pb, 24-hr average, 1993
SPPb2494.ADI	SPPb2494.ADO	Pb, 24-hr average, 1994
BPIP Prime Files:		
SP******.BPI	SP******.PRO	BPIP Input and Output Files For AERMOD Prime Refined Runs
SACTI Files:		
Mult**.out	Tables**.out	SACTI model input and output files.
Prep**.out		

TABLE 9B-9: AIR QUALITY IMPACT ANALYSIS CALCULATIONS AND SUMMARIES - LNG TERMINAL OPERATIONS
Sparrows Point LNG Terminal
Comparison of Project Direct and Indirect Emissions With County Emissions Inventory

Source: http://www.epa.gov/air/data/geosel.html
Geographic Area: Maryland
Year: 2001

EPA Region	State	County Code	County	Source Category	Emissions Year	CO Emissions (Tons)	NOx Emissions (Tons)	VOC Emissions (Tons)	SO2 Emissions (Tons)	PM2.5 Emissions (Tons)	PM10 Emissions (Tons)	NH3 Emissions (Tons)	Total Pollutant Emissions
3	MD	24001	Allegany Co	All Categories	2001	44,845	12,262	4,990	20,453	3,234	5,620	387	88,556
3	MD	24003	Anne Arundel Co	All Categories	2001	148,538	36,715	18,185	71,439	5,955	10,410	932	286,220
3	MD	24005	Baltimore Co	All Categories	2001	305,419	43,464	26,218	42,719	9,311	16,974	1,546	436,339
3	MD	24009	Calvert Co	All Categories	2001	23,310	3,146	3,338	647	983	2,642	152	33,234
3	MD	24011	Caroline Co	All Categories	2001	10,839	1,472	1,507	310	692	2,573	2,104	18,805
3	MD	24013	Carroll Co	All Categories	2001	50,833	12,164	6,312	3,266	2,911	7,717	1,766	82,059
3	MD	24015	Cecil Co	All Categories	2001	36,330	5,502	4,441	949	1,143	3,308	501	51,030
3	MD	24017	Charles Co	All Categories	2001	34,593	20,927	5,146	79,120	8,115	10,385	200	150,372
3	MD	24019	Dorchester Co	All Categories	2001	17,434	2,004	3,966	2,346	692	1,682	1,351	28,783
3	MD	24021	Frederick Co	All Categories	2001	108,415	12,701	8,766	10,114	3,054	8,767	2,257	151,019
3	MD	24023	Garrett Co	All Categories	2001	30,816	4,445	2,423	709	791	2,295	717	41,404
3	MD	24025	Harford Co	All Categories	2001	68,046	8,662	8,607	1,946	1,840	5,058	997	93,316
3	MD	24027	Howard Co	All Categories	2001	84,686	9,987	9,468	2,702	1,582	4,329	416	111,588
3	MD	24029	Kent Co	All Categories	2001	8,715	1,009	1,846	228	501	1,642	704	14,144
3	MD	24031	Montgomery Co	All Categories	2001	276,154	32,890	30,429	41,024	8,640	17,216	1,068	398,782
3	MD	24033	Prince George's Co	All Categories	2001	211,743	34,697	24,877	44,813	7,533	13,166	1,095	330,390

EPA Region	State	County Code	County	Source Category	Emissions Year	CO Emissions (Tons)	NOx Emissions (Tons)	VOC Emissions (Tons)	SO2 Emissions (Tons)	PM2.5 Emissions (Tons)	PM10 Emissions (Tons)	NH3 Emissions (Tons)	Total Pollutant Emissions
3	MD	24035	Queen Anne's Co	All Categories	2001	15,981	2,149	2,631	428	1,031	3,666	1,125	25,981
3	MD	24037	St. Mary's Co	All Categories	2001	36,896	3,823	5,915	1,098	1,070	2,683	342	50,756
3	MD	24039	Somerset Co	All Categories	2001	12,776	1,404	2,627	252	438	1,196	2,050	20,306
3	MD	24041	Talbot Co	All Categories	2001	17,896	2,435	2,994	353	710	2,272	812	26,762
3	MD	24043	Washington Co	All Categories	2001	68,135	13,064	7,379	6,256	2,145	5,296	1,543	101,674
3	MD	24045	Wicomico Co	All Categories	2001	30,835	3,577	4,657	1,089	1,062	2,836	4,061	47,055
3	MD	24047	Worcester Co	All Categories	2001	20,086	1,929	3,364	417	716	1,747	2,974	30,516
3	MD	24510	Baltimore city	All Categories	2001	173,337	34,810	21,261	10,686	2,898	7,413	1,532	249,039

Total LNG Terminal + LNG Ship Offloading (w/out Power Plant)	37	33	19	4	35	35	10	172
Total Stationary Sources + LNG Ship Offloading (w/ Power Plant)	160	122	52	5	77	77	175	667
Total Marine, Maint. Dredging and Indirect Emissions (MD)	357	918	32	542	53	53	11	1,967
Total Direct and Indirect Emissions (w/out Power Plant)	394	951	52	546	88	88	21	2,139
Total Direct and Indirect Emissions (w/ Power Plant)	517	1,040	84	547	130	130	186	2,634
Baltimore County Emissions (2001)	305,419	43,464	26,218	42,719	9,311	16,974	1,546	436,339
Worst-Case Project Emissions as Percentage of Baltimore Co. Inventory	0.2%	2.4%	0.3%	1.3%	1.4%	0.8%	12.0%	0.6%