Golden Pass Terminal LP
Golden Pass Pipeline LP
P.O. Box 4876
Houston, Texas 77210-4876

09 August 2004

Mr. Mike Magee
Environmental Planning and Implementation Division
Texas Commission on Environmental Quality
MC-206
P.O. Box 13087
Austin, Texas 78711-3087

Hand Delivery & Electronic Mail Delivery

Subject: Comments regarding revisions to the Beaumont/Port Arthur State Implementation Plan

Dear Mr. Magee:

Golden Pass LNG Terminal LP (GPLNG) and Golden Pass Pipeline LP (GPPL) submit the following comments to the Texas Commission on Environmental Quality (TCEQ) regarding the revised Beaumont/Port Arthur (BPA) Attainment Demonstration State Implementation Plan (SIP).

The GPLNG and GPPL project was introduced to TCEQ management and staff in meetings held in February, May, and July 2004. On 28 April 2004, GPLNG and GPPL submitted a conformity request, comments on the BPA SIP, and a voluntary estimate of air emissions related to terminal and pipeline construction and operations for inclusion into the revised BPA SIP. Upon receipt of the April letter, TCEQ recommended that GPLNG and GPPL submit a second request and set of comments during the public comment period for the revised BPA SIP. Herein, GPLNG and GPPL submits this request and the following preliminary emissions inventory (Attachments). By submittal of this letter during the SIP public comment period, GPLNG and GPPL are requesting this project be accounted for in the BPA SIP.

Additionally, GPLNG and GPPL requests that TCEQ draft a Preliminary General Conformity Determination associated with federal actions (i.e., permits, licenses, etc.) required to construct and operate the Golden Pass LNG Terminal and Golden Pass Pipeline. Based on an evaluation of air emissions for both the construction and operation of the proposed project, a General Conformity determination for nitrogen oxides (NO_x) and volatile organic compounds (VOC) emissions is required for federal actions.

PROPOSED PROJECT

GPLNG and GPPL are filing applications with the Federal Energy Regulatory Commission (FERC), the U.S. Army Corps of Engineers (USACE), U.S. Environmental Protection Agency (EPA), TCEQ, and other regulatory entities seeking the necessary authorizations to construct and operate a marine LNG terminal and pipeline for the importation, storage, regasification, and transportation of foreign-source LNG. The GPLNG terminal will be located within Jefferson County, Texas and the GPPL pipeline system will be located within Jefferson, Orange, and Newton counties, Texas and Calcasieu Parish, Louisiana.

The GPLNG terminal includes the following components:

- A marine terminal designed to receive up to 200 LNG ships per year, with berthing capabilities to simultaneously moor two LNG ships;
- LNG unloading and transfer facilities and related mechanical and piping support systems consisting of two berths, each including four unloading arms and one vapor return arm, mooring and breasting dolphins, gangway tower, firewater monitors, anemometer, service utilities, and associated valves and piping;
- Up to five onsite LNG storage tanks (approximately 155,000 cubic meters [m^3] working capacity each);
- Ten LNG vaporizers and related regasification support systems capable of an annual average send out capacity of 2.0 billion cubic feet per day (bcfd) of natural gas, with a peak capacity of 2.7 bcfd;
- A boil-off gas (BOG) recovery system consisting of three BOG compressors, one return gas blower, and a direct-contact recondenser;
- Twenty LNG booster pumps to transfer LNG from the storage tanks to the vaporizers;
- Ten shell-and-tube LNG heat exchangers to vaporize the LNG;
- A total of eight gas-fired heaters, each with a maximum rating of 230 MMbtu/hr heat input; and,
- Associated terminal support facilities, including administrative buildings, storage and maintenance areas, electric power systems, terminal access roads, and other civil works related to the GPLNG terminal.

The proposed GPPL system will be designed to deliver an annual average of 2 bcfd of natural gas from the GPLNG terminal to existing Texas intrastate and interstate natural gas pipeline systems. The GPPL is a system consisting of three pipelines and associated pipeline support facilities, including pig launchers/receivers, and metering equipment, as follows:

- *Golden Pass Pipeline*, an estimated 77-mile, 36-inch diameter pipeline commencing at the proposed GPLNG terminal send out metering station and continuing to its terminus at a new metering and regulating station (M & R station) at an

interconnection with the existing Transcontinental Gas Pipe Line Corporation (Transco) interstate pipeline near Starks, Louisiana.

- *Golden Pass Loop Line*, an estimated 43-mile, 36-inch diameter pipeline commencing at the proposed GPLNG terminal send out metering station parallel to and looping the Golden Pass Pipeline as far as the Sabine Gas Pipeline Meter Station in Orange County, Texas; and,
- *Beaumont Lateral*, a 2-mile, 24-inch diameter lateral pipeline connecting the Golden Pass Pipeline to Beaumont and Port Arthur industrial customers.

The current construction schedule for the GPLNG and GPPL project begins in 2005 and would extend through 2009.

