EL PASO ENERGY

March 29, 2001

Attn: Jarrett Mack
Broward County Dept. of Planning and Environmental Protection
218 SW 2nd Ave.
Fort Lauderdale, FL 33301



Re: El Paso Merchant Energy Company
Broward Energy Center
Pollution Prevention Plan

Dear. Ms. Mack:

El Paso Merchant Energy Company is planning to construct, own, and operate a new electric power generating plant in Broward County, Florida. Four copies of the Pollution Prevention Plan required by Broward County Article IV, Chapter 27-178 are enclosed with this letter for your review. An Application for Air Permit – Title V Source was submitted to the New Source Review Section of the state Division of Air Resources Management office on March 27, 2001. A copy of the application was submitted to the Broward County Department of Planning and Environmental Protection (DPEP) on the same day. Please contact Krish Ravishankar at 713/877-7023 if there are any questions. Thank you for your attention to this matter.

Sincerely,

Jennifer Mollhagen

Jennifer Mollhagen
Senior Environmental Engineer

cc: Krish Ravishankar, El Paso Merchant Energy Company

A. A. Linero, P.E., Administrator
New Source Review Section
Division of Air Resources Management
Florida Dept. of Environmental Protection

Enclosures

# POLLUTION PREVENTION PLAN
# BROWARD ENERGY CENTER
# BROWARD COUNTY, FLORIDA

**Prepared for:**

elpaso

**Houston, Texas**

**Prepared by:**

ECT

*Environmental Consulting & Technology, Inc.*

*3701 Northwest 98th Street*
*Gainesville, Florida 32606*

**ECT No. 000965-0400**

**March 2001**

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# 1.0 INTRODUCTION

The proposed Broward Energy Center (BEC) project is a combined-cycle (CC) and simple-cycle (SC) power plant to be located in Deerfield Beach near northern Broward County, Florida. Major components of the BEC include:

- One CC unit comprised of one General Electric (GE) 7FA combustion turbine generator (CTG), one unfired heat recovery steam generator (HRSG), and one steam turbine generator (STG). This CC configuration is commonly referred to as a "1 by 1 by 1" configuration with the values referring to the number of CTGs, HRSGs, and STGs, respectively.
- Three GE 7FA CTGs operating in SC mode.
- One 5-cell mechanical draft, fresh water cooling tower.
- One 2,600-horsepower (hp) emergency diesel-fired electrical generator.
- One 250-hp emergency diesel-fired fire water pump.
- Ancillary equipment, including raw and demineralized water storage tanks.

The proposed BEC is a source that results in a potential to emit in excess of major source criteria. Pollution control is addressed in Chapter 127 of the Broward County Code of Regulations. Article 4 addresses air pollution. Section 27-178 requires that affected sources develop a Pollution Prevention Plan (P2). This document has been prepared to meet that requirement.

The P2 Plan is a systematic accounting of all waste streams and a subsequent analysis of potential waste minimization methods. The objective of the plan is to reduce pollutant emissions through appropriate technology selection, source reduction and recycling (with preference given to source reduction), and improved operating practices. Airborne pollutants and their associated emissions reductions are identified explicitly; pollution prevention in other media are covered as well.

Chapter 2 of this P2 plan includes name, address, and telephone numbers of the contact person responsible for the P2 plan, the owner, the operator, and the responsible official at the source. Chapter 3 provides a systematic analysis of the proposed plant's waste streams and identifies technology, procedures, and options considered available and technically feasible for reducing the use of each hazardous air pollutant (HAP) and air pollutant at the plant. Chapter 3 also provides strategies which will be implemented upon startup and operation of the plant.

## 2.0 MANAGEMENT INITIATIVES

El Paso Merchant Energy Company will demonstrate its commitment to emissions reductions through the P2 Plan by designating an onsite person who performs policy or decision-making functions for the corporation, and who is authorized to make management decisions which govern the operation of the regulated facility, including having the capability of making capital investment recommendations, and initiating and directing other measures to assure long term environmental compliance with environmental laws and regulations. Until plant staff have been hired, the corporate contact for pollution prevention planning shall be as follows.

| | |
|---|---|
| **Source owner/operator**: | El Paso Merchant Energy Company |
| **Corporate contact name**: | Krish Ravishankar |
| **Corporate contact address**: | El Paso Merchant Energy Company<br>Nine Greenway Plaza<br>Houston, TX 77046 |
| **Telephone**: | (713) 877-7023 |

It is anticipated that the P2 plan will be modified during startup and operation of the plant. A revised P2 plan will be kept onsite and will be made available for inspection.

# 3.0 WASTE ASSESSMENT

BEC operations which produce waste can be reduced to the following: (1) operation of the generators; (2) operation of the HRSG/STG, (3) operation of the cooling tower; and (4) maintenance of plant equipment. Much of the waste assessment activities for the first three processes have been conducted during Best Achievable Control Technology (BACT) analysis, as required by the FDEP air permit application. Information obtained from the BACT analysis will be summarized in the waste analysis for these three processes.

## 3.1 OPERATION OF GENERATORS

The BEC will consist of CC unit comprised of a CTG, an unfired HRSG, and one STG, and three CTGs operating in SC mode. All of the CTGs are fired by natural gas.

### 3.1.1 IDENTIFICATION OF WASTE(S)

Raw material inputs for the CTGs are natural gas and air. Products of the combustion cycle include carbon monoxide (CO), nitrogen oxides ($NO_x$), sulfur dioxide ($SO_2$)/sulfuric acid ($H_2SO_4$), particulate matter (PM)/particulate matter less than or equal to 10 micrometers ($PM_{10}$), volatile organic compounds (VOCs), hazardous air pollutants (HAPs), and thermal and electric energy.

### 3.1.2 MAJOR MATERIAL LOSSES AND CAUSES

Estimated pollutant emissions are given in Table 1. Besides energy losses, relevant losses for operation of generators are uncombusted fuel and byproduct pollutants. CO is the result of incomplete combustion of fuel. An increase in combustion zone residence time and improved mixing of fuel and combustion air will increase oxidation rates and cause a decrease in CO emission rates. Emissions of $NO_x$ and CO are, however, inversely related; i.e., decreasing CO emissions will increase $NO_x$ emissions. Due to the high combustion efficiencies of CTGs, approximately 99 percent, CO emissions are inherently low.

Table 1. Maximum Annualized Emission Rates (tpy)

| Pollutant | CTGs | Emergency Diesel Engines | Cooling Tower | BEC Totals |
|---|---|---|---|---|
| $NO_x$ | 529.9 | 4.4 | N/A | 534.3 |
| CO | 419.0 | 1.0 | N/A | 420.0 |
| PM | 224.9 | 0.2 | 1.6 | 226.7 |
| $PM_{10}$ | 224.9 | 0.1 | 1.0 | 226.0 |
| $SO_2$ | 86.7 | 0.1 | N/A | 86.8 |
| VOCs | 35.6 | 0.2 | N/A | 35.8 |
| Lead | 0.3 | <0.001 | N/A | 0.3 |
| Mercury | 0.000017 | <0.00001 | N/A | 0.000017 |
| $H_2SO_4$ mist | 12.6 | <0.001 | N/A | 12.6 |
| 1,3-Butadiene | 0.0013 | <0.00001 | N/A | 0.0013 |
| Acetaldehyde | 0.9357 | <0.00001 | N/A | 0.9357 |
| Acrolein | 0.1216 | <0.00001 | N/A | 0.1216 |
| Benzene | 0.3973 | <0.00001 | N/A | 0.3973 |
| Ethylbenzene | 0.4950 | <0.00001 | N/A | 0.4950 |
| Formaldehyde | 2.4750 | <0.00001 | N/A | 2.4750 |
| Naphthalene | 0.0137 | <0.00001 | N/A | 0.0137 |
| Polycyclic Aromatic Hydrocarbons | 0.0102 | <0.00001 | N/A | 0.0102 |
| Propylene Oxide | 0.6209 | <0.00001 | N/A | 0.6209 |
| Toluene | 1.4763 | <0.00001 | N/A | 1.4763 |
| Xylene | 1.4134 | <0.00001 | N/A | 1.4134 |

Note: N/A = not applicable.

Sources: EPMEC, 2001.
ECT, 2001.
General Electric, 2001.

$NO_x$ emissions from combustion sources consist of two components: oxidation of atmospheric nitrogen contained in the inlet combustion air (thermal $NO_x$ and prompt $NO_x$), and conversion of chemically fuel bound nitrogen. Typically, natural gas contains a negligible amount of fuel based nitrogen; therefore, this discussion treats thermal and (to a lesser extent) prompt $NO_x$. Thermal $NO_x$ results from the oxidation of atmospheric nitrogen under high temperature combustion conditions. Thermal $NO_x$ increases with temperature and residence time (which, as observed in the previous paragraph, is the reverse for CO). Prompt $NO_x$ is formed near the flame front from the oxidation of combustion intermediates containing nitrogen (e.g., hydrogen cyanide, nitrogen, and NH). Prompt $NO_x$ can be an important consideration with respect to combustors that use lean fuel mixtures.