AIR EMISSIONS INVENTORY ESTIMATES (Attachments)

The attached air emissions inventory format and level of detail for the GPLNG and GPPL project are based on TCEQ staff recommendations received during a July 2004 meeting and subsequent conversations with the GPLNG and GPPL environmental consultant. Construction-related emissions were calculated for non-road construction sources, for on-road mobile sources, and for sources related to dredging activities (specifically for the USACE Permit). Construction emissions were calculated for each year during the projected construction period (2005-2010). Operation-related emissions were calculated for LNG ships, and tug boats, and stationary sources to be permitted (i.e., boilers, emergency generator, firewater pumps, diesel storage tanks, and fugitive sources). Operations-related emissions were calculated for the first year of partial operation (2008) and for the following three years. Total project emissions (sum of direct permitted and indirect emissions) were calculated for each year between 2005 and 2011, and the years with the maximum total project emissions of NO_x and VOC were identified. The maximum project emissions include components in categories for which General Conformity must be demonstrated.

REQUEST FOR GENERAL CONFORMITY DETERMINATION

Pursuant to the General Conformity Rule (40 CFR 51.855), this preliminary emissions inventory is being provided in support of a Draft General Conformity Determination to demonstrate that the GPLNG and GPPL project will comply with the requirements of the General Conformity Rule and will be in conformity with the Texas SIP. However, as specified in the TCEQ General Rules, Chapter 101, the state must make a determination and document that the total of direct and indirect emissions from the action, or portion thereof, would result in a level of emissions that, together with all other emissions in the BPA nonattainment area, would not exceed the SIP emissions budget. Therefore, it is requested that the TCEQ review the preliminary project

emissions in support of a General Conformity Determination and provide a formal determination and confirmation that the project emissions can be accommodated in the SIP.

Please contact Mr. Bryan Trimm (281) 654-3067 if you have questions regarding this submittal.

Sincerely,

Harold W. Yates
Authorized Representative
Golden Pass Terminal LP
Golden Pass Pipeline LP

Attachments

cc: Erik Gribben (TCEQ)
Ken Gathright (TCEQ)
Jennifer Kerrigan (FERC)
FERC Docket PF04-1
Patricia Patterson (TRC)
Bruce Bennett (USACE-Galveston)

Attachment

Estimated Air Emissions for the Golden Pass LNG Terminal and the Golden Pass Pipeline

Attachment: Estimated Air Emissions for the Golden Pass LNG Terminal and the Golden Pass Pipeline

1.0 Introduction

The following summarizes estimated air emissions associated with the construction and operations for the Golden Pass LNG Terminal and Pipeline System. These air emission estimates are provided to support the Texas Commission on Environmental Quality (TCEQ) as it prepares a draft General Conformity Determination. Golden Pass LNG Terminal LP will submit a General Application for Air Preconstruction Permits (Form PI-1 and associated forms) for the stationary air emissions at a later date.

Table 1 summarizes the estimated nitrogen oxides (NO_X) and volatile organic compounds (VOCs) associated with the terminal and pipeline construction and terminal operations (pipeline operations estimates are considered to be less than 0.01 tpy NO_X and thus negligible for the purposes of this discussion). Terminal construction is subdivided into terminal (onshore), marine and dredging components. Furthermore, air emission estimates were calculated for the applicable non-road, mobile, and stationary sources. NO_X and VOCs were summarized in Table 1 since the Beaumont-Port Arthur (BPA) area is designated as a nonattainment area for ozone. Other air emission parameters (SO_2, CO, and PM_{10}) are provided in the backup tables (2 through 11) for the reader's convenience.

2.0 Construction Emissions

Construction emissions were estimated for the project years 2005-2010 based on a typical equipment spread for the terminal, including onshore and nearshore construction. Construction activities for the terminal would be expected to last approximately 60 months. Onshore construction emissions are based on applicable hourly and annual emissions calculations. Construction activities for the marine portion of the project would be expected to last up to 24 months. Construction activities generally would include deliveries, site grading and preparation, concrete mixing for onshore and nearshore construction, heavy lifting equipment operation, vehicle exhaust and dust, and dredging.

<u>Terminal (Onshore) Construction Emissions</u>

Construction activities will commence with site preparation of the onshore facility, including filling and compacting the site to the finished grade elevation, and construction of surge protection barrier. Construction of the LNG tanks will involve building a pile foundation for the tanks, constructing a concrete slab, and building the tanks. The operation of construction vehicles (e.g. bulldozers, track cranes, hydraulic cranes, track hoes, back hoes, forklifts, dozers, compactors,

graders, water trucks, concrete pump trucks, trucks, shovels, front-end loaders, pile driving rigs, and dump trucks) and other fuel-burning equipment (e.g., welders, air compressors, electrical generators, lifts, mules, and site transportation vehicles) would generate air emissions typical of vehicles powered by diesel-fueled internal combustion engines. The assumed typical workweek was 50 hours in duration, consisting of five 10-hour days. Non-road construction emissions for on-site equipment were based on Tier I emission factors referenced from EPA Nonroad 2002 data obtained in Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling–Compression-Ignition (USEPA, 2004). The on-site equipment emissions were based on EPA published load factors (ranging from 21% to 59%) from Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling (USEPA, 2004) which corresponded to the type of equipment. These emissions are summarized in Table 1 for all the years of construction, and summarized for each year in Tables 2 through 7.