$PM/PM_{10}$ emissions resulting from the combustion of natural gas are due to oxidation of ash and sulfur contained in the fuel. Due to its low ash and sulfur content, natural gas combustion generates inherently low $PM/PM_{10}$ emissions.

Natural gas suppliers reduce sulfur content to very low levels, when necessary, prior to distribution. $SO_2/H_2SO_4$ mist emissions are inherently low since the sulfur content of natural gas is low (more than 100 times lower than other fossil fuels such as coal).

VOC and HAP emissions result principally from incomplete combustion of the natural gas. VOC and HAP emissions are inherently low given the high combustion efficiencies of CTGs.

### 3.1.3 WASTE MANAGEMENT COSTS

Waste management costs, in the case of generator operation, relate to pollution control equipment fuel type, and electric power generating technology applied (e.g., CT, ST, CC). The BACT analysis identified pollution control equipment, where applicable, which would minimize pollutant emissions. The BACT analysis considered technical feasibility and operational costs in a manner in line with a conventional waste analysis. Pollution control equipment and associated costs are shown below.

| Pollutant | Means of Control | Capital Cost ($) | Operating Cost ($/yr) | Energy Penalty ($/yr) |
|---|---|---|---|---|
| $PM/PM_{10}$ | Exclusive use of low-sulfur and low-ash natural gas | N/A | N/A | N/A |
| | Efficient combustion (state-of-the art combustor design) | N/A | N/A | N/A |
| CO and VOC | Efficient combustion (state-of-the art combustor design) | N/A | N/A | N/A |
| $NO_x$ | Use of advanced dry low-NOx (DLN) combustor technology and conventional SCR (for CC CTG/HRSG) | 2,583,165 | 876,203 | 138,000 |
| | Use of advanced DLN combustor technology (for SC CTGs) | N/A | N/A | N/A |
| $SO_2/H_2SO_4$ mist | Exclusive use of low-sulfur natural gas | N/A | N/A | N/A |

Note: N/A =not applicable.

Sources: EPMEC, 2001.
ECT, 2001.
General Electric, 2001.

### 3.1.4 ANALYSIS OF EXISTING/POTENTIAL ADDITIONAL POLLUTION PREVENTION/WASTE MINIMIZATION STRATEGIES

The advantage of preparing a pollution prevention plan for a plant in the design stage is that technologies, processes, and raw materials can be selected with pollution prevention in mind. The disadvantage is, of course, operations to be analyzed do not yet exist. For this reason, the following subsection treats existing (proposed) waste minimization strategies based on good engineering practice applied to plant design. Additional pollution prevention opportunities, such as inventory control for equipment maintenance chemicals, are addressed in Section 3.4.

**Existing/Proposed Pollution Prevention/Waste Minimization Strategies**

Selection/design of the generators and pollution control equipment involved analysis of technical and economic feasibility as well as environmental impacts. Design engineers at this point have the advantage of choosing state-of-the-art technology. Waste minimization strategies applied to plant design are summarized below.

| Strategy | Comment |
|---|---|
| Use low-sulfur natural gas combustion turbines | Low-sulfur natural gas is the cleanest of the fossil fuels used in the fossil fuel electric power generation industry. This translates to lower airborne pollutant emissions as well as virtually no solid waste such as fly ash, bottom ash, or slag. |
| Use CC CTG/HRSG/STG as primary power source | Steam turbine thermal efficiency is approximately 35%. Gas turbines have a 20-30 percent efficiency. The combined cycle system has an efficiency of about 54 percent, and the fuel consumption is approximately 25 percent lower. |
| Use state-of-the art combustor design | The combination of clean burning fuel and highly efficient combustion turbines minimizes CO and VOC emissions. |
| Use advanced DLN combustor technology | Premixing of turbine fuel and air prior to combustion in the primary zone homogenizes the air/fuel mixture, making the peak and flame temperatures the same, which causes a relative decrease in thermal $NO_x$ emissions. |
| Use postcombustion conventional SCR (CC CTG) | Although application of SCR increases back pressure on the CTG (resulting in reduced turbine output power), the reduction in $NO_x$ emissions offsets the energy penalty. |

## 3.2 OPERATION OF HRSG/STG

The HRSG is the steam generation part of the steam cycle (in combined cycle operation). Waste heat from the CTG is captured by the HRSG as latent heat of boiler water as it is turned into steam. The heat energy from the steam is converted to electric energy at the STG.