Mobile source emissions associated with terminal construction would be generated from commuter and delivery vehicles traveling to the site. Commuter vehicles would likely include a mix of cars and light duty trucks burning primarily gasoline. Delivery vehicles, consisting of concrete trucks, dump trucks, and soil fill trucks, were assumed to consist exclusively of heavy-duty diesel vehicles. These vehicles were assumed to travel 60 miles round-trip to travel to the site. Some on-site travel for these vehicles was assumed. The emission factors were derived from EPA's mobile source emission model, MOBILE6.2 Jefferson County input file. The in-county vehicle mix used the Texas Transportation Institute's statewide actual on-road mobile source emission inventory as provided by the TCEQ Office of Environmental Policy, Analysis & Assessment. Emissions factors for these vehicles were obtained on a gram/mile basis. These emissions are summarized in Table 8 for each year of construction and in Table 1, which summarizes emissions for the project for all years.

Marine Construction Emissions

Dredging related air emissions were separated from the marine construction category. Thus for this project, typical marine construction activities are pile driving and slip construction which includes: installation of loading dock pile caps, installation of deck slabs, installation of dolphin pile caps, and installation of unloading/vapor return arms, other deck facilities, and access trestles. Construction of the slip would require the use of a typical Gulf of Mexico Inland Waterway Marine Construction Spread, consisting of cranes (200, 140, 80, and/or 12 ton capacities), and pile hammers. Other equipment that will be used includes tugs, workboats, and delivery vehicles. Engine sizes were estimated based on typical construction equipment associated with the model types described with a range from 150-1000 hp. Equipment was assumed to burn

diesel fuel, with the exception of smaller pick-up trucks, which were assumed to use gasoline.

Emissions from marine construction activities would consist of exhaust from marine construction equipment. Marine construction is scheduled to last up to two years. Construction activities are typically expected to occur 5 days per week, 10 hours a day, approximately 50 hours per week. The duration of construction activities varied by equipment type. Emissions calculations for pile drivers were based on information provided by construction contract companies, based on typical construction duration. Slope construction activities using the dredge (discussed in the following section) would be scheduled to last for ten months. The remaining construction activities requiring the cranes would be expected to last 16 months.

Tier I Emission factors for engine emissions were obtained from EPA Nonroad 2002 data obtained in Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling–Compression-Ignition (USEPA, 2004) and AP-42 Chapter 3.3 Gasoline and Diesel Industrial Engines, Table 3.3-1 for gasoline industrial engines. All SO_2 factors assume the use of 0.3% sulfur. The load factors applied were obtained from USEPA guidance Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling (USEPA, 2004). These emissions are summarized on an annual basis in Table 1 under marine construction equipment. Tables 2 through 7 summarize emissions by year for all construction activities.

For marine vessel (work boats and tugs) emissions associated with marine construction activities, emission factors were calculated based on the anticipated load factor using methods described on page 5-3 of Analysis of Commercial Marine Vessels Emissions and Fuel Consumption Data (USEPA, 2000). Load factors were assigned for marine vessels on the basis of information supplied in Table 5-2 of the same document. Emissions from these sources are included under marine construction equipment in Tables 2 through 7 as described above.

All marine equipment emissions were calculated as non-road sources.

Dredging Emissions

Dredging of the marine slip would be initiated following excavation of the top 6 feet of unsaturated soils down to the water table. A 30-inch hydraulic dredge would pump the dredged material to the designated disposal area. Dredging would continue on a 24-hour basis, 7 days per week, up to 10 months. Additional equipment associated with dredging may include a booster pump to transport the material to the spoils management area and dozers for spoils management at the dredge spoils disposal location. Tier I Emission factors for engine emissions were obtained from EPA Nonroad 2002 data obtained in

Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling – Compression-Ignition (USEPA, 2004). The load factors applied were obtained from USEPA guidance Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling (USEPA, 2004). Fuel was assumed to contain 0.3% sulfur. These emissions are incorporated in Table 1 for each year in which dredging occurs. Emissions are also summarized for each year of construction in Tables 2 through 7.

All emissions from the above-described activities were calculated as non-road sources. No mobile source emissions are anticipated as a result of dredging activity.

Pipeline Construction Emissions

The proposed GPPL system will be designed to deliver an annual average of 2 bcfd of regasified natural gas from the GPLNG terminal to existing Texas intrastate and interstate natural gas pipeline systems. The GPPL is a system consisting of three pipelines and associated pipeline support facilities, including pig launchers/receivers, and metering equipment. Simultaneous construction of the pipelines is expected to take 12 months, beginning in November 2006 and continuing through the end of October 2007. Construction activity will include surveying, site preparation and grading, trench excavation, directional drilling through sensitive areas, pipe stringing, pipe bending, welding, pipeline laying, backfilling, and site cleanup and restoration as needed. Typical equipment used during the construction of the project will likely include: multiple types of dozers, cranes, backhoes, site grading equipment including a motor grader, bending machinery, pipe laying equipment, various trucks and tractors, welders, welder tractors, air compressors, electrical generators, and road boring equipment. Power requirements for these types of equipment were identified based on the equipment description and range from 10-600 hp. Emissions from construction equipment were calculated assuming that the equipment uses diesel fuel containing 0.3% sulfur. Construction is expected to occur 50 hours per week, 10 hours per day, 5 days per week.

Tier I Emission factors for engine emissions were obtained from EPA Nonroad 2002 data obtained in Exhaust and Crankcase Emission Factors for Nonroad Engine Modeling–Compression-Ignition (USEPA, 2004). The load factors (ranging from 21% to 59% loads) applied were obtained from USEPA guidance Median Life, Annual Activity, and Load Factor Values for Nonroad Engine Emissions Modeling (USEPA, 2004).

Mobile source emissions associated with pipeline construction would be generated from commuter and delivery vehicles traveling to the site. Commuter vehicles would likely include a mix of cars and light duty trucks burning primarily gasoline. The number of commuter vehicles assumed a vehicle-occupancy rate of 1.3 persons per vehicle. Delivery vehicles were assumed to consist

exclusively of heavy-duty diesel vehicles. These vehicles were assumed to travel 60 miles round-trip to travel to the site. Some on-site travel for these vehicles was assumed. The emission factors were derived from EPA's mobile source emission model, MOBILE6.2 Jefferson County input file. The in-county vehicle mix used the Texas Transportation Institute's statewide actual on-road mobile source emission inventory as provided by the TCEQ Office of Environmental Policy, Analysis & Assessment. Emissions factors for these vehicles were obtained on a gram/mile basis. These emissions are summarized in Table 8 for each year of construction and in Table 1, which summarizes emissions for the project for all years.

3.0 Operating Emissions

Operation emissions include the stationary source emissions, primarily resulting from vaporizing the LNG, emissions from the LNG ship traffic in the channel, emissions from the ships while unloading the LNG at the slip, hotelling at the slip, and emissions from tugs which escort the LNG ships in the channel and assist the ships during docking and undocking operations. These emissions are summarized in Table 1 under operations emissions and are provided for the first year of operations, 2008, and the subsequent 3 years (2009-2011).

Stationary Source Emissions

Stationary emission sources associated with the operation of the terminal would include eight natural gas-fired Heat Transfer Fluid (HTF) heaters (boilers), two of which would be spares, one 33,600-gallon tank, one 3,800-gallon tank, two 500-gallon tanks, two emergency diesel firewater pumps, each rated at a typical capacity of 600 horsepower (hp), and one approximately 2,500 kilowatt (kW) emergency diesel generator. Emissions calculations for stationary source emissions are located in Table 9. In the case of the HTF heaters (boilers), emissions would be controlled to the extent that low-NO_X burners have been proposed. Controlled emission calculations demonstrate that NO_X and CO emissions from the HTF boilers would be controlled using Selective Catalytic Reduction equipped with honeycomb catalyst that would reduce emissions of NO_X and CO. The underlying assumptions, emission factors, and calculation methodologies are discussed below for each emission source. Stationary source emissions are summarized in Table 1 under operating emissions. Stationary source emissions are also described by source in Table 9 for full-time operation of the terminal.

HTF Heaters

The eight natural gas-fired HTF heaters would be used to provide heat for the aqueous propylene glycol heat transfer medium used in the LNG vaporization process. Emissions from the heaters are based on an operating heat duty of 227

MMBtu/hr per heater. Heaters would use the vaporized LNG as their sole fuel source. Heaters would operate 8,760 hours per year (year-round operation). The NO_X emission factor is approximately equivalent to 6 ppmv using SCR to reduce NO_X emissions. The CO emission factor is based on control of CO using a CO catalyst. VOC and PM_{10} emission factors were obtained directly from AP-42 Chapter 1.4. SO_2 emissions were calculated by mass balance, assuming that the incoming LNG contains 1 ppmv sulfur compounds.

Diesel Fuel Storage Tanks

Diesel fuel would be stored in four tanks at the facility for use in the diesel-fired emergency equipment. Emergency equipment would include an emergency generator and two diesel firewater pumps. The diesel fuel would be stored in a nominal 33,600-gallon API tank with a working volume of 26,800 gallons. The diesel would then be distributed and stored in three smaller day tanks for use in the emergency equipment. A 3,800-gallon day tank would be used to supply diesel for the emergency electric generator and two 500-gallon day tanks would supply diesel for each of the two firewater pumps. The day tanks would remain full at all times. Emissions from the diesel tanks were estimated using the EPA Tanks 4.09b software program. Emissions calculations assumed use of Number 2 diesel fuel.

Diesel Firewater Pumps

The facility would be equipped with two emergency diesel firewater pumps, each rated at a typical capacity of 600 hp. The pumps would burn diesel fuel containing 0.3% sulfur. The emission factors were obtained from AP-42 Chapter 3.3 for Gasoline and Diesel Industrial Engines, Table 3.3-1. Calculations assume 100 hours of operation per year. Emissions for the firewater pumps are represented in Table 9 in the stationary source emissions summary table. These emissions were included in the operating emissions summary provided in Table 1.

Emergency Generator

The emergency generator is an approximately 2,500 kW unit. Emissions factors are based on Chapter 3.4 of AP-42, Table 3.4-1 for large stationary diesel engines using diesel fuel containing 0.3% sulfur. Calculations assume 100 hours of operation per year. Emissions for the emergency generator pumps are represented in Table 9 in the stationary source emissions summary table. These emissions were included in the operating emissions summary provided in Table 1.

Fugitive Emissions

Potential fugitive emissions were estimated for the terminal based on the number of valves, pumps, compressors, relief valves, flanges/connectors, open-ended lines, and sampling connections incorporated into the terminal facility design. The LNG is assumed to contain 95.25% methane, 4.24% C_2 hydrocarbons, 0.44% N_2, and 0.0655% C_{3+} hydrocarbons. All percentages are in mole percent. Fugitive emissions would be reduced by capping or blinding open ended lines, maintaining an open loop sampling system, and venting relief valves to a vent header.