### 3.2.1 IDENTIFICATION OF WASTE(S)

Raw material inputs for HRG/STG operation are thermal energy and makeup water. Products of the process are blowdown, demineralizer regenerant (boiler water purification), waste thermal energy, and electric energy.

### 3.2.2 MAJOR MATERIAL LOSSES AND CAUSES

Water to make steam may be recirculated and eventually builds up impurities in the HRSG. This water is periodically purged from the system. Blowdown (a portion of water removed from the HRSG to control the concentration of dissolved solids in the HRSG) is typically alkaline, is low in total dissolved solids, and contains chemical additives used to control scale and corrosion. Blowdown also contains trace amounts of copper, iron and nickel.

HRSG feed water systems may require treatment of makeup water prior to use. Ion exchange resins used in the treatment of the water accumulate cations and anions removed from the raw water. These resins are regenerated using a strong acid or a strong base. Regenerant waste contains dissolved solids, both from raw wastewater and from excess acid or base.

### 3.2.3 ANALYSIS OF EXISTING/POTENTIAL ADDITIONAL POLLUTION PREVENTION/WASTE MINIMIZATION STRATEGIES

The most significant opportunity for waste minimization is removal of solids during the demineralization process, in order to minimize blowdown. Design/selection of a state-of-the-art demineralizer system will minimize blowdown. Optimization of the frequency of boiler cleanouts and other maintenance related pollution prevention strategies are addressed in Section 3.4.

## 3.3 COOLING TOWER OPERATION

Cooling water is circulated through a condenser to condense steam left after the generation of electricity. The resulting condensate can be returned to the HRSG. Cooling water for the BEC will be recirculated through a cooling tower.

### 3.3.1 IDENTIFICATION OF WASTE(S)

Waste from cooling tower operations consists of cooling tower blowdown and PM/$PM_{10}$ from cooling tower drift. Evaporative losses, though principally a function of the environment, play an integral part in cooling tower blowdown rate and, so, is mentioned here.

$PM/PM_{10}$ emissions will also occur due to cooling tower operations. Because of direct contact between the cooling water and ambient air, a small portion of the recirculating cooling water is entrained in the air stream and discharged from the cooling tower as drift droplets. These water droplets contain the same concentration of dissolved solids as found in the recirculating cooling water. Large water droplets quickly settle out of the cooling tower exhaust stream and deposit near the tower. The remaining smaller water droplets may evaporate prior to being deposited in the area surrounding the cooling tower. These evaporated droplets represent potential $PM/PM_{10}$ emissions because of the fine $PM/PM_{10}$ formed by crystallization of the dissolved solids contained in the droplet. The only feasible technology for controlling $PM/PM_{10}$ from cooling towers is the use of drift eliminators.

### 3.3.2 ANALYSIS OF EXISTING/POTENTIAL ADDITIONAL POLLUTION PREVENTION/WASTE MINIMIZATION STRATEGIES

Selection/design of the cooling towers and associated treatment systems involved analysis of technical and economic feasibility as well as environmental impacts. Design engineers at this point have the advantage of choosing state-of-the-art technology. Waste minimization strategies applied to plant design are summarized below.

| Strategy | Comment |
|---|---|
| Use high efficiency drift eliminators | The 5-cell mechanical draft, fresh water cooling tower will be equipped with drift eliminators, achieving a drift loss rate of no more 0.0005 percent of circulating water flow rate. |
| Use publicly owned treatment works (POTW) reuse water | The project will use treated effluent from the North Regional Wastewater Treatment Plant. Blowdown is also returned to the POTW. |
| Recirculate cooling water | Recirculation instead of once-through cooling is a recognized pollution prevention strategy. |

## 3.4 MAINTENANCE OF PLANT EQUIPMENT

This aspect of pollution prevention is more activity-oriented than design/technology oriented; therefore, implementation of pollution prevention/waste minimization techniques discussed in this section is future-oriented as well. Nevertheless, the strategies discussed in this section are based on industry practices and accepted pollution prevention techniques such that a practical framework for future P2 efforts.

### 3.4.1 IDENTIFICATION OF WASTE(S)

Fossil fuel electric power generation facilities, like many industrial facilities, use solvents and other chemicals for everyday operations. Everyday operations include parts washing, lubricating, general cleaning, and degreasing application during plant and equipment maintenance activities. Often, chemical wastes generated by these operations are made up of out-of-date, necessary, off-specification, and spilled or damaged chemical products. Actual costs for materials used include not only the cost of the original product, but also the costs of disposal. Inventory management and preventive maintenance are ways these facilities can decrease the amounts of chemical wastes generated in a cost-effective manner.