Mobile source emissions associated with terminal operations would be generated from commuter vehicles traveling to the site. Commuter vehicles would likely include a mix of cars and light duty trucks burning primarily gasoline. The number of commuter vehicles assumed a vehicle-occupancy rate of 1.3 persons per vehicle. Delivery vehicle emissions were not included as these are currently expected to be minimal. Commuter vehicles were assumed to travel 60 miles round-trip to travel to the site. Some on-site travel for these vehicles was assumed. The emission factors were derived from EPA's mobile source emission model, MOBILE6.2 Jefferson County input file. The in-county vehicle mix used the Texas Transportation Institute's statewide actual on-road mobile source emission inventory as provided by the TCEQ Office of Environmental Policy, Analysis & Assessment. Emissions factors for these vehicles were obtained on a gram/mile basis. These emissions are summarized in Table 8 for each year of operation and in Table 1, which summarizes emissions for the project for all years.

Ship Emissions

Emissions from the LNG ships would be generated from both the main engines and the on-board electric generators in the process of transiting the SNWW (with assistance from tugs) and maneuvering in and out of the slip (docking), and from the on-board electric generators used during unloading (discharging LNG to the terminal) and hotelling (idle mode while docked). Up to 200 LNG ships are expected to dock at the terminal each year. Emissions from the main engines and the on-board electric generators are estimated based on representative ship emissions data and the USEPA guidance provided in Analysis of Commercial Marine Vessel Emissions and Fuel Consumption Data (USEPA, 2000). LNG Ships Emissions are summarized in Table 10 in grams per call and on a tons per year basis.

Main Propulsion Engine Emissions

Emissions of NO_X, CO, VOC, SO_2, and PM_{10} from the LNG ships' engines were estimated for LNG ship transit in the channel and docking. Emissions from the main engine are estimated using emission factor equations for NO_X, CO, and VOC based on vendor provide emissions data and SO_2 and PM_{10}, as presented on page 5-3, Table 5-1 in Analysis of Commercial Marine Vessel Emissions and Fuel Consumption Data (USEPA, 2000). Emission factors for NO_X, CO, and VOC were based on emissions test data at various engine loads. The PM_{10} emission factor is dependent on the engine load factor, which is a ratio of actual output to the rated output for the engine, based on the following equation:

$$\text{Emissions Rate (g/kW-hr)} = a * (\text{Fractional Load})^{-x} + b.$$

The variables a, x, and b are experimentally derived based on testing of various engine sizes, output ranges, and types of engines. For SO_2, the emission factor equation is derived from the fuel consumption rate and sulfur content of the diesel fuel using the following equation:

$$\text{Emissions Rate (g/kW-hr)} = a * (\text{Fuel Sulfur Flow in g/kW-hr}) + b.$$

The variables a and b are experimentally derived. To calculate the fuel sulfur flow, fuel consumption for the engines was estimated using the following experimentally derived equation:

$$\text{Fuel Consumption (g/kW-hr)} = 14.12 / (\text{Fractional Load}) + 205.717.$$

The fuel sulfur flow was then calculated by multiplying a typical sulfur content of 3.5% by the fuel consumption rate. The emission factor was then multiplied by the kW rating of the main engine and the number of hours of usage to obtain the emissions generated. The annual emissions are based on an assumed six hours

per ship for transit and docking operations and 200 LNG ships per year, for a total of 1,200 hours per year. These emissions are summarized in Table 10 by activity in terms of grams per call.

On-board Electric Generator Emissions

Emissions generated from on-board electric generators are a result of on-board electrical power generation that is used to provide electrical power to the ship for on-board power needs, both while in transit and while at the terminal. Emissions from on-board electric generators were estimated using a combination of experimental data for NO_X, CO, and VOC emissions at several power loads (100%, 75%, 50%, 25%, and 10%) for the on-board electric generators and emission factor equations for SO_2 and PM_{10}. The power loads depended on the different operational modes of the engines: transit, docking, operating of electrical discharge pumps, and hotelling. Emission factors for SO_2 and PM_{10} were estimated using the equations found on page 5-3, Table 5-1 in Analysis of Commercial Marine Vessel Emissions and Fuel Consumption Data (USEPA, 2000), and were calculated as described for transit and maneuvering emissions. These emissions are summarized in Table 10 by activity in terms of grams per call.

Tug Emissions

Typically, a total of three tugs would assist the ship while it navigates the SNWW (both into and out of the channel) and during docking and undocking operations. Typical operation of the tugs assumes that one tug would accompany the LNG ship as it first enters the channel. A second tug would begin to assist the ship as it approaches the halfway point (between the SNWW jetties and the GPLNG Terminal slip). A third tug would rendezvous with the ship and other two tugs as the ship enters the slip. All three tugs would assist the ship as it maneuvers into the slip. When the LNG ship leaves the slip, three tugs would assist the ship as it maneuvers out of the dock. Two tugs would assist the LNG ship as it maneuvers out of the channel, and one tug would assist the LNG ship as it leaves the SNWW. These emissions are summarized in Table 11.

Engine emissions are estimated using generalized emission factors for NO_X, CO, VOC, SO_2, and PM_{10} as presented on page 5-3, Table 5-1 in Analysis of Commercial Marine Vessel Emissions and Fuel Consumption Data (USEPA, 2000). The emission factors (except for SO_2) are dependent on the engine load factor, which is a ratio of actual output to the rated output for the engine, based on the equation of the form:

$$E\ (g/kW\text{-}hr) = a * (\text{Fractional Load})^{-x} + b.$$

The variables a, x, and b are experimentally derived based on testing of various engine sizes, output ranges, and types of engines. For SO_2, the emission factor

equation is derived from the fuel consumption rate and sulfur content of the fuel using the equation:

$$\text{Emissions Rate (g/kW-hr)} = a * (\text{Fuel Sulfur Flow in g/kW-hr}) + b.$$

The variables a and b are experimentally derived. To calculate the fuel sulfur flow, fuel consumption for the engines was estimated using the following experimentally derived equation:

$$\text{Fuel Consumption (g/kW-hr)} = 14.12 / (\text{Fractional Load}) + 205.717.$$

The fuel sulfur flow was then calculated by multiplying a typical sulfur content of 1.5% by the fuel consumption rate.

Table 1
GPLNG and GPPL Project Emissions By Year

		2005		2006		2007		2008		2009		2010		2011	
Activity	Source	NO_x	VOC	NO_x	VOC	NO_x	VOC	NO_x	VOC	NO_x	VOC	NO_x	VOC	NO_x	VOC
Terminal Construction	(Non-Road)	41.80	13.02	140.46	46.53	162.78	50.50	103.45	29.76	50.86	14.75	10.76	3.07	0.00	0.00
	(Mobile)	3.10	1.59	17.34	2.90	24.02	8.27	17.07	8.72	6.28	3.23	0.40	0.20	0.00	0.00
Marine Construction	(Non-Road)	0.00	0.00	18.07	2.06	40.00	4.16	19.62	2.01	0.00	0.00	0.00	0.00	0.00	0.00
	(Mobile)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Dredging Construction	(Non-Road)	0.00	0.00	319.28	16.61	216.24	11.28	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(Mobile)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pipeline Construction	(Non-Road)	0.00	0.00	40.18	2.23	274.85	15.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	(Mobile)	0.00	0.00	1.99	1.08	8.21	3.42	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Construction Subtotal		*44.90*	*14.61*	*537.32*	*71.41*	*726.10*	*93.57*	*140.14*	*40.49*	*57.14*	*17.98*	*11.16*	*3.27*	*0.00*	*0.00*
Terminal Operations	(Stationary)	0.00	0.00	0.00	0.00	0.00	0.00	11.85	8.31	29.62	20.78	47.39	33.24	47.39	33.24
	(Non-Road)	0.00	0.00	0.00	0.00	0.00	0.00	189.65	12.62	474.12	31.56	758.59	50.49	758.59	50.49
	(Mobile)	0.00	0.00	0.00	0.00	0.00	0.00	0.44	0.57	0.81	1.07	0.74	0.98	0.68	0.90
Operations Subtotal		*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*201.94*	*21.50*	*504.55*	*53.40*	*806.72*	*84.71*	*806.66*	*84.63*
Emission Totals		**44.90**	**14.61**	**537.32**	**71.41**	**726.10**	**93.57**	**342.08**	**61.99**	**561.69**	**71.38**	**817.88**	**87.98**	**806.66**	**84.63**

w/o Dredging 218.04 54.8 509.86 82.27

Table 2 2005 Construction Emissions From Nonroad Sources					
	Emissions (tpy)				
Equipment Type	NO_x	VOC	CO	SO_2	PM_{10}
Terminal Construction Equipment	41.80	13.02	7.54	2.96	2.55
Marine Construction Equipment	0.00	0.00	0.00	0.00	0.00
Dredge Construction Equipment	0.00	0.00	0.00	0.00	0.00
Pipeline Construction Equipment	0.00	0.00	0.00	0.00	0.00
Total Emissions	41.80	13.02	7.54	2.96	2.55

NOTES:

These preliminary emission tables are provided to support general conformity determination associated with federal actions (i.e., permits, licenses, etc.) required to construct and operate the Golden Pass LNG Terminal and Golden Pass Pipeline.

Table 3 2006 Construction Emissions From Nonroad Sources					
	Emissions (tpy)				
Equipment Type	NO_x	VOC	CO	SO_2	PM_{10}
Terminal Construction Equipment	140.46	46.53	25.06	9.68	8.34
Marine Construction Equipment	18.07	2.06	30.70	5.48	1.14
Dredge Construction Equipment	319.28	16.61	66.47	53.30	15.67
Pipeline Construction Equipment	40.18	2.23	11.01	7.19	2.59
Total Emissions	517.99	67.42	133.23	75.64	27.73

NOTES:

These preliminary emission tables are provided to support general conformity determination associated with federal actions (i.e., permits, licenses, etc.) required to construct and operate the Golden Pass LNG Terminal and Golden Pass Pipeline.