There are two categories of inventory management, including inventory control and material control. Inventory control includes techniques to reduce inventory size, reduce toxic and/or hazardous chemical use, and increase current inventory turnover. Material control includes the proper storage and safer transfer of materials. Proper material control will ensure that materials are used efficiently to reduce waste and preserve the ability to recycle the wastes.

Corrective and preventive maintenance can reduce waste generation. A well-run preventive maintenance program will serve to identify the potential for releases and correct problems before material is lost and/or considered a waste. New or updated equipment can use process materials more efficiently, producing less waste.

## 3.4.2 ANALYSIS OF EXISTING/POTENTIAL ADDITIONAL POLLUTION PREVENTION/WASTE MINIMIZATION STRATEGIES

Following are potential pollution prevention/waste management strategies for plant maintenance.

**Pollution Prevention Opportunities for Facility Maintenance Wastes**

| Strategy | Comment |
|---|---|
| Use high quality fluids | While costing more initially, high quality fluids may last twice as long in service. |
| Routinely monitor fluid condition | Waste fluid generation can be reduced by switching to a replacement schedule based on fluid condition. Low-cost testing services can provide detailed information. |
| Eliminate use of hazardous materials | Substitution of hazardous materials with non-hazardous materials reduces waste disposal costs. |
| Solvent substitutions | Petroleum distillate and D-limonene blends are effective cleaners for electrical equipment. Detergents are good for general purpose cleaning but must be kept out of yard drains and oil/water separators. |
| Use high transfer efficiency painting equipment | Brushes, rollers, and hand mitts are very efficient but labor-intensive. Airless spray is common for field use since a source of clean, dry air is not required. |
| Inventory Control | Purchase only the quantity of material needed for the job or a set period of time<br><br>Evaluate set expiration date on materials, especially for stable compounds, to determine if they could be extended. Search the inventory at other company sites for available stock before ordering additional material.<br><br>Purchase material in the proper quantity and the proper container size. If large quantities are needed, purchase in bulk. If the material has a short shelf-life or small quantities are needed, purchase in small containers.<br><br>If surplus inventories exist, use excess material before new material are ordered. Contact supplier to determine if surplus materials can be returned. If not, identify other potential users or markets. |

**EL PASO ENERGY**

March 26, 2001



Mr. A. A. Linero, P.E.
Administrator, New Source Review Section
Division of Air Resources Management
Florida Department of Environmental Protection
2600 Blair Stone Road, MS # 5505
Tallahassee, Florida 32399-2400

**Re: El Paso Merchant Energy Company**
**Broward Energy Center**
**Air Construction Permit Application**
0112545-001-AC PSD-FL-316

Dear Mr. Linero:

El Paso Merchant Energy Company (EPMEC) is planning to construct, own, and operate a new electric power generating plant in Broward County, Florida. The new power plant, designated as the Broward Energy Center (BEC), will be a combustion turbine generator (CTG) facility comprised of one combined cycle (CC) CTG with a nominal generating capacity of 250 megawatts (MW) and three simple cycle (SC) CTGs, each with a nominal generating capacity of 175 MW. The CC unit will consist of one nominal 175 MW CTG, one unfired heat recovery steam generator, and one steam turbine generator constrained to generate less than 75 MW. Total BEC generating capacity will be a nominal 775 MW. The BEC CTGs will be fired exclusively with natural gas. BEC will be located in Broward County east of the Florida Turnpike and approximately 2.4 km (1.5 miles) northwest of the intersection of State Road (SR) 845 (Power Line Road) and SR 834 (Sample Road).

Seven copies of an Application for Air Permit – Title V Source, together with a check in the amount of $7,500 as payment of the required permit processing fee, are enclosed for your review. Three of the applications include a CD-ROM containing the dispersion modeling files. Also enclosed is a copy of the Pollution Prevention Plan required by Broward County Article IV, Chapter 27-178. Your expeditious processing of the EPMEC air permit application will be appreciated. Please contact me at 713/877-7023 if there are any questions.

Sincerely,

**EL PASO MERCHANT ENERGY COMPANY**

K. Ravishankar

Krish Ravishankar
Environmental Manager

cc: Ms. Daniela Banu, Director
Broward County DPEP
C. Holladay
G. Goldman, SED
EPA
NPS

Enclosures