Table 4 2007 Construction Emissions From Nonroad Sources					
Equipment Type	Emissions (tpy)				
	NO_x	VOC	CO	SO_2	PM_{10}
Terminal Construction Equipment	162.78	50.50	28.72	10.31	8.76
Marine Construction Equipment	40.00	4.16	61.71	13.60	2.36
Dredge Construction Equipment	216.24	11.28	45.07	36.16	10.68
Pipeline Construction Equipment	274.85	15.94	73.80	49.19	17.95
Total Emissions	693.87	81.88	209.30	109.27	39.76

NOTES:

These preliminary emission tables are provided to support general conformity determination associated with federal actions (i.e., permits, licenses, etc.) required to construct and operate the Golden Pass LNG Terminal and Golden Pass Pipeline.

Table 5 2008 Construction Emissions From Nonroad Sources					
	Emissions (tpy)				
Equipment Type	NO_x	VOC	CO	SO_2	PM_{10}
Terminal Construction Equipment	103.45	29.76	18.53	6.94	6.08
Marine Construction Equipment	19.62	2.01	30.72	7.23	1.13
Dredge Construction Equipment	0.00	0.00	0.00	0.00	0.00
Pipeline Construction Equipment	0.00	0.00	0.00	0.00	0.00
Total Emissions	123.07	31.77	49.26	14.17	7.21

NOTES:

These preliminary emission tables are provided to support general conformity determination associated with federal actions (i.e., permits, licenses, etc.) required to construct and operate the Golden Pass LNG Terminal and Golden Pass Pipeline.

Table 6 2009 Construction Emissions From Nonroad Sources					
Equipment Type	Emissions (tpy)				
	NO_x	VOC	CO	SO_2	PM_{10}
Terminal Construction Equipment	50.86	14.75	9.12	3.47	3.06
Marine Construction Equipment	0	0	0	0	0
Dredge Construction Equipment	0	0	0	0	0
Pipeline Construction Equipment	0	0	0	0	0
Total Emissions	50.86	14.75	9.12	3.47	3.06

NOTES:

These preliminary emission tables are provided to support general conformity determination associated with federal actions (i.e., permits, licenses, etc.) required to construct and operate the Golden Pass LNG Terminal and Golden Pass Pipeline.

Table 7 2010 Construction Emissions From Nonroad Sources					
	Emissions (tpy)				
Equipment Type	NO_x	VOC	CO	SO_2	PM_{10}
Terminal Construction Equipment	10.76	3.07	1.94	0.76	0.67
Marine Construction Equipment	0	0	0	0	0
Dredge Construction Equipment	0	0	0	0	0
Pipeline Construction Equipment	0	0	0	0	0
Total Emissions	10.76	3.07	1.94	0.76	0.67

NOTES:

These preliminary emission tables are provided to support general conformity determination associated with federal actions (i.e., permits, licenses, etc.) required to construct and operate the Golden Pass LNG Terminal and Golden Pass Pipeline.

TABLE 8

EMISSION FROM DAILY COMMUTE AND DELIVERY VEHICLES

Fleet Year	Daily Vehicles[1] (/day)	Annual Emissions (tpy)				
		NO_X	VOC	CO	SO_2	PM_{10}
2005 Terminal Construction	120	3.10	1.59	19.19	0.09	0.07
2006 Terminal Construction	222	17.34	2.90	30.47	0.55	0.32
2006 Pipeline Construction[2]	424	1.99	1.08	12.07	0.05	0.05
2007 Terminal Construction	619	24.02	8.27	90.28	0.10	0.52
2007 Pipeline Construction[2]	429	8.21	3.42	37.62	0.04	0.19
2008 Terminal Construction	687	17.07	8.72	97.12	0.10	0.44
2008 Operations	60	0.44	0.57	6.53	0.01	0.02
2009 Terminal Construction	275	6.28	3.23	36.14	0.04	0.17
2009 Operations	60	0.81	1.07	12.22	0.01	0.04
2010 Terminal Construction	56	0.40	0.20	2.26	0.00	0.01
2010 Operations	60	0.74	0.98	11.42	0.01	0.04
2011 Operations	60	0.68	0.90	10.73	0.01	0.04

NOTES:

1. Daily vehicle estimates taken from Golden Pass LNG Environmental Resource Report 5, Section 5.3.6 and associated background documentation. Daily vehicles assume an average occupancy rate of 1.3 persons per vehicle. Fractional number of vehicles rounded up to the nearest whole number.

These preliminary emission tables are provided to support general conformity determination associated with federal actions (i.e., permits, licenses, etc.) required to construct and operate theGolden Pass LNG Terminal and Golden Pass Pipeline.

Table 9
Stationary Source Emissions
Golden Pass LNG, Sabine Pass, Jefferson County, Texas

Source Name	NO_x Emission Rate		CO Emission Rate		VOC Emission Rate		PM_{10} Emission Rate		SO_2 Emission Rate	
	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr	lb/hr	ton/yr
Emergency Generator[1]	75.06	3.75	19.94	1.00	1.92	0.10	2.35	0.12	7.11	0.36
Diesel Firewater Engine[2]	37.04	1.85	7.98	0.40	3.02	0.15	2.60	0.13	2.44	0.12
HTF Heaters[3]	12.72	41.78	6.36	20.89	9.80	32.19	13.54	44.48	0.29	0.96
TANKS[4]					0.25	0.01				
FUGITIVES[5]					0.18	0.80				
Total	**124.83**	**47.39**	**34.28**	**22.29**	**15.18**	**33.24**	**18.49**	**44.72**	**9.83**	**1.43**

NOTES:

1. The emergency generator is a 2500 kW unit. Emission factors are based on combustion of 0.3% sulfur diesel and emission factors from AP-42, Chapter 3.4, Table 3.4-1 .
2. There are two diesel firewater engines, each rated at approximately 600 hp. Emission factors are based on AP-42 Chapter 3.3, Table 3.3-1.
3. The HTF heaters are boilers with an operating duty of 227 MMBtu/hr. Short term emissions are based on the operation of all 8 boilers. Annual emissions are based on the full-time operation (8760 hrs) of 6 boilers. Emission factors are from AP-42 Chapter 1.4 for VOC and PM10, calculated using the AP-42 natural gas heating value. The SO_2 emission factor is based on the concentration of reduced sulfur of approximately 1 ppmv in the LNG. The NO_X emission factor is approximately equivalent to 6 ppmv using SCR to reduce NOX emissions. CO emissions would be controlled using a CO catalyst in the SCR.
4. Emissions from the tanks were calculated using EPA TANKS 4.09b and assumed that the material stored would be Number 2 Diesel. The tanks have design capacities of 33,600 gallons (26,800 working volume) for the primary storage tank, 3,800-gallon day tank associated with the emergency generator, and two 500-gallon tanks for use with the firewater engines.
5. Fugitive emissions were estimated based on the components in LNG service at GPLNG. LNG and NG streams use SOCMI without ethylene emission factors from the TNRCC October 2000 Draft Air Permit Technical Guidance for Chemical Sources: Equipment Leak Fugitives, p. 49. TNRCC (TCEQ) Guidance is based on EPA-453/R-95-017, November 1995. Diesel Stream Emission Factors from page 2-15 of EPA-453/R-95-017.

These preliminary emission tables are provided to support general conformity determination associated with federal actions (i.e., permits, licenses, etc.) required to construct and operate the Golden Pass LNG Terminal and Golden Pass Pipeline.

Table 10 LNG SHIP EMISSIONS					
Mode	NO_X Mass Emitted (g)	CO Mass Emitted (g)	PM_{10} Emitted (g)	VOC Mass Emitted (g)	SO_2 Mass Emitted (g)
Onboard Electrical Generators[4]					
Transit to Terminal and Maneuvering[1]	381648.94	21237.28	8653.41	43993.90	262945.43
Hotelling/Unloading[1,3]	1144125.68	66508.42	26718.01	127707.99	808931.09
Main Propulsion Engines[4]					
Cruise break water to terminal[2]	1215189.14	82709.84	20526.63	36778.70	1467848.25
Maneuvering[2]	294545.53	64942.88	5707.76	13641.25	411256.56
TOTAL (g/Call)	3035509.3	235398.4	61605.8	222121.8	2950981.3
TOTAL (tpy)	669.2	51.9	13.6	49.0	650.6

LNG Carrier - 200 calls per year

NOTES:

1. Onboard electrical generator fueled with 1.5% sulfur diesel.
2. Main propulsion engine fueled with 3.5% sulfur Marine Diesel/Heavy Bunker.
3. SO_2 emission factor is based on generalized fuel consumption calculation from *Analysis of Commercial Marine Vessel Emissions and Fuel Consumption Data* (USEPA, February 2000).
4. Emissions factors provided by design documents for a 185,000-m^3 diesel-powered engine for NO_X, VOC, *Commercial Marine Vessel Emissions and Fuel Consumption Data*, USEPA, February 2000, EPA420-R-00-002, page 5-3.

These preliminary emission tables are provided to support general conformity determination associated with federal actions (i.e., permits, licenses, etc.) required to construct and operate the Golden Pass LNG Terminal and Golden Pass Pipelir

Table 11 Tug Assist Emissions						
		NO_X	CO	PM_{10}	VOC	SO_2
Mode	No. Tugs	Mass Emitted (g)[1]	Mass Emitted (g)[1]	Mass Emitted (g)[1]	Mass Emitted (g)[1]	Mass Emitted (g)[1]
Initital Tug Escort	1	110404.04	8746.63	2724.84	696.35	81711.24
Tug Assist - Midpoint Channel	2	220808.09	17493.26	5449.68	1392.70	163422.47
Maneuvering / Docking	3	74245.52	26239.90	2011.14	4671.24	61622.58
	TOTAL (g/Call)	405457.65	52479.79	10185.66	6760.29	306756.29
	TOTAL (g/yr)	81091529.87	10495958.40	2037132.99	1352057.68	61351257.11
	TOTAL (lb/yr)	178777.16	23139.75	4491.13	2980.79	135257.08
	TOTAL (tpy)	89.39	11.57	2.25	1.49	67.63

NOTES:

1. Emission factors for NO_X, VOC, CO, SO_2, and PM were obtained from Analysis of Commercial Marine Vessel Emissions and Fuel Consumption Data, USEPA, February 2000, EPA420-R-00-002, page 5-3.
2. Phase I begins operations and ships begin arriving at the GPLNG Terminal July 2008.
3. Phase II operations begin in October 2009 (early completion of construction phase).
4. Miles are reported in nautical miles.
5. Speed is reported in knots.

These preliminary emission tables are provided to support general conformity determination associated with federal actions (i.e., permits, licenses, etc.) required to construct and operate the Golden Pass LNG Terminal and Golden Pass Pipeline.